Emerging Innovative Research in Science and Technology

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Editors

Dr. K. Elangovan & Dr. T. Sivaraman

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EMERGING INNOVATIVE RESEARCH IN SCIENCE AND TECHNOLOGY

Editors

Dr. K. Elangovan
Principal

Dr. T. Sivaraman
Dean – Research

Dhanalakshmi Srinivasan Engineering College
Perambalur – 621212, Tamil Nadu, India

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About the Editors

Dr. K. Elangovan
Principal
Dhanalakshmi Srinivasan Engineering College
Perambalur - 621212, Tamil Nadu, India

Dr. K. Elangovan is currently serving as the Principal of Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. He completed his higher studies and Research at esteemed institutions like the Government College of Engineering, Salem, and the National Institute of Technology, Tiruchirappalli. He has an impressive teaching background with over 23 years of experience in the field of Engineering and technology, and the extensive tenure undoubtedly grants him valuable knowledge and expertise in educating and shaping the minds of aspiring engineers and technologists. His research expertise primarily lies in the domains of manufacturing and metal forming, with a specific focus on sheet metal forming. The comprehensive analyses and findings from his research work have contributed to a deeper understanding of this problem and potential solutions. He has a remarkable research record, having published 11 articles in international journals. Additionally, he has authored three technical books, contributing to the dissemination of knowledge in the fields of Engineering and Technology. These publications reflect his dedication to advancing the academic and professional communities through scholarly contributions.

Dr. T. Sivaraman
Dean – Research
Dhanalakshmi Srinivasan Engineering College
Dhanalakshmi Srinivasan Group of Institutions
Perambalur – 621212, Tamil Nadu, India.

Dr. T. Sivaraman is right now working as a Dean – Research at Dhanalakshmi Srinivasan Engineering College, Dhanalakshmi Srinivasan Group of Institutions, Perambalur - 621212, Tamil Nadu, India. He received his Ph.D. in Chemistry from National Tsing Hua University, Taiwan, in 1999. As of now, he has more than 27 years of research experience in the areas of Toxinology, Cancer Biology, Computational Biology and Drug Design. As of July 2023, he has published > 100 research articles in reputed international journals (with a cumulative impact factor of > 212; > 1400 citations; h-index: 20; i10-index: 37), 5 books, and delivered more than 100 presentations at various scientific events to his credit to date. He has guided >80 research projects for students in the Science and Engineering Streams at all three higher educational levels. He has successfully completed a few research projects sponsored by funding agencies such as DBT, ICMR, and CSIR, New Delhi, India. He is on the Editorial Board and Reviewer of several reputed journals and is also a member of many International and National societies and organisations.

FOREWORD

Shri. A. Srinivasan

Chancellor

Dhanalakshmi Srinivasan University

I am delighted to introduce the book "Emerging Innovative Research in Science and Technology". This book is a compilation of the latest research being conducted by the faculty members of **Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu.** This book serves as a testament to our commitment to fostering intellectual growth, academic excellence, and interdisciplinary collaboration within our institution.

The book consists of 39 chapters, and these chapters present theories, methodologies, and applications that impact industry revolutionization, global challenges, technology development, novel therapeutics, and financial management. In this regard, in today's rapidly advancing world, where breakthroughs and innovations shape the course of our society, it is imperative that the research activities of the Dhanalakshmi Srinivasan Engineering College (Autonomous) stay at the forefront of emerging research.

My best wishes to the Editors, Associate Editors, Technical Editors, Publishers, and Authors, whose research and insights have enriched this volume. To the readers, I encourage you to immerse yourself in the chapters of this book and embrace the spirit of discovery. As you delve into the depths of emerging research in science and technology, I hope you are inspired by the remarkable achievements and the immense potential that lie within these fields.

I am confident that this book will be a valuable resource for students, researchers, and anyone who is interested in science and technology. I am also confident that this book will serve as a catalyst for further research, collaboration, and innovation. I once again extend my heartfelt appreciation to the editors for their unwavering dedication and commitment to bringing together this comprehensive collection. I wish you all an inspiring journey through the pages of "Emerging Innovative Research in Science and Technology".

PREFACE

The world is changing at an unprecedented pace, and science and technology are at the forefront of this change. New scientific discoveries and innovative products are being made all the time. The advances cause profound impact on our lives in one way or another. **While science and technology are essential in making our lives easier, more comfortable, and more productive, they are not without their risks.** Thus, the use of science and technology with meaningful responsibility is the creation of a better future for all of us.

In this background, the book titled **"Emerging Innovative Research in Science and Technology"** provides remarkable advancements being made recently in streams of Science, Engineering, Technology, and Business Management. Most of the chapters of the book, if not all, describe the research activities carried out by the faculty members of Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. The book consists of 39 chapters, and the chapters are classified into four broader domains for the sake of clarity for the readers: Biological Sciences, Circuit Engineering, Non-circuit Engineering, and Management Studies. Of the 39 chapters, 36 shed light on the innovative engineering and technology practices that underpin advancements in various fields such as agricultural, biological, and pharmaceutical sciences and mechanical, electrical, civil, communication, and computer engineering. Three of the book chapters provide critical insights into effective strategies for organizational success from a management standpoint. **Together, the book provides a comprehensive overview of some of the most exciting and promising research being conducted at Dhanalakshmi Srinivasan Engineering College (DSEC), Perambalur, Tamil Nadu.** The book is for anyone who is interested in science and technology and wants to learn about the future of the world.

Taking this opportunity, the Editors express heartfelt gratitude to **Honourable Ayya A. Srinivasan, Chancellor, Dhanalakshmi Srinivasan University (DSU),** for constructive suggestions and blessings, which powered us to achieve the adventure in a successful manner. The Editors extend their gratitude to the Vice-chairman, Secretary, and all dignitaries of the Dhanalakshmi Srinivasan

Group of Institutions for their moral support and perspective on the book's publication. The Editors would like to thank all the authors who contributed their expertise and knowledge to the book's present scientific merits. The Editors would also like to express sincere thanks to the Editorial Board, consisting of Associate Editors and Technical Editors, who worked diligently to bring this collection together in a meaningful manner. Our special thanks to the Trueline Academic and Research Centre for their fruitful entrepreneurial patronage and for successfully bringing the book to life in all possible ways. The Editors also thank all the personnel, well-wishers, and Almighty who are behind this achievement.

Constructive suggestions on any parts of the book may be sent to the editors as well as to the Publishers, and those suggestions will be addressed in future editions of the book.

Dr. K. Elangovan,
Principal, DSEC.

Dr. T. Sivaraman
Dean – Research, DSEC.

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BIOLOGICAL SCIENCES

CHAPTER 1

STEPWISE UNFOLDING PATHWAYS OF AN ALL-BETA-SHEET PROTEIN BY HYDROGEN EXCHANGE

T. Sivaraman*
Department of Chemistry & Research and Development Cell
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

Protein unfolding pathways are indispensable in understanding protein folding and misfolding, designing new drugs and therapies, and engineering proteins with new biological functions. The denaturation of proteins can be caused by a variety of physical and chemical methods, and the disruptions of the three-dimensional structures of the proteins can be systematically monitored at molecular and residue-level resolutions using an array of biophysical techniques. In the present studies, the unfolding events of cardiotoxin III, an all beta-sheet protein, treated with GdnDCl and Urea at different concentrations have been investigated by hydrogen-deuterium exchange methods in conjunction with two-dimensional NMR techniques. Comprehensive analyses of the amide proton exchange data suggested that destabilization of the protein's cleft region is a prerequisite event for unfolding the protein. In addition, the studies demonstrated the mechanisms by which the chaotropic denaturants, GdnDCl and Urea, denature the protein at residue-level resolution.

Keywords: *Chaotropic Denaturants, Drug Designing, Hydrogen Exchange, GdnHCl, NMR, Protein Unfolding and Urea.*

Introduction

Each protein adopts a unique, compact, and stable three-dimensional (3D) structure, which is important for its biological activities. The secondary and tertiary structural interactions of proteins are primarily stabilized by non-covalent interactions such as hydrophobic, hydrogen-bonding (H-Bonding), salt-bridge, and electrostatic interactions, though disulfide bonds play essential roles in bringing any two cysteine residues into close contact in three dimensional space of the proteins; otherwise, they would be far away from each other in their primary structure [1-3]. Disruptions of the non-covalent interaction cause protein denaturation or unfolding, and the unfolding can be caused by a variety of physical and chemical methods. Studies of the protein unfolding processes at high resolution provide valuable insights into the structure, folding, and function of

proteins, and they have practical applications in protein purification, protein engineering, and biotechnological processes [4, 5].

As mentioned above herein, determining the relative stability of different regions within a protein and the order of assembly in the unfolding and folding processes are major goals of studies on protein folding and design. In the present study, we have demonstrated the unfolding processes of Cardiotoxin III (CTX III, an all-beta-sheet protein purified from Taiwan cobra, *Naja naja atra*) at residue-level resolution. The CTX III treated with different concentrations of chaotropic denaturants (GdnDCl and Urea-d_6) was subjected to hydrogen-deuterium (H/D) exchange for 30 minutes, and then patterns of amide proton exchange were monitored using two-dimensional (2D) Nuclear Magnetic Resonance (NMR) spectroscopy.

As described by the Boltzmann distribution law, a small fraction of all possible conformations of protein molecules exist at all possible energy levels, even under native conditions [6, 7]. Measurements of the amide proton exchange rates as a function of denaturants can occur by at least two different opening mechanisms: global unfolding and local fluctuations [8,9], and the amide protons could be classified into two types: marker and joining protons [10]. Amide Protons (NHs) that exchange through small local fluctuations are insensitive to denaturants (the slope value of 'm' is about 0), and the NHs that belong to this class are denoted as joining protons. On the other hand, the marker protons exchange through global unfolding, and the H/D exchange is dependent on denaturant concentration (m ~ 1), implying proteins undergo drastic conformational changes during the opening events. The unfolding pathways of proteins can be systematically probed by analyzing the H/D exchange patterns of the marker protons with respect to the denaturant concentration. In this background, the unfolding mechanisms of the CTX III in the presence of GdnDCl and Urea are brought to the fore in a systematic manner as described below herein.

Materials and Methods

The CTX IIIwas purified from the crude Taiwan Cobra venom (*Naja naja atra*) using the procedure described by Yang *et al.* [11]. Deuterium oxide (D_2O) was purchased from Cambridge Isotope Laboratories, USA. Ultrapure guanidine hydrochloride (GdnHCl) and urea were purchased from Sigma Chemical Co., USA, and deuterated powder forms of both the chaotropic denaturants were prepared by

dissolving in D_2O followed by lyophilization. All other chemicals used in this study were of high analytical quality.

Circular Dichroism (CD) spectroscopy: The denaturation processes of the CTX III treated with GdnDCl and Urea were monitored at 25 ^{0}C in deuterated solutions at pD 3.6. The concentration ranges of the GdnDCl and the urea varied from 0–7 M and 0–8 M, respectively. Each sample was equilibrated for about 6 hours at 25 ^{0}C before acquiring data using a Jasco J720 spectropolarimeter. The CD measurements were performed using 0.2 mm and 1 mm path length quartz cells for monitoring the signal in the far-UV CD (200–250 nm) and near-UV CD (250–320 nm) signals of the CTX III at different solution conditions, respectively. The CD spectra of each sample were an average of five scans. Ellipticity values are reported as mean residue ellipticity in the present report.

Hydrogen – Deuterium Exchange Measurement: The protein concentration used for all the H/D exchange experiments was about 1 mM. The H/D exchange patterns of amide protons of the CTX III treated with different concentrations of the GdnDCl-d_6 and the urea-d_4 in D_2O containing 500 mM Glysine-DCl buffer were monitored by acquiring 2D COSY NMR experiments. All the 2D NMR experiments were carried out on a Bruker DMX 600 MHz spectrometer. Typical data acquisition parameters were set as mentioned elsewhere. It should be mentioned that the time between sample preparation and data acquisition was strictly maintained at 30 minutes. In the case of GdnDCl, the H/D exchange measurements were carried out at 10 different concentrations ranging from 0 to 3.0 M (0.1, 0.3, 0.5, 0.75, 1.0, 1.2, 1.5, 1.7, 1.8, and 2.0 M GdnH-DCl) as the protein begins to unfold globally beyond 2.0 M GdnDCl. In the case of the urea-induced unfolding of the CTX III, the 2D NMR experiments were performed at 12 different urea concentrations ranging from 0 to 4 M (0, 0.1, 0.3, 0.5, 0.75, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, and 4.0M urea), as the protein showed intact structural stability up to the 4 M urea concentration. To ensure that no aggregation occurred during data collection, 1D and 1H spectra with 1024 datapoints, 8 dummy scans, and 64 scans were acquired before and after each of the H/D exchange experiments. Cross-peak intensities of aromatic protons and amide protons were measured by both volume and intensity integration methods. The total number of amide protons and intensity of each amide proton were plotted as a function of denaturant(s) (GdnDCl-d_6 or urea-d4), and the data were fitted using an appropriate single exponential function with or without asymptotes. The minimum concentration of the GdnDCl and Urea to exchange out a particular amide proton in the defined experimental conditions was estimated based on

analyses of the exchange data using KaleidaGraph (Abelbeck). All 55 amide protons of the CTX III molecule have been classified into very weak, weak, strong, and very strong based on their protection against solvent exchange in the presence of GdnDCl and Urea.

Results and Discussion

The chaotropic denaturantsGdnDCl and urea are well-known chemical denaturants for studying the unfolding and folding pathways of proteins. However, to date, no clear mechanism exists to explain how the denaturants unfold the proteins [12]. Robinson and Jencks [13, 14] attempted to unravel this puzzle by using the model peptide ATGEE (acetyltetraglycine ethyl ester), an uncharged compound composed principally of amide groups. Based on the results obtained from the solubility and activity co-efficient experiments, they concluded that non-hydrophobic interactions make a major contribution to the unfolding of proteins by the GdnDCl and the urea. Tanford [15] attempted to account qualitatively for the denaturing effect of urea on proteins using model compounds, and the results suggested that urea interacts directly with the peptide backbone of protein molecules. Based on the results, it has been proposed that hydrogen atoms bound to nitrogen atoms in urea and GdnDCl could undergo polyfunctional hydrogen bonding with the peptide groups of proteins. However, the presence of urea molecules near the hydrophobic residues of proteins has been explicitly reported [16]. Therefore, it remains unclear how proteins unfold in the presence of chaotropic agents such as urea and GdnDCl.

In this background, we attempted to understand the unfolding mechanisms of the CTX III in the presence of GdnDCl-d_6 and urea-d_4 using NMR-assisted H/D exchange methods [17,18]. The CTX III consists of 60 standard amino acids, and among them, 5 are proline residues located at 8, 15, 30, 33, and 43. Hence, there are 55 amide protons, which are the probes of the H/D exchange reactions in the present studies. About 50% of the protein residues are involved in secondary structural interactions, and the amide protons of these residues are consecutively protected from exchange due to their inter-strand and intra-strand H-bonding patterns. In addition to the H-bonding patterns, the steric effect and hydrophobic environment may also shield the amide protons from exchange with solvent deuterons.It is also worth mentioning in this context that the GdnDCl- and urea-induced unfolding kinetics of the CTX III at pD 3.6 were found to be a two-state model. The free energies of unfolding of the CTX III at pD 3.6 as estimated from the GdnDCl- and

Urea-induced denaturation were estimated to be 4.2 kcal/mol and 4.0 kcal/mol, respectively.

Table 1: Exchange patterns of backbone amide protons (NHs) of CTX III treated with different concentrations of GdnDCl are shown. Amino acids for which NHs are exchanged in the defined experimental condition are represented against their respective GdnDCl concentrations. Amino acids are represented in single-letter codes with their positions in the primary structure of CTX III.

S. No.	GdnDCl (M)	Amino acids
1	< 1 M	L1, K2, L6, V7, L9, F10, K12,T13, C14, A16, G17, L20, M26, V27, A28, T29, V32, G37, C38, D40, K44, S45, S46, L47, L48, V49, K50, C53 & T56
2	1 – 2 M	N4, Y11, K18, N19, M24, K31, C42, Y51, N55, C59 & N60
3	2 – 3 M	C3, C21, F25, V34, K35, R36, V41 & R58
4	> 3 M	K5, Y22, K23, I39, V52, C54 & D57

The finger-print region of the COSY spectra recorded for CTX III treated with various concentrations of GdnDCl showed that the number of protected protons is getting less and less with increasing concentrations of denaturant in the defined experimental condition. The volume of each protected amide proton (NH-C^aH) cross-peak was integrated and plotted as a function of GdnDCl concentration, and the data were fitted using appropriate exponential equations. The minimum concentration of GdnDCl required for all 26 protected amide protons involved in the secondary structural segments of CTX III to exchange with solvent deuterons was estimated. On the basis of the exchange protections, the amide protons are classified into four categories: very weak, weak, strong, and very strong (Table 1). It should be mentioned that more than 80% of amide protons belong to the very weak category and were exchanged out within the experimental time limitation of 30 minutes, indicating that those protons are exchanging due to local structure fluctuations rather than unfolding events. Most of the residues belong to the other three categories and are involved in the b-sheet interactions. It is interesting to note that residues such as Lys 5, Tyr 22, Lys 23, Ile 39, Val 52, Cys 54, and Asp 57 are well resistant to solvent exchange. All these residues, except Lys 5 and Asp 57, constitute inter-strand H-bonding interactions among strands III, IV, and V in the head portion of the triple stranded domain of CTX III. The amide proton of Tyr 22, Lys 23, Ile 39, Val 52, and Cys 54 has hydrogen bonding with the carbonyl group of

Gly 37, Val 52, Lys 23, Cys 21, and Tyr 22 residues, respectively. It clearly indicates that at least two MCD patterns of the triple-strand domain could not be fully unfolded even at a 2M GdnDCl concentration in the defined experimental condition. The amide proton of Lys 5, belonging to strand I of the double-stranded domain, has an H-bonding partner with the carbonyl group of Phe 10, and Asp 57 is located in the C-terminal region of the CTX III. The three-dimensional structure of the CTX III reveals that a strong network of backbone interactions among the residues located in the N- and C-termini of the CTX III protects the NHs in the region from solvent exchange [19-22].Comprehensive analyses of the NHs exchange patterns of CTX III treated with GdnDCl revealed that the order of stability of the CTX III molecule is as shown herein.

Loops < C-terminal < Double strand < Triple strand

As discussed above, the exchange patterns of amide protons in the CTX III treated with different concentrations of urea were mapped out, and Table 2 shows the amide protons belonging to four categories: Very week, Week, Strong and Very Strong. The order of stability of the CTX III molecule on the basis of the NHs exchange patterns of urea-induced denaturation is shown herein.

Loops / C-terminal < Double strand < Triple strand

Table 2: Exchange patterns of backbone amide protons (NHs) of CTX III treated with different concentrations of urea are shown. Amino acids for which NHs are exchanged in the defined experimental condition are represented against respective urea concentration. Amino acids are represented in single-letter codes with their positions in the primary structure of CTX III.

S. No.	Urea (M)	Amino acids
1	< 1.25 M	L1, L6, L9, F10, K12,T13, C14, A16, G17, L20, K23, M24, M26, V27, A28, T29, V32, G37, C38, D40, K44, S45, S46, L47, L48, V49, K50, C53, N55, D57 & T56.
2	1.25 – 2.5 M	Y11, N19 & F25.
3	2.5 – 4 M	K2, V34, C42, Y51 & C59.
4	> 4 M	C3, N4, K5, V7, K18, C21, Y22, K31, K35, R36, I39, V41, V52, C54, R58 & N60.

Although the NHs exchange patterns of the CTX III treated with GdnDCl and urea are found to be similar, significant differences could be observed in the mode of interactions between the two denaturants with the CTX III. For example, the amide protons of residues such as Cys 3, Asn 4, Val 7, Lys 18, Lys 31, Lys 35, Arg 36, Val 41, Arg 58, and Asn 60 were found to be resistant to H/D exchange even up to a concentration of 4.0 M urea (Table 2). Except for Val 41, all other residues are located in the cleft region of the CTX III. The cleft of the CTX III is constituted by strand 1, strand IV, and the C-terminal of the CTX III, and the cleft region is predominantly constituted by charged residues. The NHs exchange patterns suggested that the cleft region of the CTX III couldn't be unfolded even at a concentration of 4.0 M urea in the defined experimental condition. However, the amide protons of those residues located in the cleft region were exchanged quite rapidly at a concentration of 2 M GdnDCl. This particular disparity between the modes of interactions of the GdnDCl and Urea with the CTX III could be attributed to the presence of a high density of charged residues in the cleft region of the protein. It is very likely that GdnDCl, being a cationic denaturant, could disrupt the high density of hydrogen bonds involving the residues in the cleft region of the CTX III. However, urea, being a neutral denaturant, did not elicit a similar response. The results also point out that the dominant force in the unfolding event of the CTX III molecule is non-hydrophobic interactions, especially charge-charge interactions and H-bonding interactions. Moreover, the results in the high-resolution structural contexts demonstrate the molecular interactions that cause the GdnDCl to be a stronger denaturant than the urea in the denaturation processes of the CTX III.

Concluding Remarks

The unfolding pathways of CTX III treated with GdnDCl and Urea have been comprehensively analyzed on the basis of exchange patterns of the backbone amide protons of the protein. Overall, the unfolding mechanisms of the CTX III could be envisaged into three stages: destabilization of the cleft region of the CTX III molecule is considered as a prerequisite event to initiate the unfolding of the CTX III; following the destabilization of the cleft region, the secondary structures composed of the double stranded domain and the triple stranded domain begins to melt; of the two domains, unfolding rates of the double stranded domain was found to be faster than that of the triple stranded domain; finally, the globular head of the CTX III was found to be destabilized leading into completely unfolded or

random coil states of the protein. The cleft region of the CTX III is constituted by a high density of charged residues. The cationic denaturant GdnDCl is relatively stronger at interacting with those charged residues present in the cleft of the CTX III compared to the interaction of the cleft residues with urea, which is a neutral denaturant. The differences in the modes of interactions between the GdnDCl and Urea with the CTX III are primary attributes for rationalising dissimilarities in the degree of denaturation efficiencies of the GdnDCl and urea.

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CHAPTER 2

SYNTHESIS AND EVALUATION OF BIO-SCAFFOLD USING BOTH TRADITIONAL AND 3D PRINTING METHOD FOR BONE TISSUE REGENERATION

Yogapriya M S*, Narayanan C,Nivedha A K, Subhashini P, Roshini M & Veerasathiya D

Department of Biomedical Engineering

Dhanalakshmi Srinivasan Engineering College (Autonomous) Perambalur, Tamil Nadu

Abstract

Bone regeneration is a crucial aspect of modern medicine, as it is often required for patient who have suffered from bone injuries or disease. The use of bone scaffolds has become increasingly. Popular as means of promoting bone regeneration. This study focuses on the development of a bone scaffolds using essential oil. Biopolymers, bio composites. The essential oil used in this study posses various therapeutic properties, which can aid in the promotion of bone regeneration. Biopolymers such as chitin, pectin and gelatin were used to form the scaffolds structure, While the bio composite, Beta tricalcium phosphate was used to enhance the scaffolds mechanical properties.

Keywords: *3D scaffold, bone tissue regeneration, freeze casting method, bio ceramics and polymer.*

Introduction

Bio-ceramics, specifically hydroxyapatite, have gained significant attention in the field of bone tissue engineering. Hydroxyapatite is a calcium phosphate-based ceramic that closely resembles the composition of natural bone, making it an excellent candidate for promoting bone cell growth and regeneration.In addition to hydroxyapatite, various forms of calcium phosphate ceramics, such as alpha and beta, have been explored for their potential applications in bone tissue engineering.

To enhance the effectiveness of bio-ceramics in promoting bone regeneration, researchers have focused on developing bio-ceramic scaffolds with controlled composition and hierarchical structures at multiple scales (macro, micro, and nano). These scaffolds play a crucial role in determining the mechanical properties, degradation rate, permeability, and biological response of the implanted biomaterial[1,2]. Traditional fabrication methods, such as gas forming, freeze drying, and particulate/salt leaching, have limitations in controlling thepore shape, architecture, porosity, and interconnectivity of the scaffolds, which are essential for optimal cell growth and tissue regeneration.

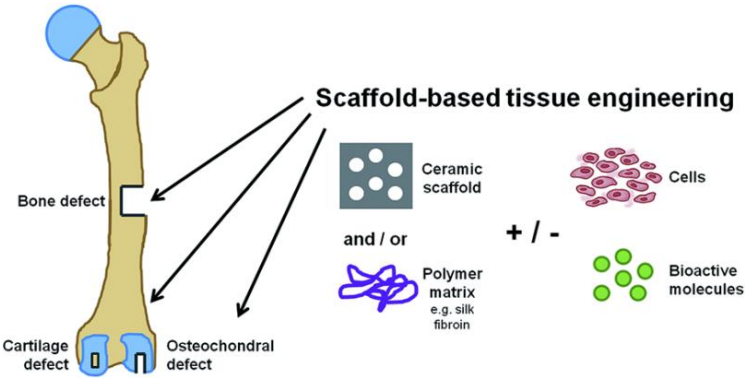

Fig:1 The notion of musculoskeletal tissue rejuvenation through methods of tissue Engineering stems from scaffolding.

To overcome these limitations, 3D printing technology, coupled with computer-aided design (CAD) and computer-aided manufacturing (CAM), has emerged as a promising approach for fabricating bio-ceramic scaffolds with precise control over their chemistry, shape, and interconnected porosity. This advanced manufacturing technique enables the design and production of scaffolds with tailored properties to better mimic the natural bone structure and facilitate enhanced bone tissue regeneration.

In addition to their structural properties, the osteoinductive nature of bio-ceramics is another crucial factor for successful bone tissue engineering [8]. The surface chemistry and charge of calcium phosphate ceramics influence protein adsorption, which, in turn, promotes cell differentiation through interactions with the extracellular matrix[3,4]. These properties contribute to the bioactivity and osteoinductivity of bio-ceramic scaffolds, facilitating the formation of new bone tissue.

In this context, the present review focuses on the advancements in 3D printed bio-ceramic scaffolds[6], highlighting their different compositions and hierarchical structures. The review encompasses their effects on mechanical strength, degradation rate, permeability, and biological properties. Furthermore, it explores the expanding applications of these bio-ceramic scaffolds, ranging from bone tissue regeneration to bone-related disorders and injuries.

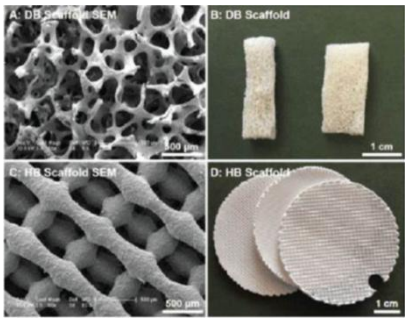

Fig:2 3D printing of Scaffold using SEM for Tissue Regeneration

The Research have initiated in ao's but it has scope in recent 5-6 years. In this Project we are using calcium phosphate which is also a variety of hydroxyapatite[7]. An added benefit is economical and cost effective.

Surprisingly we are using natural nutrients and ingredients for bioscaffold bone regeneration. Such as Lemon grass in the form of essential oil, Beta Tricalcium phosphate and polymers (Gelatin, Chitin). It can be used for all kinds of patients with no side effects.

Table:1 For the purpose of determining the consistency, a comparison of adjusting the grammes and amounts of Gelatin, Chitin, and Beta Tricalcium Phosphate

Gelatin	Chitin	Beta Tricalcium Phosphate	Results
1.5g	1.5g	3.5g	Liquid consistency - Failure
2g	2g	4.5g	Curdled milk - Failure
2g	1.5g	5g	Sticky consistency - Success

Here we have attainted 60% of results which is really a great difference. The Major focus of this project is to regenerate Knee bone.

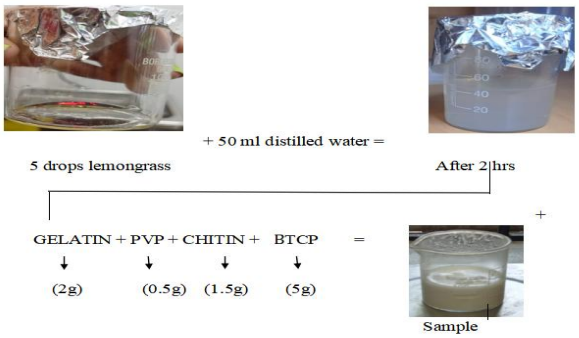

Fig:3 An amalgamation of Gelatin, PVP, Chitin, BTCP, five mg of lemograss, and water distillation gave rise to a solution exhibiting 60% of the entirety of the findings after relaxing over two hours

1. Take a beaker and added 3 drops of Lemon grass essential oil to heated in the Ultrasonicator
2. Then take 50 ml of distilled water in same beaker and heat it for 2 hrs.
3. 3.After this process add 2gram of Gelatin and it heated in Magnetic Stirrer.
4. In the same beaker to added in PVP (0.5g) , Chitin (1.5g)
5. Then added 5gram of βTCP in same beaker for 30 mins to 1 hrs.
6. After that the sticky needed consistency for the Scaffolds is achieved.

Equipments

- Ultrasonicator
- Magnetic stirrer

Microscopic a vacuum conditions droplets are formed in the amount of liquid while inadequate pressure is put on because this causes high-impact waves with ultrasonic frequencies to be created. In the event of a high-pressure phase, the bubbles disintegrate as soon they begin to reach their saturating point. The condition is the name of this procedure.

The stirring that results from exposing an inert sample to ultrasonic resonance (>20 kHz). When the sound waves enter liquids medium, they cause alternate phases of elevated (compression) and low-pressure conditions exist (rarefaction).

Magnetic Stirrer

One piece of scientific apparatus used for heating and mix solutions or liquids is a the flame stirrer with magnets. It is made up of a system for controlling the temperature, a magnetic stirrer, and an element that heats. The liquid or solution is heated until it reaches the desired temperature using the component that heats it.

Fig: 4 Magnetic Stirrer-Setting the value of 8 point with 1000 rpm stirring speed and also enhance the direction change for agitation and mixing purpose

Testing

- Anti-inflammatory
- Scanning electron microscope (SEM)
- Fourier transform infrared spectroscopy (FTIR)
- X-ray diffraction analysis (XRD)

Anti–Inflammatory Result

- A drug or substance that reduces inflammation (Redness, Swelling, and Pain) in the body. Anti-inflammatory agents block certain substances in the body that cause inflammation. They are used to treat many different conditions. Some anti-inflammatory agents are being studied in the prevention and treatment of cancer. aspirin (such as Disprin) ibuprofen (such as Nurofen) naproxen (such as Naprosyn) diclofenac (such as Voltaren).

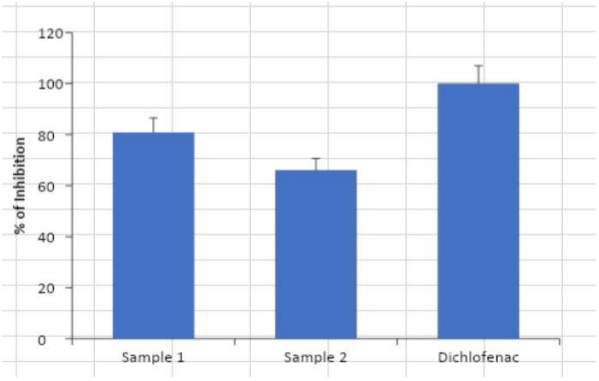

Fig:5 The Samples were taken for Anti-inflammatory which includes aspirin, nurofen, naproxen and diclofenac

X-Ray Diffraction Analysis (XRD)

- X-Ray diffraction analysis (XRD) is a nondestructive technique that provides detailed information about the crystallographic structure, chemical composition, and physical properties of a material.
- It is based on the constructive interference of monochromatic X-rays and a crystalline sample.

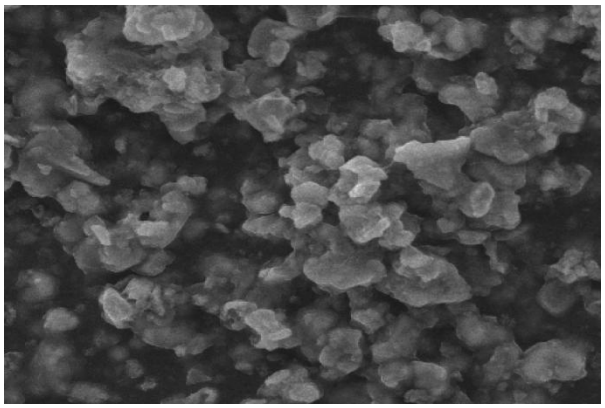

Fig:6 The crystal configuration, that reflects the substances formulation, is visible in the monochrome X-rays

Fourier Transform Infrared Spectroscopy (FTIR)

- Fourier Transform Infrared Spectroscopy (FTIR) identifies chemical bonds in a molecule by producing an infrared absorption spectrum.
- The spectra produce a profile of the sample, a distinctive molecular fingerprint that can be used to screen and scan samples for many different components.

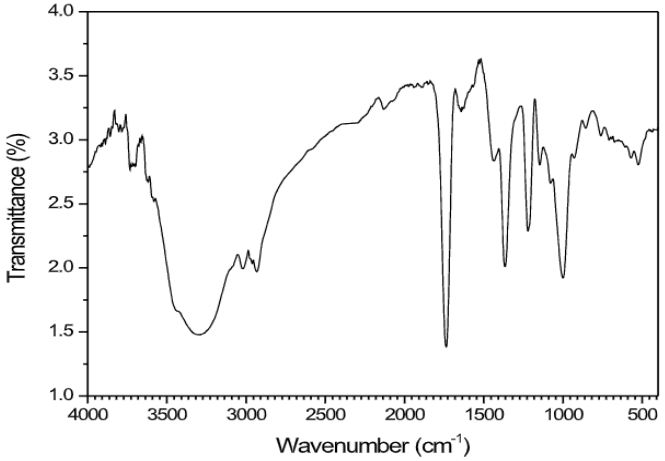

Fig:7 In FTIR the signal's transmittance levels responds to changes through wave number

Scanning Electron Microscopy(SEM)

- A technique whereby both structural and analytical information can be obtained from bone.
- An instrument that produce a largerly magnified image by using electron instead of light to form an image.

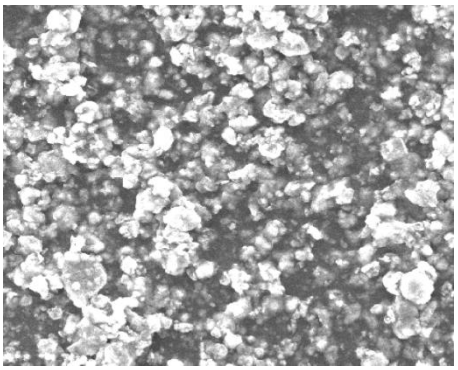

Fig:8 The SEM depictions provide an enlarged picture for the bone-regenerating components

Conclusion and Future Work

Rejuvenation of bony deformities is a challenging issue. despite the fact that tissue engineering of bone has been used in several trials to restore bone abnormalities, there's is currently none optimal strategy because of its elevated rate of complications and subpar functioning results.

To withstand an impact load, varnishes must have enough surface adherence and mechanical stability. Perforated scaffolding have been suggested to facilitate cell and vascular infiltration for optimal the development of bones.

Multiple research investigations have shown that the growth factors administration therapy is effective, however there are rising concerns related to the usage of certain growth variables, their dose, and combinations.

- Cell Line Study
- In viva animal model study

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CHAPTER 3

ANTI-ARTHRITIC ACTIVITY OF ISOLATED COMPOUND 2-(3,4-Dihydroxyphenyl)-3,5,7-Trihydroxychromen-4-ONE From ETHANOLIC EXTRACT OF CARDIOSPERMUM HALICACABUM LINN LEAVES

Vinothini G*, Narayanan C, Gomathi T,Gokulprakash P,Barathraj S & Dhiwakar A

Department of Biomedical Engineering

Dhanalakshmi Srinivasan Engineering College (Autonomous) Perambalur, Tamil Nadu

Abstract

Rheumatoid arthritis is an immune mediated inflammatory disorder. This is treated by modern drugs, but it gives only temporary relief from pain and leads to some side effects. So, we choose leaves of medicinal plant of Cardiospermum halicacabum linn because it decreases body pain and used for the treatment of diarrhea and mainly used for arthritis. The present study is aimed to investigate anti-arthritic activities of isolated compound 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one from this plant. Therefore, in the present study the 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one was isolated, purified, drug isolation, identification and characterization by CC, TLC, UV, FTIR, H1-NMR, C13-NMR, and HPLC. Then isolated drug 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one will be tested by using inhibition of protein denature method for giving human. From the result, isolated drug 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one was the more effective and the highest activity for rheumatoid arthritis. Then, it will control the rheumatoid arthritis. In future, this plant drug can make as a palm or other by-products, and these are given to rheumatoid patient and arthritic patient.

Keywords: *Rheumatoid arthritis, Cardiospermum halicacabum linn leaves, Isolated drug 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one, ethanolic extract, and anti-arthritic activity.*

Introduction

Rheumatoid arthritis (RA) is a chronic, inflammatory, autoimmune condition that primarily affects the joints. With a prevalence of approximately 5 out of every 1000 individuals, RA can lead to significant joint damage and disability. The management of RA focuses on reducing joint inflammation, alleviating pain, and preventing or slowing down joint deterioration. Inflammatory diseases, particularly various forms of arthritis, contribute significantly to global morbidity, often referred to as the "King of Human Miseries." While conventional medications are available for RA, they may be associated with adverse effects such as digestive issues.

In search of alternative treatment options, traditional medicinal plants have gained attention, particularly in countries like India. Cardiospermum halicacabum, commonly known as balloon vine, is one such plant that has been utilized in traditional Indian medicine systems for the treatment of rheumatoid arthritis. Balloon vine, recognized as a popular leafy green vegetable in India, belongs to the Sapindaceae family and is distributed widely across the world and Oceania. This herbaceous climber contains a significant amount of quercetin compounds, known for their anti-rheumatic, anti-arthritic, and anti-inflammatory effects.

A study published in the Biomedical & Pharmacology Journal by K. Eswar Kumar et al. in 2008 investigated the anti-arthritic effects of oral administration of Cardiospermum halicacabum leaf ethanolic extract (CEE) on rats with Freund's complete adjuvant (FCA)-induced arthritis. The study evaluated the efficacy of two different doses, 125 mg/kg and 250 mg/kg, by measuring paw volume and assessing hematological indicators such as hemoglobin (Hb) content, total red blood cells (RBC), white blood cells (WBC), and erythrocyte sedimentation rate (ESR). The findings revealed that the Cardiospermum halicacabum leaf extract effectively suppressed FCA-induced arthritis in a dose-dependent manner, with a more pronounced effect observed at a dose of 250 mg/kg. Moreover, the extract administration led to significant improvements in body weight compared to the arthritic rats. The results indicated that Cardiospermum halicacabum leaf ethanolic extract possesses substantial anti-arthritic properties.

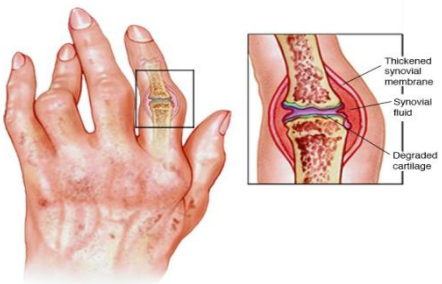


Fig: 1 Normal Rheumatoid Arthritis is the defense mechanism of our bodies targets its own connective tissue, which includes joint. The body's internal systems are attacked in extreme instances.

To further explore the therapeutic potential of Cardiospermum halicacabum, researchers isolated a specific compound, 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one, from the plant leaves. The compound was characterized using methods such as column and thin-layer chromatography. Its anti-

inflammatory effects were confirmed through inhibition of protein denaturation assays using egg albumin and human red blood cells (HRBC).

Based on the aforementioned research findings, it can be concluded that Cardiospermum halicacabum naturally exhibits anti-arthritic activity due to its quercetin content. However, further studies are required to validate these findings and determine the optimal dosage forms for human use. In the future, the development of a topical balm or drug formulation utilizing Cardiospermum halicacabum could offer a novel and natural approach to managing rheumatoid arthritis, providing relief to patients with inflammatory and arthritic conditions.

Materials & Methods

1.) Plant Collection & Extraction

Leaves of Cardiospermum halicacabum L. in their natural state. The plant's leaves were gathered from Perambalur's neighborhood markets. In the shade, the collected leaves were dried. It was powdered using a mixer. The powder was sieved and kept in a dry, airtight container. Cardiospermum halicacabum Linn leaves were collected, washed, dried in the shade, and ground into powder. A portion of the powdered material weighing about 100gm was individually weighed and extracted with 200 ml of ethanol using a Soxhlet extract device. Following extraction, the extract was run through Whatman No. 1 filter paper. Using the hot percolation method, the filtrate was evaporated in a rotary evaporator at a limited temperature and low pressure. The plant's ethanol-based concentrated extract was kept at -20°C until it was needed for additional research. It could take up to 18 hours to complete this operation. Finally, we gather the Cardiospermum halicacabum Linn ethanolic leaf extraction.

2.) Qualitative

The quality of a plant's antibiotic activity is evaluated using a test, and phytochemicals are employed to make that determination. Pick up 18 test tubes filled with chemical components and plant extracts. The phyto constituents found in the ethanolic extract of Cardiospermum halicacabum Linn leaves after that test include tannins, saponin, flavonoids, terpenoids, alkaloids, steroids, protein, coumarins, phenols, xanthoproteins, glycosides, emodin, anthocyanin, cardiac glycosides, and leucoanthocyanin. The medicinal qualities of Cardiospermum halicacabum Linn leaves are caused by the actions of phytochemical components found in the leaves.

3.) Quantitative Analysis

The level of antibiotics present in plant extract is determined via quantitative analysis. It is done by adding ethanol, methanol, and aqueous solvent depending on the polarity of secondary metabolism. Here, six different tests are being used to estimate their quantity using some items. After running this test, we discovered that there are various amounts of flavonoids, tannin, saponin, phenol, alkaloids, and terpenoids. These amounts are 0.033, 0.019, 0.009, 0.006, 0.009, and 0.003, respectively. This test allowed us to confirm that medicinal plants have a greater amount of flavonoid.

4.) Total Flavonoid Content

Take 6 test tube. Add 1ml of quercetin sigma and ethanol in 5 aspect ratios (20+980, 40+960, 60+940, 80+920 and 1000µl/ml) in test tube (1,2,3,4,5) simultaneously. Then One last test tube as 6 which add 1ml of plant extract. Add 0.5ml 0f distilled water in all test tube and add 0.5ml sodium nitrate, aluminum chloride, and sodium hydroxide one after one. Then Place those tubes in dark place with 10 minutes. By using UV-digital spectrometer calculate their OD value. After getting OD values we calculate TFC by using the formula is y=mx+c for how many total flavonoid contents (TFC) is present in the ethanolic extract of cardiospermum halicacabum linn leaves. Total flavonoid contents present in the ethanolic extract of Cardiospermum halicacabum linn leaves is **39.5 mg/g**.

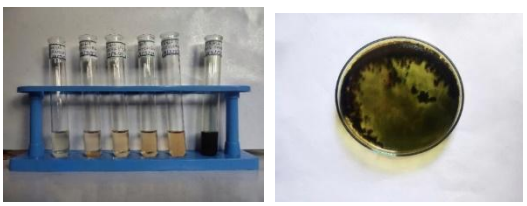


Fig:2 Six test containers were used to collect the process's total flavonoids content, and each one received a millilitre of the solution at the end. Each tube also included a herbal extraction

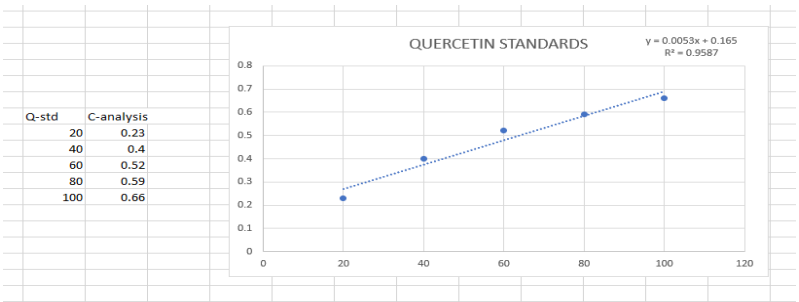


Fig:3 In accordance to the OD estimation, wherein absorption was 39.9 mg/g.

5.) Isolation & Purification of Plant Extract

Column chromatography is run by using plant extract and some chemical compounds likes silica gel for column chromatography, n-hexane, ethyl acetate and methanol with proper apparatus. In column apparatus, dry condition of silica gel as 100g is added in burette. Then add n-hexane into that silica gel added stand for wet their dry condition. Add 10ml of plant extract. The condensed ethanol extract of cardio spermum halicacabum linn was subjected to column chromatography, which is filled with silica gel. Elution of the column first with n-hexane, increasing amount of ethyl acetate in n-hexane and finally with methanol yielded a 15 number of fractions. Then again once run the column chromatography with 15th Fraction as like same procedure. We yield some another fractions. Totally, we yield 26 number of fractions. In that fraction, we get isolated 2-(3,4-dihydroxyphenyl)-3,5,7 trihydroxychromen-4-one compound in 24th fraction.Based upon above collected fraction 24 is used to proceed next steps like TLC for purify that isolated compound. Purified isolated compound is confirmed by using some steps with some results like single peak of yellow colour band is present in that TLC plate coated with silica gel G for TLC by applying 4-6 drop of plant extract and then tipped into 5:5 ratio of ethyl acetate and methanol added beaker. Then this purified 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one was given to three colleges for make centrifuge drug and proceeding a characterization process.

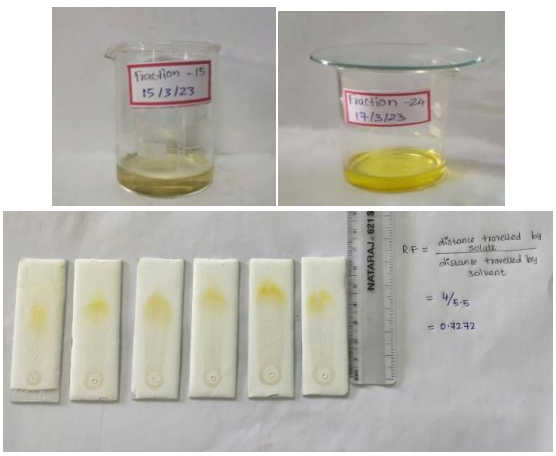


Fig:4 A extracted chemical, having resembles the 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one combination is hue and appearance, will be used to assess the following category of method.Thin layer chromatography (TLC), the next phase, serves for purifying the distinct chemical using the fragment 24 of the obtained separated molecule. A single yellow colour stripe that appears on every plate of TLC indicates that the chemical has been separated and refined.

6.) Characterization of Purified Compound

Purified 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one centrifuged drug is characterized by using some techniques and methods for determine and analysis of chemical property and structure of purified 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one drug. They are UV-vis spectroscopy, FTIR, NMR-H1, NMR-C13, and HPLC. These tests are examined in some colleges and universities at Trichy. That results are collected and verified based upon some literature papers. This intimate that plant centrifuged drug is a 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one compound based on their chemical properties and their structure. Then we proceed next step based upon that fraction 24 is named as drug.

7.) Inhibition of Isolated Compound by Protein Denaturation Model

i.) Egg Albumin Process

Standard Diclofenac sodium was employed as a control medication of rheumatoid arthritis which is inhibited protein denaturation at varied doses (20-100 µl/ml). The egg albumin method protein denaturation was likewise inhibited by an isolated compound at various doses (20, 40, 60, 80, and 100 µl/ml). Then calculated their OD values by using formula (C-T/C ×100) where C=1.19 and T=OD values.

Fig:5 Albumin from eggs procedures 11 test tubes, please. only pour the produced solutions at varied concentrations to 10 test containers, and subsequently add 1 millilitre of dilute saline.The last testing tubes is referred as being the control tube. Add one millilitre of a buffer with phosphate & 1ml of egg albumin that has been taken out of the egg to each tube of testing. After approximately five minutes, everything can be set up on a database lasting a period of time to accumulate OD data.

ii.) HRBC Method

Standard Diclofenac sodium was employed as a control medication of rheumatoid arthritis which is inhibited protein denaturation and stabilizing the HRBC membrane at varied doses (20-100 µl/ml). The HRBC method protein denaturation and stabilizing the HRBC membrane by an isolated compound at

various doses (20, 40, 60, 80, and 100 µl/ml). Then calculated their OD values by using formula (C-T/C ×100) where C=1.20 and T=OD values.

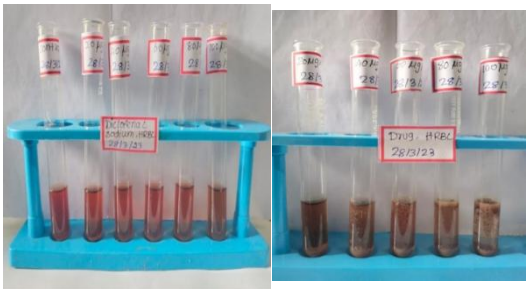


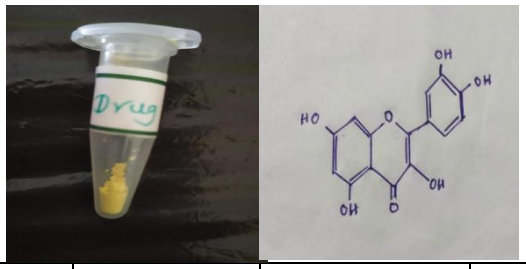
Fig:6 Standard Diclofenac sodium were stabilizing at Varied doses and the calculated by OD values.

Results

Based on above process we concluded some results and verified statements for produce purified 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one drug, and that will control rheumatoid arthritis. They are explained as follows.

1.) Characterization

2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one melting point 314-315°C, MW: 302.238 g/mol which corresponds to the molecular formulae C15H10O7. The UV visible spectroscopy isolated flavonoid of ethanolic extract of cardiospermum halicacabum linn shows peak at 255.10 nm and 369.05 nm. FTIR: (KBr) vmax: The characteristic stretch C=O for 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one occurs at the band 1630.70 cm- 1. The C-O-H deformation mode was observed at 1462.44 cm-1 for2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one. The slight shifting of stretching bands of C-O-C and C=O at 1023.62 cm-1, 1271.16 cm-1 and the band at 1408.42 cm-1. The O-H frequencies appeared in the range at 3396.33 cm-1.H1-NMR (DMSO-d6, 500 MHz) δ (ppm), 12.269 (1H, s, OH-5), 8.077 (1H, s, OH-7), 8.062 (1H, s, OH-3), 7.835 (1H, d, J=OH-3'), 7.722 (1H, d, J=2.0 Hz, H-2'), 7.706 (1H, dd, J=2.0, 8.0 Hz, H-6'), 6.864 (1H, d, J=8.5 Hz, H-5'), 6.367 (1H, d, J=2.0 Hz, H-6), 4.984 (1H, d, J=2.0 Hz, H-8).C13-NMR (DMSO-d6, 125 MHz) δ (ppm), 147.989 (C-2), 137.212 (C-3), 177.312 (C-4), 162.480 (C-5), 99.234 (C-6), 165.544 (C-7), 94.418 (C-8), 158.215 (C-9), 104.515 (C-10), 121.682 (C-1'), 116.000 (C-2'), 146.203 (C-3'), 148.755 (C-4'), 116.225 (C-5'), 124.143 (C-6'). The Retention time of 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one isolated from the ethanolic extract of sample was about 3.526 was shown by HPLC peak.



Peak#	Retention Time	Area	Height	Area %	Height %
1	3.526	460968	239376	100.000	100.000
Total		460968	239376	100.000	100.000

Fig:4 The point at which it dissolves of 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one, with a chemical composition of C15H10O7, is 314–315 °C. Its molecular density is 302.238 g/mol. The extracted flavonoids extracted from the ethanolic form of extract of Cardiospermum halicacabum Linn exhibited excesses across the UV apparent spectrum.

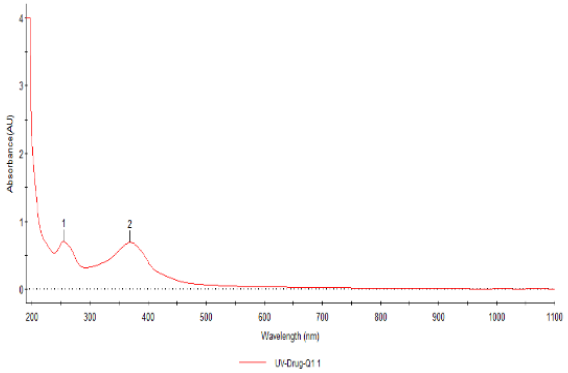


Fig:4 Spectrometry of a single component graphs in the Ultraviolet and visible spectrum

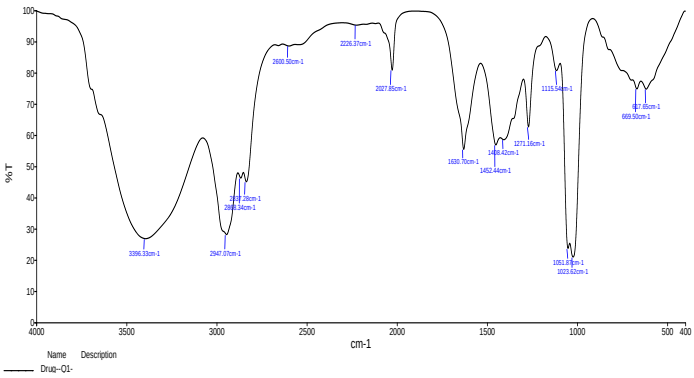


Fig:5 FTIR spectrum of isolated compound graph

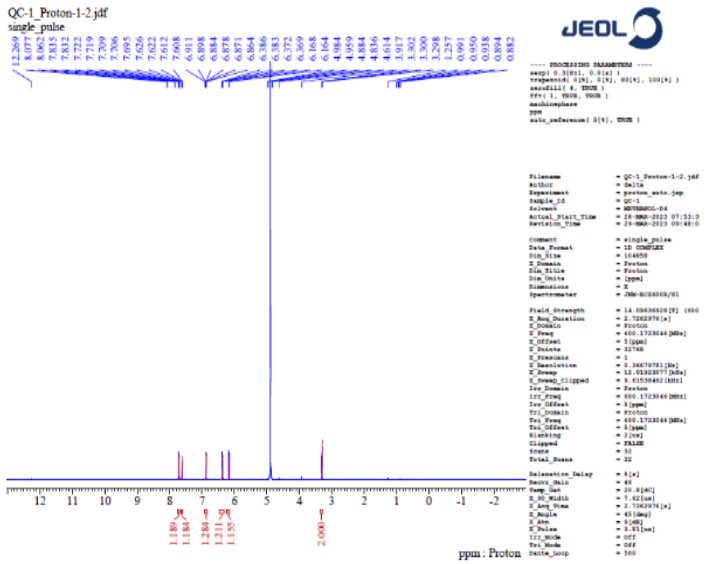


Fig:6 H1-NMR of isolated compound graph

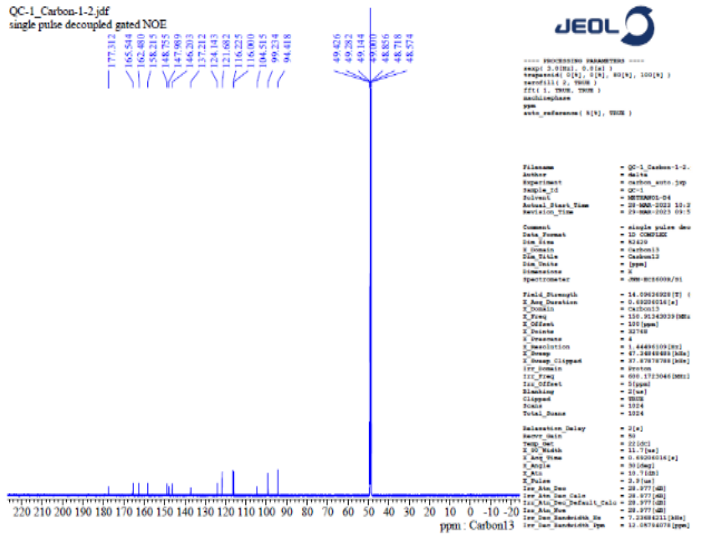


Fig:7 C13-NMR of isolated compound graph

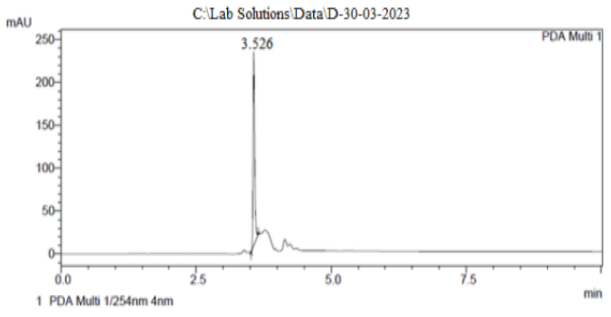


Fig:8 HPLC of isolated compound

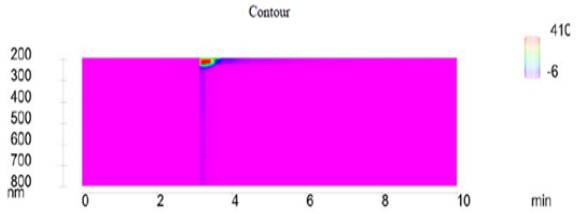


Fig:9 HPLC spectra for isolated compoundPDA Ch1 254 nm 4nm HPLC of purified 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one compound

2.) Inhibition of Protein Denature

Isolated compound was found to have a stronger effect 57.14% in 100µl/ml and the standard diclofenac sodium exhibits the higher effect 75.63% at 100µl/ml. Finally, we observed the anti-arthritic activities presence in the egg albumin process. Isolated compound was found to have a stronger effect 65.83% in 100µl/ml and the standard diclofenac sodium exhibits the higher effect 76.66 at 100µl/ml. Finally, we observed the anti-arthritic activities presence in the Human red blood cell (HRBC) method.

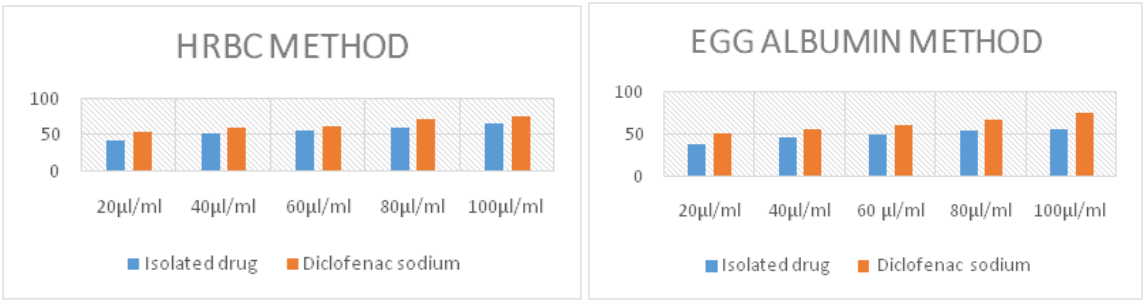


Fig:10 Anti-arthritic activity compared to isolated compound and diclofenac sodium with egg albumin chart

Conclusion

Based on TFC, we found more amount of flavonoid is present in medicinal plant. Then isolated and purified compound is characterized. From result we concluded that isolated drug is a pure 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one. Then after we found that egg albumin method protein denaturation was likewise inhibited by an isolated compound at various doses (20-100 µl/ml). Isolated compound was found to have a stronger effect 57.14% in 100µl/ml and the standard diclofenac sodium exhibits the higher effect 75.63% at 100µl/ml. The protein denaturation and stabilizing the HRBC membrane at varied

doses (20-100µl/ml). The HRBC method protein denaturation and stabilizing the HRBC membrane by an isolated compound at various doses (20, 40, 60, 80, and 100 µl/ml). Isolated compound was found to have a stronger effect 65.83% in 100µl/ml and the standard diclofenac sodium exhibits the higher effect 76.66% at 100µl/ml. Finally, both methods have the presence of the anti-arthritic activities is observed. Then the isolated compound 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one is will control rheumatoid arthritics which is extracted from the ethanolic extract of cardiospermum halicacabum linn leaves.The most advantages of the project is for fighting free radices,It controls more pain compare with modern drugs. 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one is a more powerful antioxidant than vitamin C, E, or beta carotene.

Future Scope

In future, this plant 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one drug can be made as a palm or other by-products, and these are given to rheumatoid patient, inflamed patient, and arthritic patient.

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CHAPTER 4

REMODELLING AND SIMULATION OF CUSTOMIZED 3D PRINTED LEG BRACE FOR STABLIZING THE MUSCULOSKELETAL DISORDERS

Keerthi Vembu* NVP, Rubina Begam M, Krishnapriya S, Jeevanantham D,Dinovishal J & Bavish A

Department of Biomedical Engineering

Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

Musculoskeletal diseases are a group of conditions that affect the bones, joints, muscles, and connective tissues. These conditions can cause discomfort and loss of function. The global marketplace is flooded with enormous, ungainly-looking, and sometimes unpleasant worldwide hinge leg brace. The standard leg brace design may be modified and streamlined using 3D printed components, making it compact, lightweight, and pleasant. When compared to traditional processing and manufacturing technologies, 3D printing technology not only saves time and labour, but also allows for "personalised manufacture," which makes the product unique. The demands of patients with specific patient data in application, however, can be better met by 3D printed rehabilitation braces. This research is about the design and development of 3D printed customized leg brace for stabilizing the musculoskeletal problems using Acrylonitrile Styrene Acrylate (ASA). Amorphous synthetic thermoplastic Acrylonitrile Styrene Acrylate (ASA) works effectively in extruding materials the printing process.. It is a high-impact material capable of producing functional components. The printed 3D leg brace was thoroughly examined and simulated at 30 N using Analysis software.

Keywords: *Musculoskeletal disorder, 3D printing, Leg brace and Customized.*

Introduction

Musculoskeletal disorders (MSDs) encompass a wide range of conditions that affect the musculoskeletal system, including bones, joints, muscles, tendons, ligaments, and other connective tissues. These disorders can cause varying degrees of discomfort, chronic pain, and disability. Among the common MSDs are osteoarthritis and rheumatoid arthritis, both of which impact the joints and can significantly impair mobility and quality of life.

Figure 1.- Encompasses an Assortment of ailments that have an impact on the skeletal muscles,tendons,ligaments,bones and its joint spaces

Osteoarthritis, often referred to as "wear and tear" arthritis, involves the gradual deterioration of the protective cartilage in the joints. This condition leads to symptoms such as pain, stiffness, and reduced range of motion. While the exact causes of osteoarthritis remain unclear, factors such as genetic predisposition, aging, obesity, joint injuries, overuse, and deformities contribute to its development. It can affect any joint, but the hands, hips, knees, and spine are typically the most affected.

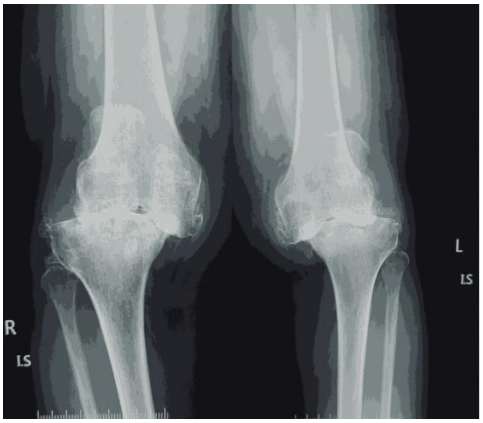


Figure 2.- This figure shows that the stage where repetition tears away the Cartilage that acts as a barrier that cushioning the extremities of all Joints.

Rheumatoid arthritis (RA) is a chronic autoimmune disease that primarily affects the joints, resulting in inflammation and damage to the surrounding tissues. This prevalent form of arthritis affects approximately 1% of the global population and occurs more frequently in women than men. Blood tests can be identify markers such as rheumatoid factor (RF) and anti-cyclic citrullinated peptide(anti-CCP) antibodies, which target the synovial membrane lining the joints and lead to

swelling, discomfort, and inflammation[3]. If left untreated, RA can lead to joint deformities and loss of function.

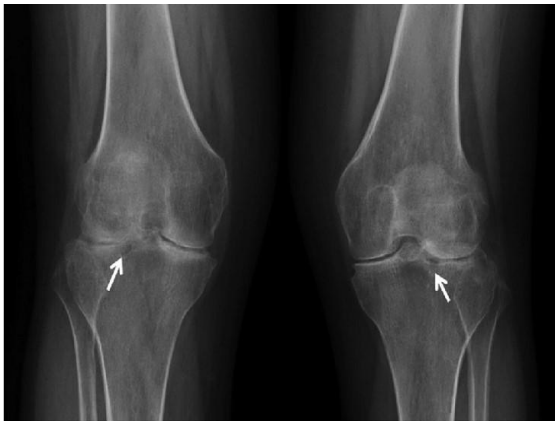


Figure 3.- Rheumatoid Arthritis (RA)- The Defence mechanism of the human physique destroys its very own tissues,notably joints, the most common in this condition

In the realm of managing musculoskeletal disorders, the use of braces has become increasingly important. Knee braces, for example, are worn to support and protect injured or painful knees, while also serving as preventive measures during sports activities[1]. These braces are typically made from a combination of materials such as metal, foam, plastic, elastic, and straps.

This article explores the design and development of leg braces using 3D printing filament, with a focus on creating braces that are slightly flexible, wearable, durable, and strong. By leveraging the benefits of customized designs and selective 3D printing filament, these leg braces aim to effectively transfer the load from the leg to the lower extremity, reducing pain and inflammation[2,5,7]. The project's simulation demonstrates that the braces can withstand static and displacement loads of 60kg and 100kg, respectively. The integration of advanced materials and innovative manufacturing techniques holds promise for enhancing structural strength and providing relief to individuals suffering from joint-related ailments.

Problems of Leg Brace

Long-term usage of a leg brace may result in skin irritation, especially ifthe brace is uncomfortable to wear or constructed of a material that prevents the skin from breathing.

Muscle atrophy: The muscles in the affected leg may weaken or atrophy if a leg brace is worn for an extended period of time.

Reduced mobility: Because leg braces can be heavy and inconvenient, it may be difficult for the wearer to move around without assistance.

Dependency: If a person needs a leg brace to move around, they can startto hesitate to move without it, which could result in a dependency on the device.

Cost: Leg braces can be pricey, particularly if they need to be created to order or if they need to be adjusted frequently.

Impact on the mind: A leg brace can be emotionally taxing to wear because it serves as a continual reminder of an individual's injury or impairment. Additionally, it could cause feelings of uneasiness or self- consciousness.

Materials & Methods

Acrylonitrile Styrene Acrylate (ASA)

- Acrylonitrile Styrene Acrylate (ASA) filament is an FFF 3D printing thermoplastic material. This is implemented in a variety of applications, including automotive, construction, and electronics. ASA is a copolymer which includes acrylonitrile, styrene, and acrylic rubber, giving it a distinct set of qualities.
- ASA has good weather ability and UV resistance, therefore being perfect for outdoor applications that are subjected to direct sunlight and weathering. It is also resistant to impact and chemicals, making it suited for usage in hostile conditions. Because of its superior weathering performance and colour stability, ASA is frequently used as a substitute for other materials such as polycarbonate, ABS (Acrylonitrile Butadiene Styrene), and PVC (Polyvinyl Chloride). In filament form, ASA has excellent toughness, chemical stability, and aesthetic quality.
- These qualities, combined with exceptional UV resistance, make ASA filaments well suited for tough use cases and outdoor applications. Tooling, functional prototypes, and end-use components such as outdoor electrical enclosures and fixtures, and automotive housings are common applications using ASA filament.

ASA in 3D Printing

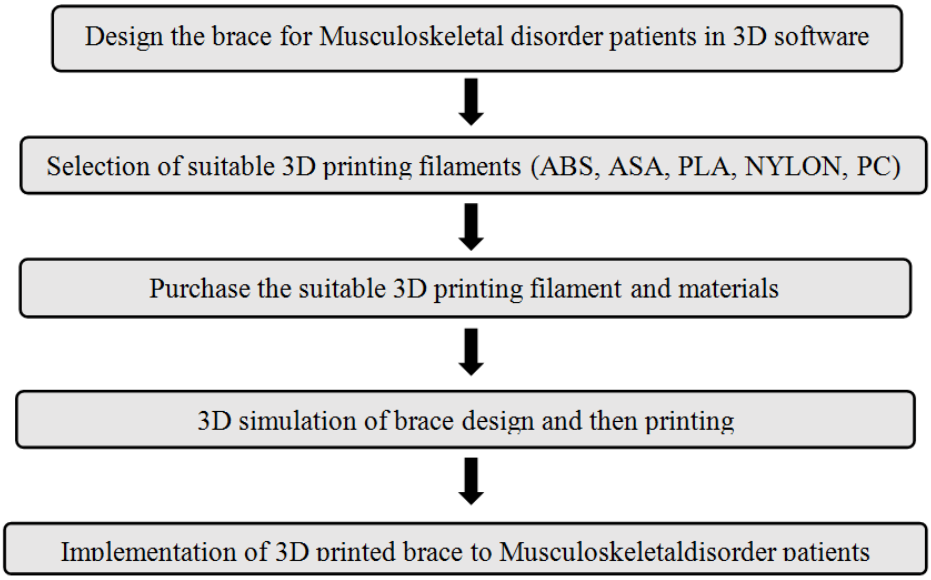
Prototyping: Because of its strong dimensional stability, ASA is an excellent material to construct functional prototypes that require high accuracy and

repeatability. Because of its mechanical qualities, ASA is also perfect for producing functioning prototypes of items that will be injection-molded in production.

Manufacturing: ASA can be used to create parts for a range of sectors, including automobiles, aircraft, and consumer goods. Because of its strength and endurance, it is perfect for manufacturing items that will be subjected to heavy use or stress.

Aesthetic applications: Because ASA comes in a variety of colours and finishes, including matte, glossy, and metallic, it is an excellent choice for manufacturing decorative or aesthetic pieces.

Flow Diagram



Methodology

- Software-Solid works: To produce tangible replicas of concepts that can either be subsequently investment-cast or utilised as master for Room Temperature Vulcanizing (RTV) silicon moulding, A solid scapes quick system prototypes have been combined with 3-D computer-aided design (CAD) software.
- All SOLIDWORKS, 3D, CAD software programmes are interoperable with Solidscape's system.
- Printing methodology: The most common three-dimensional printing method is fusing filaments depositing, which is an extrusion-based AM method.

Results

Due to its superior mechanical, thermal, and UV resistance capabilities, ASA (Acrylonitrile Styrene Acrylate) is a thermoplastic substance that finds extensive use innumerous industries. Since ASA has better weathering characteristics than ABS (Acrylonitrile Butadiene Styrene), it is a great option for outdoor applications.ASA is the best material for applications where parts will be subjected to strong loads or frequent impacts because of its great impact resistance. Additionally, due to its great chemical resistance, it can tolerate exposure to a variety of substances without deteriorating or disintegrating. In addition, ASA has good dimensional stability, meaning it keeps its size and shape even when exposed to temperature and humidity fluctuations.

Fig.4 Overall 3D Knee brace structure which covers thigh and knee for supporting purpose

According to the data's from the simulation the input parameters of PEEK were determined as follow as Tensile strength 9.5e+07 N/m^2, Compressive strength 1.25e+08 N/m^2, Elastic modulus 3.9e+09 N/m^2, Poisson's ratio 0.4, Mass density 1,310 kg/m^3. The axial breaking strength is greater than the circumferential breaking strength, as seen by the stress-strain curves. The findings of the trial demonstrated the leg brace placements wherein cracks or damages occurred.

The leg brace simulation's stress concentration positions correlate to the experiment's section in terms of location. Therefore, by examining the legbrace's stress distribution, the weak point can be identified. This makes the leg brace's structural optimization more convenient. Stability and support areprovided by the leg brace.Leg braces that can support loads of 60 kg in a static posture and 100 kg while they are moving were examined.

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CHAPTER 5

THE ANTICANCER ACTIVITIES OF ANNONA MURICTA FRUIT HYDROALCOHOLIC EXTRACT AGAINST HUMAN OSTEOSARCOMA CELLS

Krishnaveni S*, Maria J Mukkadan & Thilagavathy R

Department of Food Technology

Dhanalakshmi Srinivasan Engineering College(Autonomous), Perambalur, Tamil Nadu

Abstract

Cancer is considered as the second leading cause of mortality and over 10 million new patients are diagnosed with cancer annually with over 6 million and represents 12% of worldwide mortality. The rapid increase in cases is due to genetic manipulations, adoption of behavioural and dietary risk factors like smoking, unhealthy diet, physical inactivity and environmental pollutions. To overcome these issues, herbal drugs prepared from natural sources are used, as it has little or no side effects. In this study,Annona muricata(AM) extract was studied for anticancer activity in human osteosarcoma cells. Hydroalcoholic extract of AM extract showed the presence of carboxylic acid, carbohydrates, saponification, proteins, saponin, and gum and showed the dose dependent inhibition rate in anticancer activity. The anticancer activity of AM hydroalcoholic extract was found to be 83.54µg/ml and confirmed the apoptosis inducing property in ETBR/AO staining. Thus,Annona muricata fruit hydroalcoholic extract will act as a good therapeutic agent in anticancer property.

Keywords: *Annona muricata, Anti-cancer activity, Apoptosis.*

Introduction

Any organ or tissue in the body can develop cancer, which is a broad category of diseases. It is the disease within which the abnormal cells in human flesh grow uncontrollably and starts to metastasize through blood and lymph system and further dwell other organs where they will again repeat the uncontrolled growth cycle. There are many forms of cancer, but they begin due to control growth of abnormal cells. Most cancers are named from the cells or organ from which they start to metastasis (spread to other sites in the body from one site to another). They express varying degree of fidelity to their precursors. Several parts of the body get affected by cancer. Normal cells in our frame are constantly subjected to biological cell signaling that directs the cells to divide and differentiate to different cell or die immediately. New cells are created to interchange older ones or to perform new functions. Cancer cells develop a degree of autonomy themselves, and that they

don't stop growing when there are enough number of cells present within the body. This mechanism of continued growth often leads to tumor formation [1].

Cancer is either the leading or second-leading cause of death before the age of 70 in 91 of the 172 countries in the globe. According to GLOBOCAN, 9.6 million individuals worldwide lost their lives to cancer in 2018. By 2040, it is expected that there would be 29.5 million new cases of cancer and 16.3 million deaths from it. The growing cancer burden worldwide, which largely affects middle-to-low socio economic nations like India, is caused by a number of new and challenging concerns, including rapid urbanisation, population ageing, sedentary and unhealthy lifestyles, indoor and outdoor air pollution, etc. 5% of disability-adjusted life years (DALYs) and 8.3% of deaths were caused by cancer alone, according to the Global Burden of Disease (GBD) 2016 study. GLOBOCAN 2018 recorded 1.1 million new cases of cancer. Cancer was the fifth most prevalent cause of death in India in 2018, accounting for 5.7% of all fatalities, according to the Medical Certification of Cause of Death, 2018. By 2040, it is anticipated that more than 1 million people would die from cancer and that almost 2 million new cases will occur. The most current data from India, the National Cancer Registry Programme (NCRP), emphasises the differences in cancer incidence rates. The Aizawl district of Mizoram had male and female cancer incidence rates that were 7 and 4 times higher, respectively, than Osmanabad and Beed in Maharashtra.

When cells continue to grow and divide without stopping or dying when they should, a tumour is said to form. Tumours are abnormal masses of tissue. They arise when the body's cells multiply and expand too quickly. Malignant (cancerous) or benign (non-cancerous) tumours are two more possible tumour types. Malignant cancer cell tumours have the capacity to enter and expand across the encompassing tissues. While cancer cells sometimes break off and wander to foreign places in various parts of the body through blood or lymph systems and form new tumours far from the original tumour, benign tumours are made up of cells that do not invade other unrelated tissues or organs of the body despite continuing to grow in abnormal size. Any system will let go of unhealthy or superfluous cells to make way for new, healthy ones.[2]

Numerous types of bone cancer are referred to by different names depending on their histologic source: chondrosarcomas arise from cartilage, osteosarcomas from bone, fibrosarcomas of the bone are caused by fibrogenic tissue, and hemangioendothelioma and hemangiopericytoma are caused by vascular tissue. Notochordal tissue creates the chordoma. A number of primary bone cancers, most

notably the Ewing sarcoma family of tumours (ESFT), are unknown in terms of their histopathological origin. Adults who are middle-aged and older are more likely to develop chondrosarcoma. Osteosarcoma and Ewing sarcoma are more frequently seen in children and young adults. Chordoma is more common in males and increases in frequency in the fifth to sixth decades of life [3].

Methods and Materials

Chemicals and Reagents

Methanol,Whatman No.1 filter paper ,Fetal Bovine Serum (FBS), antibiotic solution, DMSO (Dimethyl sulfoxide) , MTT (3-4,5 dimethylthiazol-2yl-2,5-diphenyl tetrazolium bromide) (5 mg/ml), EtBr, Acridine, RPMI medium, 1X PBS, LSM ,96 well tissue culture plate and wash beaker.

Extraction of Plant Sample using Soxhlet Extraction

The test sample (AM), fresh or dried, was crushed using a pestle and mortar to provide a greater surface area. In our tests, we used an average of 14 g of thyme in a thimble of 25 x 80 mm, and the test sample needed to be big enough to fill the thimble made of porous cellulose. Stands and clamps were used to construct a rig that would support the extraction tool. A flask with a circular bottom that is attached to a Soxhlet extractor and condenser on a heating mantle was then filled with 50g of the sample and 50g of the hydroalcohol.The crushed plant material was placed in the thimble before being placed into the Soxhlet extractor. The side arm was lagged with glass wool. The solvent was heated by the heating mantle, which caused it to start to evaporate and travel through the apparatus to the condenser. The condensate then started to drip into the reservoir containing the thimble. When the solvent level reaches the syphon and runs back into the flask, the cycle begins again. The operation was set to take place for a total of 4 hours, then the machinery was turned off.

Qualitative Examination of Phytochemicals

The AM extract's phytochemical analysis was conducted using the methodology outlined in earlier research papers. [4]

1. **Detection of Resins**

After adding 3 ml of $CuSO_4$ solution to 0.5 ml of plant extract and shaking for one to two minutes, the appearance of a green precipitate showed the presence of resins.

2.Detection of Carboxylic acid

2 ml of sodium bicarbonate solution were added to 1 ml of plant extract. Changes in hue were a sign that carboxylic acid was present.

3. Detection of Tannins

2-3 ml of 10% HCl were added to 2 ml of plant extract before being heated for 5–6 minutes. Tannin presence was suggested by the appearance of a red colour.

4. Detection of Steroids

5ml of chloroform and an equal volume of concentrated H_2SO_4 were added to 0.5 ml of extract. Steroids were present because of the creation of red and yellow with green colours in the top and lower layers.

5.Detection of Flavanoids

4ml of 1% ammonia and 1ml of concentrated H_2SO_4 were added to 0.5 ml of extract. Flavonoids were present as evidenced by the development of a yellow tint.

6. Detection of glycosides

A.Preparation of hydrosylate

2 ml of concentrated HCl was added to 50 mg of extract, maintained in a water bath for an hour, and then filtered. The filtrate had moisture.

B. Born- Trageru's Test

After vigorously shaking 2ml of hydrosylate and 3ml of chloroform, the chloroform layer separated. A solution of 10% ammonia was then added. Pink colour formation suggested glycosides were present.

7.Detection of Proteins (Bradford Method)

The Bradford reagent was added to 500 µl of plant extract, incubated at room temperature for 10 to 15 minutes, and the optical density (OD) was measured at 575 nm.

8.Detection of Phenol (Ferric Chloride Test)

5ml of distilled water, along with a few drops of a 5% ferric chloride solution, were added to 50 mg of extract. When phenol was present, dark green colour started to emerge.

9. Saponin Test

A 2 cm layer of foam that formed after 15 minutes of vigorous shaking with 50 mg of plant extract and 20 ml of distilled water revealed the presence of saponins.

10.Saponification test

2 ml of extract was added to 1 or 2 ml of 10 N sodium hydroxide, and the mixture was then heated for 2 minutes. The production of soap or fat signalled a successful saponification test.

11.Gum Test

2 ml of distilled water were used to dissolve the 100 mg of plant extract. With steady stirring, 2ml of pure alcohol was added to it. Gums and mucilages were suggested by the white, hazy precipitation.

12.Detection of flavanoglycoside

5ml of ethanol was used to dissolve the 50 milligrams of plant extract. A few drops of magnesium sulphate and a few drops of concentrated HCl were added to that solution. Flavanoglycoside was present as shown by the development of pink colour.

13. Test for Alkaloids - Mayer's test

Two drops of Mayer's reagent were placed along the test tube's sidewalls to a few ml of plant sample extract. Alkaloids were present because of the precipitate's appearance, which was white and creamy.

14.Biuret Test

A drop of 2% $CuSO_4$ solution was added to 2 ml of extract. Next, 2–3 sodium hydroxide pellets and 1 ml of 95% ethanol were added. The development of the pink coloration suggested that the test was successful.

15.Detection of Carbohydrates

Benedict reagent was mixed with 0.5 ml of extract and heated for 2 minutes. The appearance of precipitate and colour changes suggested the presence of carbohydrates.

MTT Assay for Anti-Cancer Activity

Cell Culture

MG63 (Human Osteosarcoma cells) were purchased from NCCS, Pune and were cultured in liquid medium (DMEM) supplemented 10% Fetal Bovine Serum (FBS), 100 µg/ml penicillin and 100 µg/ml streptomycin, and maintained under an atmosphere of 5% CO_2 at 37^oC**.**

MTT Assay

The AM sample was examined using the MTT assay on MG63 cells to determine its in vitro anti-cancer effectiveness [5].The growing MG63 cells were quickly harvested by trypsinization, and they were then gathered in a 15 ml tube. Following that, the cells were plated into a 96-well tissue culture dish at a density of 105 cells/ml cells/well (200 L) and exposed to several doses of the AM sample in a serum-free DMEM media. The cells were cultivated for 24 hours at 37 °C in an

incubator with 5% CO2 humidity, with three replicates of each sample. Following the initial incubation, MTT (10 L of 5 mg/ml) was added to each well, and the cells were then allowed to continue to incubate for an additional 2-4 hours until purple was observed.After being aspirated out of the wells, the medium and MTT (220 L) were washed with 1X PBS (200 l). In order to dissolve the formazan crystals, more DMSO (100 L) was added, and the plate was stirred for 5 minutes. The absorbance for each well was measured at 570 nm using a microplate reader (Thermo Fisher Scientific, USA) and the percentage of cell viability and IC50 value were calculated using Graph Pad Prism 8.0 software (USA).

Apoptosis Assay

ETBR/AO Staining

In a nutshell, MG63 cells were seeded at a density of 5 x 105 cells/ml into a tissue culture plate with 96 wells and incubated for 24 hours in DMEM growth media. Following incubation, the cells were given 83.54 µg/ml of an AM extract devoid of serum. The plate was incubated for 24 hours at 37°C at 5% CO_2 incubator. 10 µl of 1 mg/ml acridine orange and ethidium bromide were added to the wells after incubation and gently mixed. The plate was then spun for 2 minutes at 800 rpm, reviewed within an hour, and at least 100 cells were observed using a fluorescent filter under a fluorescence microscope [6].

Results and Discussion

Primary bone malignancies are exceedingly uncommon neoplasms that make up less than 0.2% of all cancers, yet the real prevalence of these tumours is difficult to ascertain due to their rarity. The three most prevalent types of bone cancer are osteosarcoma (35%), chondrosarcoma (30%), and Ewing sarcoma (16%) [7]. Giant cell tumour of the bone (GCTB), fibrosarcoma, chordoma, and malignant fibrous histiocytoma are uncommon tumours that make about 1% to 5% of all primary malignant bone tumours [8]. According to the WHO, 70 percent of cancer fatalities occur in low- to middle-income nations. In this investigation, bone osteosarcoma cells were tested against a hydroalcoholic extract of *Annona muricata*. Hydroalcohol was used as the solvent in a soxhlet extraction to get an anona muricata extract. A series of 15 qualitative phytochemical experiments were run on AM fruit extract to identify secondary metabolites, and anti-cancer activity in bone osteosarcoma cells (figure 1), MTT assay (figure 2), and apoptosis assay (ETBR/AO) (figure 3) were run as well.In a phytochemical examination, AM extract demonstrated negative

findings for resins, tannins, steroids, flavonoids, glycosides, phenol, biuret, flavanoglycoside, and alkaloids but confirmed the existence of carboxylic acid, carbohydrates, saponification, proteins, and gum. Alkaloids, saponins, Terpenoids, flavonoids, Coumarins, lactones, anthraquinones, tannins, cardiac glycosides, phenols, and phytosterols were found in the ethanolic leaves extract of *Annona muricata*, according to Yahaya et al. [9]. The outcomes achieved by Yahaya et al. were comparable to the outcomes

The MTT method was used to examine the anticancer efficacy of AM hydroalcoholic extract against human bone osteosarcoma cells. A higher concentration of 500g/ml of AM fruit extract revealed a cell viability of 71.26%, whereas a lower concentration of 10g/ml of AM extract revealed a cell vitality of 114.62% (figure 2). AM hydroalcoholic extract was discovered to have 83.54 g/ml of antitumor activity. According to a recent study, *Annona muricata* leaves cold extract has anticancer properties that reduce tumour size, exhibit anti-metastatic properties, and cause apoptosis in 4 T1 cells both in vitro and in vivo [10]. Yahaya et al. observed that the ethanolic and water leaves extract of *Annona muricata* had anticancer and antitumor effects on Ehrlich ascites carcinoma cells, breast cancer cells, MDA, and SKBR3 [8]. The ethanolic extract of Annona muriate leaf extract demonstrated a concentration-dependent decrease in cell population [11].

Conclusions

The hydroalcoholic fruit extract of *Annona muricata* was shown in the current investigation to have anticancer properties. The hydroalcoholic extract of AM extract revealed the presence of a number of phytoconstituents including carboxylic acid, carbohydrates, saponification, proteins, saponin, and gum, which are essential for the anti-cancer action. AM hydroalcoholic extract demonstrated 83.54 g/ml of anti-cancer efficacy in bone osteosarcoma cells. The results of this study indicate that Annona muricata hydroalcoholic extract has anti-cancer action and may be a useful therapeutic agent in anti-cancer investigations.

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Legends to Figures

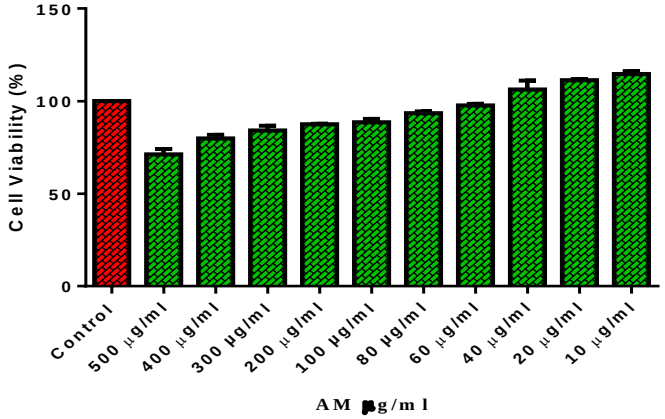

Figure 1:Percentage of cell viability against AM extract

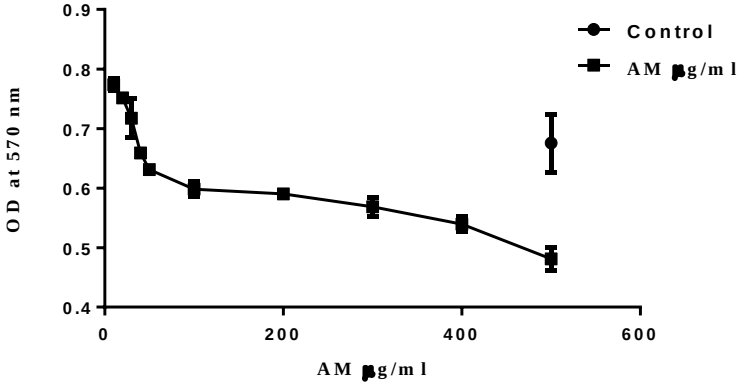

Figure 2: Absorbance obtained for AM extract at 570nm (MTT assay)

Table 1: Results of ETBR/AO staining

S.No	Dead cells	Necrotic cells	Pro-Apoptotic cells	Apoptotic cells	Live cells
1.	11	5	24	26	4
2.	13	9	21	23	7

CHAPTER 6

DECOLORIZATION STUDIES OF SYNTHETIC REACTIVE YELLOW 4 AZO DYE BY RHIZOPUS ORYZAE

P. Rajkumar & N. Sangeetha*
Department of Chemical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

T. Jayakumar
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

Abstract

Rhizopus Oryzae, a fungus, decolored the synthetic dye (CI Reactive yellow 4). The factors that determine the decolorization pattern during dye decolorization include dye concentration, pH, nitrate, and co-substrates (dextrose, starch, and sewage). The amount of CI Reactive Yellow 4 that has been decolored is 88% of the dye's 10 mg/lit starting concentration. The elimination percentage reduces as concentration rises. The range of 6.6 to 7.8 was examined and confirmed to be the ideal pH for decolorization. Starch, a co-substrate, has been proven to be more effective than comparable amounts of dextrose and sewage in terms of decolorization rate. The decolorization pattern exhibits an inhibiting impact of nitrate. Substrate inhibition modeling was used to simulate the kinetics of dye decolorization. The Levenspiel model was used for the substrate inhibition and was found to suit the experimental data effectively. Calculations revealed that the Levenspiel model's constants are K_m *= 15.22,* K_i *= 85.96, and* V_{max} *= 0.832.*

Keywords: *Azo dye – Reactive Yellow – Decolorization – effect of pH, Nitrate, Co-substrate – Levenspiel model.*

Introduction

Because of their ease of use, cost-effectiveness in synthesis, stability, and range of hues compared to natural dye, synthetic dyes are widely utilized in a variety of applications including textiles, wall colors, foodstuffs, paper, and printing industries. The main producers of poisonous dyes that harm the environment are the textile and dye production sectors. The total number of individual colors and pigments utilized is about 10000.

According to estimates, during the dyeing process, 40% of the dye is lost in the effluent. The aesthetic value, water transparency, and gas solubility of water bodies

are all negatively impacted by the presence of even a very little amount of dye (10–50 mg/L) in the water. Acidic, basic, direct, dispersion, mordant, reactive, sulfur, aces, and vat dyes are some of the dyes that are often used in the textile and tannery industries. Synthetic dyes can be categorized according to their chromophores, which include orzo, anthraquinone, and indigo chromophores, and have varied chemical structures to satisfy specific coloring requirements.

The majority of the more than 10,000 commercial dyestuffs are azo dyes. In traditional activated sludge treatment, the majority of azo dyes are resistant to aerobic microbial attack. However, it has been discovered that azo dyes can be effectively removed from water by sequential anaerobic-aerobic treatment.

Due to the fact that commercial dyestuffs contain ouzo and other chromophores, dye composition may also have a significant role in unstable decolorization. As a first step in understanding and resolving the issue of unstable decolorization performance, we looked into the decolorization potential and kinetics of the most active bacteria in the mixed population of sludge.

The current physicochemical methods of decolorization may be replaced by economically and ecologically appealing biological solutions in the future. Numerous naturally occurring microorganisms, including bacteria and fungi, can be used to perform biological decolorization.

Synthetic dye was decolored using pure culture. The type of microorganisms utilized and the process's operating circumstances affect how well dye can be decolored.

Literature Survey

According to Zollinger (1987), more than 10,000 commercial dyes are manufactured. Anthraquinone and azo functional groups are the most prevalent in nonionic dyes, whereas anionic chromophores are what give colors their properties. Due to their intricate aromatic structures, anthraquinone-based dyes linger in wastewater for a longer period of time. According to Mishra and Tripathy (1993), metal complex dyes are highly carcinogenic in nature while basic dyes have good visibility even at very low concentrations. A majority of the dyes produced—60% of all dyes—are azo dyes. 2001's Abdul Rahim Khatri Figure 1 below shows the structure of reactive azo dye (Yellow).

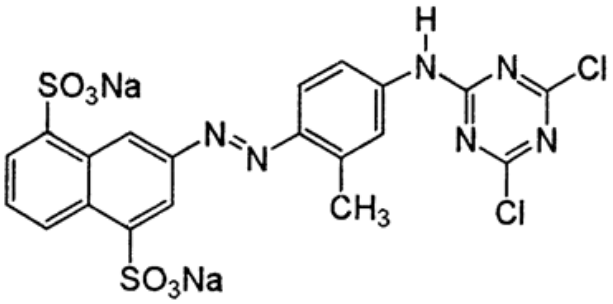

Fig.1 Structure of Reactive azo dye

Jiyan Yu, et al. (2001) conducted research on Pseudomonas strains' ability to decolorize synthetic dyes in the best possible way. A Pseudomonas strain GM3's decolorization of Acid Violet 7 (mono azo) under diverse circumstances was carefully examined. A tight temperature range (35-400C), a narrow pH range (7-8), and the presence of organic and ammonium nitrogen all contributed to the highest levels of decolorization activity. Nitrate significantly inhibited the decolorization of azo dyes: 10 mg/L resulted in a 50% reduction in decolorization activity, and 1000 mg/L in a full depression of activity. A kinetic model is developed that shows how the decolorization rate varies with dye concentration and cell mass concentration (first- and second-order, respectively).

Bar-Yann (2002) Chen conducted research on the toxicity and kinetics of Pseudomonas luteola's decolorization of reactive azo dyes. Reactive acid yellow (RAY), Reactive black B (BB), and Reactive red 22 (RR22) are the three colors in the toxicity series. The less harmful dyes, like RR 22, are easier to bio-decolorize.

In order to absorb Reactive Brilliant Red in solution, Gallagher et al. (1997) used Rhizopus Oryzae biomass. They found that both Freundlich and Langmuir isotherm models fit biosorption well, indicating adsorption by combining mechanisms into a heterogeneous surface.

In a 2003 study, S. Padmavathy et al. investigated the decolorization of reactive azo dyes by aerobic oxidation in the presence of a number of co-substrates, including glucose, starch, lactose, and sewage. It was found that the best source of carbon for decolorizing reactive dyes was starch.

Modeling the kinetics of microbial dye decolorization is an important aspect of dye utilization studies. The reaction rate obtained for dye decolorization was modeled by Michaelis - Menten kinetics (Bailey and Ollis, 1986) and substrate inhibition models of Haldane and Levenspiel.

C.krithika (2003) studied azo dye decolorization using mixed culture and calculated the parameter in haldane and levenspiel model. The parameter values in

Levenspiel model were obtained by numerical and analysis applying mat lab version 6.1.

Material and Methods

Glucose, Dextrose, Starch, Lactose (S.D. Fine chemicals limited and SLR fine chemicals limited) and other chemicals also used. Commercial-grade synthetic dyes were utilized in this investigation, and they were purchased from a firm that processes textiles.

Fungal Strain

The Institute of Microbial Technology in Chandigarh provided *Rhizopus Oryzae - 262 (7:250C).*

Growth Media

Potato Dextrose Agar (Fungal cultures):

Potatoes - 200g.
Dextrose - 20g.
Agar - 15g.
Water - 1lit.

Boil diced potatoes in 500 ml of water in order to fully boil them, Cheesecloth should be used as the filter, and water up to 1 litre should be added. Agar is added in the filtrate and it will be dissolved by boiling. Remove from heat and adjust pH to 5.6 by adding glucose.

Apparatus Required

Auto clave, Hot air oven, Laminar flow chamber, Loop wire, Petri dish, Test tube, Beaker, Conical flask, Pipette, Burette, Standard flask, Measuring jar.

Different Synthetic Dyes

Table 1 lists the various synthetic dye types employed in this study.

Table 1.Different Synthetic Dyes.

S.No	Synthetic dye
1	Acid red 183
2	Acid violet 7
3	CI reactive red17
4	CI reactive yellow 4
5	Acid green 27

6	Reactive black 5
7	Acid red 183

Maximum absorbance for synthetic dyes:

The maximum wavelength for the following synthetic dyes is shown in Table 2

Table 2.Maximum wavelength for Synthetic Dyes.

S.no	Name of synthetic dye	Maximum wavelength (λ_{max}) (nm)
1	CI Reactive Yellow 4	400
2	CI Reactive Red 17	360

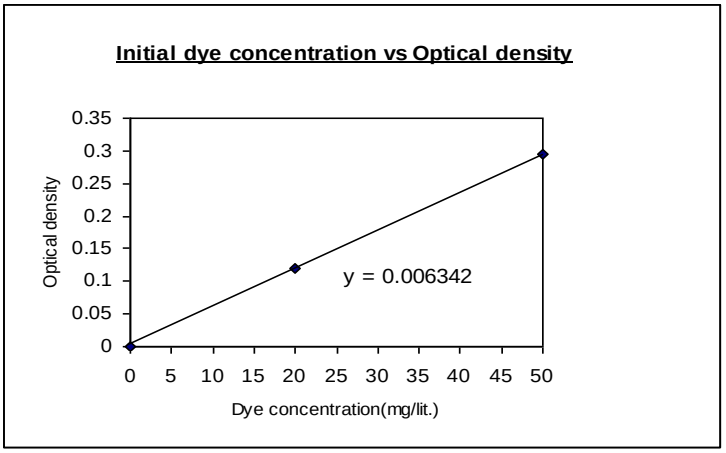

Fig.2 Standard chart for CI Reactive yellow 4.

Experimental Method

250 ml Erlenmeyer flasks with a 100 ml working volume were used for batch investigations. Utilizing an EVERFLOW vertical laminar flow cabinet under sterile conditions, pure fungal cultures produced on agar plates were used for inoculation. The inoculated flasks were incubated at ambient temperature (32 °C) or under agitated conditions in an orbital shaker that rotated at 120 rpm (Orbitek, India). All experiments were performed in triplication and results at the same conditions were averaged.

Screening of Synthetic Dyes

To test the decolorization potential of Rhizopus oryzae, seven synthetic dyes (Acid violet 7, CI Reactive yellow 4, Reactive black 5, CI Reactive red 17, Reactive

blue 2, Acid green 27, Acid red 183) were used. One of these dyes (CI Reactive yellow 4) had a high decolorization potential with the aforementioned strain.

Analytical Techniques

Analysis of Dyes

An UV-Vis Spectrometer (ELICO, SL164, Hydrabad, India) was used to colorimetrically detect the amounts of unabsorbed dye in the solution. At each color's maximum wavelength, the absorbance was measured.

Biomass

For 15 minutes, a fixed volume of culture media was centrifuged. The pellets were taken out, cleaned with double-distilled water, and then put through a Millipore membrane filter that had been dried and weighed beforehand. At 103^{o}C, the filter paper was dried to a consistent weight, and the biomass dry weight was calculated.

Results and Discussion

Rhizopus oryzae was used to study the effects of many parameters on decolorization, including dye concentration, pH, inoculum size, glucose, nitrate, and co-substrate.

Effect of Dye Concentration

For CI reactive Yellow 4, the influence of dye concentration on decolorization was investigated between 10 and 50 mg/litre. Figure 3 depicts the results of the study on the influence of dye concentration on decolorization for CI reactive Yellow 4.

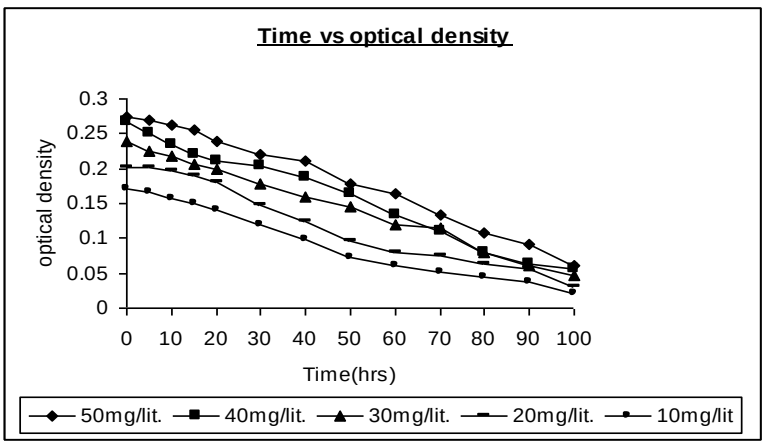

Fig. 3 Decolorization plots for CI Reactive Yellow 4 dye by pure culture.

Figure 4 shows the proportion of dye removed at various initial dye concentrations.

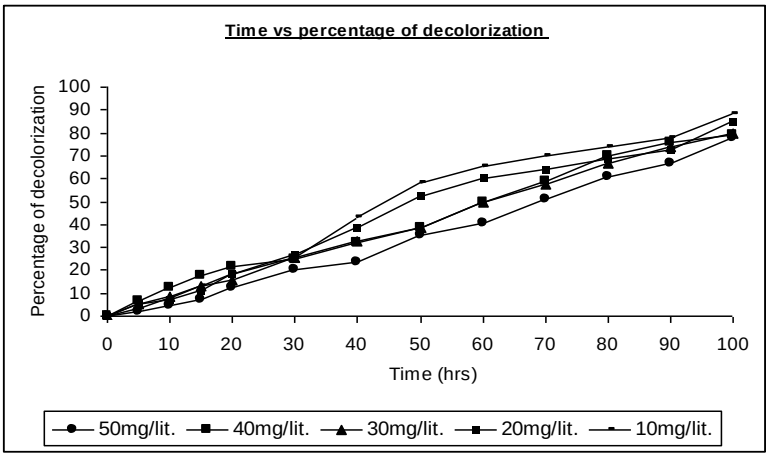

Fig.4 Percentage of decolorization

Effect of pH:

The pH range of 6.4 to 7.8 was studied to determine how pH affected decolorization.

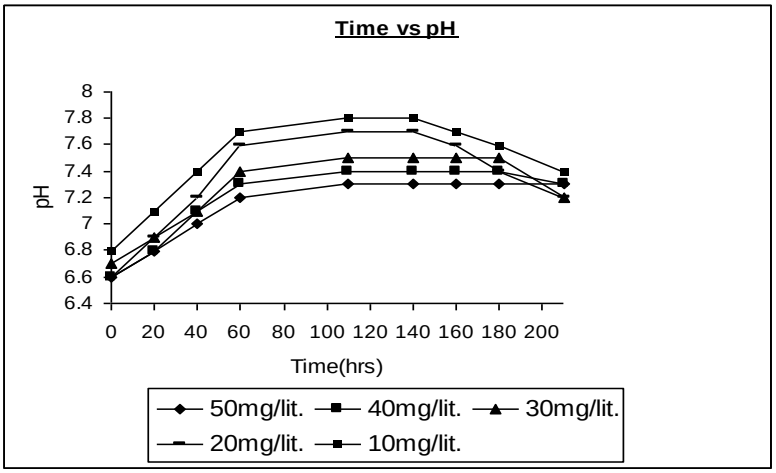

Fig. 5 Effect of pH on decolorization

The tested pH range reveals that the largest quantity of decolorization was seen at pH 7.8.When the pH of the medium is raised above 7.8, the decolorization effect is shown to diminish. The decolorization procedure should therefore begin with 7.8.

Effect of Inoculum Size

The culture was inoculated with precedes media in the range of 2-20%

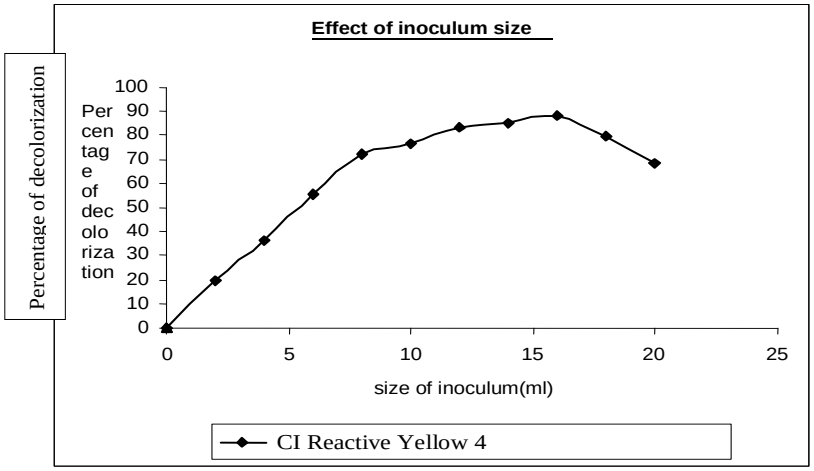

Fig. 6 Effect of inoculum size on decolorization for Reactive dyes

The maximum amount of inoculum decolorization, shown in fig. 4.3, is caused by the availability of nutrients and the impact of population density on the hydrodynamic properties of the medium, both of which ultimately contribute to the decolorization phenomenon.

Effect of Co-Substrate on Decolorization

The percentages of color decolorization for reactive azo dyes in the presence of a co-substrate are shown in Table 3**.**

Table 3. percentages of color decolorization for reactive azo dyes

Azo dye Concentration (10mg/lit.)	Percentage of decolorization (%)		
	Dextrose	Starch	Sewage
Reactive Yellow 4	85.2	90.26	87.2

When numerous co-substrates, including glucose, starch, and sewage, are present, decolorization of synthetic reactive azo dyes (CI Reactive yellow 4) is compared. Regarding decolorization, starch is regarded as the best co-substrate.

Effect of Nitrate on decolorization:

A nitrate concentration of 1000 mg/litre led to only 2% color loss, which was most likely caused by the physical adsorption of dye molecules by cell mass, as compared to 88% color removal under natural conditions.

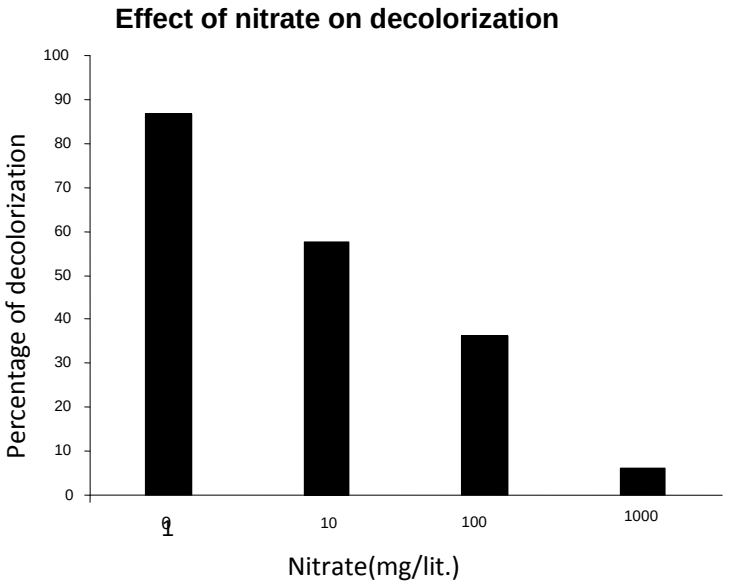

Fig. 7 Inhibitive effect of nitrate for CI Reactive Yellow 4.

Decolorization Kinetic Model

Modeling the kinetics of microbial dye decolorization rate is an important aspect of dye utilization studies. The parameters for the initial dye concentration and decolorization rate for CI Reactive yellow 4 are shown in Table 4 and fig 8

Table 4. Values for initial dye concentration and decolorization rate

Dye concentration (mg/lit.)	Decolorization rate (mg/lit.hrs)
0	0
10	0.176
20	0.231
30	0.246
40	0.257
50	0.27

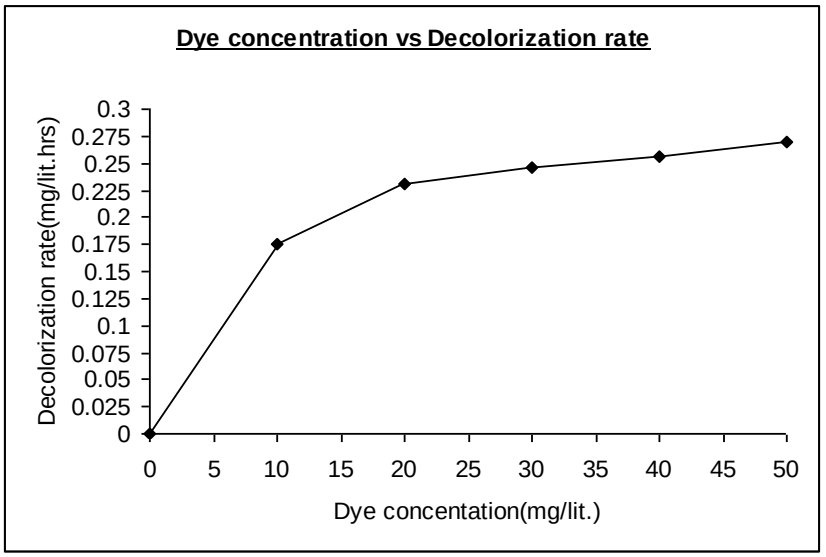

Fig.8 Decolorization rate for CI Reactive yellow 4.

Decolorization rate

Although there was a non-linear increase in rate with the dye content in the media, it was found that the decolorization rate was reliant on the starting dye concentration.

Biomass Growth in Presence of Dye

The growth cures shown in presence of dye are indicated in figure 9 and 10 at 15ml dye solution.

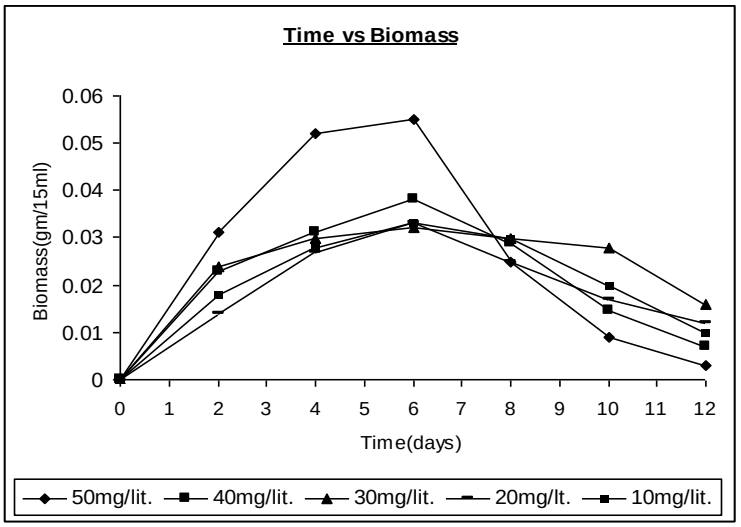

Fig.9 Biomass growth curve for CI Reactive Yellow 4.

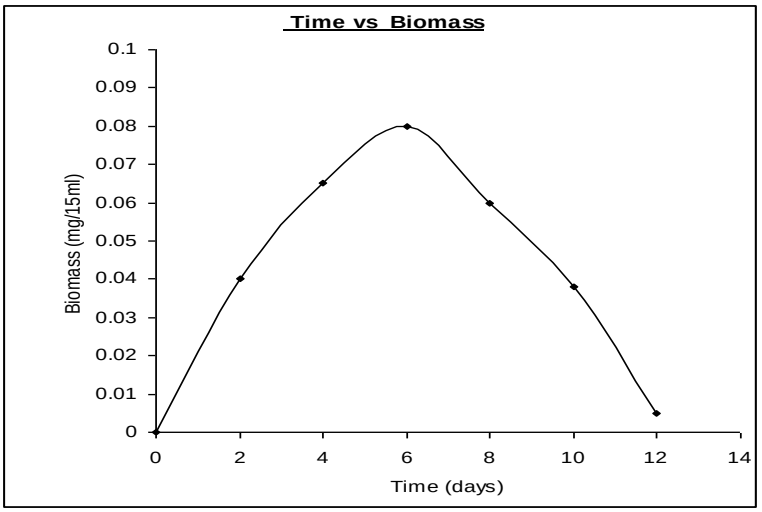

Fig. 10 Biomass growth in absence of dye

Then graph between initial dye concentration and specific growth rate was drawn

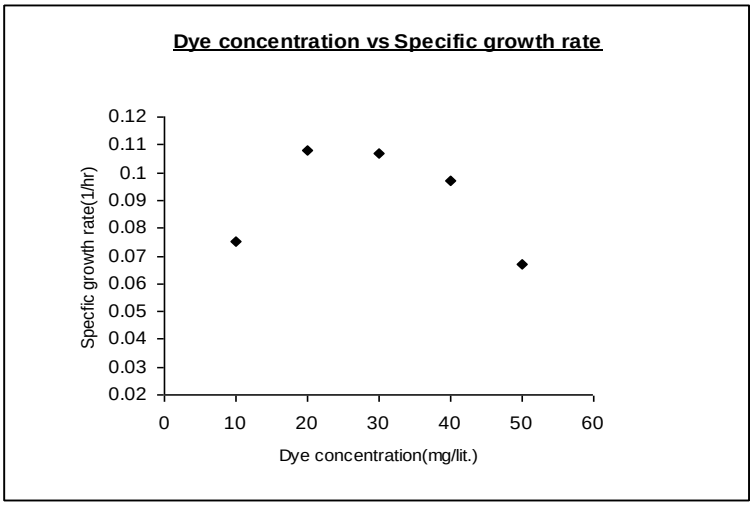

Fig.11 Effect of initial dye concentration on the specific growth rate

It is possible to estimate the effect of the substrate inhibiter on the reactor rate from the graph above.

The relationship between the specific growth rate and the rate of dye decolorization can be observed in the graph below.

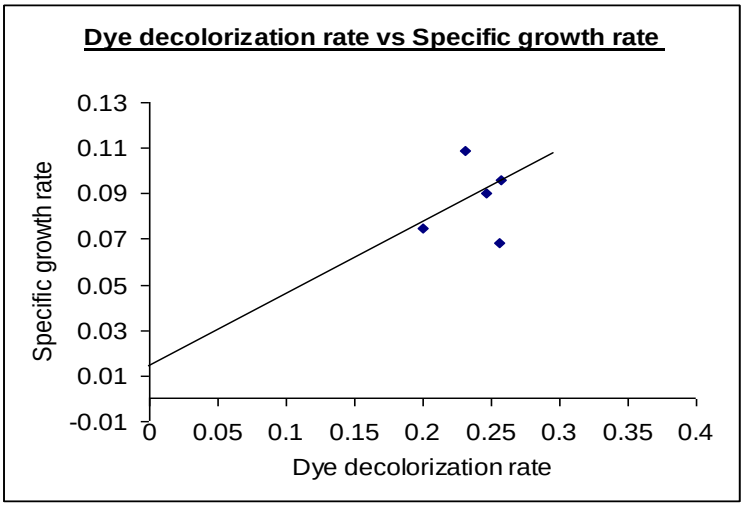

Fig. 12 Variation of specific growth rate with concentration

Kinetic Model

The reaction rate obtained for dye decolorization was modeled of Levenspiel. Using a Lineweaver-Burk plot, the Michaclis-menten constant K_m and decolorization rate V_m were estimated for the current system.

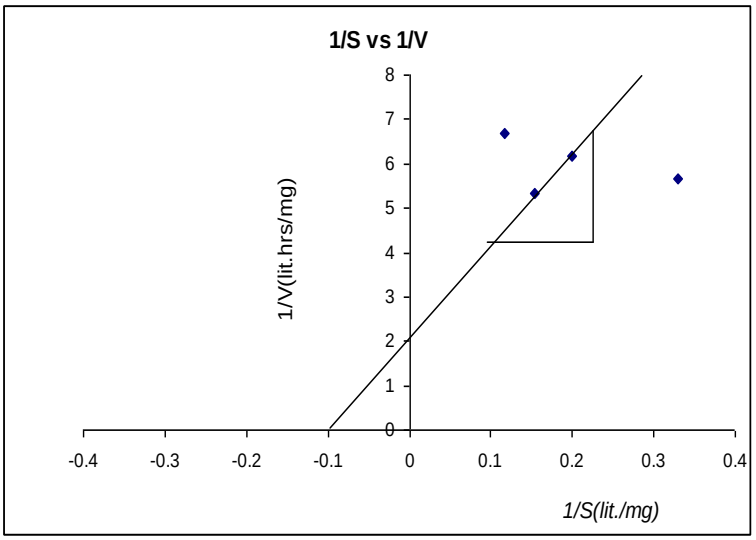

Fig.13 Lineweaver-Burk plo

$1/V_{max} = 0.1$

$V_{max} = 10$

$K_m/V_{max} = 1.57$

$K_m = 15.7$

The predicted decolorization rates according to the Levenspiel model were compared with experimental values is shown in figure 13 and 14.

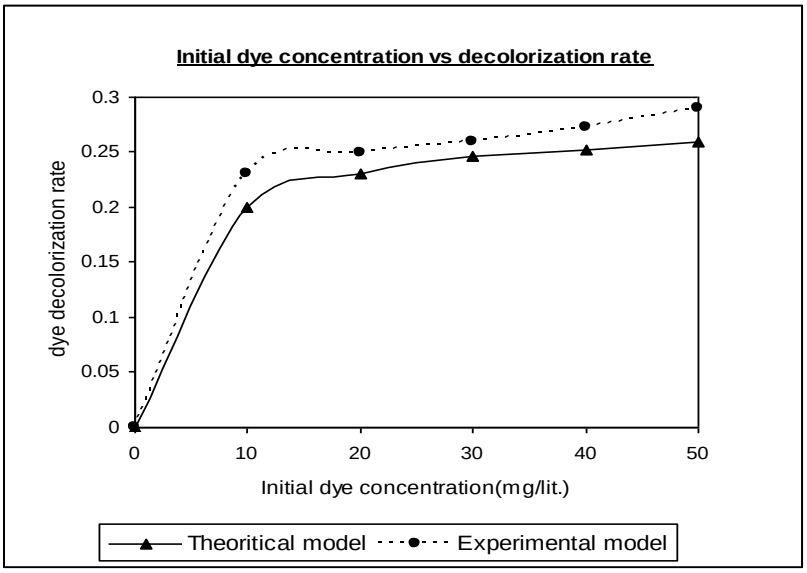

Fig. 14 Dependence decolorization rate on the initial concentration of CI Reactive yellow 4

Conclusions

At an initial dye concentration of 10 mg/lit, decolorization was reported to be 88% for reactive yellow 4 azo dye and 84% for reactive red 17 azo dye. Drop in removal % as initial concentration increases.

The optimal range of pH for decolorization was shown to be between 6.5 and 7.8. The effects of other variables like nitrate and co-substrates on azo dye decolorization are investigated. In presence of Nitrate inhibitory effect was observed and the in presence of co-substrate (starch) the decolorization is enhanced. The dye decolorization pattern was found to correlate with the biomass growth in the system. The dependence on the dye initial concentration was described by Michaelis-Menten and related substrate inhibition kinetic models.

Levenspiel model fitted the experimental data and the corresponding Km = 15.22,

K_i = 85.96 and V_{max} = 0.832. was found by numerical analysis using mat lab 6.1.

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CHAPTER 7

DESIGN OF RECHARGE PIT IN RED LOAMY SOIL FOR DUG WELL RECHARGE IN PUDUKOTTAI DISTRICT

Abinaya A*
Department of Agriculture Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Prabavathi S, Prithivi M & Durka Devi A
Department of Civil Engineering
Agni College of Technology, Chennai, Tamil Nadu

Abstract

Water is the crucial element which plays a main role in all kind of activities such as drinking water supply, irrigation, hydropower and navigation etc., there are two aspects of water in or on the earth. One is surface water and another one is groundwater. In many areas due to the population increases and uncertainties of rainfall, groundwater level decreasing by the activity named as "Overexploitation of Groundwater" So it is important to restore the Groundwater. It is done by either natural or artificial recharge techniques. In artificial groundwater recharge, dug well recharge is the method to improve the Groundwater level. In the study area, the runoff is taken into the account to recharge the well. This excess water is diverted into the filtration unit and after the filtration process, it is directed to the wells.

The main aim of the study is to design the efficient filtration system for the particular soil type. Based on the soil condition different models are carried out to find a suitable system. Finally, an efficient filtration system (3x3x4 cubic feet) is designed from the arrived models. These filtration unit consist of (from bottom to top) Coarse aggregate layer (0.5 ft), Gravel 5mm (0.5ft), Sand (0.5ft), Charcoal (0.5ft), Gravel 5mm (0.5ft) and freeboard (1ft). Charcoal and sand are used to arrest the fine particles. This method is simple, affordable and anyone can adopt it easily.

Keywords: *Overexploitation, Groundwater, Filtration, Dug well and Artificial Recharge*

Introduction

General

Water is a vital component that determines the full potential of the agricultural sector of any country. There are many ways of harvesting water. The main categories include surface water collection, Groundwater collection, and Augmentation of GroundwaterRecharge.Runoff water collection is one of the useful methods for augmenting water especially in rural areas which can be easily

adopted by implementing filtration system with the involvement of the local people. This method is an ideal solution to water problem where there is inadequate groundwater supply. The collected water can be stored in either wells or ponds which can later be utilized for agricultural and other domestic purposes during dry periods and even it serves for groundwater recharging. Efficient utilization and management of available rainwater along with recharge options is the core issue if the cropping intensity and production are to be enhance [1][6].

Illupur is a panchayat town located in Pudukkottai district. The project deals with the design, construction and manipulation of efficient and cost-effective water harvesting structure. The main aim of this project is to find an ideal solution to the water problem in these areas of minimum rainfall intensity and inadequate groundwater supply. In regards with field visit and questionnaire survey, the main issues and problems were identified to be an insufficiency in water availability and deposition of silt and mud inside the wells due to the inefficient filtering unit. Various literature survey, design approach and experimental study were conducted in order to arrive at the best-suited filtering system of water harvesting structure. The main objective is to design the recharge pit in red loamy soil for dug well recharge in Pudukottai district, to recharge wells by collecting runoff from the surrounding catchment area and to conserve rainwater in the dry and semi-arid regions and for efficient utilization of good water during dry periods for irrigation and another domestic purpose [21].

The rainfall intensity and Groundwater potential in the semi-arid region are below average. The simple and economical way to increase the Groundwater level is Recharging of water either by natural or Artificial. Due to the uncertainties of rainfall and overexploitation of Groundwater, water in the well decreasing its level which results in water scarcity, poor irrigation and the low productivity. So it is needed to augmenting the Groundwater in the well for the study area to ensure water productivity [13][14][15].

Study Area Description

An experimental study was conducted in the field area called Pattikadu Campus of Illupur Agriculture Producer Company Limited (IAPCL) and samples for the experimental study were collected from the catchment of corresponding wells around Illupur.

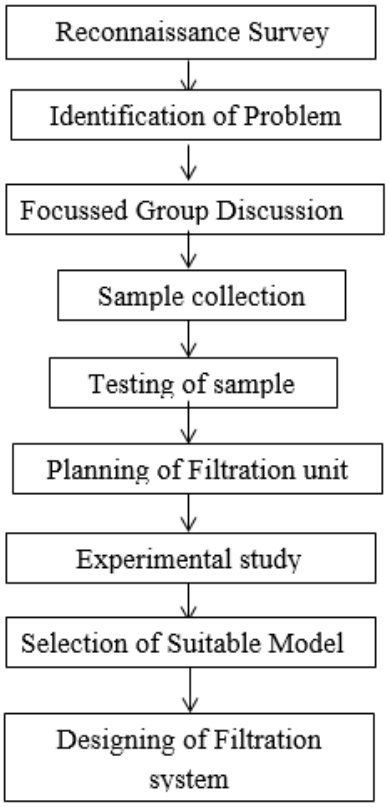
Illupur is located in Pudukkottai district at a latitude of 10.51 N and longitude of 78.62 E. It has an average elevation of 142 metres (465 feet). According to the 2011 census, the taluk of Illupur had a population of 2,18,961. The soil texture at the site is Red loam with fine clay particles. The study area is located in a hot semiarid region. The area experiences only limited rainfall with the average annual rainfall intensity of around 690mm. The rainfall intensity is insufficient to meet the water requirement. The mean annual minimum and maximum temperatures are 26˚C and 36˚C respectively [5][20].

Problem Identification

Here, the type of soil is Red loam. Runoff from those areas has more sedimentation. While visiting the Filtration system (Implemented by Government) it is identified that the filtration is not functioning properly. The sand particles from the runoff are highly deposited on the first layer and it disturbs the entire flow of water. Hence it totally affects the filtration process. Since it is a normal conventional system, they have used the materials like Sand, Gravel and Coarse Aggregates in their filtration system which results in muddy water into the well. Hence, it comes to know that the turbidity is controlled by providing standard depth of layers[2][3].

Methods and Materials

In this project, a reconnaissance survey is done to study the existing filtration system and the factors responsible for its failure. After that, the causes for their problem have been addressed. To work out these things, samples from that area are collected to assess the soil characteristics. Based on these, a filtration unit was planned and many of the experimental models have been prepared to select the suitable model. Finally, an efficient Filtration system is being proposed.[4][19]



This project deals with efficient water harvesting structure carried over by Illupur Agriculture Producer Company Limited (IAPCL) funded by MSSRF. In this chapter, the process of sample collection, modelstudy were discussed below. Samples are collected from various places around the village. The runoff from the surrounding well area contains some amount of dust particles and clay particles in it. These samples are tested to know the amount of turbidity.In some places, the runoff water has more turbidity due to the high amount of clay particles present in the water.A water sample of 500ml is being taken to test the settlement of clay particles. It is found that none of them has been settled because the clay particles are very finer in nature, it dissolves in water.Therefore, it is concluded that the clay particles can be separated only if the coagulant is added. In this coagulation process, Potassium Aluminium Sulphate (Alum) is used to trap the clay particles present in water. It is followed` by people in some places for the purpose of water purification, fertilizer purpose, etc., and hence it is a simple and economical way of treating the turbidity water [7][11].

Coagulation Test

A coagulant (typically a metallic salt) with the opposite charge is added to the water to overcome the repulsive charge and "destabilize" the suspension. For example, the colloidal particles are negatively charged and alum is added as a coagulant to create positively charged ions.In this test, a 2litre of the raw sample is taken from the catchment area and 20mg of Alum powder is added. While adding the Alum, it mixes with the dissolved particles and traps the particles to be settled down in 2 to 5min.Alum neutralize the negative electrical charge on particles, which destabilizes the forces keeping colloids apart. So it is recommended that in places where the dissolved clay content is high the Alum powder is suggested [8][17][18].

Materials

Coarse Aggregates

Coarse aggregates are particles greater than 4.75mm but generally, range between 9.5mm to 37.5mm in diameter. They can either be from Primary, Secondary or Recycled sources.

Gravel

Gravel is a coarse marine-won aggregate; land won coarse aggregates include gravel and crushed rock. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder [15].

Charcoal

Granular Activated Carbon is an effective filtration media to remove the turbidity and iron content. Tests (Joyce, 1966) had shown that, in accordance with adsorption theory, granular carbon in beds is more efficient than pulverized carbon used in the slurry form in accordance with conventional water plant procedures. Granular activated carbon with an effective size greater than approximately 0.80-0.90 mm will probably usedin filtration process.[16]

Sand

Sand is the naturally available material which can be used as a filtration medium and gives good quality of water without adding any chemicals. The use of sand below the carbon layer can increase the quality of filtration [12].

Preparation of Model Filtration Unit

The model study was conducted by setting different layers of materials in a black limestone setup (Kadapakal) of dimensions 2x1.5x1 feet. The Water samples collected were allowed to pass through the layers and the removal of turbidity was checked and their outflow was measured.

Results and Discussion

Different trials were made to find the suitable filtration unit. The last trials with the measurements of gravel (5mm) 3.2cm, charcoal 5.6 cm, sand 2.8 cm, gravel(5mm) 5cm and gravel (40mm) 3 cm are considered to be a well filtering unit with the turbidity removal of 95% with good flow rate. So these particulars are chosen for the good filtration system.

Runoff Estimation

Runoff estimation is made with the assumption for different areas and it is calculated with the rational method.

Rational Method

Q = CiA

Where, C = Runoff coefficient (sandy loam/cultivable).

i = maximum rainfall intensity (inches/hr).

A = Total Catchment Area (Acre).

Trial: 1

Assume,

Rainfall intensity = 4 cm/hr

Area = 1 acre

Runoff coefficient = 0.5

Solution:

Q = CiA

1cm = 0.394 inches

Therefore, 4 cm = 1.576 inches/hr

Q = 0.5 x 1.576 x 1

= 0.788 cubic feet

= 22.31 lit/sec

Q = 80,316 lit/hr.

Trial: 2

Assume, rainfall intensity = 1 cm/hr = 0.394 inches/hr

Q = 0.5 x 0.394 x 1

z= 0.197 cubic feet

= 5.578 lit/sec

Q = 20,080 lit/hr

Trial: 3

Assume, rainfall intensity = 0.4 cm/hr

Q = 0.5 x 0.1576 x 1

= 0.0788 cubic feet

= 2.237 lit/sec

Q = 8032.96 lit/hr

Computation of Inflow and Outflow

Dimensions of the model filtration unit:

Diameter = 17 cm

Depth = 4 feet

Outflow of water for 1 min = 1.2 lit

Area calculation:

$A = \pi d^2/4$

$A = \pi \times 17^2/4$

$= 226.98\ cm^2 = 0.02269\ m^2$ or 0.244 sq feet.

Filtration Pit Trail Dimensions

Calculations were done using the outflow data obtained while testing the model filtration unit. And also the filtration timing will vary according to the dimensions of the filtration structure. So several trail dimension is made for choosing the efficient dimension for implementation.

Trail: 1

5 x 4 sq feet

Q = 5 x 4 x 1.2 /0.244

= 98.36 lit/min or 5901.6 lit/hr

The flow obtained by estimating the rainfall for 1cm per hr = 20,080 lit/hr. These 5 x 4 sq feet pit takes 3-4 hrs to filtrate the whole one-hour rainfall.

Trail: 2

4 x 3 sq feet

Q = 4 x 3 x 1.2/0.244

= 59 lit/min or 3540 lit/hr

The flow obtained by estimating the rainfall for 1 cm of rain per hour = 20,080 lit/hr. when we implement 4 x 3 sq feet it takes 5-6 hours to filtrate the whole one-hour rainfall.

Trail: 3

3 x 2 sq feet

Q = 3 x 2 x 1.2/0.244

= 29.50 lit/min or 1770 lit/hr

The flow obtained while estimating the rainfall for 1 per hour = 20,080 lit/hr. The 3 x 2 sq feet takes 12 hours to filtrate the whole one-hour rainfall.

Trail: 4

3 x 3 sq feet

Q = 3 x 3 x1.2/0.244

= 44.26 lit/min or 2655 lit/hr

The flow obtained while estimating the rainfall for 1 cm of rain per hour = 20,080 lit/hr. when we implement 3 x 3 sq feet it takes 7-8 hours to filtrate the whole one-hour rainfall.

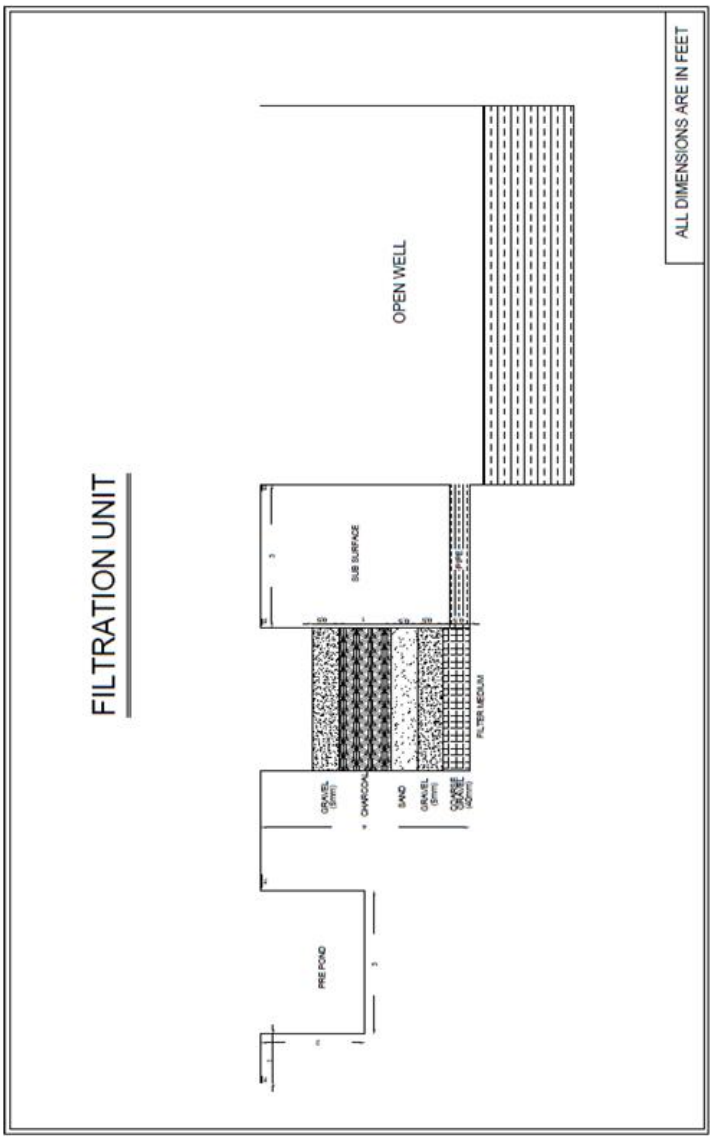
Selection of Dimension

From the above 4 trails it is concluded that the 4th trail is more efficient than the other estimated trails for the following reasons:

1. The rainfall data chosen here is the maximum rainfall for all over the puthukottai district and the surrounding villages.
2. The ***3 x 3 sq. feet*** structure is efficient to filter the rainfall for 1 hour within 8 hours and if the flow of rain continuous also it can filtrate the whole rainfall within a day.
3. The average rainfall for the district is only near 1 cm rainfall. It is efficient to provide the structure which filtrates the rainfall within a day because the available rainfall for this district is very low for the last 15 years.
4. It is enough to provide the structure with 3 x 3 sq feet and 4 feet depth.

Design of Filtration System

The filtration unit for the Dug Well is designed based on several studies considering the type of soil, topography of the certain area, average rainfall and also other required data was collected. The rainfall data for more than 30 years in the certain region was collected from the IMD and the study was carried out with the data. And also flow measurement were checked periodically for the different layers of material packages and the result was concluded [9][10].



Conclusion

Artificial Recharge of Ground Water is one of the most efficient Ground Water Management tools for controlling decline in Ground Water levels, resource

augmentation.Keeping in view the concerns regarding the problems of over-exploitation of Ground Water Resources, Dug Well recharge is the simplest method of water harvesting to ensure the sustainable water resource management. In this method, dug well is used for storing the water from surrounding catchment areas.

Dug well recharge is one of the wide groundwater recharge method and there are many government sectors and NGO'S like Central Ground Water Board, NABARD, MSSRF, DHAN etc., who actively engaged in funding and implementation of various schemes and subsidies related to dug well recharge using rainfall runoff from the surrounding agricultural lands.

MSSRF implemented a project of dug well recharge under subsidy in order to replenish the dried up wells around Illupur in Pudhukottai district, which is majorly covered by red loamy soil. Considering the impact factors of the government project already existing and the consequences of the problem related to red loamy soil, a new dug well recharge structure was implemented for 34 open wells which hopefully facilitates improvement in the irrigated agricultural productivity.

The present techniques are easy, cost-effective and sustainable in the long term especially for red loamy soil. In Tamil Nadu nearly 30% of the land area is covered with red loamy soil, where this technique is more suitable and can be suggested for implementation.

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CHAPTER 8

RECENT TECHNOLOGIES IN INNOVATIVE WHEY PRODUCTION – A REVIEW

Sangeetha N*, Akilandeshwari R, Dharani M & Priyadharshini Y
Department of Agriculture Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Shibani M
Department of Chemical Engineering (FPT)
Annamalai University, Chidambaram, Tamil Nadu

Abstract

It is well known that a variety of elements, including animal genetics, milk quality (chemical, physical, and microbiological), production technique, type of rennet used, and dairy cultures utilized, can affect the yield and quality of cheese. Major variations in the same kind of cheese (hard cheese) are brought on by by the dairy cultures and rennet, which have an impact on the ripening process. This review will examine recent developments in animal genetics, techniques for isolating and producing rennet and dairy cultures, potential uses of microencapsulation in the production of rennet and dairy cultures, and the challenge that biodiversity preservation poses to existing dairy technologies. Since the very beginning of cheesemaking techniques, whey cheeses have been produced as a sustainable way to employ whey, the main by-product of the process.A conclusion that can be drawn from the studied scientific literature is that novel approaches and the techniques outlined can considerably

Keywords: *dairy cultures; cheese quality; rennet; chymosin; coagulation; biodiversity; sustainable; microencapsulation*

Introduction

Cheese is a dairy product which is rich in minerals, protein, and lipids. Some aged cheddar and hard block cheeses with little moisture are simple to store and transport because they don't need refrigeration.Due to its reduced lactose content, a form of sugar that is difficult to digest if a person lacks the enzyme to break it down cheese may be more tolerable than milk for certain people.Cheese contains a variety of nutrients. One ounce of hard cheese, has 180 mg of calcium, 120 calories, 8 g of protein, and 6 g of saturated fat.120 calories, 14 g of protein, 3 g of saturated fat, and 80 mg of calcium are all included in a half-cup of soft cheese, such as 4% full-fat cottage cheese. The majority of cheeses include 300–450 mg of sodium per serving because salt is an essential component for retaining moisture and

preventing bacterial overgrowth.However, some cheeses, such as Swiss, whole-milk mozzarella, and goat cheese, have only 50–100 mg of salt per servingFull-fat dairy products include a lot of saturated fat and a little amount of cholesterol. Milk contains about 70% saturated fat, 25% monounsaturated fat, and 5% polyunsaturated fat. (1-3).Cheese is typically high in salt and frequently high in saturated fat, both of which can increase LDL cholesterol levels. It is generally advised to eat cheese in moderation as its ingredients may have a deleterious impact on health.However, there is continuous debate over cheese's potential health benefits. Despite the fact that the U.S. Dietary Guidelines advise choosing low-fat dairy products (milk, yogurt, and cheese) to ward off cardiovascular disease (CVD), some studies have found that full-fat dairy products may actually reduce the incidence of both type 2 diabetes and CVD.[4] According to these research, certain elements included in cheese, such as calcium and conjugated linoleic acid, may be makes the heart-healthy, and the saturated fatty acids found in cheese may affect the heart differently from those found in red meat. Some cheeses are processed by adding bacteria during the fermentation process, which may change how it affects blood cholesterol levels.

Starch is added to cheese in order to lessen the impact of the fat content. This study will aid in our comprehension of the contributions made by various textural starches to the mechanical characteristics of processed cheese with various types of casein networks.

Cheese

Cheese is a sort of fermented milk-based cuisine that is available in a range of flavors, textures, and fragrances. Around 8,000 years ago, the Fertile Crescent, a region between the Euphrates and Tigris rivers in what is now Iraq, is thought to have been the birthplace of cheese. Aging cheese is a science-based practice that helps to develop its distinctive flavours, aromas, and textures It is created by coagulating milk proteins and separating the curd from the whey. Cheese can be classified into three groups: fresh, soft and hard. Fresh cheese is the most basic variety and is usually made with just milk, salt and bacteria. Soft cheese typically has other ingredients, such as cream and rennet, and is usually spreadable. Hard cheese is the most complex and is made by aging the cheese for a certain period of time, which creates a more intense flavour and texture. Cheese is commonly used in many dishes, from salads and sandwiches to pizzas and pasta dishes, as well as in sauces and dips. It is rich in protein and calcium, and can be a nutritious part of a balanced diet [5].

The ageing of cheese is an important scientific step that creates the unique taste and texture of the end product. Depending on the sort of cheese, this will take a certain amount of time. Depending on the type of cheese, this will take a different amount of time [6]. Sales of cheese have steadily increased, largely because it is frequently used as a component in a range of processed foods, including pizza and pies. Cheese enhances the flavor, texture, and nutritional value of many foods [7].Recently, there has been a heightened focus on using starch in processed cheese for cost and health reasons. The relationship between the included starch and the protein source (commonly casein) can alter the texture of the cheese, as has been demonstrated[8].

Types of Cheese

Around 35 different kinds of cheese are often consumed worldwide. The cheeses that are included are American cheese, Asiago cheese, Blue cheese, Bocconcini cheese, Brie cheese, Burrata cheese, Camembert cheese, Cheddar cheese, Cheese curds, Colby cheese, Colby fack cheese, Cold pack cheese, Cotija cheese, Cottage cheese, Cream cheese, Emmental cheese, Farmers cheese, Feta cheese, Fresh mozzarella cheese, Gorgonzola cheese, Gouda cheese, Gruyere cheese, Halloumi cheese, HavartFrom this we have selected 3 types of commercially available cheese for the further work[9].

Mozzarella Cheese

Mozzarella, a popular cheese from the south of Italy, is traditionally produced using Italian buffalo's milk and the pasta filata procedure. Generally, this cheese is white in colour, but when it is aged, it may take on a light-yellow hue, depending on the diet of the animal. Benefits: Mozzarella cheese offers a host of nutrients such as protein, calcium, and phosphorus, which all play a role in keeping your body functioning at its best. Drawbacks: However, overindulging in mozzarella cheese can result in digestive issues like diarrhoea, inflammation, bloating, and weight gain[10-12].

Cheddar Cheese

This sort of cheese is often yellow or orange in color and manufactured from cow's milk. It has a firm texture and a sharp, tangy flavour that intensifies with age. It is usually used for grating and melted on top of dishes as well as in sauces, sandwiches and soups. The positive aspects of consuming bones include enhanced bone strength and healthy teeth. However, there are some downsides to this such

as feeling bloated, suffering from diarrhoea, being gassy, and potentially having an adverse effect on heart health[13].

Cream Cheese

This cheese is characterized as being soft and having a mild flavour, and is made from a combination of milk and cream. The advantages of consuming this food product include being high in vitamin B12, containing a small amount of lactose, and being free of gluten. However, a disadvantage of this food item is that it does not provide a good amount of nutrients, as well as containing artery-clogging fat[14].

American Cheese

Modern American cheese is a processed form of cheddar, Colby, or related cheeses that was created in the early 1900s. It has a mild taste, with a creamy and salty flavour, and a softer texture than other types of cheese. It melts easily, making it a popular choice for many dishes.Benefits of American Cheese: This cheese has a low carbohydrate content and provides an excellent source of quality protein. Plus, it's got a long shelf life. Drawbacks: Unfortunately, American cheese is high in sodium and fat[15].

Parmesan Cheese

Produced from cow's milk, Parmesan cheese is an Italian hard, granular cheese that has been aged for a minimum of 12 months.The protein content of Parmesan cheese makes it a desirable food source. It is more easily digested than other types of cheese, however, consuming a large amount of it can lead to headaches, stomach cramps, nausea, and diarrhoe. The general properties of the various cheese are given in Table 1.

Table1 Properties of cheese

Properties	Mozzarella	Cheddar	Cream	American	Parmesan
pH	4.8	5.1	4.5	4.98	5.35
Melted Temperature	125℃	130℃	85℃	45^{0}C	140^{0}C
Moisture Content	52%	38%	55%	44%	52%
Fat Content	less than 45%	74%	less than 38%	Less than 23%	Less than 45%
Shelf Life	21 days	1-2 months	Up to 10 days	1-2 months	21 days

Starch

All green plants produce starch, an organic substance that is white and granular. Its texture is mildly granular and tasteless, and it is unaffected by alcohol, cold water, or other solvents. Starch has the chemical formula (C6H10O5)n. Due to its capacity to serve as a thickener, this substance has been finding increasing use in a variety of industries and food products (Ammar B. Altemimi et al., 2017).Amylopectin is a highly branched glucan with α,1 – 4 glycosidic linkage, α,1 – 6 glycosidic linkages and an abundance of reducing end groups. This substance is composed of two macromolecular polymers of α-D-glucose: amylose and amylopectin. The former is a linear glucan with alpha-1-4 glycosidic linkages and minimal branching, resulting in few reducing end groups. Amylopectin, on the other hand, is a highly branched glucan with alpha-1-4 and alpha-1-6 glycosidic linkages, as well as an abundance of reducing end groups [16].

Sweet potato, potato, cassava, yams and Taro are used to extract starch. Sweet potatoes are one of the most widely cultivated food crops around the world, particularly in tropical countries. It is the fourth most important crop for human sustenance and the second largest producer globally. Sweet potatoes contain a large amount of starch, accounting for 50-80% of the root's dry matter. These starch granules are embedded in cellulosic fibers and are bound together by pectin [17].Mung bean, the seed of Vigna radiate, is a common ingredient in soup, pancakes, and cold noodles in many parts of China. Mung bean starch has a good cooking quality and when heated, it transforms into a solid, translucent gel with a smooth, flexible texture. Eleocharis dulcis, a fruit crop cultivated in China, India, and Southeast Asia, is ground into flour that is used in a number of southern Chinese desserts. The degree to which water molecules may access the starch granules and the amount of amylase present in the mung bean and water chestnut starches differ, which affects the starches' capacity to scatter and gelatinize [18].Approximately 80% of the world's starch market is made up of maize or corn starch. The USA is a significant producer of this starch, while Europe is the main source of wheat and potato starches. Asia produces the majority of cassava and tapioca starches. Potato and corn starches are often utilized commercially. Compared to cereal starches, tuber and root starches have bigger granules and contain less protein and lipid. After processing, root and tuber starches form clear pastes with a bland taste, which is beneficial for many food products. Global tuber crop production is dominated by five species, which account for almost 99% of the yield: potato (46%), cassava (28%), sweet potato (18%), yams (6%) and taro (1%).

These crops are typically rich in starch, water, minerals, vitamins and small amounts of protein and lipids (Neeraj et al., 2020).It may cause an allergic reaction in some people due to its saponin content, which may show symptoms such as itching, swelling, and redness of the skin. It is best to consume it in moderate quantity as excessive consumption may lead to severe health issues.

Sweet Potato

The scientific name for the sweet potato is Ipomoea batatas, and it belongs to the Convolvulaceae family of dicotyledonous plants, which also contains morning glory and bindweed. Its large, starchy, sweet-tasting tuberous roots are eaten as a root vegetable..[19] Sometimes the young branches and leaves are consumed as greens. Sweet potato cultivars have been bred to produce tubers with flesh and skin of different hues. Both sweet potato and the common potato (Solanum tuberosum), members of the Solanales order, are only distantly related to one another .Despite the fact that darker sweet potatoes are occasionally referred to as "yams" in some parts of North America.

Potato

The potato is a root vegetable that is indigenous to the Americas, a starchy food, and a tuber of the plant *Solanum tuberosum*. The perennial plant is a member of the nightshade family, Solanaceae.Various wild potato species can be found everywhere from the south of the United States to the south of Chile. The potato was once believed to have been separately domesticated by Native Americans in a number of locations, but later genetic research revealed a single origin, in the area of today's extreme northwestern Bolivia and southern Peru. Approximately 7,000–10,000 years ago, a species of the Solanum brevicaule complex that is related to potatoes was domesticated there.Some of the potato's close cousins are grown in the Andes region of South America, where the species is native.

Taro

Root vegetables include the taro (Colocasia esculenta). It is one of several species of plants in the family Araceae that are farmed for their corms, leaves, stems, and petioles, which are used as vegetables. Similar to yams, taro corms are a staple food in the cultures of Africa, the Pacific, East Asia, Southeast Asia, and South Asia. One of the first cultivated plants is thought to be taro.

Yams

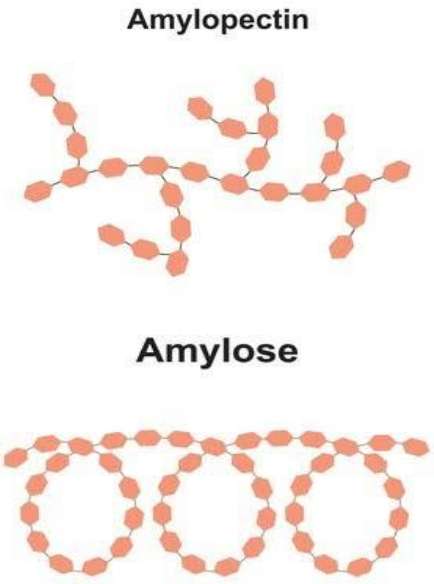
The term "yam" is used to refer to some Dioscorea (Family Dioscoreaceae) plant species that yield edible tubers.Some other species in the genus, including D.communis, have toxic tubers.Perennial herbaceous vines known as yams are grown for their edible tubers in a variety of temperate and tropical climates, including in West Africa, South and Central America, the Caribbean, Asia, and Oceania. Because there are so many cultivars and related species, the tubers, also known as "Yams", appear in a variety of shapes. Yams were separately domesticated in Africa (D. rotundata), Asia (D. alata), and the Americas (D. trifida) on three different continents.

Cassava

Manihotesculenta, often known as cassava, manioc, or yuca (among many other regional names), is a woody shrub that belongs to the Euphorbiaceae family of spurges and is indigenous to South America, specifically Brazil and some of the Andes. Cassava is a perennial plant that is typically grown as an annual crop in tropical and subtropical areas for its delicious starchy tuberous root, a significant source of carbohydrates. It is unrelated to the shrub known as yucca, which belongs to the Asparagaceae family, despite the fact that it is sometimes called yuca in some parts of Spanish America and the United States.

Structure of Starch

The structure of amylopectin and amylose are shown in Fig. 1



Advantages of Starch Addition to Cheese

The advantages of starch adding to cheese are given below.

- Since starches can imitate the lubricity of full-fat goods, they can be utilized as fat substitutes.
- Due to their high ability for retaining water, carbohydrates may act to improve texture in reduced-fat fresh cheese.
- According to Codex Standard 221-2001, starch is a permissible component to be added to fresh cheeses.
- The typical range of starch concentrations used as a fat replacement in cheese is between 0.5 and 1.5%., Where authorized by rules, starch plays a significant part in the production of processed and analog cheese.
- They can add to the body and texture of the cheese while also supplying other useful qualities.

The majority of commercial starch is made from corn, but it is also made from wheat, tapioca, and potatoes. Crushing or grinding starch-containing tubers or seeds, mixing the pulp with water, and then filtering out any remaining impurities before drying the paste are the steps used to make commercial starch.In addition to their essential nutritional roles, starches are used in brewing and as thickeners in baked goods and confections.[22-24].

Nutritional Properties of Starch

Table 2 nutritional properties of starch

Components	Cassava	Potato	Sweet Potato	Taro	Yams
Starch(%)	70	80	85	72	20
Sodium (g/ 100g)	0.014	0.006	0.055	0.011	0.009
Potassium(g/100g)	0.271	0.421	0.337	0.615	0.816
Carbohydrate (g/100g)	38	17	20	39	28
Fibre(g/100g)	1.8	2.2	3	7	4

The Production of Classic Whey Cheeses

Whey is boiled at high degrees until the proteins are denaturized and the whey coagulates to create whey cheeses, a unique type of cheese. Whey cheeses are made utilizing traditional techniques all around the world, either through artisanal or standardized industrial procedures , in accordance with the principles of the

circular economy [42–45]. Many whey cheeses were initially created as by-products from sheep or goat whey. Dairies now use cows' whey to make whey cheese or incorporate cows' milk due to their rising consumption. They all employ whey as their main raw material, but their processes differ. The bulk of them are heat- and/or acid-coagulated cheeses.

Aspects of Whey Cheese's Microbiology

In order to denaturize the whey proteins, whey cheeses are heated to between 88 and 92 C. This procedure is harmful to the microbiota of the milk, cream, or both that are added to the whey as well as the whey itself. After heating, the local microbiota is deactivated, and no starting cultures are added [46-50]. According to a report, Escherichia coli O157:H7 can survive and thrive in Myzithra, Anthotyros, and Manouri whey cheeses at temperatures as low as 2 °C [51]. L. monocytogenes was found to proliferate quite quickly in similar whey cheeses, although the maximal populations in Myzithra cheese at 5 and 12 C were noticeably lower than those in Anthotyros and Manouri cheese at the same temperatures.

Whey cheeses' sustainable preservation methods

Packaging for Modified Atmospheres

The utilization of sustainable and efficient techniques for whey safety and preservation In order to prevent cross-contamination of fresh whey cheeses during storage, cheeses must be used. Extended study on improvements in cheese preservation focused on "clean labels" has resulted from the rise in consumer demand for fresh, preservative-free goods [55]. MAP is frequently employed as a storage strategy, prolonging the shelf life and improving the appearance of many goods while satisfying the chemical preservative-free strategies for diverse items [56]. Active packaging and MAP have the ability to increase the shelf life of dairy goods, particularly cheese [52–54].

Herbs and/or plant extracts added

The addition of various herbs and/or plant extracts, as well as their possible use in combination with various packaging materials, have been the subject of several studies in the literature [55-60]. Because of their sensory and antioxidant qualities, black cumin, thyme, and rosemary are regularly added to cheeses [61-65]. Akpinar et al. [66] investigated both cheeses in artificial casings as well as whey cheeses packaged in goat-skin bags used for the storage of conventional cheeses with a long

shelf life (semi-hard and hard cheeses). Along with various packaging materials, the possible use of various herbs (black cumin, thyme, and rosemary) in the manufacturing of Lor cheese was assessed.

Bio-Preservation

It has been extensively researched how to use natural antibacterial chemicals from a wide range of natural sources or protective LAB cultures, or bio-preservation [67-70]. Due to its ecological sustainability and consumer friendliness, bio-preservation is of great interest [71]. Bio-preservatives have negligible to no negative impact on health, in contrast to synthetic chemical preservatives, which over time can be poisonous [72-75]. Numerous dairy products have had their shelf lives increased using nisin, a bacteriocin generated by cultures of Lactococcus lactis subsp. lactis [76–80]. Nisin prevents the growth of spores produced by species of the genera Bacillus and Clostridium as well as Gram-positive bacteria such Listeria monocytogenes and Bacillus cereus [81–85].

New Methods for Increasing Shelf Life

Whey cheeses have undergone a number of cutting-edge processes over the past ten years to extend their shelf life and enhance their functional and sensory properties. characteristics. In order to demonstrate an alternative to refrigerated storage, Duarte et al. [86] placed Requeijo in 100 MPa hyperbaric storage at variable room temperature. Growth of Enterobacteriaceae and all aerobic mesophiles was suppressed.Hyperbaric storage shown an extra microbial inactivation impact for LAB, yeasts, and molds. With an estimated 26-fold reduced carbon footprint than chilled storage, this method is more environmentally friendly [87].

Whey Products and Novel Whey Cheeses

By using dried whey protein concentrate 65% in place of fresh cheese whey, Myzithra cheese was created in a modified version [88]. In comparison to control Myzithra cheese, the modified Myzithra cheese had increased levels of lactose, potassium, and sodium and lower levels of total bacteria, protein, ash, calcium, hardness, and adhesiveness. Yeasts and molds were also missing. Although excessive amounts may create negative changes in the texture and flavor of Cheeses, attempts to include fresh whey protein concentrates in Queso fresco have produced positive results in terms of yield and acceptance [89]. The procedure

needs to be refined. As an alternate technology for small and medium size producers of queso fresco, whey cheese inclusion in milk was recommended.

Conclusions

Production of whey cheese has a long history of being a sustainable way to use the whey that is generated when milk curdles. Worldwide production and consumption of whey cheeses are both based on their nutritive content and pleasant sensory qualities. The type of whey used, the method employed, and the diversity in composition and traits shared by several types all reflect this wide variation. In any event, there are numerous practical and monetary advantages to using whey in the production of whey cheeses. The type of microorganisms present in the finished product depends on the unique cheesemaking techniques and composition. Whey cheeses should be consumed quickly after manufacturing because they may be contaminated due to their neutral pH and high moisture content. Whey cheeses have very low counts of microorganisms after production because the natural milk and whey microbiota is initially inactivated after the coagulation of whey proteins and because starting cultures are irrelevant due to the heating of the whey. However, handling the raw curd after it has been heated results in cross-contamination, which leads to a variety of degradation, primarily the growth of yeasts, molds, coliforms, pseudomonads, and potentially harmful bacteria. Therefore, when handling, packaging, and storing, it is essential to follow hygienic practices.

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CHAPTER 9

AN OVERVIEW OF AMYLASES INDUSTRIAL APPLICATIONS – REVIEW

Gebiru Sinshaw
Department of Biotechnology, College of Biological and Chemical Engineering
Addis Ababa Science and Technology University, Addis Ababa, Ethiopia

Vignesh Raj S, Aanandhalakshmi R & Chandran Masi*
Department of Biotechnology, Dhanalakshmi Srinivasan Engineering College (Autonomous),
Perambalur, Tamilnadu, India

Abstract

One of the most often used enzymes in industry is amylase. These kinds of enzymes hydrolyze starch molecules into glucose-based polymers. The possible applications of amylases in industry span the food, fermentation, and pharmaceutical industries. Amylases can be found in a wide range of organisms, including bacteria, mammals, and plants. However, bacterial and fungal enzymes have dominated the industrial industry. It takes the enzyme amylase to change starches into oligosaccharides. Wheat, rice, maize, tapioca, and potatoes are just a few examples of commercially significant crops that contain significant amounts of starch as a main storage product. Starch-converting enzymes are used to create modified starches, glucose, and fructose syrups, among other products. There have been a ton of microbial amylases found. Food, textiles, paper, and detergents are just a few of the industries that use a wide spectrum of microbial amylases. Amylases are typically produced through submerged fermentation, although solid-state fermentation techniques appear to be a promising alternative.

Keywords*: Amylase, a-amylases, Fermentation, Gluco-amylases, Pharmaceutical.*

Introduction

Enzymes are biological catalysts that catalyze thousands of biochemical events in living organisms. Because each type of enzyme has a specific binding site for its own substrate, enzymes are unique molecules. Food production, fermentation, animal nutrition, detergents, cosmetics, brewing, paper industries, pharmaceuticals (medicine), and research and development are only a few of the domains where they are used [1, 2, 3, and 4]**.**Because they have numerous uses in industries like dairy, soft drinks, chocolates, pharmaceuticals, food processing, leather, textile, paper, wine, meat, fish processing, and many others, amylases (especially a-Amylases, E.C.3.2.1.1) are among the most significant industrial enzymes from a biotechnological perspective [5, 6].

Amylases (α-amylases, β-amylases, and gluco-amylases) (**Table 1**) were discovered in animals, plants, insects, and microbes in the eighteenth century. They belong to the GH13 family of glycoside hydrolases, which consists of eight subfamilies and hydrolyzes starch into glucose, maltose, and maltodextrins [7, 8]. The three categories of enzymes known as amylases are α -amylases, β -amylases, and gluco-amylase [9]. A large range of industrial processes, including those in the food, fermentation, textile, paper, detergent, and pharmaceutical industries, depend on α-amylases because of their potential temperature and pH stability. α -amylases are employed in a variety of industrial processes [10, 6]. The largest percentage of the market for enzymes is accounted for by α -amylase. The market is dominated by α -amylases produced by fungi and bacteria. More α -amylases can be produced by fungi than by bacteria [11, 12, and 13].

In living things, α - amylases play a crucial role in the metabolism of starch. These amylolytic enzymes are used in the liquefaction and saccharification of starch in industrial settings. They are a member of the roughly 28,000 strong glycoside hydrolase (GH) family of proteins. Amylases are a member of the glycoside hydrolase (GH) family, which includes about 28,000 distinct protein sequences [14, 15].Amylases are a broad group of hydrolase or transferases that break down large alpha-linked polysaccharides, including starch and related oligosaccharides. They are among the enzymes that are most frequently used in industrial operations. The demand for bakery and sugar-derived products, biofuels, detergents, breweries, animal feeds, medicines, paper, and textiles is expected to increase over the next few years, accounting for about 25% to 30% of the global enzyme market [16]. By the end of 2024, the market for amylase is projected to be worth USD 320.1 million [10, 17].

Table. 1 Amylases are divided into three categories

Types of amylase	Specificity of glycosidic bonds	Mode of Action	Products	References
α-amylase (Glucan-1,4- α-glucanohydrolase)	α-(1-4)-glucosyl	Endo oligosaccharides	Linear and branched	[7, 8, 24]
β-amylase (Glucan-1,4- α-maltohydrolase)	α-(1-4)-glucosyl	Exo Dextrin	Maltose and dextrin limit	[9, 10]

γ-amylase (Exo-1,4-α-glucosidase; glucohydrolase)	α-(1-4)-glucosyl and Glucose α-(1-6)-Glucosyl	Exo / Endo	Glucose	[8, 17]

α-amylases

The enzymes known as alpha-amylases (EC 3.2.1.1) can break down polysaccharides like starch and glycogen [18]. These enzymes, which are found in fungi and bacteria, offer significant biotechnological potential because they are used in a variety of industrial fields, from food to biofuels (**Figure.1**) [18, 19]. Furthermore, α-amylasesdue to the advantages of growth on low-cost renewable substrates, simplicity of enzyme extraction, broader pH and temperature stability, and the lack of a cofactor requirement, it is a good candidate for industrial amylase production in case it covers 25% of the market for industrial enzymes [10, 20].Its activity increases by K^+, Na^+, Mg_2^+ and Ca_2^+ [21].

β-amylases

Beta - amylase (EC 3.2.1.2) is an exo-enzyme that shows high specificity for cleaving the α-1, 4-glucosidic linkage of starch from the non-reducing end, thereby liberating maltose β-amylase from *Bacillus aryabhattai* is novel[22]. On the other hand, catalyze starch hydrolysis into maltose within the polysaccharide chain (endo). Despite the fact that the critical catalytic residues are identical to those found in amylases, which are typically a pair of carboxylic acids, these acidic residues are 6–12 pH. [23, 24, 25]. The optimal amounts of enzymes used in the production of maltose syrup led to a maltose content more advanced than those using enzymes from soy beans and microbes [26].

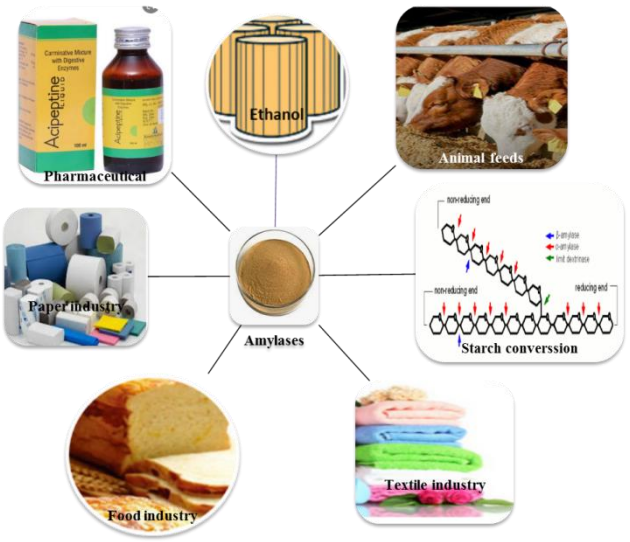

Figure.1 Amylases in different industrial application

Only seven microbial -amylases have been sequenced and described, but many -amylases have been discovered, the majority of which are from plants. Two primary clusters are readily visible in the results: one for microbes and one for plants [16] (**Figure.2**).

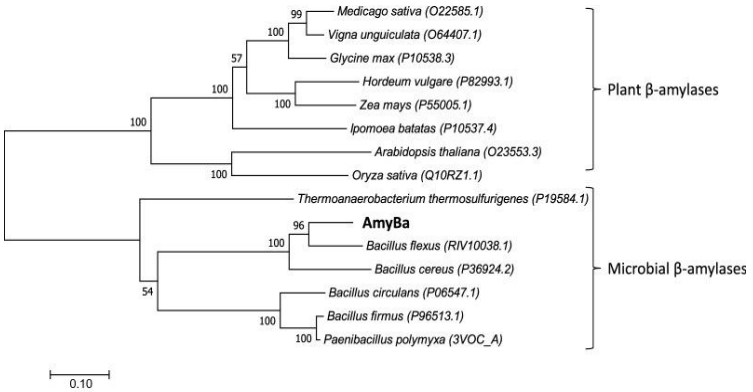

Figure. 2. Phylogenetic tree of β-amylases identified from different microorganisms and plants

Gluco-amylases

Glucoamylase (GA), also known as amylo-glucosidase or gluco-amylase (EC 3.2.1.3), is a biocatalyst that inverts the anomeric structure of α -1,4 glycosidic linkages in raw (sparsely soluble) or soluble starches and related oligosaccharides to produce h-glucose. The enzyme not only hydrolyzes **α** -1,4 linkages but also **α**-1,6 glycosidic starch linkages slowly. In stirred tank vessels, airlift reactors, or stacked trays, submerged, solid-state, and semisolid-state fermentation can all be

used to make glucoseamylases **(Table.2)[** 27, 28, 29]**.** The output of GA is influenced by the bioreactor's design and method of operation. In flasks, trays, rotary reactors, and columns (horizontal and vertical) bioreactors, GA production has been investigated [30, 31, and 32]. *Aspergillus niger*using glucoamylase is a major industrial biocatalyst which is used to mass produce glucose from raw starch or soluble oligo-nucleotides **(Table.3)**[33, 34].

The industrial enzyme gluco-amylase is one of the most significant and widely utilized enzymes, with applications in sugar, ethanol, and bread [35], beer, textiles and pharmaceuticals. The hydrolysis of α-1, 4 and -1, 6 glycosidic linkages in starch and similar oligosaccharides from non-reducing ends to release α-d-glucose could be catalyzed by gluco-amylase [22] (**Figure. 3**). Commercial gluco-amylases are now derived primarily from filamentous fungus like *Aspergillus niger, Rhizopus niveus,* and *Rizopus delemar*, which have intermediate thermo stability and slow catalytic activity [36, 37].

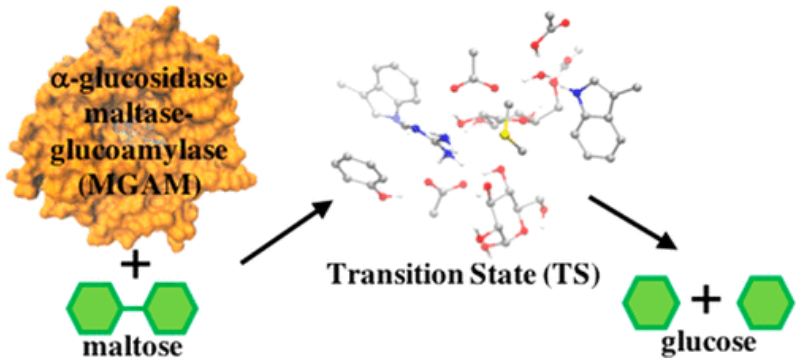

Figure. 3. Bond breakdown by gluco-amylases in Maltose to glucose

Table. 2 Amylases have the potential to be used in a variety of industrial processes

Enzyme	Sources of Strain	Temp. optimum (°C)/ stability	pH optimum/ stability	Activity Enhanced	Activity Inhibitor	References
α-amylases	Lp_0179	40–65	4-7	In 5mM K^+, Na+, Mg^{2+} and Ca_2^+.	In 5mM Cu^{2+}, Pb2+, Fe^{2+} Fe^{3+}, Cd2+ Cu^{2+}, Mn2+, Co^{2+}, Hg2+	[38, 10, 39, 40]
	Lp_2757	30–37	4-6			
	LB04	65	3			
	Aspergillus oryzae	32.5	4.5			
	PersiAmy1	90	9			
	α-amylase A4	50	4.5-8.5			

β-amylases	*Bacillus aryabhattai*	50	6.5	K+, Na+, Zn2+, Mg2+	Cu2+ and Hg2+	[22, 41]
Glucoamylases	AtriGA15A *Aspergillus tritici* WZ99	40-45	4-5	K+, Na+,	Cd2+ $Cu^{2+,}$	[8,12.26,34. 42]
	Amy1T *Tetracladium sp.*	30	6	Mg2	Mn2+	
	Caulo GA *Caulobacter crescentus* CB15	40	5	Zn2+	$Co^{2+,}$ Hg2	
	Caulo GA *Caulobacter crescentus* CB15	40	5-9	K+, Na+	Cu2+ and Hg2+	

Table. 3 Amylases have the potential to be used in a variety of industrial processes and medical applications

Industries	**Potential microbe's**	**Optimum temp. & pH**	**References**
Starch Sacchari fication and Liquefaction	*Bacillus amyloliquefa-ciens* BH072 *Geobacillus sp.* K1C	60 ◦C, pH 7.0 80 ◦C, pH 6.0	[23]
Baking	*Bacillus subtilis strain* US586 *Laceyella sp.* DS3 (ex-pressed in *Escherichia coli* BL21	60 ◦C, pH 4.0–6.0 55 ◦C pH 6.0 -7.0	[43, 35]
Beverages	Thermomyces dupontii (Expressed in Koma-gataella phaffii	60 ◦C, pH 6.5 72 ◦C,	[44]
Detergent	*Bacillus licheniformis MTCC1483,* *PersiAmy1 Anoxybacillus thermarum A4 strain* *Bacillus sp. BCC 01-50*	PH 8, 40◦C 70 °C; - 65 °C; 60-70 °C	[45, 46, 47]

Textile and Leather	*Bacillus licheniformis*	pH6.5, 80◦C	[48]
Biodegradation	*Bacillus licheniformis HULUB1* and *Bacillus subtilis SUNGB2*	pH 6.0 and 65 °C	[49]
Fuel alcohol production	*Escherichia coli* or *Bacillus subtilisBacillus licheniformis*	55 ◦C pH 6.0 -7.0	[50, 6, 51]

Factors Affecting the Production of α-Amylase

Several physicochemical characteristics influence the level of enzyme production; thus, optimizing them is necessary to increase enzyme yield by several times. PH, temperature, incubation length, moisture content, agitation, inoculum level, and various organic and inorganic nutritional supplements are some of the basic parameters (**Figure.4**). One-factor-at-a-time (OFAT) optimization is used when just one variable is changed while all other variables remain constant [12, 52].

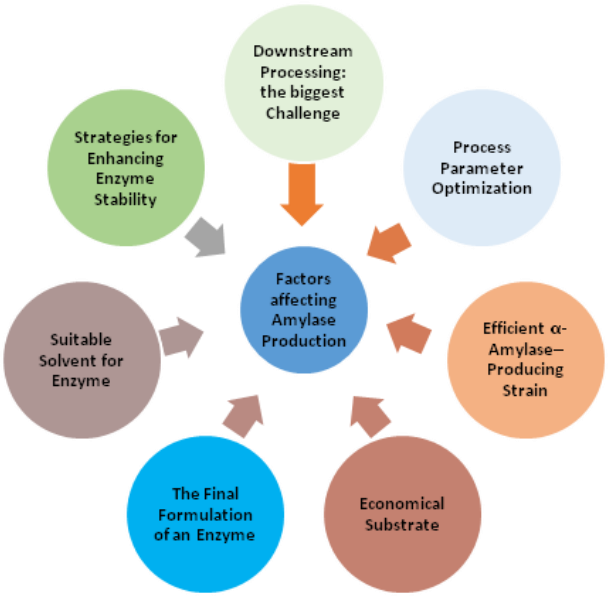

Figure.4 Different factors are affecting amylase production

Industrial Application of Amylase

Conversion of Starch

In order to hydrolyze starch during the starch liquefaction process, which converts starch into fructose and glucose syrups, the starch industry most usually uses α -amylases [53, 8, and 12]. All starch can be converted enzymatically in a variety of ways, including gelatinization, which involves the dissolution of starch granules and the production of a viscous suspension, liquefaction, which involves

partial hydrolysis and loss of viscosity, and saccharification, which involves the production of glucose and maltose through additional hydrolysis [54, 10, and 15].

Detergent Industry

These enzymes convert the remains of starchy foods like potatoes, gravies, custard, chocolate, etc. into dextrins and other smaller oligosaccharides in automatic dishwashing machines and laundry detergents [55, 14, and 27]. One of the most important properties for using amylases in detergents when the washing environment is extremely oxidizing is their oxidative stability. Amylases are active at lower temperatures and an alkaline pH, maintaining the necessary stability under detergent-like conditions [56, 13, and 29].

Fuel Alcohol Production

Ethanol is the most widely used liquid biofuel. Due to its low cost and widespread availability as a raw material in the majority of the world, starch is the most often used substrate for the synthesis of ethanol [57,33 and 44]. Fermentation, which involves converting sugar into ethanol using an ethanol-fermenting microbe like yeast, comes after liquification and saccharification, which involve first turning starch into sugar using an amylolytic microorganism or enzymes like α-amylase. cerevisiae, or *Saccharomyces cerevisiae*. Bacteria, such as α- amylase from thermoresistant strains of *Escherichia coli* or *Bacillus subtilis* or from modified strains of *Bacillus licheniformis*, are utilized in the initial stage of the hydrolysis of starch suspensions for the manufacture of ethanol [12,25,34,50].

Food Industry

Brewing, making sweets, and baking all use α -amylases in various ways [59, 16, 28, 34]. Due to its beneficial properties, including high pH stability, Ca^{2+} independence, strong activity towards starch saccharification, thermostability, and high production of maltose syrup, RmAmyA, a novel high maltose-forming α -amylase from Rhizomucor miehei, has a promising future in the food industry [60, 35, 18]. Before processing, amylases are used to clear beer, fruit juices, and animal feed to improve the digestion of fiber. The ability of α -amylases to prevent staling, particularly in baked goods, extends their shelf life and improves their softness [61, 16, 34].

Textile Industry

In order to strengthen the thread before it is turned into fabric, starch, a sizing agent, is widely employed in the textile industry [62, 25]. Desizing is the process of removing the starch from the fabric, which acts as a reinforcement to keep the warp thread from snapping during the weaving process. In the textile business, amylases are used in the desizing procedure. The -amylases specifically remove only the size while sparing the fibers [62, 38]. The textile industry has traditionally utilized a bacillus strain to produce amylase [63, 39]. Cloned into E. coli, highly heat-resistant α-amylases from Thermotoga petrophila have the ability to shrink fabric [61, 41].

Paper Industry

Paper artifacts frequently get starch stains. The surface of the paper is deformed by this stain, which also promotes the development of microbial deterioration [64,7, and 31]. The starch of coated paper is modified by α -amylases in the pulp and paper industry, resulting in low-viscosity, high molecular weight starch [6, 13]. For the elimination of starch strains, silver and gold nanoparticles are also used in addition to α -amylases [64, 19].

Pharmaceutical Industry

For enzyme applications in the pharmaceutical and medicinal industries, high purity amylases are required [6, 14]. As a digestive tonic, α-amylase is widely used to treat digestive problems. Additionally, amylase and dextran or dextrins are frequently included in pharmaceutical formulations [12, 29]. A candidate for application in the pharmaceutical industry is a version of -amylase that has been immobilized [65, 33].

Conclusion

Since many years ago, α-amylase has been widely used in starch-based industries. Although there are many microbiological sources for the effective production of this enzyme, only a few carefully chosen strains of fungi and bacteria are suitable for industrial production. More recently, a number of writers have demonstrated successful methods for developing amylase purification, allowing use in the pharmaceutical and therapeutic fields that demand very pure amylases. By overcoming the issues brought on by improper disposal of these solid wastes, the use of agro-waste residue will also assist to protect the environment. The purification process must be handled carefully because the function of amylase

depends on its level of purity. Extremophiles should be researched rather than isolating Amylase from merely common microorganisms. They produce distinctive, stable amylases that can tolerate a variety of challenging environmental circumstances and have outstanding metabolic qualities. A variety of mutagenesis techniques can be employed to construct wild-type amylases using computer-aided structural design. An exceptionally stable amylase for industrial usage will be produced using this technique. Above were described other techniques for obtaining stable and industrial-grade amylase.

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CHAPTER 10

DOUBLE SUBSTRATE BASED MILKY MUSHROOM CULTIVATION – A COMPARATIVE STUDY

Amirtha Varshini R*, Karthikeyan Kandasamy, Sathiyaraj S & Chandran Masi
Department of Pharmaceutical Technology
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamilnadu, India

Abstract

Calocybe indica (milky mushroom) is a edible mushroom which have good nutritional and medicinal values. Mushrooms are generally healthy foods, low in calorie and fats, higher amount of vitamins, fibres and minerals. Numerous substrates like agricultural wastes are used for the cultivation of milky mushroom. Previous studies reported that the paddy straw and wheat straw are used as a best substrate for the milky mushroom cultivation. Both substrate act as a popular variety because of its different flavour, richer protein content, pleasant tastes and shorter harvesting period compared to other. This chapter contains with comparative study of two substrates for the cultivation of milky mushroom (Calocybe indica).

Keywords: *Calocyba indica, Paddy straw, Wheat straw, Healthy foods, Cultivation.*

Introduction

Fungi synthesize numerous extra cellular enzymes and secondary metabolites. It also produces organic acids, pigments and other food additives. They are act as a antibiotic and immunosuppressant. Mushrooms are most known edible filamentous fungi. Natural products have been considered as solutions to health, due to their minimum adverse effects [1]. It may be cultivated in a range between 20° and 30°C, and a relative humidity of 55–75% is needed. The possibilities for harvesting and processing are excellent in the northeast. Mushrooms come in two primary varieties: button and oyster. Milky mushrooms do not require a significant investment and are simple to collect and process. The *Calocybe indica* high yield strain thrives in a temperature range of 24°C to 27°C. Although they are very low in sugar and fat and high in vitamins and minerals, mushrooms provide many nutritional benefits. The application of edible fungi in nutraceuticals, functional foods, and tumor prevention and treatment has been investigated [2]. Additionally, they are abundant in protein and unsaturated fatty acids.

The fruiting body of a fungus that produces mushrooms is fleshy, bears spores, and usually grows on soil or its feeding supply. Since ancient times, Greeks and

Romans have used mushrooms as part of their diet. They were referred to as "food of God" by the Romans and "elixir of life" by the Chinese [3]. For their flavor, texture, and in some cases for their therapeutic qualities, mushrooms have long been valued. They are a very nutritious food and a significant potential source of biologically active substances from a physiological basis. Mushrooms are currently recognized as being high in high-quality protein, having a sufficient proportion of unsaturated fatty acids, and having a low enough nucleic acid level to be used regularly as a vegetable[4].

Nutritional Value

Mushrooms are naturally high in digestible proteins and low in fat. Mushrooms have increased protein, carbohydrate, fat, ash, and moisture nutritional values [5]. Mushrooms are largely made up of unsaturated fatty acids, which are less harmful to your health than saturated fatty acids found in animal fats [6]. Mushrooms also have a high concentration of amino acids [7]. The most prevalent essential amino acids in mushrooms are leucine, valine, glutamic acid, and aspartic acid [8]. Mushrooms can be utilized as a dietary source to combat malnutrition. Because of their great digestion, mushrooms are being examined as a potential alternative for muscle protein [9].Aside from protein, mushrooms are an excellent source of vitamin-D, which is not found in other food supplements [10]. It's high in thiamine, riboflavin, nicotinic acid, pyridoxine, biotin, and ascorbic acid [11].

Mushrooms have high nutritional value, in particular as a source of protein that can improve human diets [12]. Linoleic acid and oleic acid were discovered to be the most abundant unsaturated fatty acids in *Calocybe indica*. When compared to proteins and carbs, the fat content of mushrooms appears to be quite low. Furthermore, the mushroom's fats are dominated by unsaturated fatty acids. Because of their high protein content, mushrooms are thought to be a useful food supplement for aquaculture. The key macronutrient absorption in the intestine is sodium, magnesium, potassium, and calcium, which are used for regular metabolism [13].

Typesof Mushroom

Mushrooms are found in diverse agro-climatic conditions ranging from arid to evergreen forest conditions. Worldwide more than 3000 mushrooms have been identified as edible, of which 200types are reported to have been produced under controlled conditions. There are about a dozen varieties which are cultivated on

commercial scale. In India, more than 300 varieties of mushrooms are found in the wild. The major mushroom varieties of commercial importance are Button (*Agaricus bisporus, A. bitorquis), Oyster (Pleurotus sp.), Milky Mushroom (Calocybe indica), Paddy Straw (Volvariella sp.), Black Ear (Auricularia sp.), Shiitake (Lentinula edodes), Winter mushroom (Flammulina velutipes), Reishi (Ganoderma lucidum) etc.* In India, three types, namely button, oyster and straw mushroom are extensively cultivated on commercial scale [14].

Milky Mushroom (*Calocybe indica*)

Calocybe indica, commonly referred to as the milky white mushroom, is a type of edible mushroom native to India. The name is derived from the Ancient Greek words kalos ("pretty") and cubos ("head"). The milky white mushrooms appear in fields after rainfall in the summer. It is traditionally eaten and grown in West Bengal, but it is also grown commercially across many Indian states and other tropical nations. It may be grown all year in hot, humid climates with temperatures ranging from 25 to 35 °C. The advantage of growing at higher temperatures opens up new opportunities for profitably exploring milky white mushroom farming around the world [14].

Cultivation of Species *(Calocybe indica)*

Mushroom cultivation very recently began in India, and the country is quickly rising as a significant mushroom growing country in the globe. These are a diverse group with varying sizes, forms, personalities, colours, and physical characteristics [15]. During the monsoon season, the majority of edible mushrooms grow spontaneously. *Agaricus, Pleurotus, Volvariella, Calocybe, Termitomyces, Tuber, Morchella, and Auricularia* are other common genera. It may grow on a range of substrates, including unfermented rice straw, chopped banana pseudostem, tree stumps and logs, industrial byproducts, and plant wastes [16]. *Calocybe indica*also known as "Dhuth chatta"(meaning "Milky white mushroom" and which is native to India).Milky white mushrooms can be found growing in tropical and subtropical parts of India on humus-rich soil in agricultural fields or along the roadside. The benefits of milky mushrooms include an easy cultivation method, minimal investment, a highly attractive fruiting body, an appealing milk-white shade, a long shelf life, being more nutritional, and taking less time to grow [17].

Substrates

Milky mushroom cultivation uses a variety of agricultural waste materials such as wheat straw, cotton waste, paper waste, banana leaves, sawdust, sugarcane bagasse, corncobs, peanut hull, and so on [18]. Many attempts have been undertaken to determine the optimal substrate for increased *Calocybe indica* output. The milky mushroom developed on a sterile substrate of paddy straw, maize, or wheat bran [19]. Wheat straw, maize stalks, sorghum stalks, sorghum meal, and wheat bran were examined as a basal substrate for *Calocybe indica* development. Wheat straw was the most effective substrate for fruit body formation. Paddy straw has shown significant potential as a raw material and provides an economically feasible way of producing milky mushrooms [20].

Materials and Methods

Compost Preparation(Spawning)

Paddy straw, wheat straw, and vegetable plant leftovers were used to grow milky mushrooms. Paddy straw and wheat straw are both readily available and inexpensive. It is extensively utilized for milky mushroom cultivation. For more than 12 hours, paddy straw or wheat straw was soaked in fresh water with formalin and carbendazim. Excess straw water was drained by spreading it over jute fabric. Wheat straw or paddy straw is supplemented with organic and inorganic nitrogen fertilizers in synthetic compost. Compost can be made using either a long or short composting approach. Only those with pasteurizing capabilities can use the shortcut approach. A good compost is dark-brown, free of ammonia, with low greasiness and 65-70% moisture [20].

Spewing and Casing

A bottle of spawns will cover 35 kilograms of compost spread over 0.75 square meters (approximately two trays). Trays are then stacked and covered with newspapers in the cropping room. They have 2% formalin sprinkled on them. The ideal room temperature is around 18°C with a humidity level of 95%. To stimulate the growth of sporophores, compost colonized with mushroom mycelium is covered with a 3-5cm thick casing layer in commercial mushroom cultivation. Edible mushroom cultivation has a long tradition, and the use of casing to encourage the growth of sporophores has been done since the 17th century. The primary function of the casing layer is the mass generation of mushrooms. The transition from vegetative growth to the fruting stage is accompanied by significant

morphological changes brought on by the capping layer, a nutrient-poor medium. Casing is typically carried out to provide a surface where uniform frutification can occur as well as to offer anchoring and crucial reserves for mushroom sporophores to develop. Peat/moss is used for casing in the majority of regions where mushrooms are grown, either by itself or in conjunction with other materials [20].

Cropping

Following casing, the beds must be incubated before being covered in polythene sheets. Room temperature should be between 24 and 28 °C, relative humidity should be between 80 and 95 percent, and light intensity should be between 1600 and 3200 lux. In this chamber, proper ventilation is also necessary for the growth. To keep the surface of the casing at 50–60% moisture, the beds are often sprayed with water. In general, pinheads start to form 8–10 days after casing, and the first harvest can be made 6–8 days afterwards. The casing medium is slightly flattened again after the first harvest and constantly sprayed with water.

Harvesting, storing, and selling mushrooms are the final steps in mushroom production. Milky mushrooms develop at a rapid pace. Mushrooms must be gathered twice a day, in the morning and at night. Harvest the mushroom before the margins of the caps flatten out completely or even flip up. Having a slight role on the edge of the Milky mushroom will keep the mushroom's optimal texture and storability. Two crates and plastic bins with openings for air movement can be used for harvesting. Harvesting at this point also reduces the number of spores emitted by the mushroom. The mushroom should not be overpacked [20].

Effect of Substrate

In the milky mushroom cultivation, wheat straw substrate required fewer days for complete spawn run, first harvest, and fruiting bodies than paddy straw. The maximum yield in paddy straw was higher than in wheat straw. Both paddy straw and wheat straw demonstrated significant biological efficiency [20]. As a result, while wheat straw required the fewest days for spawn run and pinhead development for *Calocybe indica*, paddy straw produced the greatest quantity [21]. *Calocybe indica* culture was carried out on paddy straw waste and resulted in an outstanding yield after 15 days. In the cultivation of milky mushrooms, wheat straw needed only a few days and produced the lowest yield [22]. On the wheat straw substrate, the total yield, number of fruiting bodies, biological effectiveness, protein, phosphorus, and potassium contents, maximum pileus diameter, and stalk length were all noted. The yield and qualities that contribute to yield will be

improved by the addition of supplements to the substrate [23]. It took 14 days for the spawn to flow on paddy straw substrates, and 500g of yield was obtained per 1500g of substrate. According to reports, paddy straw is the greatest substrate for growing milky mushrooms [24]. The spawn run in wheat straw can be completed in as little as 13.67 days, and it can be collected with a lower yield than paddy straw [20]. For the growth of milky mushrooms, wheat straw proved to be a superior substrate [25].

Mushroom Consumption

In the future decades, there will be an increase in demand for high-quality foods like mushrooms due to population growth, urbanization, and changing dietary habits. Mushrooms are excellent in digestibility, necessary amino acids, and protein, as has already been stated [26]. Mushrooms are beneficial for the heart as well because they contain a lot of antioxidants and unsaturated fatty acids. Some mushrooms include substances that are known to decrease blood cholesterol. Additionally, mushrooms have a high potassium and low sodium content, making them a healthy diet for people with high blood pressure [27, 30]. The mushrooms are also thought to be beneficial for diabetics. These are beneficial for the digestive system because they are also high in fiber. These characteristics classify the mushroom as a functional food and a nutraceutical [28, 26]. It is necessary to spread awareness of the health advantages and cooking techniques for mushrooms in order to increase local consumption. The capability of antioxidants may be increased by these active molecules' involvement in scavenging processes [29]. Additionally, our findings concur with earlier studies, which found that *Calocybe sp*. edible mushrooms had the highest levels of "antioxidant power" in their chemical and biochemical assays [30, 27].

Conclusion

Milky mushrooms are the least expensive and easiest to cultivate of all the farmed edible mushrooms. The nutritional value of milky mushroom is attributed to its high levels of vitamins, proteins, and non-saturated fatty acids. Milky mushroom consumption lowers cholesterol levels, diabetes, and has been linked to anti-cancer properties. The production of milky mushrooms is primarily determined by the spawn and substrate used. many spawn substrates used in the development of milky mushrooms. Paddy straw was discovered to be the optimum substrate for the production of milky mushrooms, as previously reported. Because

of differences in nutritional value and physical qualities, the production potential of various substrates varies. Here, Paddy straw and wheat straw were used as a best substrate to get a good yield of milky mushroom. This reviewstates that the wheat straw took minimum days for cultivation of milky mushroomand the paddy straw has high water holding capacity for cultivation of milky mushroom.The future study on milky mushroom cultivation using other substrates can be processed.

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CHAPTER 11

JACKFRUIT AS A KEY INGREDIENT IN PLANT-BASED MEAT ALTERNATIVES: A COMPREHENSIVE REVIEW OF MANUFACTURING, NUTRITIONAL COMPOSITION, SENSORY ATTRIBUTES, AND CONSUMER ACCEPTANCE

Princess Monica*, Krishnaveni S, Thilagavathy R & Maria J Mukkadan

Department of Food Technology

Dhanalakshmi Srinivasan Engineering College (Autonomous), Thuraiyur Road, Perambalur, Tamil Nadu

Abstract

A variety of meat substitutes have been created in response to the rising desire for healthy, plant-based eating options. Due to its distinct texture and flavor, jackfruit, a versatile tropical fruit, has drawn significant interest as a major component in plant-based meat products. The manufacturing process, nutritional makeup, sensory qualities, and consumer acceptance of plant-based meat substitutes that use jackfruit as a main ingredient are all thoroughly examined in this research. Picking ripe jackfruit, using processing methods like shredding and marinating, and creating ingredients to improve flavor, texture, and nutritional content are all part of the manufacturing process. A balanced diet is aided by the nutritional makeup of meat substitutes based on jackfruit, which includes both macronutrients and micronutrients. To provide an enjoyable shopping experience for the consumer, sensory qualities including texture, flavor, and appearance are assessed. Consumer studies have been carried out to evaluate the preferences and acceptance of meat substitutes made from jackfruit, taking into account elements like flavor, texture, familiarity, and desire to purchase. The increasing demand for these products is also reflected in market developments, with accessibility, cost, and customer demographics playing major roles. The review also emphasizes potential health effects and discusses the environmental impact of using jackfruit as a sustainable component. Overall, this thorough evaluation clarifies the potential of meat substitutes made from jackfruit as a promising and sustainable choice in the plant-based food sector.

***Keywords**: Plant-based meat, jackfruit, alternative ingredients, sustainability, sensory attributes, consumer acceptance.*

Introduction

In recent years, there has been a striking increase in the demand for plant-based, sustainable food solutions worldwide. This change in customer preferences has encouraged the creation and production of meat substitutes, which offer a practical and sustainable alternative to traditional animal-based products. Jackfruit has drawn a lot of attention as a major element among the wide variety of plant-based

substances used in these substitutes because of its distinctive qualities, including texture and flavor.The tropical fruit jackfruit *(Artocarpus heterophyllus)*, which is gaining popularity as a promising component due to its distinctive fibrous texture and mild flavor, is one such ingredient [1]. With the right preparation, jackfruit may closely resemble the texture of meat, making it a popular ingredient. The purpose of this review study is to investigate the possibility of jackfruit as a replacement ingredient in plant-based meat alternatives. The versatility of jackfruit in cooking has long made it a beloved tropical fruit that is native to South and Southeast Asia. Its fibrous and flesh-like texture, when correctly prepared, makes it a perfect choice for making plant-based meat substitutes that resemble the flavor and appearance of animal-based goods. Additionally, because jackfruit has a moderate, somewhat sweet flavor, it can be prepared with a variety of seasonings and spices, which improve flavor and create a pleasurable sensory experience [2].But there are difficulties in using jackfruit as a substitute for meat in plant-based products. To obtain the correct texture and flavor profiles, processing methods must be optimized. In addition, since taste, texture, and familiarity are key factors in consumer acceptability of plant-based meats made from jackfruit, it is important to take into account how consumers view these products.This review study intends to add to the expanding body of knowledge on wholesome and sustainable substitutes for conventional meat products by investigating the possibilities of jackfruit in plant-based meat compositions. By gaining a better understanding of the qualities, uses, and difficulties of jackfruit, we can advance the advancement of plant-based meat products and advance the establishment of a more moral and sustainable food system.

Methodology

Harvesting and Selection

The initial step in the production of plant-based meat using jackfruit is the collection and selection of ripe jackfruit. The greatest flavor and texture of jackfruit are guaranteed when it is harvested at the ideal stage of maturity [3]. Ripe Jackfruit can be recognized by its sweet aroma, vivid color, and somewhat pliable flesh. To obtain desired qualities in the finished product, careful selection of high-quality jackfruit is essential.

Processing Techniques

The jackfruit is harvested and carefully chosen before going through a variety of processing steps to give it a texture-like flesh [4]. Typical processing methods include:

Washing and Peeling: To get rid of any dirt or impurities, the harvested jackfruit is thoroughly washed. The fruit's edible portion is then revealed when the outer peel has been removed.

De-Seeding: Jackfruit pods are stripped of their enormous, difficult seeds. The goal is to produce plant-based meat by using the fruit's fibrous flesh.

Cooking: Jackfruit flesh is boiled to make it softer and make it easier to separate the fibers. Depending on the desired texture and flavor, different cooking techniques are used, such as boiling, steaming, or pressure cooking.

Pulping or Shredding: The cooked jackfruit is pulped or shredded to give it a fibrous texture similar to pulled or shredded beef. The ideal meat-like appearance and mouthfeel are made possible by this procedure

Formulation and Ingredient Combination

To improve flavor, nutritional profile, and binding qualities, the jackfruit is blended with other ingredients after being processed into a texture resembling flesh. To make a well-rounded and tasty plant-based meat composition, other plant-based ingredients can be added, such as legume flour, soy protein, gluten, and spices [5]. Depending on the desired flavor and the properties of the final product, the exact ingredient mix may change.

Production on an Industrial Scale

Jackfruit-based formulations are produced on an industrial scale to satisfy the rising demand for plant-based meat products. To assure consistency and quality across batches, industrial-scale production includes optimizing processing methods, ingredient ratios, and product consistency [6]. To increase productivity and satisfy production goals, large-scale machinery, and automated procedures may be used. To assure customer safety and the integrity of the product, strict adherence to food safety laws and quality control standards is necessary.Plant-based meat producers can produce jackfruit-based meat substitutes that closely mirror the feel and appearance of conventional meat products while providing the advantages of sustainability and minimal environmental impact by using these manufacturing techniques.

It is vital to remember that different manufacturers and product formulas may use different specialized manufacturing procedures. Research and development efforts are still being undertaken in this field to examine and improve production methods to raise the caliber and acceptance of plant-based meat products created with jackfruit as an alternative ingredient.

Nutritional Composition

Macronutrients

Jackfruit's nutritional profile has a big impact on whether or not it can be used as a component in products that are made to resemble meat from plants [7]. To increase the nutritional value of jackfruit, a variety of macronutrients are offered:

Carbohydrates: Jackfruit has a lot of carbohydrates, mainly in the form of dietary fiber and unrefined sugars. In addition to giving us energy, carbohydrates also help give plant-based meat products their overall texture and mouth feel.

Protein: Although jackfruit has a little quantity of protein compared to meat from animals, it is nonetheless there. Protein, a crucial ingredient of meat substitutes made from plants, is necessary for muscle growth and repair. To boost the protein content of meat substitutes made from jackfruit, however, additional protein sources might be required.

Fat: Jackfruit has a comparatively low-fat content, which may be appealing to people looking for low-fat plant-based foods. Unsaturated fats, which are thought to be better and may contribute to a favorable nutritional profile, make up the majority of the jackfruit's fat composition.

Micronutrients

Several micronutrients are also present in jackfruit, adding to its nutritional worth and health advantages.

Vitamins: Vitamin C, vitamin A, and many B vitamins are all present in jackfruit. These vitamins are crucial for maintaining overall health, boosting immune system performance, and supporting some physiological functions.

Minerals: Jackfruit is an excellent source of calcium, magnesium, and potassium. These minerals are essential for supporting healthy body processes like muscular contraction, nerve conduction, and bone health.

Dietary Fiber: Jackfruit is particularly high in this substance, which has several positive health effects. Fibre facilitates digestion, encourages feelings of fullness, and assists in controlling blood sugar levels.

Jackfruit is a desirable ingredient in plant-based meat products because it contains a variety of important macronutrients and micronutrients. To achieve a well-rounded nutritional profile with acceptable protein content, it is crucial to take into account the overall nutritional balance of the plant-based meat formulation and make sure that other ingredients are included.

Sensory Qualities

Texture

A key sensory component of plant-based meat products, texture helps to simulate the texture of traditional meat while also enhancing the entire eating experience. When modified and optimized, the distinctive fibrous texture of jackfruit can be made to approximate the texture of meat. The methods used to prepare and process jackfruit can contribute to giving it a tender, fibrous, and chewy texture that closely resembles that of some varieties of meat [8]. The cooked jackfruit can further improve its capacity to mimic the texture of pulled or shredded meat by being pulped or shred properly. Consumer acceptability and enjoyment of plant-based meat made from jackfruit can be greatly influenced by its texture.

Flavour

In plant-based meat substitutes, the flavor is still another crucial sensory component. Even though jackfruit naturally has a mild, slightly sweet flavor, it may be improved and changed by adding spice and other ingredients to create a savory and meat-like flavor profile [9]. A more powerful and savory flavor that is reminiscent of conventional meat can be produced using spices, herbs, and flavor enhancers. To produce a flavor that customers would enjoy and that closely reflects the flavors associated with various forms of meat, the flavor of jackfruit-based plant-based meat should be carefully adjusted.

Appearance

Consumer acceptability of plant-based meat products, particularly those made with jackfruit, depends on how they look. The fibrous texture of jackfruit, which resembles the strands or fibers present in some forms of meat, might help it have an appealing appearance [10]. Jackfruit can resemble pulled or shredded meat in appearance when it has been properly processed. Through cooking or seasoning methods, coloration and browning can be created, further strengthening the

likeness to traditional meat. To draw customers, jackfruit-based plant-based meat products should have an appetizing appearance and appear to be similar to meat.

For jackfruit-based plant-based meat products to be accepted and enjoyed by consumers, the sensory qualities of texture, flavor, and appearance must be optimized. To achieve these sensory qualities and produce a product that nearly approaches the sensation of ingesting traditional meat, proper processing methods, seasoning, and ingredient combinations are essential. For plant-based meat products made from jackfruit to satisfy consumer expectations and preferences, sensory evaluation and consumer testing are crucial phases.

Results and Discussions

Consumer Studies

The success of plant-based meat products employing jackfruit as an alternative ingredient depends heavily on consumer acceptance. Understanding consumer perceptions, preferences, and acceptability of these products depends heavily on consumer studies and sensory assessments [11]. To acquire information on aspects such as taste, texture, flavor, appearance, and general satisfaction, consumer research may involve conducting questionnaires, focus groups, taste tests, and preference studies. The sensory qualities and general consumer acceptance of meat substitutes made from jackfruit are improved by these tests, which also help identify areas for improvement and offer manufacturers useful input.

Market Trends

Keeping an eye on market trends is crucial for determining customer demand for and acceptability of plant-based meat alternatives, especially those made using jackfruit. Trends in the market offer useful information about consumer preferences, buying patterns, and product placement. The best target market, target audience, and marketingand branding tactics can all be understood by manufacturers by analyzing market trends. The availability and diversity of meat substitutes made from jackfruit, as well as comments and evaluations from customers, can all be revealed by market trends [12]. With the use of this data, product development, marketing strategies, and consumer education programs may be better targeted to increase customer acceptance and market success.

Manufacturers can fine-tune jackfruit-based plant-based meat products to match consumer preferences and expectations by understanding consumer acceptance through consumer studies and keeping up with market developments.

Manufacturers can create goods that offer sustainable and nutritious alternatives as well as items that are popular with customers and contribute to the expanding market for plant-based meat by taking consumer insights and market dynamics into account.

Environmental and Health Implications

Jackfruit-based plant-based meat products may have less of an impact on the environment than traditional meat products do [13]. Alternatives based on jackfruit provide various environmental advantages over traditional meat production, such as:

- *Less land used:*Producing meat from plants uses less land than producing cattle, helping to preserve natural habitats and halt deforestation.
- *Less water footprint:* Plant-based meat products made from jackfruit typically have a lower water footprint than meat made from animals, which helps save water resources.
- *Less greenhouse gas emissions:*The production of meat from jackfruit plants emits fewer greenhouse gases than the production of traditional meat, aiding in the fight against global warming.
- *Biodiversity conservation:* By lowering the demand for animal goods, jackfruit-based plant-based meat products help ease pressures on biodiversity and contribute to the preservation of ecosystems [14].
- The potential for jackfruit-based plant-based meat products to be more environmentally sustainable than conventional meat products has been suggested by the evidence so far, albeit additional investigation and analysis are needed to determine their entire environmental impact.People can actively contribute to environmental preservation and the fight against climate change by making these choices.

Conclusion

The utilization of jackfruit in plant-based meat alternatives presents significant prospects for the creation of savory and sustainable meat substitutes. When properly processed, jackfruit can closely approximate the texture and appearance of meat due to its distinct fibrous texture and mild flavor. Harvesting and selecting ripe jackfruit, using a variety of processing methods, and blending it with other ingredients to improve flavor and texture are all part of the manufacturing process.

A key element in the success of meat substitutes made from jackfruit is consumer acceptability. Producing goods that meet consumer expectations and demands requires an understanding of consumer preferences, sensory assessments, and market trend monitoring.Overall, the use of jackfruit in plant-based meat replacements offers a chance to develop wholesome, sustainable substitutes that can meet customer demand for meat-like products while addressing environmental issues. To improve the production method and improve the sensory qualities of jackfruit-based plant-based meat, further research, development, and consumer education is required. This will ensure greater acceptance and market success.

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CHAPTER 12

RFID BASED INTERACTION FREE INFANT: BREAST MILK LACTATION CONDITIONING AND MONITORING SYSTEM

R. Ragul Kannan*, Dr. D. Karthikeyan,
S. Muthulakshmi, R. Deepthi, P.Dharini & T.Durga devi
Department of Biomedical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

C. Sathish Kumar
Department of Electronics and Communication Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

A. Madasamy
Department of Chemical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

Breastmilk monitoring is essential in neonatal care as it plays an important role in the growth and development of infants during premature delivery. Main Conventional techniques for donated breastmilk monitoring are often time-consuming, labor-intensive, and prone to human error, Environmental factors, weather conditions, etc,. Therefore, the essentials of an automated system that can accurately identify, monitor, and classify the received and donated breastmilk have arisen. The conventional techniques for the milk monitoring involve manual monitoring and recording of the date, time and also quantity as well quality of breastmilk. The milk is then labeled with the mother's name and stored in a refrigerator with normalized temperature range. However, in this method is level to human error, and it is not easy to track the termination of breastmilk. In this project, we proposition RFID-inbuilt breastmilk identification of class and monitoring system that utilizes a temperature sensor, humidity sensor and a breast milk stage classification system using a pH and color sensor. The proposed idea utilizes RFID methodology to accurately identify and monitor the breastmilk. This proposed system also includes a humidity sensor and a temperature sensor to monitor the breastmilk storage conditions in the refrigerator. The pH and color sensor are used for breast milk stage classification and it will classify breastmilk into three stages: colostrum, transitional milk and mature milk. By this we can improve immunity and health of infant. A breast milk stage classification system using a pH and color sensor provides an automated, accurate, and reliable method for breastmilk monitoring. This system has the assurance to reduce human error, save time and ensure the provision of quality care to infants for their growth.

Keywords: Breast milk classification, identify, monitoring, sensors, Quality improvements.

Introduction

When the original mother is unable to breastfeed, the first alternative, if one is available, should be the use of human milk from other sources, according to a 1980 joint statement from the WHO and UNICEF. There should be human milk banks. Infants are typically fed through breast milk, which is often regarded as the best first source of nutrition. Breast milk is a perishable food item, and if it is not maintained at the proper temperature, its quality can quickly deteriorate. Breast milk should be stored at a temperature of 0–4°C (32–39°F). By putting a temperature sensor in a milk bank, personnel can monitor the temperature of the stored milk and make sure that it stays within the advised range. If the temperature increases above this range, bacteria can proliferate quickly, resulting in spoiling and potentially hazardous amounts of bacteria. Keeping the milk safe and nutritious helps to ensure that it is suitable for newborn intake. Colostrum develops during pregnancy and persists for a few days following delivery. This thicker, yellowish, sticky milk is crucial for safeguarding your child. It's incredibly easy and simple to absorb colostrum. Colostrum contains the same nutrients as later stages of milk, but the amounts vary and it is made to suit the needs of the newborn baby. White blood cells and antibodies are abundant in colostrum, the first milk. It guards against infections and is crucial for the digestive system of your infant. The pH of colostrum ranges from 6.5 to 6.8, making it an acidic substance as well. Transitional milk replaces colostrum after two to four days. Colostrum is replaced with alteration milk. It is smooth, creamy and rich in fat, lactose, proteins, and vitamins. Milk gradually transforms from yellow to white. You might notice that your breasts are bigger, harder, and slightly uncomfortable when they begin to stimulate. Any embarrassment during this stage can be reduced with regular feeding. The pH range for transitional milk is 6.8 to 7.2. Your milk becomes fully developed after a few weeks. It maintains consistency and has a lighter hue. However, the makeup of your breast milk can still vary from day to day and feeding to feeding. Between 7.0 and 7.4, mature milk's pH value is marginally higher than that of transitional milk. (Ref 1,2,3)

Existing System

The current system, which outlines the steps the end-user, must do to utilize and keep an eye on the system. The end user will initially have to turn the system on and examine the alarm signs to ensure that all of the system's components are connected and working properly. The end user will need to repair or connect any

system components that the alarm system says are disconnected or malfunctioning, then recheck the alarm system to make sure everything is linked. After the process of operating the system, the end-user will then have to deliver the cooled milk inside the storage tanker to respective dairy processing plants. The control unit will have the buttons and screen through which the end-user will operate to view the status (level and temperature) of the milk inside the tanker. The cooling capacity of the thermoelectric cooling system of the process is dependent on the operating temperature of the substance desired for cooling, quantity of thermoelectric modules are often used, the type of thermoelectric module used and the applied power of the proposed system.

Objective

1. To develop a breast milk stage classification system using pH and color sensors that can classify breast milk into different stages based on its pH level and color of the breast milk.
2. To design IoT-based breast milk monitoring system that can provide real-time feedback to nursing mothers regarding the status of breast milk.

Proposed System

The proposed system is to classify human breast milk into these three stages using a pH sensor and color sensor, you would need to measure the pH and color of the milk at different stages And IoT system which will directly monitor the available status and stage of the milk and temperature and humidity of the refrigerator cooling system which is present inside the milk bank for engaging the process. Milk bank has sensing unit installed to it which has humidity and temperature sensor, Arduino Uno as a gateway with Wi-Fi module using wireless protocol for wireless communication between milk bank and cloud. Customizable and with low knowledge curves, an automated environmental monitoring system not only documents temperature but also the humidity to ensure the safety of milk. Continuous monitoring and automatic update of temperature and other factors. RFID-based breastmilk identification and monitoring system that can track the status of breastmilk and provide real-time feedback to nursing mothers. RFID Reader is used to reads the RFID TAG based smart milk pack and update the available milk pack to the cloud using cayenne server. The user/consumer can view milk with stored date & time without any human intervention.

To classify human breast milk into these three stages using a pH sensor and color sensor, you would need to measure the pH and color of the milk at different stages

Colostrum –First stage of Breast Milk

Colostrum develops during pregnancy and persists for a few days following delivery. This thicker, yellowish, sticky milk is crucial for safeguarding your child. It's incredibly simple to absorb colostrum. Colostrum contains the same nutrients as later stages of milk, but the amounts vary and it is made to suit the needs of the newborn baby. White blood cells and antibodies are abundant in colostrum, the first milk. It guards against infections and is crucial for the digestive system of your infant. The pH of colostrum ranges from 6.5 to 6.8, making it an acidic substance as well.

Transitional Milk – Second Stage of Breast Milk

In this stage, Colostrum is replaced with transition milk. It is smooth, creamy and rich in fat, lactose, proteins, and also vitamins. Milk progressively transforms from yellow to white. You might notice that your breasts are bigger, harder, and slightly uncomfortable when they begin to stimulate. Any discomfort experienced during this phase can be reduced with regular feeding. The pH range for transitional milk is 6.8 to 7.2.

Mature Milk – Third Stage of Breast Milk

Your milk turns mature milk after a few weeks. It maintains its consistency and is lighter in color. Your breast milk's content can still vary from day to day and feed to feed, though. The pH range for mature milk is between 7.0 and 7.4, somewhat higher than that of transitional milk.

Methodology

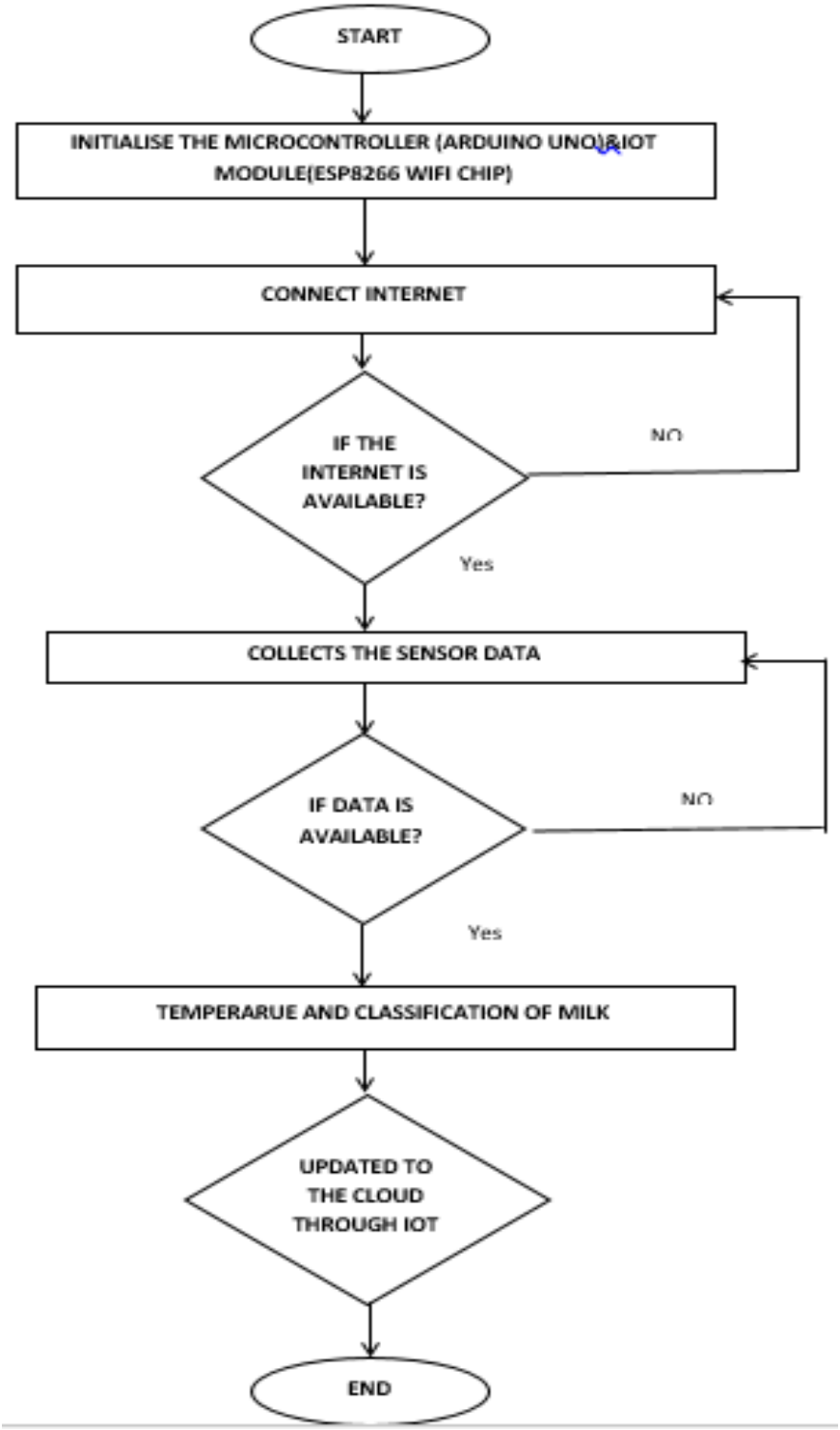

Fig.1 Flow diagram

Block Diagram

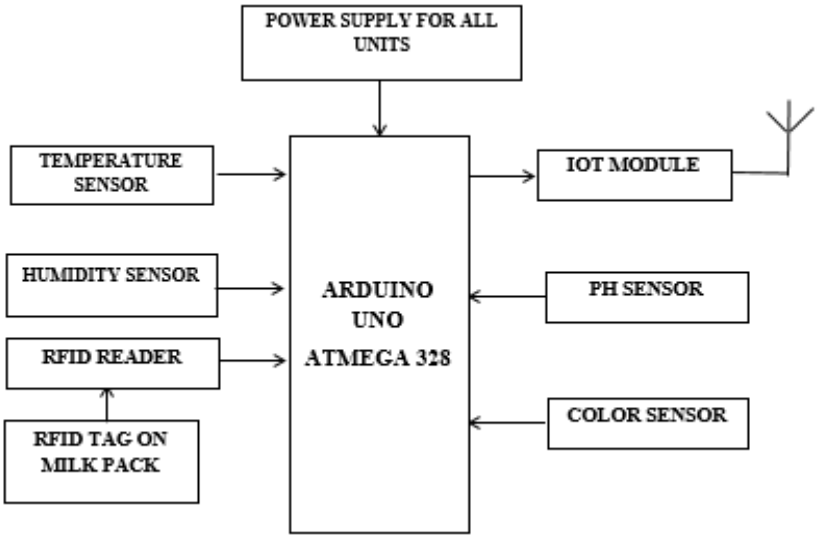

Fig.2 Block diagram

Conclusion

We recommend and proposed a RFID-based breastmilk system for the recognition and monitoring system that utilizes a temperature sensor, a humidity sensor and a breast milk stage classification system using a pH and color sensor with respect to the operation. The system also includes a humidity sensor and a temperature sensor to monitor the storage and time lapse conditions of breastmilk in the refrigerator. The system breast milk stage classification system uses a pH sensor and color sensor to classify the quality of breastmilk into three stages that is named with the colostrum, transitional milk, and mature milk. The pH and color sensor measures the pH level and color of the breastmilk and compares the reading with pre-defined values for each and every and every stage of process involved. The system provides us an automated, accurate and reliable efficient method for breastmilk monitoring and conditioning. This system has the prospective to reduce human error, save time, and ensure the provision of quality care to infants.

Result and Discussion

Breast Milk As Sample	pH	Sample Colour	Stages
Sample 1	6.5	Yellow	Colostrum milk
Sample 2	7	White	Transitional milk

Sample 3	6	Yellow	Colostrum milk
Sample 4	7.5	Bluish white	Mature milk

The system provides us an automated, accurate and reliable efficient method for breastmilk monitoring and conditioning. This system has the prospective to reduce human error, save time, and ensure the provision of quality care to infants.

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CHAPTER 13

DECOLURIZATION OF REACTIVE CONGO RED DYE BY CLOUD POINT EXTRACTION WITH PROCESS OPTIMIZATION USING EXPERIEMENTAL DESIGN

Duraimurugan M. D* & N.Sangeetha
Department of Chemical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

T. Jayakumar
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

Abstract

The exploit of non-ionic surfactants in Cloud Point Extraction (CPE) consists of a two phase process without the presence of an organic solvent. The aim of the present study is to optimize the removal of Congo red from an aqueous solution using Triton X-114 as non-ionic surfactant by Cloud Point Extraction technique. A three level factorial design and response surface methodology were occupied to estimate the effects of operating temperature and surfactant concentration on Cloud Point Extraction process. The effects of these factors on the following parameters were estimated: percentage of Congo red dye extracted, ratio between phase volumes and residual amounts of dye in dilute and surfactant rich phase after separation. Mathematical models were urbanized to predict the effect of each variable and their connections with the extraction parameters. A relationship between predicted values using model equations and experimental values revealed that the correlation coefficients (R_2) were greater than 0.98.

The models were validated by analysis of variance, significance, and prediction, allowing the optimization of process variables. Response surface methodology allows the optimization of process variables. The results showed that 98% removal of Congo red dye using this technique.

Keywords: *Congo red; surfactant; Triton X114; cloud point extraction.*

Introduction

Dyes are complex aromatic molecular structures which are intended to be stable and consequently are difficult to degrade. At present, there are more than 1,00,000 dyes available commercially (of which azo dyes, represent about 70% on weight basis), and over 1 million tons dyes are produced per year, of which 50% are textile dyes [1]. In India alone, dyestuff industry produces around 60,000 metric tons of dyes, which is approximately 6.6% of total colorants used worldwide [2]. The

largest consumer of the dyes is the textile industry accounting for two third of the total production of dyes [3].

Surfactant are amphiphilic molecules consisting of two different parts: one hydrophilic ("water loving") and the other hydrophobic ("water rejecting"). This combination makes the surfactant ambivalent; the hydrophilic head group is attracted to polar environments, for example water, while the hydrophobic tail is attracted to non polar environments.

Extensive research carried out recently has confirmed the ability of surfactants to affect the electronic absorption spectra of solutions of many dyes, viz., triphenylmethanel, azo and phenothazine. Two types of interaction between dye and surfactant may be observed depending on the chemical structure of both dye and surfactant: at concentrations below the critical micelle concentration, decrease in the absorbance with appearance of a new band indicates formation of a complex between dye and surfactant and at high micelle concentrations, increased extinction coefficient with a red shift which indicates incorporation of dye to micelle. The role of solvents plays an important role as the solvent polarity affects the interaction between the surfactants and dyes. Therefore, the understanding of those interactions enables the prediction of characteristic behavior of the dye surfactant mixture in the aqueous and mixed solvent systems.

Biological Science, Clinical Science, Social Science, Food Science, Physical and Engineering Sciences. Since RSM has an extensive application in the real-world, it is also important to know how and where Response Surface Methodology started in the history. According to Hill and Hunter, RSM method was introduced by G.E.P. Box and K.B. Wilson in 1951 (Wikipedia 2006). Box and Wilson suggested to use a first-degree polynomial model to approximate the response variable. They acknowledged that this model is only an approximation, not accurate, but such a model is easy to estimate and apply, even when little is known about the process (Wikipedia 2006). Moreover, Mead and Pike stated origin of RSM starts 1930s with use of Response Curves (Myers, Khuri, and Carter 1989).

According to research conducted (Myers, Khuri, and Carter 1989), the orthogonal design was motivated by Box and Wilson (1951) in the case of the first-order model. For the second-order models, many subject-matter scientists and engineers have a working knowledge of the central composite designs (CCDs) and three-level designs by Box and Behnken (1960). Also, the same research states that another important contribution came from Hartley (1959), who made an effort to create a more economical or small composite design. There exist many papers in

the literatures about the response surface models. In contrast, 3-level fractional design has limited works.

Thus, 3-level fractional design is an open research subject. Fractional Factorial Experiment Design for Factor at 3-Levels (Connor and Zelen 1959) is a helpful resource conducting this kind of design. Many three-level fractional factorial designs and more importantly their alias tables can be found in their study.

According to (Myers, Khuri, and Carter 1989), the important development of optimal design theory in the field of experimental design emerged following Word World II. Elfving (1952, 1955, 1959), Chernoff (1053), Kiefer(1958,1959,1960,1962), and Kiefer and Wolfowitz were some of the various authors who published their work on optimality Therefore, RSM is being increasingly used in the industry. Also, in recent years more emphasis has been placed by the chemical and processing field for finding regions where there is an improvement in response instead of finding the optimum response (Myers, Khuri, and Carter 1989). In result, application and development of RSM will continue to be used in many areas in the future.

Objective

- There is a need to obtain a model that represents CR removal considering the effects of temperature and surfactant concentration, which interfere directly on extraction efficiency.
- The following parameters were evaluated:
  - Phase volume.
  - CR concentration in the dilute phase after separation.
  - CR concentration in surfactant rich phase.
  - Extraction efficiency.

Materials and Methods

Materials

Congo red dye (FW: 991.82, λ_{max}: 597 nm, dye content: 97%, product of INDIA), and Triton X-114(t - Octylphenoxypolyoxyethylene ether), with approximately 8 - 9 ethoxy units per molecule (density at 25°C is 1.058 g. $m1^{-1}$, Molecular weight (Mol. Wt): 537, λ_{max}:223 nm, purity: 95%, product of USA), were purchased from Sigma-Aldrich, India. The critical micellar concentration (CMC) of TX-114 is 2.1×10^{-4} M at 25°C and the cloud point temperature is 23°C. RTB G-133 dye was used as solute; Triton X-114 was used as the non-ionic surfactant as shown in Figs.1 and 2,

respectively. JASCO UV-Visible spectrophotometer was used for calibration and measuring the dye concentration in dilute phase after phase separation.

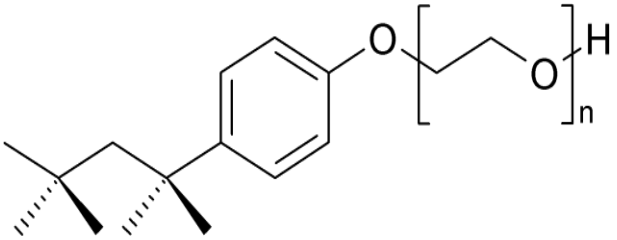


Fig.2 Molecular structure of TX-114

Cloud Point Extraction of CR Dye

Aqueous micellar solutions were prepared respectively, with varying concentrations of dye (25 ppm, 50 ppm and 75 ppm) and Triton X-114 (0.01 M – 0.1 M). The samples were kept in the thermostatic bath maintained at the desired temperatures (40°C, 50°C and 60°C**,** respectively) based on the cloud point temperature (CPT) for 30 min. After the formation of heterogeneous clear phases, the volumes of surfactant rich phase and dilute phase were noted down. Then, the concentrations of RTB G-133 in dilute phases were determined by UV-Visible spectrophotometer.

Experimental Design

There are two types of variables in the multivariate optimization procedure: responses and factors. Responses are dependent variables; their values depend on the levels of the factors [31, 32]. Factorial design was used at three levels: low, medium, and high. The graphs, analysis of variance, and calculations of the effects were obtained with DESIGN EXPERT.

Surfactant concentration(X1), dye concentration(X2) and temperature(X3) were used as factors, both at three levels (Table 1). The assays were conducted in duplicate and the mean value was used as the experimental response.

A total of 15 assays were performed, 14 related to the experimental design matrix and one a repetition at the central point (0, 0, and 0). The design matrix and the experimental results are shown in Table 2.

Temperatures and surfactant concentrations were selected for being above the turbidity curve of the surfactant under study. The cloud point was determined by visual observation. It is important to observe that the plot with CR dye showed lower cloud point values. This is due to the interaction of the organic molecules with the polar head group of surfactant.

Table1 Various levels of experimental design

	Symbol	Level		
		-1	0	1
Surfactant Concentration (M)	X_1	0.01	0.05	0.1
Dye Concentration (ppm)	X_2	25	50	75
Operating Temperature (^oC)	X_3	40	50	60

Result and Discussion

Cloud point Extraction

The experimental results obtained are shown in Table 2. Percentage of dye extracted (E); phase volume ratio (R_v); RB-5 concentration ($X_{s,d}$) in the dilute phase after separation; and RB-5 concentration ($X_{s,r}$) in the surfactant-rich phase after separation were determined.

Table 2 Experimental results for optimization of CR dye (25ppm, 50ppm and 75ppm) with TX-114 at various operating temperature (40^0C, 50^0C and 60^0C)

TEST	x1	x2	x3	EXPERIMENTAL RESULTS				CALCULATED RESULTS			
				%E	RV	Xs,d ppm	Xs,r ppm	%E	RV	Xs, d ppm	Xs, d ppm
1	-1	1	-1	75.212	2.041	0.003	1.019	75.215	2.242	0.026	1.042
2	-1	1	1	81.652	4.602	0.039	1.029	81.889	4.372	0.038	0.99
3	-1	-1	-1	82.368	5.932	0.048	1.211	82.095	5.436	0.011	1.22
4	-1	0	0	82.851	6.383	0.081	1.246	82.616	6.507	0.069	1.217
5	-1	-1	1	87.316	12.612	0.091	2.041	87.674	13.013	0.092	2.031
6	0	0	-1	90.288	16.822	0.094	2.257	90.951	16.904	0.074	2.275
7	0	1	0	90.829	16.822	0.158	2.342	91.415	17.611	0.15	2.339
8	1	1	-1	93.519	21.952	0.157	2.408	93.071	21.794	0.161	2.397
9	0	0	0	93.703	26.582	0.221	2.418	93.584	26.911	0.161	2.435
10	1	1	1	96.136	28.205	0.242	2.82	95.908	27.877	0.229	2.848
11	1	-1	-1	96.343	31.578	0.243	3.106	96.038	31.059	0.254	3.095
12	0	0	1	96.855	42.857	0.343	3.406	97	42.969	0.368	3.386
13	0	-1	0	96.855	42.857	0.48	3.506	97	43.824	0.459	3.481
14	1	0	0	97.481	44.927	0.643		97.655	44.686	0.647	
15	1	-1	1	99.684	61.291	0.929	3.655	99.682	60.972	0.909	3.683

Regression Analysis and statistical assessment:

Regression analysis was applied to obtain the mathematical models, resulting in second-order polynomial equations that express the relationship between each response and the significant factors and iterations. The following models were obtained by the experimental design:

Statistical Assessment

Percentage of CR Dye Extracted (E)

The validity of the dye extraction model was determined by Analysis of Variance (ANOVA), presented in Table 3 and the correlation measure used to estimate the model was the coefficient of determination (R^2). Table 3 shows that the model exhibited significant regression at a 95% confidence level, ($F_{calculated}$ greater than F_{tabled}) with R^2 of 0.9979, demonstrating that the model explained 99.22% of the variation in experimental data. The Model F-value of 140.72 implies the model is significant and predictive. There is only a0.01% chance that a "Model F-Value" this large could occur due to noise. The response surface graph of the proposed model for dye extraction is depicted in Figure 4 (a). Surfactant concentration has a predominant, favorable effect on dye removal, whereas temperature has no influence on the final result.

Figure 4 (a) shows that the dominance of surfactant concentration on dye extraction efficiency is more than the temperature. This can be explained by the interaction between the surfactant and dye, the concentration of the former being much higher when the coacervate phase is formed, tending to drag the contaminant along with it, irrespective of temperature.

The effects of variables on dye extraction can be clearly observed in the Pareto chart illustrated in Figure 4 (b). Within the 95% confidence interval, only surfactant concentration had a significant effect on the model. Both the linear and quadratic parts exhibit this characteristic. Figure 4 (c) shows the coherence between the values calculated by the model and those obtained experimentally.

Percentage of Dye Extracted (%):

$$\% E = 93.58 + 7.49X_1 - 2.24X_2 + 2.54X_3 + 0.76X1X_2 - 0.72X1X_3 + 0.48X2X_3 - 4.21X_1^2 + 0.078X_2^2 - 0.0089X_2^2$$

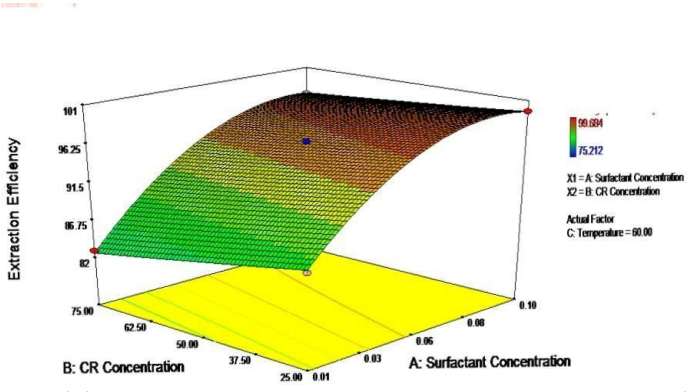


Figure (a): Response surface for dye extraction in (%)

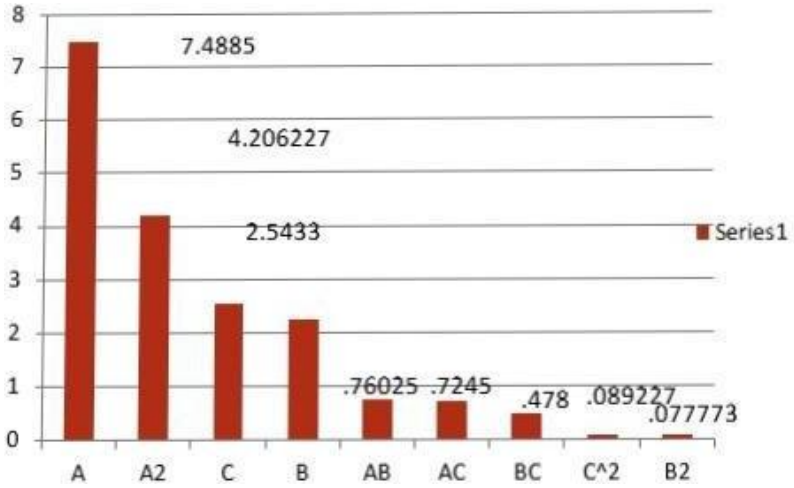


Figure (b): Effects of variables on dye extraction in P are to chart

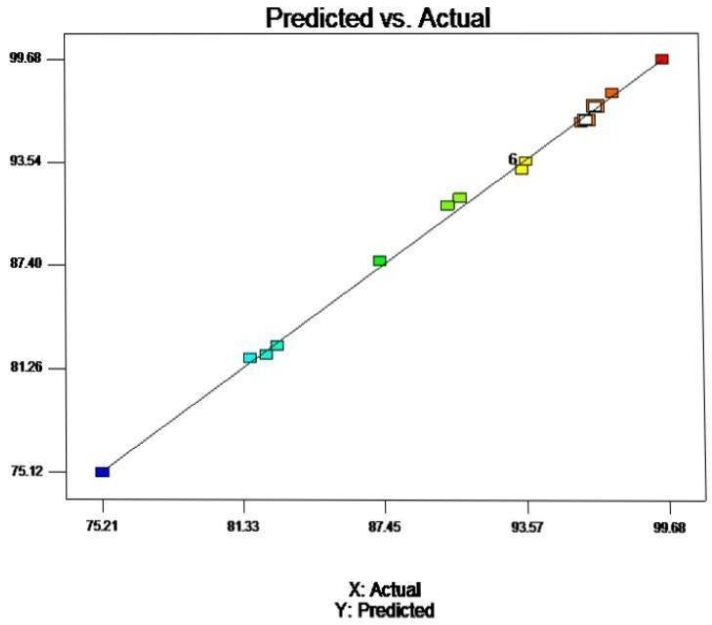


Figure (c): Coherence between predicted and observed values of % of Extraction

Phase Volume Ratio (R_v)

Table 3 demonstrates the significance of the proposed model via Analysis of Variance (ANOVA) calculations. The coefficient of determination obtained was 0.9993. The value of the $F_{calculated}$ test was compared to that of F_{tabled} for $F_{distribution}$ at a 95% confidence level with the respective degrees of freedom. The Model F-value of 1014.07 indicates that the proposed model is statistically significant, describing responses as a function of the variables analyzed. According to the response surface shown in Figure 5(a), the coacervate phase volume fraction increases with arise in surfactant concentration. Given that the coacervate phase corresponds to

practically all the surfactant in the system, the higher its concentration is, the higher the volume fraction of this phase will be. In the case of temperature, volume fraction decreases because the surfactant has lower hydrophilicity at a higher temperature and forms an even more concentrate coacervate in the surfactant. Figure 5(b) shows the effect of variables on coacervate phase volume fraction.

Surfactant concentration and temperature have a significant effect on coacervate phase volume fraction. The concentration of the surfactant has a significant positive effect showing that an increase in surfactant concentration will cause a rise in coacervate phase volume fraction. Conversely, temperature has a negative effect, indicating that an increase in this variable will lead to a decline in response, that is, a decrease in coacervate phase volume fraction. Figure 5 (c) illustrates the relationship obtained between the values calculated by the proposed model and the real values, attained experimentally.

Phase Volume Ratio (no unit):

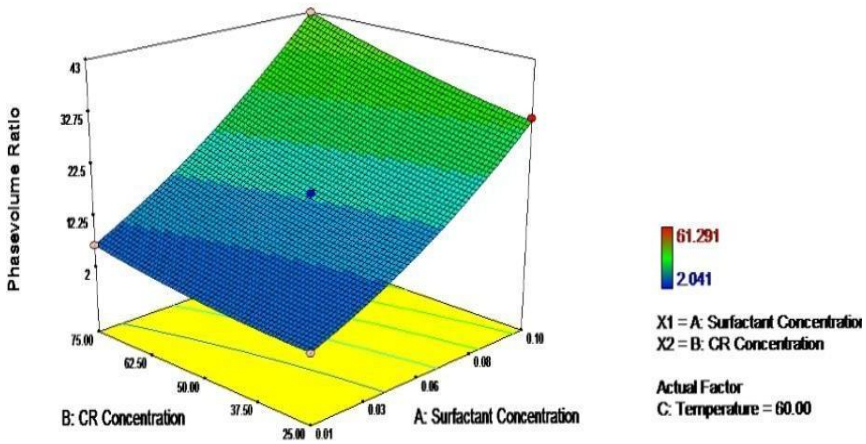


Figure (a): Response surface for phase volume ratio

$RV = 21.79 + 19.19X_1 + 5.14X_2 - 5.03X_3 \times 1.91X_1X_2 - 2.87X_1X_3 - 1.09X_2X_3 + 2.84X_2^2 + 0.95X^2 + 0.14X^2$

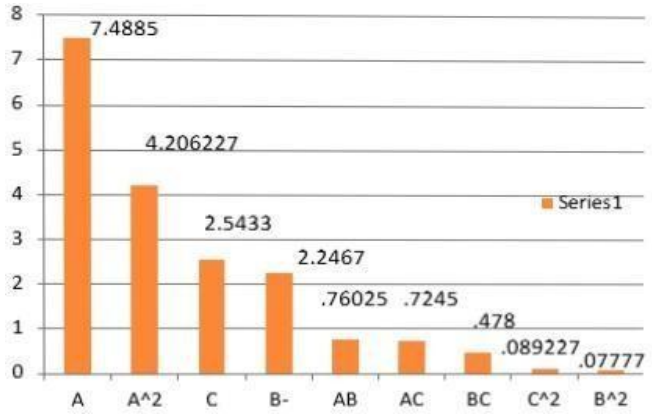
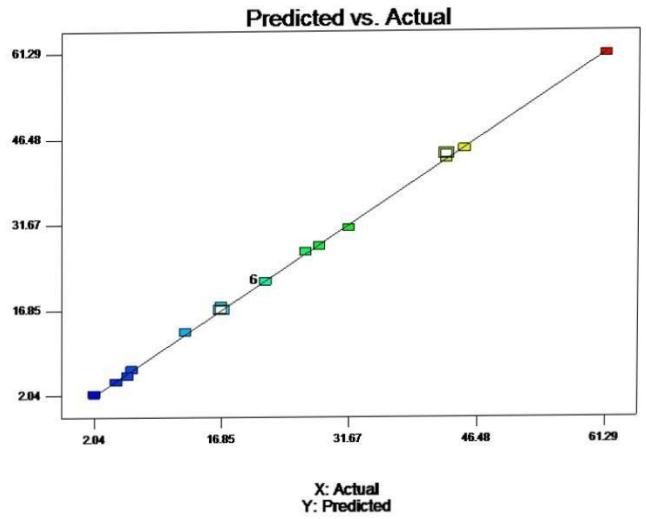


Figure (b): Effect of variables on coacervate phase volume fraction

Dye concentration in the dilute phase after separation ($X_{s,d}$):



Figure(c): Relationship between predicted and observed value

The proposed model for dye concentration in the dilute phase after separation showed significant regression at a 95% confidence level, with R^2 of 0.9950 in Table 3. The Model F-value of 91.85 implies that the model is significant and predictive. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise, indicating that the proposed model is significant and predictive. Figure 6 (a) shows the response surface graph generated by the proposed model for dye concentration in the dilute phase after separation ($X_{s,d}$). This is related to extraction efficiency, where the lower the amount of surfactant added to the system is, the lower the extraction will be. Thus, since temperature does not influence dye extraction, it will not affect residual dye concentration in the aqueous phase after separation. After the cloud point (turbidity) is reached, the surfactant forms the

coacervate phase with a very similar amount of surfactant, which is responsible for removing dye from the aqueous phase, since the surfactant also acts as extracting agent in this process. The Pareto chart Figure 6 (b) shows that within the 95% confidence interval the significant variable is surfactant concentration (linear part). The isolated effect of temperature was less significant on either the linear or the quadratic part. Figure 6 (c) shows the relationship between experimental data and values calculated by the model.

Dye Concentration in Dilute Phase after Separation (M)

XS, $d = 0.16 - 0.19X_1 + 0.18X_2 - 0.068X_3 - .11X_1X_2 + 0.020X_1X_3 - 0.042X_2X_3 + 0.10X_1^2 + 0.029X^2 - 4.545 \times E^{-5}X^2$

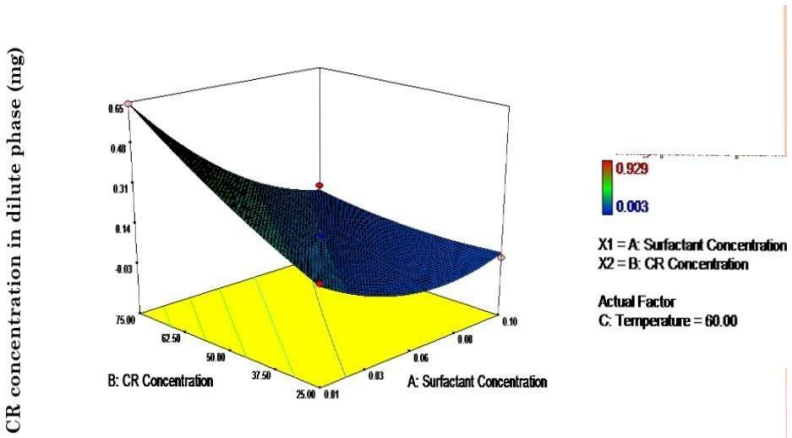


Figure (a): Response surface for dye concentration in the dilute phase after separation

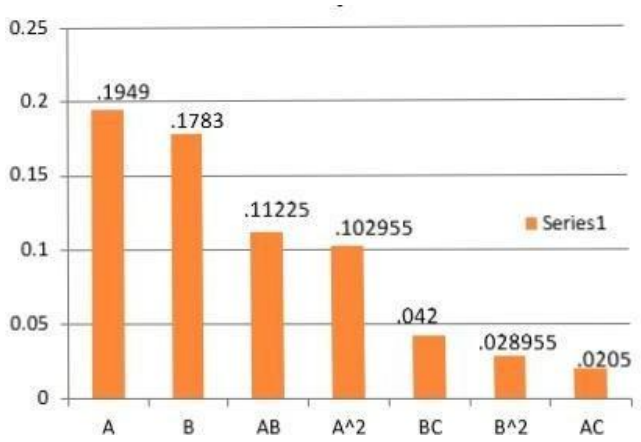


Figure (b): Pareto chart for dye concentration in dilute phase after separation

Figure (c): Comparison between predicted and observed values of dye

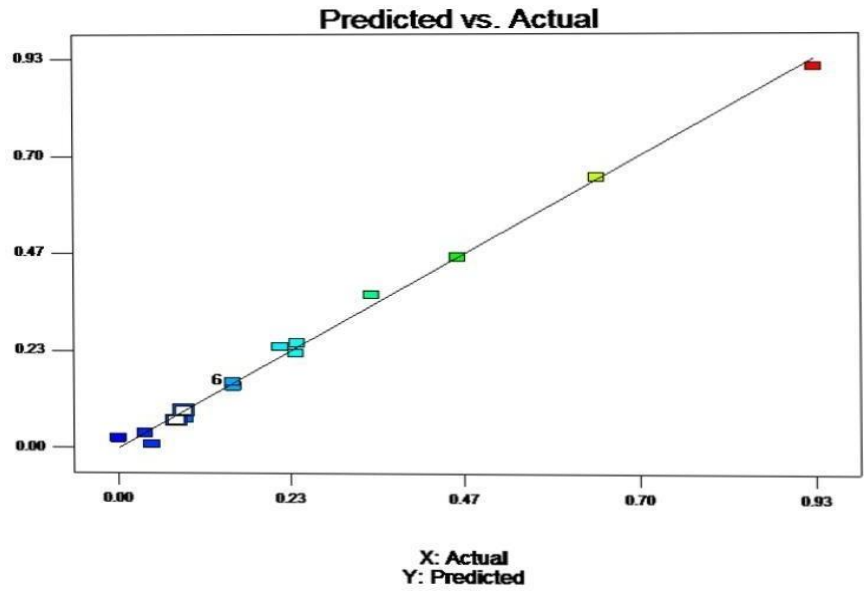


Fig 5.4 Concentration in dilute phase after separation.

Dye Concentration in the Surfactant-Rich Phase after Separation ($X_{s,r}$)

Residual dye concentration in the surfactant-rich phase after phase separation is an important parameter in terms of process viability. Even if extraction efficiency is high, elevated dye concentration makes the process unviable, since the loss of surfactant in the treated effluent promotes an increase in the cost and contamination of the effluent itself. The validity of the model in determining residual dye concentration was checked using Analysis of Variance (ANOVA), as depicted in Table 3 shows an R^2 value of 0.9995. The value of the $F_{calculated}$ test was compared to that of F_{tabled} for F distribution at a 95% confidence level with the respective degrees of freedom. The Model F-value of 77.33 implies that the model is significant and predictive. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise. Figure 7 (a) shows the effects of dye concentration and temperature via response surfaces. Within the range studied, there is a tendency to obtain increasingly lower dye concentrations in the surfactant-rich phase, where the temperature rises; reaching lower values. The increase in dye concentration results in a rise in concentration in the surfactant-rich phase.

The increase in temperature leads to a reduction in surfactant hydrophilicity, leading to its decline in the aqueous phase. According to the Pareto chart depicted in Figure 7 (b), resulting from the statistical processing of experimental data, the analysis of the significance of the effects of independent variables reveals that the initial dye concentration and temperature were significant at a 95% confidence interval. Thus, an increase in concentration leads to higher dye concentrations in

the surfactant-rich phase after separation. The rise in temperature results in increasingly lower dye concentration values in the surfactant-rich phase after separation. Figure 7 (c) shows the reliability of the results, evidenced by the relationship between experimental values and those predicted by the model.

The experimental design and response surface methodology were indispensable for optimizing and studying the effect of temperature and surfactant concentration on extraction parameters. The results obtained in the present study showed that both temperature and surfactant concentration affect process efficiency.

Dye Concentration in the Surfactant-rich Phase after separation (M)

$$X_{S,R} = 2.34 + 0.20X_1 + 1.08X_2 + 0.061X_3 + 0.10X_1X_2 - 0.012X_1X_3 + 0.051X_2X_3 - 0.11X_1^2 - 0.032X_2^2 + 3.136 \times 10^{-3}X_3^2$$

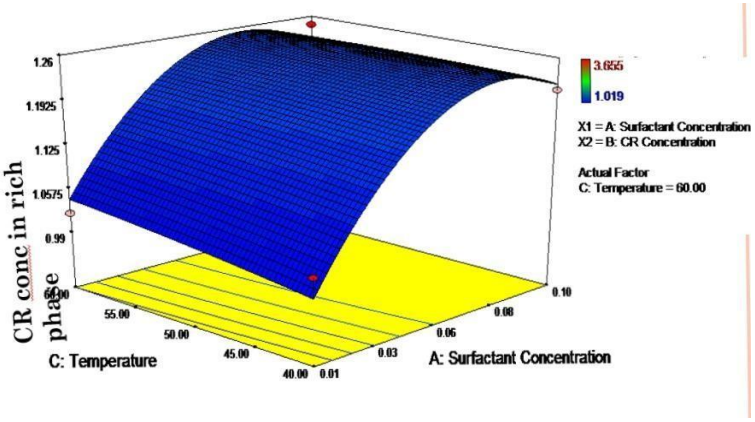


Figure (a): Response surfaces for dye concentration in surfactant-rich phase

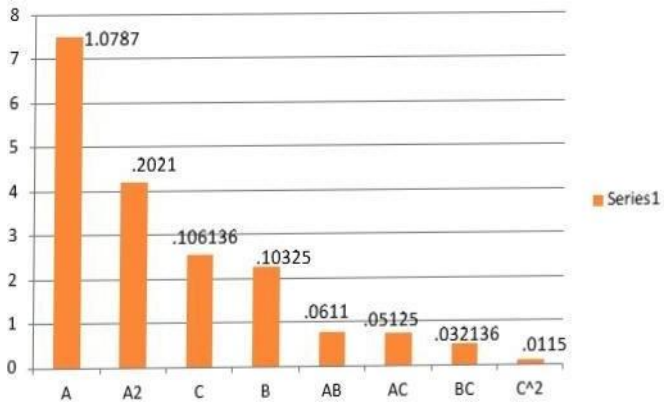


Figure (b): Pareto chart for dye concentration in surfactant-rich phase

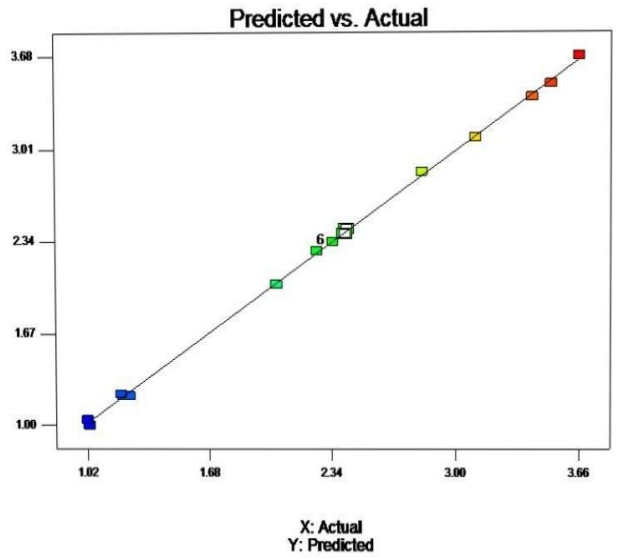


Figure (c): Relationship between predicted values of dye concentration in surfactant - rich phase and observed value

Table3 Validity of dye extraction by ANOVA

Source	Sum of Squares	DF	Mean squares	F value	P value	Remarks
Congo Red TX-114(E)-R2=0.9979						
Regression	775.37	9	86.15	536.68	<0.0001	Significant model
Residuals	1.61	10	0.16			
Lack of fit	1.61	5	0.33			
Pure error	0	5	0			
Total	776.97	19				
Phase volume Ratio (Rv)-R2=0.9993						
Regression	4370.66	9	485.63	1662.33	<0.0001	Significant model
Residuals	2.92	10	0.29			
Lack of fit	2.92	5	0.58			
Pure error	0	5				
Total	4383.58	19				
Congo Red TX-114 Concentration Dilute phase (Xs,d)-R2=0.9						
Regression	0.94	9	0.1	236.35	<0.0001	Significant model
Residuals	0.00441	10	0.000416			
Lack of fit	0.00441					
Pure error	0					
Total	0.94					
Congo Red TX-114 Concentration in surfactant rich phase (Xs,r)-R2 = 0.988						
Regression	12.27	9	1.32	2044.27	<0.0001	Significant model
Residuals	0.00667	10	0.0006671			
Lack of fit	0.00667	5	0.0013342			
Pure error	0	5	0			
Total	12.38	19				

Conclusion

- The experimental design and response surface methodology were indispensable for optimizing and studying the effect of temperature and surfactant concentration on extraction parameters.
- The results obtained in the present study showed that both temperature and surfactant concentration affect process efficiency.
- The four responses are affected significantly by surfactant concentration: dye concentration in the dilute phase decreases; whereas extraction efficiency, phase volume ratio, and dye concentration in the surfactant-rich phase increase, the last two ones almost linearly.
- Temperature has no effect on extraction efficiency, and on dye concentration in the dilute phase after separation. The effect of temperature was only observed in the coacervate phase volume ratio, where high temperatures led to lower coacervate phase volume ratio.
- The optimized extraction is obtained with 0.1M surfactant at 60^{o}C, where one can observe a 98% dye removal.

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CIRCUIT ENGINEERING

CHAPTER 14
DEVELOPING SELF-DRIVING CARS THROUGH NEAT-DRIVEN AI SIMULATION

K.Niranjani*, M.Vinoth, K.Rishivanth & R.Vengadesan
Department of Artificial Intelligence and Data Science
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

M.Parimala
Department of Computer Science and Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

This project demonstrates the implementation of the NEAT (NeuroEvolution of Augmenting Topologies) algorithm to develop an artificial neural network capable of controlling a car within a 2D environment. By utilizing the Pygame library, a simulated environment is created, featuring a track that the car must navigate. Equipped with sensors, the car detects walls and obstacles, which serve as inputs for the neural network. Through the NEAT algorithm, the network's weights and biases are continuously optimized, allowing the car to make increasingly better decisions. The evolution of the car occurs through successive generations, where each generation comprises neural networks with slightly varied weights and biases. This iterative process enables the car to adapt and improve its performance over time. Users can observe the car's evolution as it strives to find the optimal path around the track. Furthermore, the program offers manual control of the car, allowing users to actively participate and potentially save the best performing neural network for future use. This project effectively highlights the NEAT algorithm's efficacy in creating adaptable and self-improving neural networks. By harnessing evolutionary principles, artificial intelligence systems can successfully tackle complex challenges, such as navigating intricate tracks in a 2D environment. Ultimately, this project showcases the potential of NEAT and its role in developing AI solutions that can autonomously learn and solve complex problems.

Keywords: Autonomous Vehicle, NEAT Algorithm, Map Generation

Introduction

The NEAT (NeuroEvolution of Augmenting Topologies) algorithm is a type of genetic algorithm that can be used to evolve artificial neural networks. In this project, we demonstrate the application of NEAT to create a neural network that can control a car in a 2D environment. The program utilises the Pygame library to simulate the environment, which includes a track that the car must navigate. The car is equipped with sensors that detect walls and obstacles, which are fed into the

neural network as input. The NEAT algorithm then optimises the weights and biases of the neural network to enable the car to make better decisions.

The car evolves through generations, with each generation representing a new set of neural networks with slightly varied weights and biases. The program allows the user to watch as the car evolves to find the optimal path around the track. Additionally, the user can manually control the car and save the best performing neural network for future use.

Overall, this project showcases the power of the NEAT algorithm in creating a neural network that can adapt and improve over time. By using evolutionary principles, we can create artificial intelligence that can solve complex problems, such as navigating a track in a 2D environment.

Methods

"Autonomous Car Navigation using Genetic Algorithm", by Himani et al. (2019): This paper proposes a genetic algorithm-based approach for autonomous car navigation. The authors compare their approach with other machine learning-based approaches and show the effectiveness of the genetic Algorithms.

"Neuro-Evolution for Autonomous Driving: A Review", by Salimans et al. (2017): This paper provides a comprehensive review of neuro-evolution techniques for autonomous driving. The authors describe the advantages and limitations of various neuro-evolution algorithms, including NEAT.

"Deep Reinforcement Learning for Autonomous Driving: A Survey", by Liang et al. (2020): This paper presents a survey of deep reinforcement learning techniques for autonomous driving. The authors describe the current state-of-the-art approaches, including those using NEAT.

"An Application of the NEAT Algorithm for the Control of an Autonomous Vehicle," by Abreu et al. (2018): This paper describes an implementation of the NEAT algorithm for the control of an autonomous vehicle. The authors show the effectiveness of the NEAT algorithm for controlling the vehicle in a simulation environment.

"A Comparative Study of Machine Learning Algorithms for Autonomous Vehicle Control," by Li et al. (2020): This paper compares various machine learning algorithms, including NEAT, for autonomous vehicle control. The authors evaluate the performance of the algorithms based on several metrics, including speed, accuracy, and safety.

These literature surveys provide insights into the state-of-the-art techniques for autonomous driving, including those based on machine learning algorithms like NEAT. The surveys describe the advantages and limitations of these approaches and evaluate their performance based on several metrics. These literature surveys would be helpful in identifying the gaps in existing approaches and designing an effective and efficient autonomous driving system using the NEAT algorithm in Python.

Implementation

The NEAT architecture starts with a population of simple neural networks, with minimal or no connections. The networks are then evaluated on a given task and ranked according to their performance. The best performing networks are then selected and used to create the next generation of networks, with small random modifications to their weights and structure. Over time, the networks evolve and become more complex, eventually leading to optimal solutions for the task at hand. This Process flowchart is clearly shown in figure 1.

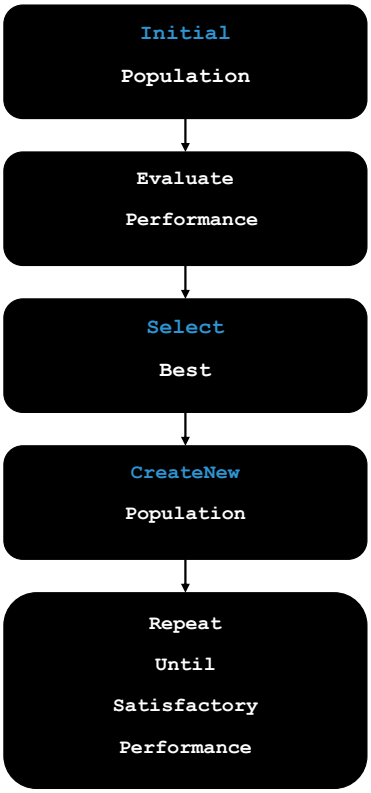

Figure 1: Process flow chart of competitive NEAT

Result and Analysis

Testing on Map

This test was conducted in map as shown in the figure 2. This was a simple map compared to others so the model doesn't struggle that much.

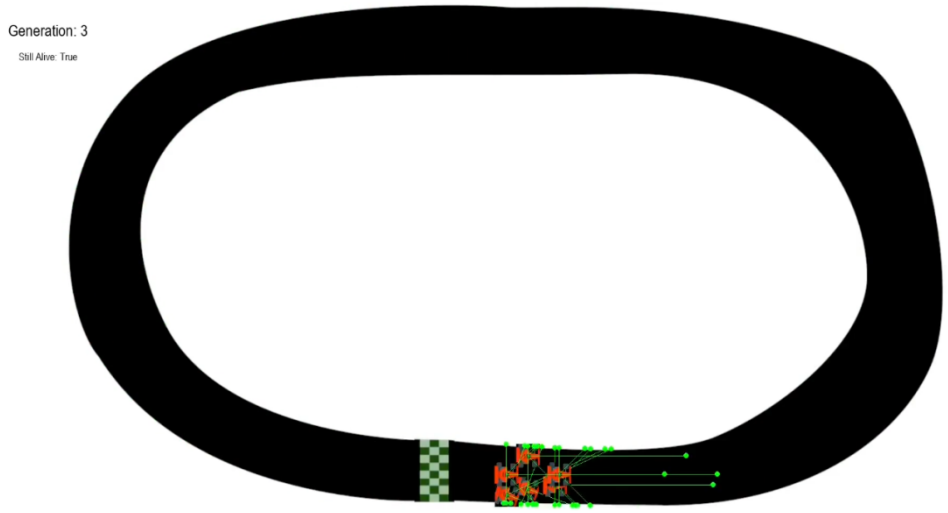

Figure 2: Number of generations on map

Result on Map

This is the fitness comparison graph that was plotted using the pandas and numpy as shown in figure 3. From the graph we can observe that through the training period the best fitness stays the same but the average fitness gradually increases over time.

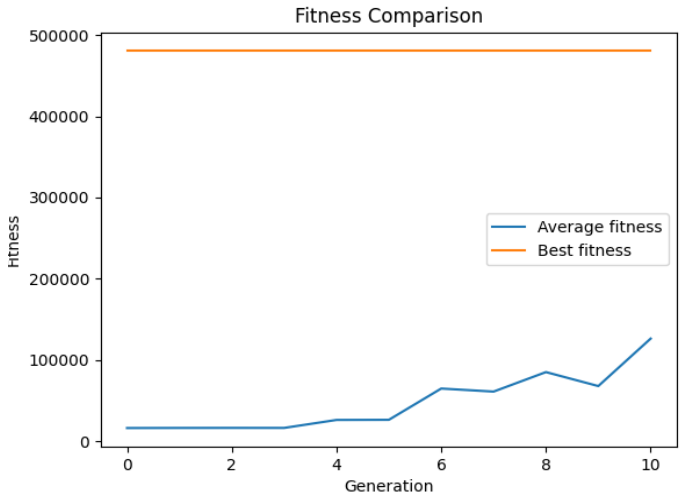

Figure 3: Fitness VS Generation graph for MAP

Conclusions and Future Work

In conclusion, this project has demonstrated the successful implementation of a simulation for an autonomous car using the NEAT algorithm. Through the use of a genetic algorithm, the car was able to learn and improve its driving behavior over time, ultimately leading to improved performance in navigating the course. The results show that the NEAT algorithm is an effective and efficient approach to training autonomous vehicles and can lead to significant improvements in driving performance. While the simulation used in this project is relatively simple, the techniques employed can be extended to more complex scenarios and environments. The project highlights the potential of AI and machine learning algorithms in the field of autonomous vehicles and paves the way for further research and development in this area.

Considerable future work on this project is, Integrate real-time sensor data from cameras, lidars, and other sensors into the simulation to enable more accurate perception and decision-making by the autonomous car.

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CHAPTER 15

STOCK PRICE PREDICTION USING LSTM

Sujithra M*, Aardra R, Akshara Lakshmi M & Lavanya.R
Department of Artificial Intelligence and Data Science
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

L.Shakira Banu
Department of Computer Science and Engineering,
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

The popularity of stocks has significantly increased in the digital world, leading to a surge in demand for stock analysis and prediction. The ability to predict and analyze stock prices provides valuable insights to individuals, enabling them to make more informed decisions when buying or selling stocks.

To address this growing demand, a new stock price prediction system has been developed based on deep learning algorithms. Deep learning is a subset of machine learning that focuses on training artificial neural networks to learn patterns and make predictions from vast amounts of data. By leveraging these algorithms, the system aims to generate accurate predictions for stock prices.

One of the key advantages of this system is its capability to predict the stock prices of any company worldwide. It is designed to handle a diverse range of stocks from various markets across the globe. This broad scope allows users to obtain predictions for a wide range of stocks, enabling them to make investment decisions across different industries and geographical locations.

Overall, the abstract highlights the increasing demand for stock analysis and prediction in the digital world. It introduces a new stock price prediction system based on deep learning algorithms, emphasizing its ability to provide predictions for stocks of any company globally. The system's analysis and visualization components further enhance its usefulness in helping individuals make informed decisions regarding stock trading.

Keywords: *Stock Analysis, Prediction, Stock Price, Deep Learning.*

Introduction

The stock market, known for its potential for high profits, has become a popular investment avenue. As trade and investment have grown, the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE) have emerged as the primary platforms for stock trading in India. However, predicting stock market movements can be challenging due to the dynamic nature of stock prices.

To tackle this complexity, investors rely on various methods and tools to increase their gains while minimizing risks. One such approach is time series

analysis, which involves analyzing past data to forecast future outcomes. By examining trends, patterns, and cycles in stock price data, time series analysis provides insights that help investors make informed decisions and identify potential opportunities. It is particularly valuable for short-term predictions, ranging from weeks and months to even minutes or seconds.

Fundamental analysis is another crucial tool for stock market forecasting. Fundamental analysts assess a company's historical performance and financial accounts to understand the intrinsic value of its stock. They utilize performance measures like the P/E ratio to evaluate the validity of a stock. By determining the true value of a stock and comparing it with its market price, fundamental analysts can identify if a stock is undervalued or overvalued. This analysis is based on the belief that a company's stock price should reflect its future earnings potential, discounted to its present value. Technical analysts, also known as chartists, utilize various tools such as chart patterns, oscillators, moving averages, and volume indicators to analyse historical price data. They believe that a stock's future price is primarily influenced by its past trends.

Methods

Sumeet Sarode etal Proposed in his paper that using machine learning techniques for stock price prediction using historical data is a popular but challenging area of research with mixed results.

Jiaqi Wang etal Proposed in his paper using Deep Learning that using stacked autoencoders and LSTM for financial time series prediction, which outperforms traditional machine learning models and can be applied to a wide range of datasets.

Kaushik Suresh etal Proposed in his paper that using LSTM recurrent neural networks for stock price prediction, achieving better results compared to traditional machine learning models.

G. Nirmala etal Proposed in his paper that hybrid approach using LSTM and ARIMA models for stock price prediction, demonstrating improved accuracy compared to individual models.

Yiqiao Yin etal Proposed in his Paper using Technical indicators that uses long short-term memory (LSTM) network-based model with multiple technical indicators for stock price prediction, achieving higher accuracy compared to individual technical indicators.

Daejin Kim etal Proposed in his paper using Financial indicators that a multi-layer LSTM model that incorporates multiple financial indicators for stock price prediction and compares its performance with traditional time series models.

Implementation

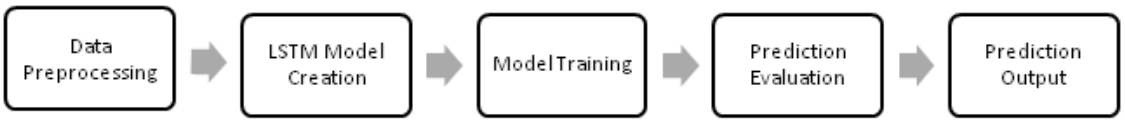

Fig.no.1 Methodology of Stock Price Prediction

- **Data Preprocessing**: Historical stock market data is collected and processed. We included 5 type stock prices of google for this. Preprocessing includes data cleaning, normalization etc.
- **LSTM Model Creation**: LSTM network architecture is designed. LSTM with three gates (Forget Gate, Input Gate, Output Gate) and additional layers such as step-down, solid or sequential layers to control the cell state.
- **Model Training**: The pre-processed data is fed into the LSTM model for training. The model learns patterns and relationships in the data and adjusts its parameters.
- **Prediction Evaluation**: After the model is trained, the performance of the LSTM network is evaluated using the test data set. This includes measuring the accuracy of the model to assess its predictive ability.
- **Prediction Output**: After training and evaluating the model, it can be used to make predictions. You can directly use any company's data set and apply algorithms that provide correct predictions.

Algorithms Used

1. LSTM

LSTM (Long Short-Term Memory) models are utilized in stock price prediction to capture and learn from temporal patterns and dependencies in historical data, enabling more accurate forecasting of future stock prices.

2. DENSE

Dense layers are commonly used in stock price prediction models to capture complex patterns and relationships within historical data, enabling the network to make more accurate predictions based on the input features.

3. DROP OUT

Dropout is used in stock price prediction to mitigate overfitting and improve generalization by randomly dropping out a fraction of neural network units during training, reducing their co-dependency.

4. SEQUENTIAL

Sequentialmodels, such as recurrent neural networks (RNNs) or long short-term memory (LSTM) networks, are commonly used in stock price forecasting to capture temporal dependencies and patterns in historical price data, enabling more accurate forecasts.

Results and Discussion

Data Set

shape is = (1258, 6)

	Date	Open	High	Low	Close	Volume
0	1/3/2012	325.25	332.83	324.97	663.59	7,380,500
1	1/4/2012	331.27	333.87	329.08	666.45	5,749,400
2	1/5/2012	329.83	330.75	326.89	657.21	6,590,300
3	1/6/2012	328.34	328.77	323.68	648.24	5,405,900
4	1/9/2012	322.04	322.29	309.46	620.76	11,688,800

Fig 2 Dataset

Here we have included the 5 year Stock Price of Google LLC for this project.
https://1drv.ms/u/s!AsWAP4dRuxlswWgPwoXBkUggSCJp

Output Visualization

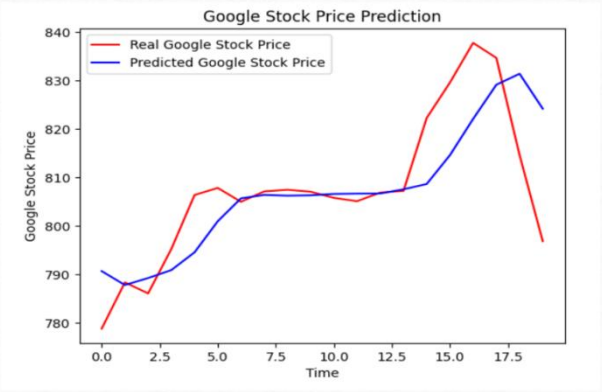

Fig no.3

X axis represents time, Y axis represents Google stock price. The red and blue lines indicate the actual Google stock price and the predicted Google stock price, respectively. Similarly, we can directly use the stock dataset of any company and apply these algorithms that will give us correct predictions. This system runs successfully on any system even on cloud platform.

Conclusion

We can predict, analyze and visualize Google stock price by applying deep learning algorithms like LSTM, DENSE, DROPOUT and SEQUENTIAL. Similarly we can directly use stock dataset of any company and apply these algorithms which will give us correct prediction. We have seen that using deep learning algorithms we are getting great accuracy and prediction. This system runs successfully on any system even on cloud platform. In conclusion, astock price forecasting project using LSTM, dense layers, dropout regularization and sequential modeling demonstrates the effectiveness of deep learning techniques in stock price forecasting. LSTM models capture complex temporal dependencies and patterns in data, allowing for accurate predictions of future stock prices. Inclusion of dense layers and dropout regularization enhance the generalization capabilities of the model and reduce overfitting. The project's evaluation results show that the LSTM model outperforms traditional methods, demonstrating its value in providing reliable and accurate stock price forecasts. This approach holds great potential for investors and financial analysts who want to make informed decisions based on robust stock price forecasts.

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CHAPTER 16

BLOCKCHAIN BASED CROWDFUNDING APPLICATION IN WEB3

Ramya Priyatharsini T.G*, Saravanan S, Saravana Kumar S, Vijayakumar D & Lalithavani K

Department of Information & Technology

Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamil Nadu

Abstract

Crowd funding is a method for funding various kinds of ventures, wherein individual founders of the ventures can request for funds. The ventures may be working for profit motive, non-profit motive, cultural or social. The funds are usually given in return for future products or equity. Due to the current era of technology, the use of internet social media platforms to connect investors with entrepreneurs to raise capital for various kinds of ventures in return for compensation or just with a motive to help the noble cause. The issue with today's crowdfunding method is that fundraisers and contributors have no control over the funds they donate and some more like Scam-startups, Intellectual Property risk, exorbitant fees. These issues in addition to solving an issue or helping a noble cause, raises few other problems and for few, it won't allow to contribute. This project creates a platform that presents a block-chain-based crowdfunding network that can provide a private, secure, and decentralized crowdfunding path by using smart contracts. The aim is to solve these problems by applying smart contracts to the crowdfunding site so that the contracts will be fully automatically executed so that frauds can be prevented, and a healthy relationship is built between the fundraisers, platform, and the contributors. This crowdfunding application is not just like any other application which just allows people to invest their money, but this platform also gives an assurance to the backers that returns will be guaranteed. The application will also provide transparency between the backers and the start-ups so that the backers can stay updated on the progress of the project work of the respective start-ups that they invested their money in.

Introduction

Blockchain - A distributed ledger technology (DLT) known as a blockchain is a growing collection of records known as blocks that are safely connected to one another using cryptography. Crowdfunding is the technique of financing a project or a start-up by soliciting donations from many different people [1][2]. Blockchain Crowdfunding Application - Stakeholders (donors) want to monitor how the organization is doing, determine whether it is accomplishing its objectives, and make appropriate recommendations [3]. This necessitates complete transparency and accurate financial data about the relevant project activities.

A blockchain-based application for crowdfunding serves the objective of giving people and organizations a decentralized and open platform to fundraise for their endeavors. By leveraging blockchain technology, the platform can offer several benefits such as increased security, immutability, and transparency [4]. The elimination of intermediaries such as banks can reduce costs and increase efficiency, while the decentralized nature of blockchain allows for all transactions to be recorded and publicly accessible, which can help build trust among contributors and ensure that funds are being used as intended. Additionally, the distributed ledger technology of blockchain can help prevent fraudulent activities and hacking attempts, creating a more secure environment for crowdfunding. Anyone with an internet connection and a digital wallet can donate to projects using a blockchain-based crowdfunding platform, regardless of their location or financial situation. In general, a blockchain-based crowdfunding tool can provide a more effective, transparent, and secure way for people and organizations to generate money for their initiatives.

Literature Survey

V. Hassija et al. [5] have proposed By supporting multiple small businesses and entrepreneurs, crowdfunding is a new financial sector that increases a country's economic competitiveness. The platform grows the client base by enabling the collection of a little sum of money from a big number of customers. By 2025, crowdfunding investments are predicted to generate $100 billion in revenue, according to a recent World Bank analysis (World Bank, 2019). By 2020, there will be 2,260,230 entrepreneurs (campaigns) operating worldwide (World Bank, 2019).

Firmansyah Ashari [6] attempts to analyze the procedures that are typically used in this fundraising organization using block chain technology, which can be a substitute solution to raise funders' trust, which will undoubtedly have an impact on the amount of money the fundraising organization will be able to raise. If all requirements are satisfied, beneficiaries can easily get these payments thanks to smart contract technology. According to prior studies, this technology can be applied to the telecommunications and medical fields.

M. N. Saadat et al. [7] have proposed a distributed database of transaction records that are shared among involved parties might be referred to as a block chain. Decentralization of data, persistence, anonymity, and auditability are some of the traits of block chain. The transaction and block are the two main parts of the

block chain technology. The block is a group of data that records the transaction and any accompanying information, such as the correct order, timestamp of creation, etc., whereas the transaction represents the participant's action. A blockchain's blocks, which serve as transaction records, are linked together cryptographically to prevent tampering. This means that no block that has been added can be changed or eliminated. Blockchain relies on consensus methods to be reliable.

Hartmann et al. [8] have proposed the study puts up the premise that understanding how the current regulatory structure relates to blockchain-based crowdfunding would be advantageous for regulators and market participants. Due to the specific properties of blockchain-based crowdfunding, legal frameworks may need to be reinterpreted in order for legislation to be successfully enforced. To fill this knowledge gap, we looked at a variety of relevant literature on success factors for both conventional and blockchain-based crowdfunding. The results of this literature review offer recommendations for the direction of future research and development.

J. Roth et al. [9] have proposed to explore tokenization of equity crowdfunding on a Blockchain in this chapter, which was suggested in the paper as a potential method to make it simpler for businesses to raise capital. They propose categorizing token standards into UTXO-based, layer-based, and smart contract-based tokens. They then look at the advantages that tokenization can provide, such as enhanced share dilution, cryptographically secured ownership, the programmability of assets, access to the Blockchain ecosystem, and the formation of a functional secondary market. The cost of secondary market transaction and the impact of the middlemen are decreased by enabling the tokenization process to decouple the asset ledger from the crowdfunding platform. They conclude by outlining a number of drawbacks, including knowledge gaps between campaign creators and funders, logistical challenges.

Mahmood Rashid et al. [10] have proposed make and store contracts between students and their higher education sponsors using a blockchain-based platform that is enabled through middlemen referred to as fundraisers. Any type of sponsorship is possible, including a scholarship, gift, or loan. A group of aggressive fund-raisers who will hold the distributed ledgers and serve as the blockchain network's miners will organize and manage the fund.

Methods

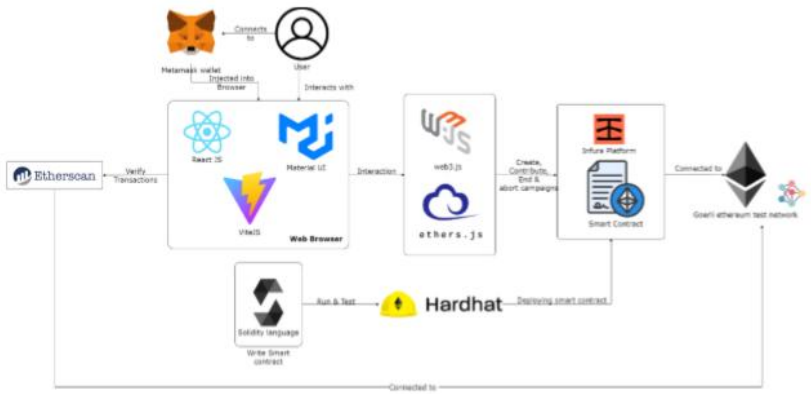

Fig. No:1 Platform Overview that shows the interactions between the modules

The smart contract which is the core of the application is written in Solidity language, which is tested locally and deployed remotely to Infura platform on Goerli test network via hardhat.

The user will be able to access the platform through deployed web application, which is built with modern JS libraries like ReactJS, ViteJS (for fast bundling of libraries & local server while developing) & Material UI (for ready-made UI components). The platform interacts with the deployed smart contract on Infura using web3.js and ethers.js libraries depending upon user interactions – like creating campaigns, displaying campaigns, ending campaigns, aborting campaigns, etc.

To perform each interaction with the blockchain (except listing out deployed campaigns) requires wallet authentication and authorization. All the transactions which take place are completely transparent and [any] user can verify the authenticity of the transaction via etherscan which is shown in Fig. No. 1.

Homepage

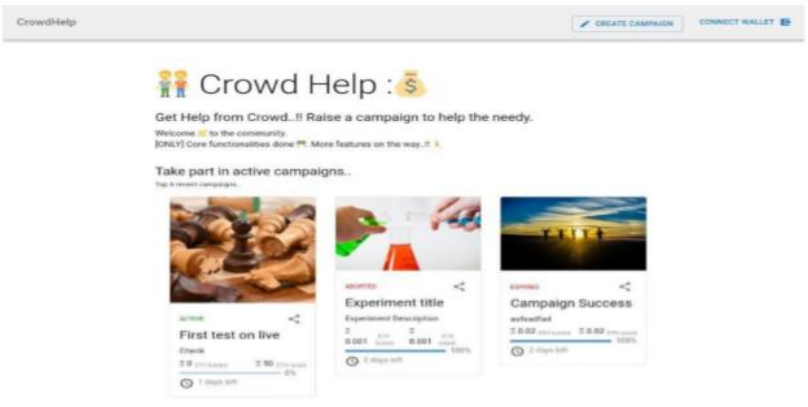

Fig. No: 2 Home Page

Wallet Connection

The Wallet Connection module is responsible for connecting users' digital wallets to the crowdfunding application which is shown in Fig. No. 3. This module ensures that the user's digital wallet is integrated with the application and ready for use. The module handles the connection process between the user's wallet and the application, verifies the wallet's authenticity and ensures that it is compatible with the crowdfunding platform. Whether campaign creation / contributing funds or any action related (except viewing) needs wallet connection & authorization at each crucial step for providing strong security.

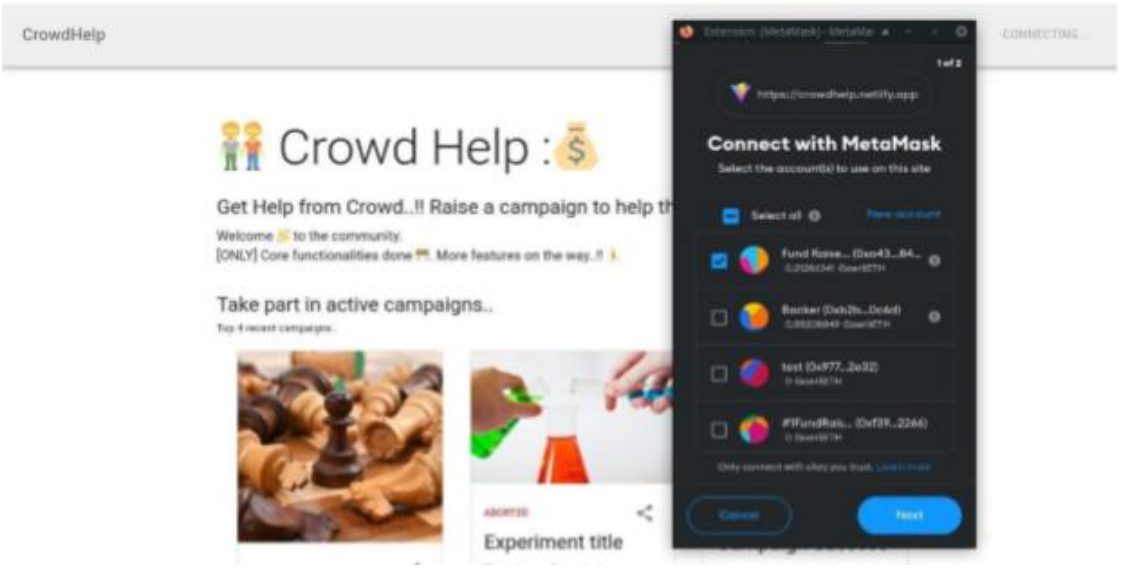

Fig. No: 3 Wallet Connection module

Campaign Creation

The Campaign Creation module is responsible for creating a new crowdfunding campaign which is displayed in Fig. No. 4. This module allows users to create a campaign by providing details such as the campaign's name, description, target funding amount, campaign duration, and other related information. The module validates the input data, saves the campaign data in the database, and provides the campaign creator with a unique campaign ID. A campaign to raise funds for a cause.

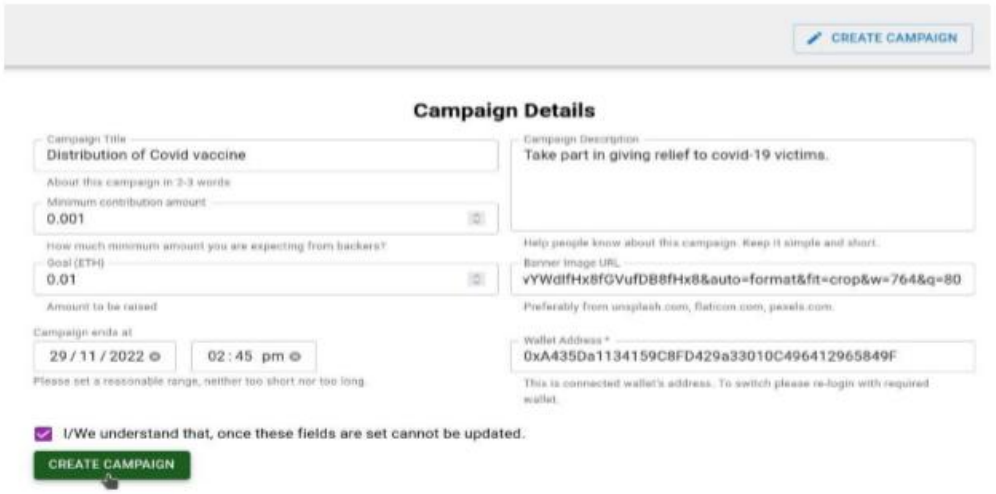

Fig. No: 4 Campaign Creation module

Displaying Campaigns

The Display Campaigns module is responsible for displaying all the available campaigns to the users which is shown in Fig. Nos. 5, 6 and 7. This module allows users to view the campaigns and their details such as the campaign's name, description, target amount, current funding status, and other relevant information. The module also allows users to filter campaigns based on different criteria like category, funding goal, etc. Displays list of campaigns in the home page, where each campaign will be displayed as a card & status is displayed as a progress bar. Upon clicking, campaign-specific page will be displayed.

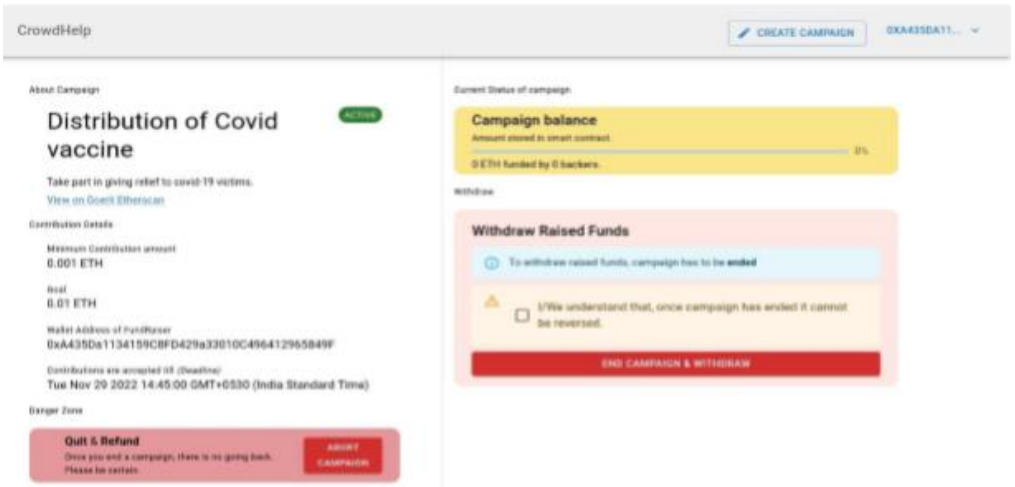

Fig. No: 5 Campaign-specific page

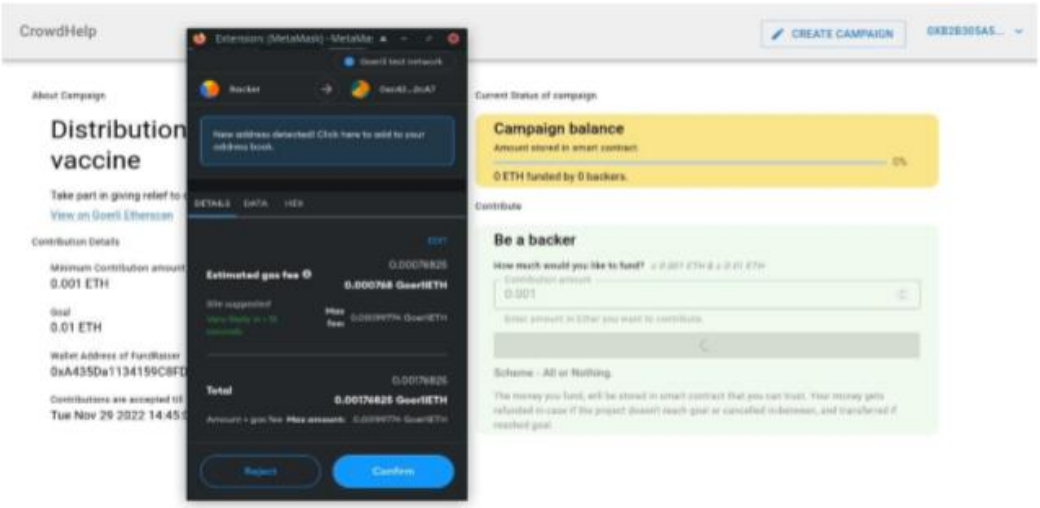

Fig. No: 6 Campaign-specific page

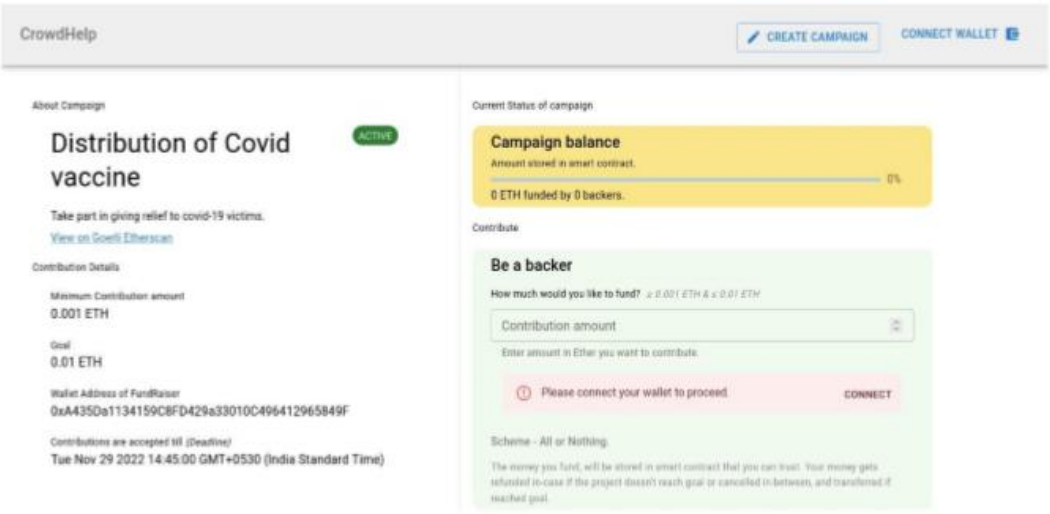

Fig. No: 7 Campaign-specific page

Fund Raising

The Fund-Raising module is responsible for handling the transactions between the users and the campaigns. This module allows users to contribute funds to the campaigns of their choice using their digital wallets. The module handles the authentication and authorization of the transaction, ensures the funds are transferred securely, and updates the campaign's funding status. A backer can support to a campaign by raising at least minimum amount (as set at the time of campaign creation). Contributed amount will be stored in the smart contract until the project end.

Abort Campaign

The Abort Campaign module shown in Fig. No. 8 is responsible for aborting the campaign at any stage of the campaign duration. This module allows the campaign creator to terminate the campaign early, return the funds to the contributors, and remove the campaign from the application. The module ensures that the campaign creator has the necessary permissions to abort the campaign, verifies the authenticity of the request, and processes the fund transfer to the contributors. Fund raiser can abort campaign (before deadline) - with whatsoever may be the reason. In this case, all the raised funds (if any) will be paid back to backers.

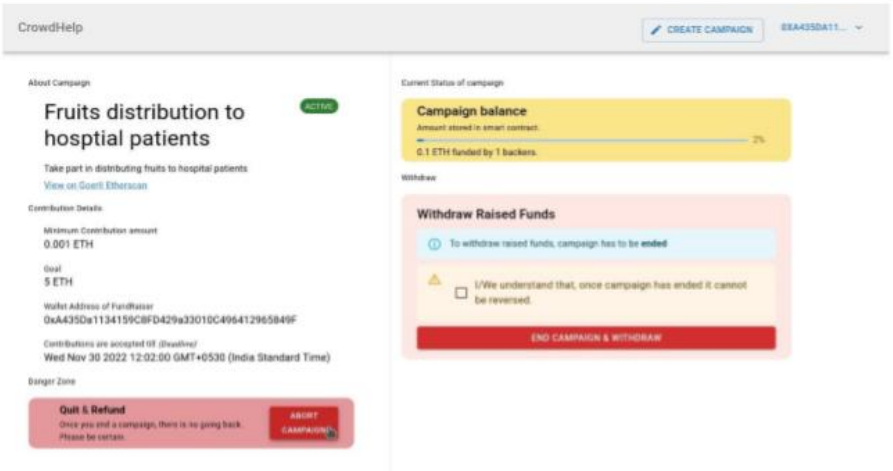

Fig. No: 8 Abort Campaign module

Ending & Withdrawing

The Ending and Withdrawing modules shown in Fig. Nos. 9, 10 and 11 are responsible for handling the end of the campaign and the withdrawal of the funds by the campaign creator. This module allows the campaign creator to withdraw the funds once the campaign has ended and the funding target has been achieved. The module ensures that the campaign creator has the necessary permissions to withdraw the funds, verifies the authenticity of the request, and processes the fund transfer to the campaign creator's wallet. Fund raisers can end the campaign [ONLY] after the deadline & the campaign has reached its goal. Else they need to abort to pay back to backers.

For documenting the functional requirements, the set of functionalities supported by the system are to be specified. A function can be specified by identifying the state at which data is to be input to the system, its input data

domain, the output domain, and the type of processing to be carried on the input data to obtain the output data. Functional requirements define specific behaviour or function of the application. Following are the functional requirements:

The system should

1. Enable the fundraisers and backers to register with appropriate proof. 2. Allow the fundraisers to launch a campaign by filling the necessary fields. 3. Allow backers to view the active campaigns and fund digital currency. 4. In case of failure to meet the criteria set (either not exceeded the timeline or not reached the required funds) – should be able to transfer back the funded amount or disburse the raised funds. 5. Allow fundraisers to update the status of the cause regularly. 6. Disburse fraction of funds automatically upon meeting the goals saved in smart- contracts. 7. Disburse the raised funds (after successful campaign) after verification.

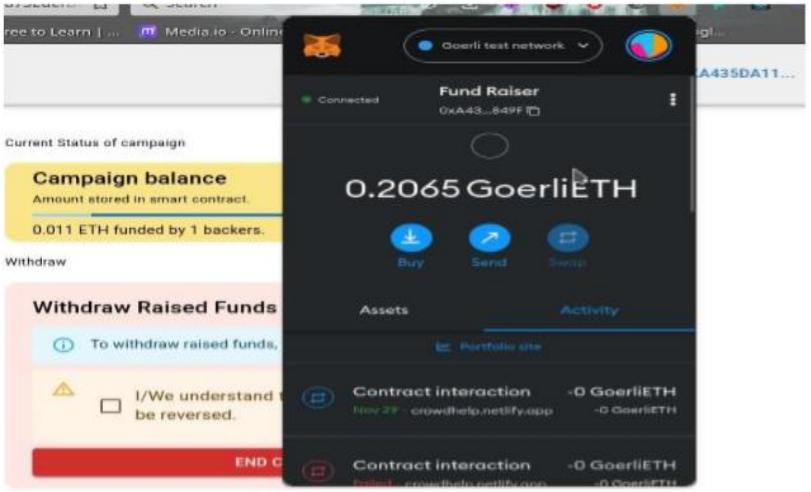

Fig. No: 9 Ending and Withdrawing modules

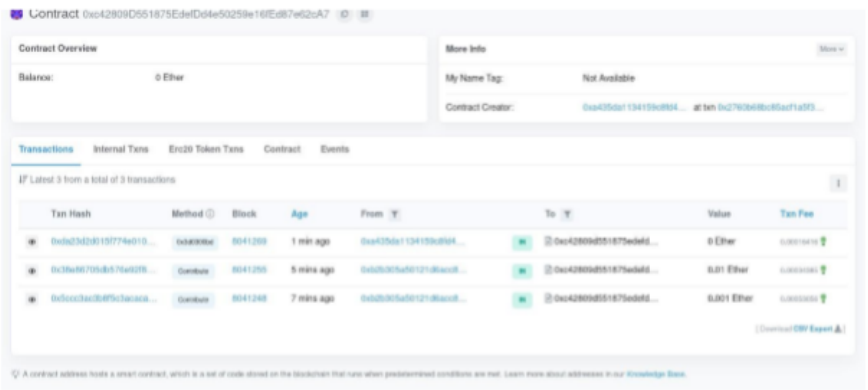

Fig. No: 10 Ending and Withdrawing modules

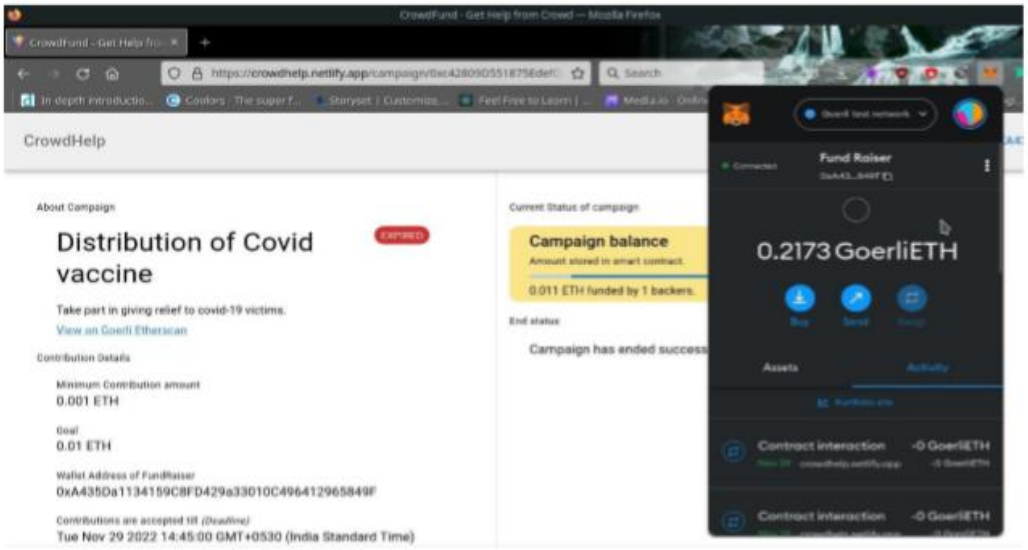

Fig. No: 11 Ending and Withdrawing modules

Results and Discussion

At the time of Covid-19 pandemic across various countries in the world – including developed countries like USA, Russia etc., Crowdfunding activities have been increased all around the world, ranging from tiny campaigns to help individuals acquire oxygen and medical assistance to huge funds like PM Cares. Contributors, crowdfunding platforms, and project administrators were the primary players in the crowdfunding event. In the recent times, India has witnessed a massive growth in the start-up industry. It is because people want to break out of the barrier of working 9-5 and our government supports it. Start-ups often look out for investors and try to approach VCs to get funding. Sometimes it gets tedious. Start-ups can try using crowdfunding as it increases the brand reach and it's easier than approaching a VC. We are highly inspired by the CryptoRelief initiative (www.cryptorelief.com) which raised ~1 billion dollars for Covid Relief in India from the entire Globe.

Conclusion

It is quite evident that crowdfunding has huge potential in present times as well as in the future. Even though it comes with its own drawbacks and challenges, this form of funding is helping new start- ups and innovators, entrepreneurs, and other creators. In the future, when blockchain will the backbone of major investor

contributions, it will make crowdfunding easier, transparent, and accessible. It is only a matter of time before creating, fund, abort & end a campaign.

In order to conclude we would like to affirm that the potential and influence that the emerging technologies possess, for crowdfunding, is immense. The current solutions for the challenges that the usual crowdfunding platforms pose are now able to transform the society for better. Crowdfunding platforms using blockchain technology hold more credibility and therefore, we believe are the future for the right investment for investors. Raising Withdraw requests: A request with amount needed and reason. Why? The funds raised by backers. The request will be approved only if >50% of contributors accept it. Approving withdraw requests: Depending on the progress achieved by campaign & amount needed, he can approve requests. NOTE: Any backer who has contributed >= Minimum amount will be considered as approver. Contributing pages: A separate page, where backer can only view the campaigns, they funded with the number of contributions. Why? To facilitate how many campaigns, they are supporting & to know SPECIFIC campaigns status to monitor how their contributed funds are in usage. Updating campaign page: To elaborate the cause.

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CHAPTER 17
IoT ENABLED GREENHOUSE PLANTATION MONITORING

S. Francis Shamili*, K.Ramya & K.Aswin
Department of Computer Science and Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomus), Perambalur

Abstract

The demand for food has been increasing over the past six decades with the global population increase. Scientists have been finding different ways to meet this demand, such as; green revolution and genetically modified crop methods. These involve an unnatural technique to increase the yield, such as chemical fertilizers, pesticides, and modified seeds; these might be beneficial in the short term but might slowly disturb the internal body mechanism. In recent years, consumers are becoming more concerned about their food intake and prefer food with no adulteration and harmful pesticides. This has brought in the hype for a subdivision of framing, organic farming, where organic fertilizers and pesticides are used to retain the quality and nutrition values of the crop bring harvested. In organic farming, the right crop must be chosen according to the soil type and climate. This reduces the chance of pre-harvest crop losses caused by the abiotic stress in the environment, such as the soil moisture, improper irrigation, climate, and temperature. Desired conditions are provided to the crop, we can reduce the pre-harvest loss up to 35%. This paper offers a practical approach to reduce this loss by predicting what crop can be planted according to the present soil conditions and climate to prevent pre-harvest losses. The model involves a temperature and humidity sensor, a soil moisture sensor, LDR,a gas sensor, IoT, lamp and a water pump under a greenhouse environment connected with the help of a development board, Arduino Uno , and machine learning techniques.
Keywords: *LDR, Arduino UNO, IoT, Humidity Sensor, and Soil Moisture Sensor.*

Introduction

Greenhouse is integrated with smart farming to improve agricultural growth management and, as a result, diverse conditions should be observed at precision agriculture. Focusing on the effect of universal food insecurity, over 60% of sub-Saharan countries are predicted to be in a state of malnourishment and yet several farming places are under drought state. The climatic condition is believed to be biannual dry seasons which is very difficult for farmers to cultivate crops due to shortage of water and poor soil fertility. Yet heavy rainfall is still a great threat for the farmers since it devastates cash crops. Use of a smart greenhouse with Artificial Intelligence to grow and protect plants in both dry and wet seasons and reduce labor-intensive human tasks and automate pervasive data analytics of daily plant status can surprisingly boost food security.

Artiificial Intelligence

Artificial intelligence (AI), digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience. Since the development of the digital computer in the 1940s, it has been demonstrated that computers can be programmed to carry out very complex tasks—as, for example, discovering proofs for mathematical theorems or playing chess—with great proficiency. Still, despite continuing advances in computer processing speed and memory capacity, there are as yet no programs that can match human flexibility over wider domains or in tasks requiring much everyday knowledge.

On the other hand, some programs have attained the performance levels of human experts and professionals in performing certain specific tasks, so that artificial intelligence in this limited sense is found in applications as diverse as medical diagnosis, computer search engines, and voice or handwriting recognition.

Basics

A typical AI analyzes its environment and takes actions that maximize its chance of success. An AI's intended utility function (or goal) can be simple ("1 if the AI wins a game of Go, 0 otherwise") or complex ("Do mathematically similar actions to the ones succeeded in the past"). Goals can be explicitly defined, or induced. If the AI is programmed for "reinforcement learning", goals can be implicitly induced by rewarding some types of behaviour or punishing others. Alternatively, an evolutionary system can induce goals by using a "fitness function" to mutate and preferentially replicate high-scoring AI systems, similarly to how animals evolved to innately desire certain goals such as finding food. Some AI systems, such as nearest-neighbor, instead of reason by analogy, these systems are not generally given goals, except to the degree that goals are implicit in their training data. Such systems can still be benchmarked if the non-goal system is

framed as a system whose "goal" is to successfully accomplish its narrow classification task.

AI often revolves around the use of algorithms. An algorithm is a set of unambiguous instructions that a mechanical computer can execute.

A complex algorithm is often built on top of other, simpler, algorithms. A simple example of an algorithm is the following (optimal for first player) recipe for play at tic-tac-toe. Many AI algorithms are capable of learning from data; they can enhance themselves by learning new heuristics (strategies, or "rules of thumb", that have worked well in the past), or can themselves write other algorithms. Some of the "learners" described below, including Bayesian networks, decision trees, and nearest-neighbor, could theoretically, (given infinite data, time, and memory) learn to approximate any function, including which combination of mathematical functions would best describe the world. These learners could therefore, derive all possible knowledge, by considering every possible hypothesis and matching them against the data. In practice, it is almost never possible to consider every possibility, because of the phenomenon of "combinatorial explosion", where the amount of time needed to solve a problem grows exponentially. Much of AI research involves figuring out how to identify and avoid considering broad range of possibilities that are unlikely to be beneficial. For example, when viewing a map and looking for the shortest driving route from Denver to New York in the East, one can in most cases skip looking at any path through San Francisco or other areas far to the West; thus, an AI wielding a pathfinding algorithm like A* can avoid the combinatorial explosion that would ensue if every possible route had to be ponderously considered in turn.

The earliest (and easiest to understand) approach to AI was symbolism (such as formal logic): "If an otherwise healthy adult has a fever, then they may have influenza". A second, more general, approach is Bayesian inference: "If the current patient has a fever, adjust the probability they have influenza in such-and-such way". The third major approach, extremely popular in routine business AI applications, are analogises such as SVM and nearest-neighbour:

"After examining the records of known past patients whose temperature, symptoms, age, and other factors mostly match the current patient, X% of those patients turned out to have influenza". A fourth approach is harder to intuitively understand, but is inspired by how the brain's machinery works: the artificial neural network approach uses artificial "neurons" that can learn by comparing itself to the desired output and altering the strengths of the connections between its

internal neurons to "reinforce" connections that seemed to be useful. These four main approaches can overlap with each other and with evolutionary systems; for example, neural nets can learn to make inferences, to generalize, and to make analogies. Some systems implicitly or explicitly use multiple of these approaches, alongside many other AI and non-AI algorithms; the best approach is often different depending on the problem.

Machine Learning

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, uncovering key insights within data mining projects. These insights subsequently drive decision making within applications and businesses, ideally impacting key growth metrics. As big data continues to expand and grow, the market demand for data scientists will increase, requiring them to assist in the identification of the most relevant business questions and subsequently the data to answer them.

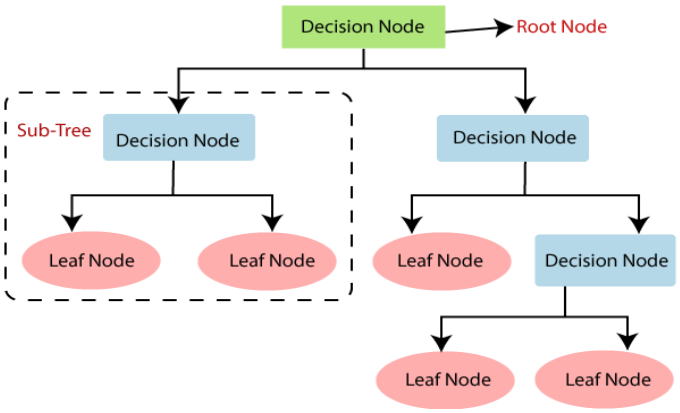
Decision Tree Algorithm

Decision Tree is a **supervised learning technique** that can be used for both classification and Regression problems, but mostly it is preferred for solvingClassification problems. It is a tree-structured classifier, where **internal nodes represent the features of a dataset, branches represent the decision rules** and **each leaf node represents the outcome.**In a Decision tree, there are two nodes, which are the **Decision Node** and **Leaf Node.** Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches. The decisions or the test are performed on the basis of features of the given dataset. It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions. It is called a decision tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure.

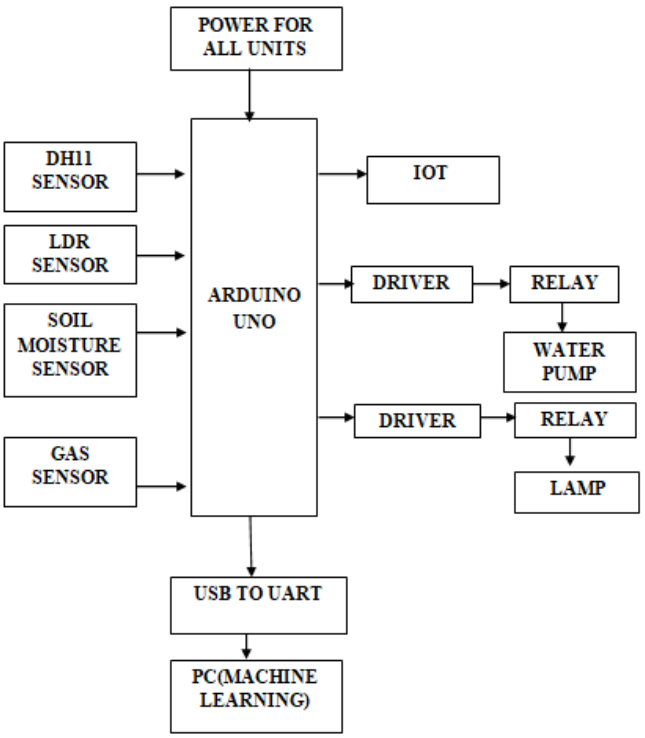
Decision Tree Terminologies

1. **Root Node:** Root node is from where the decision tree starts. It represents the entire dataset, which further gets divided into two or more homogeneous sets.

2. **Leaf Node:** Leaf nodes are the final output node, and the tree cannot be segregated further after getting a leaf node.
3. **Splitting:** Splitting is the process of dividing the decision node/root node into sub-nodes according to the given conditions.
4. **Branch/Sub Tree:** A tree formed by splitting the tree.
5. **Pruning:** Pruning is the process of removing the unwanted branches from the tree.
6. **Parent/Child node:** The root node of the tree is called the parent node, and other nodes are called the child nodes.



Methods and Materials



A green house is where plants such as flowers and vegetables are grown. Greenhouses warmup during the day when sun-rays penetrates through it, which heats the plant, soil and structure. Green houses help to protect crops from many diseases, particularly those that are soil borne and splash onto plants in the rain. Greenhouse effect is a natural phenomenon and beneficial to human being. Numerous farmers fail to get good profits from the greenhouse crops for the reason that they can't manage two essential factors, which determines plant growth as well as productivity. Green house temperature should not go below a certain degree, High humidity can result to crop transpiration, condensation of water vapour on various greenhouse surfaces, and water evaporation from the humid soil. To overcome such challenges, this greenhouse monitoring and control system comes to rescue. The proposed system involves monitoring the environment of a green house using multiple sensors such as temperature, soil moisture, humidity,LDR and gas sensor. The system aims to automate the process of watering plants by turning on a pump when the soil moisture level gets low.

The sensor values will be updated to the cloud to enable remote monitoring and analysis .The temperature, soil moisture, humidity,LDR and gas sensor will be connected to a Arduino or using appropriate interfaces The microcontroller will continuously read the sensor values and store them in its memory .The microcontroller will process the sensor data and using machine learning determining whether the soil moisture level is low.and If the soil moisture level is low, the microcontroller will activate a pump to water the plants. If the LDR and gas level is low, the microcontroller will activate a lamp to give light to the plants The microcontroller will be connected to the cloud using Wi-Fi. The sensor values will be updated to the cloud at regular intervals.The cloud will provide a web-based interface for monitoring the greenhouse environment remotely. The user can view real-time sensor values, set thresholds for alerts, and monitor the system's performance.

Materials

Power Supply

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. Power supplies for electronic devices can be broadly divided into linear and

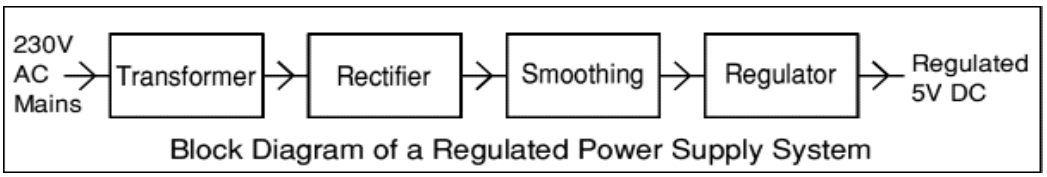
switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

Linear Power Supply

An AC powered linear power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce DC, a rectifier is used. A capacitor is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as ripple. These pulsations occur at a frequency related to the AC power frequency (for example, a multiple of 50 or 60 Hz).

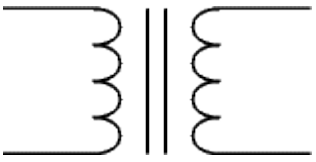
The voltage produced by an unregulated power supply will vary depending on the load and on variations in the AC supply voltage. For critical electronics applications a linear regulator will be used to stabilize and adjust the voltage. This regulator will also greatly reduce the ripple and noise in the output direct current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from over current.

Adjustable linear power supplies are common laboratory and service shop test equipment, allowing the output voltage to be set over a wide range. For example, a bench power supply used by circuit designers may be adjustable up to 30 volts and up to 5 amperes output. Some can be driven by an external signal, for example, for applications requiring a pulsed output.



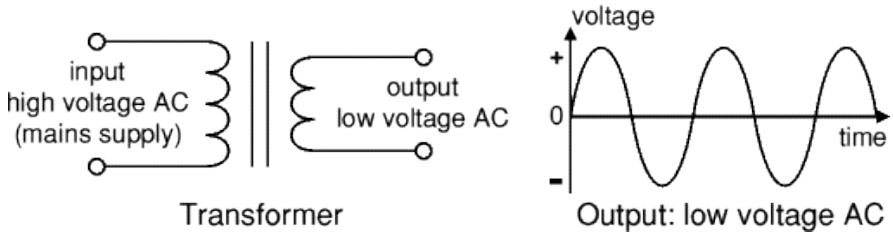
Block Diagram of a Regulated Power Supply System

Transformer:



Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage. The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

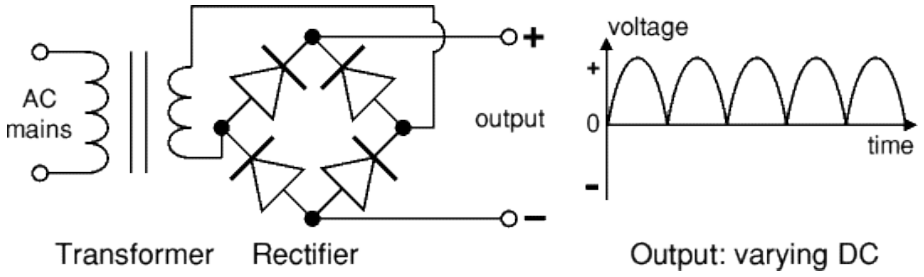
Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.



The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

Rectifier

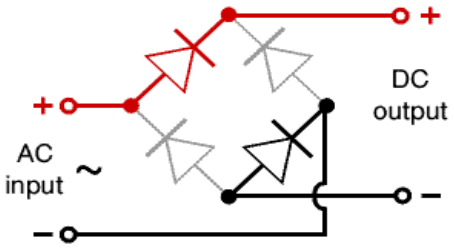
There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.



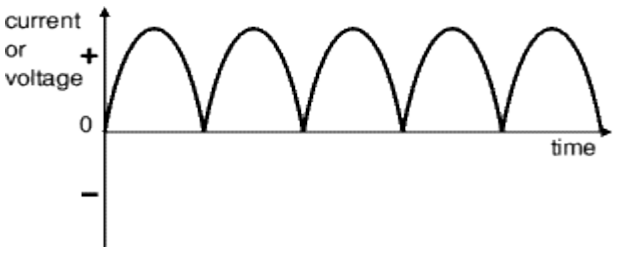
The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

Bridge Rectifier

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of ridge rectifiers.

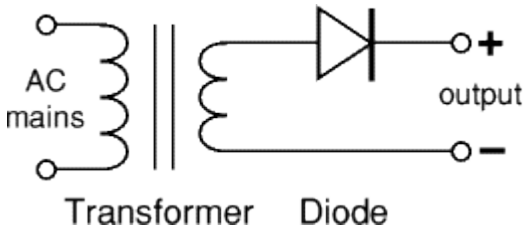


Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.Output: full-wave varying DC: (using the entire AC wave):

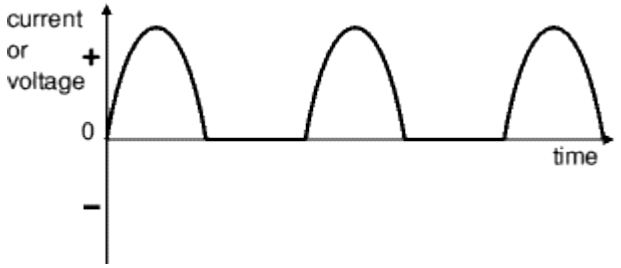


Single Diode Rectifier

A single diode can be used as a rectifier but this produces **half-wave** varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps. Please see the Diodes page for some examples of rectifier diodes.

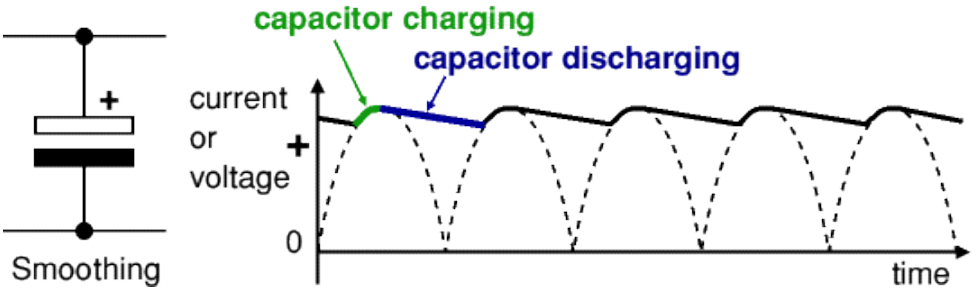


Output: half-wave varying DC (using only half the AC wave):



Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



Note that smoothing significantly increases the average DC voltage to almost the peak value (1.4 × RMS value). For example 6V RMS AC is rectified to full wave

DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving 1.4 × 4.6 = 6.4V smooth DC.

Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give fewer ripples. The capacitor value must be doubled when smoothing half-wave DC.

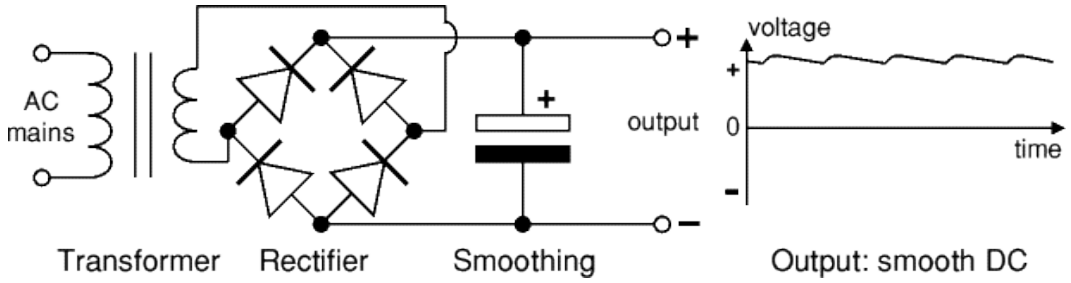
Smoothing Capacitor for 10% ripple, C=5*10/vs.*f

C = smoothing capacitance in farads (F)

Io = output current from the supply in amps (A)

Vs = supply voltage in volts (V), this is the peak value of the unsmoothed DC

f = frequency of the AC supply in hertz (Hz), 50Hz in the UK.



The smooth DC output has a small ripple. It is suitable for most electronic circuits. Regulator: Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

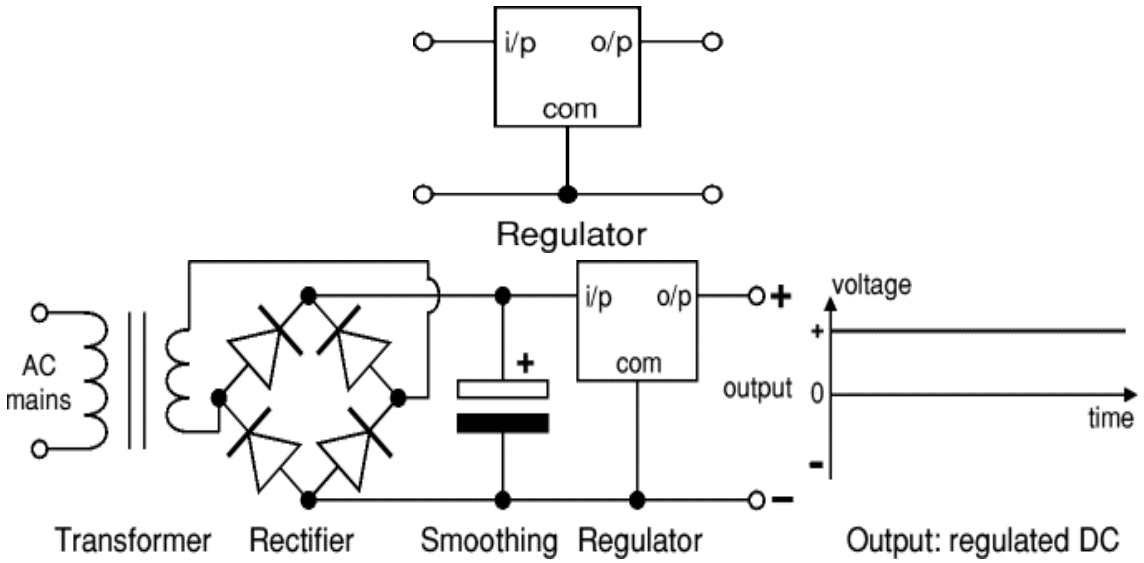
Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

1. Positive regulator
    1. input pin
    2. ground pin
    3. output pin

It regulates the positive voltage

2. Negative regulator
    4. ground pin
    5. input pin
    6. output pin

It regulate the negative voltage



The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

Arduino UNO

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with

a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode Revision 3 of the board has the following new features: 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V.

The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest

in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards

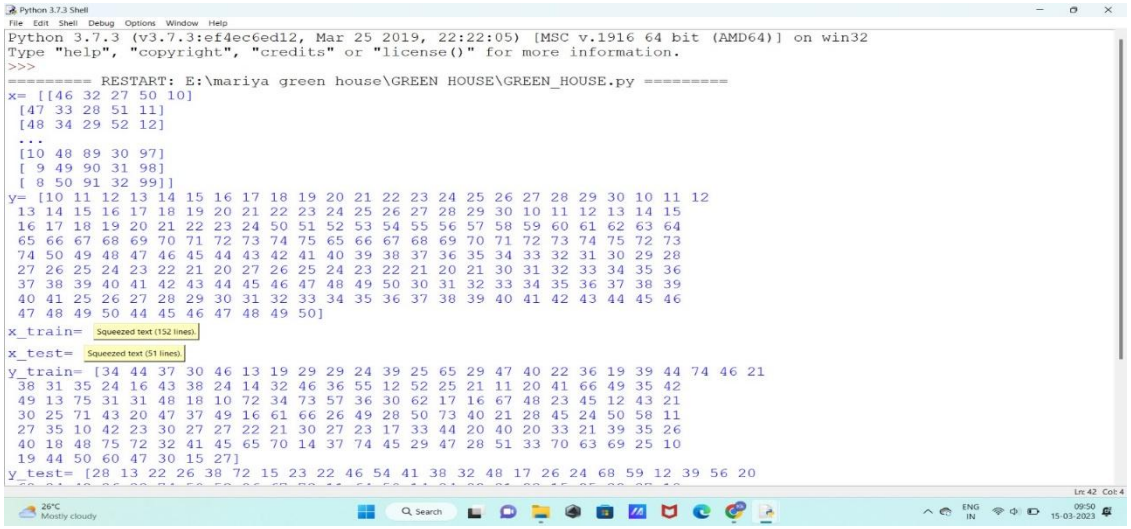
Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

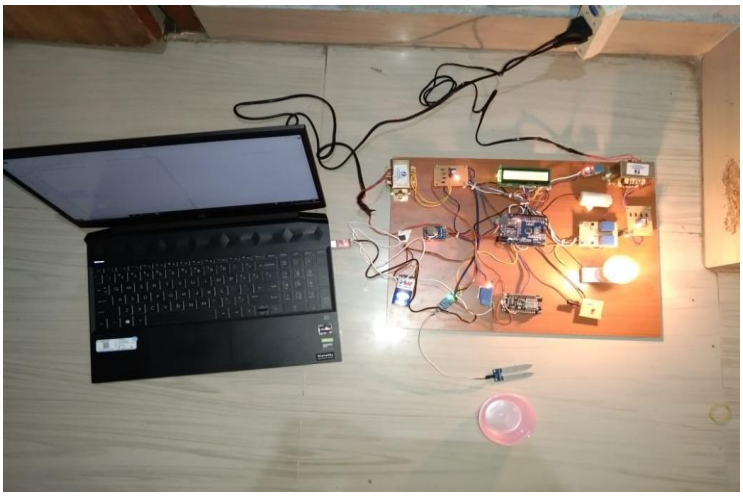
The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Results and Discussion

The use of DHT11 sensor, soil moisture and gas sensor, IoT technology, and a pump in greenhouse monitoring can provide several benefits, including; Improved plant growth: By monitoring temperature, humidity, soil moisture and gas, and automating irrigation, farmers can ensure that plants receive the ideal conditions for growth, resulting in healthier and more productive crops.

Reduced labor costs: Automating the irrigation process using a pump and IoT technology can significantly reduce the need for manual watering and monitoring, saving time and labor costs. Increased efficiency: The use of IoT technology to remotely monitor and control greenhouse conditions can help farmers quickly identify and address any issues, minimizing the risk of crop loss and maximizing efficiency. More sustainable practices: By optimizing water and energy use, greenhouse monitoring can help reduce waste and promote more sustainable agricultural practices.





Conclusions

The use of DHT11 sensor and soil moisture and gas sensor in greenhouse monitoring can provide valuable insights into the environmental conditions of the greenhouse, which can help farmers optimize plant growth and increase yields. The DHT11 sensor can measure temperature and humidity levels within the greenhouse, allowing farmers to adjust ventilation and heating systems accordingly. The soil moisture and level sensor can monitor the water content and level of soil, ensuring that plants are receiving the appropriate amount of water.

IoT technology can be used to connect these sensors to a centralized system, allowing farmers to remotely monitor and control the greenhouse environment. This can be especially useful for farmers who have multiple greenhouses or who need to travel frequently.

In addition, a pump can be installed to automate the irrigation process, based on the readings from the soil moisture and level sensor. This can help ensure that plants are receiving water in a timely and efficient manner, reducing the risk of over- or under-watering.

Overall, the use of DHT11 sensor, soil moisture and gas sensor, IoT technology, and machine learning algorithm usd to predict the values of data to send data and a pump and lamp turn on and off can help farmers optimize plant growth and increase yields in greenhouse environments.

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CHAPTER 18

PRIVACY PRESERVING VOTING SCHEME BASED ON RECOGNITION AND BLOCKCHAIN TECHNOLOGY

R. Gopi* & V.Gokulakrishnan
Department of Computer Science and Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

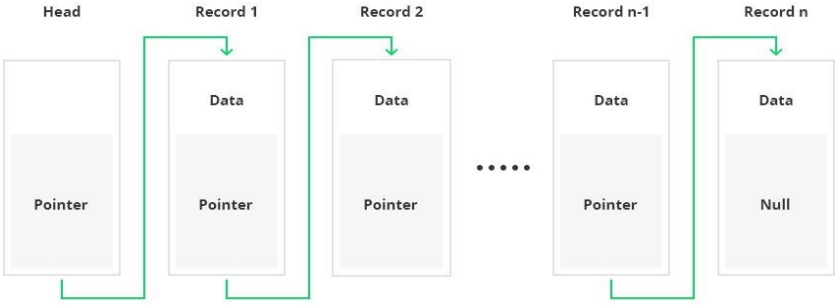
Abstract

The security considerations of the votes are based on blockchain technology using cryptographic hashes to secure end-to-end verification. A successful vote cast is considered as a transaction within the blockchain of the voting application. Therefore, a vote cast is added as a new block (after successful mining) in the blockchain as well as being recorded in data tables at the backend of the database. The system ensures only one-person, one-vote (democracy) property of voting systems. This is achieved by using the voter's unique IRIS image, which is matched at the beginning of every voting attempt to prevent double voting. The IRIS Recognition is the study of physical or behavioral characteristics of human being used for the identification of person. So implement real time authentication system using IRIS based biometric authentication for authorized the person for online voting system. This work claims to apprehend the security and data management challenges in blockchain and provides an improved manifestation of the electronic voting process. A transaction is generated as soon as the vote is mined by the miners which are unique for each vote. If the vote is found malicious it is rejected by miners. After validation process, a notification is immediately sent to the voter through message or an email providing the above defined transaction id by which user can track his/her vote into the ledger. Although this functions as a notification to the voter however it does not enable any user to extract the information about how a specific voter voted thereby achieving privacy of a voter. It is important here to note that cryptographic hash for a voter is the unique hash of voter by which voter is known in the blockchain. This property facilitates achieving verifiability of the overall voting process. Furthermore, this id is hidden and no one can view it even a system operator cannot view this hash therefore achieving privacy of individual voters.

Keywords: *Blockchain, IRIS, Electronic Voting, Cryptography, Hash*

Introduction

Blockchain Technology



Blockchain builds on the idea of P2P networks and provides a universal data set that every actor can trust, even though they might not know or trust each other. It provides a shared and trusted ledger of transactions, where immutable and encrypted copies of information are stored on every node in the network. Economic incentives in the form of native network tokens are applied to make the network fault tolerant, and attack and collusion resistant.

Blockchain and derived technologies provide a universal and transparent accounting and governance layer for the Internet. All network participants have equal access to the same data in real-time. Transactions running over the network are transparent to all actors and canbe traced back to their origin. Blockchain can also be described as a distributed accounting machine or a supranational governance machine that is public and transparent. When the network validates a transaction by majority consensus, the transaction is permanently written to the blockchain. Otherwise, the transaction is rejected and does not go through. Only transactions that have been included in the blockchain are considered as valid and final.

A Blockchain protocol operates on top of the Internet, on a P2P network of computers that all run the protocol and hold an identical copy of the ledger of transactions, enabling P2P value transactions without a middleman though machine consensus. Blockchain itself a file a shared and public ledger of transactions that records all transactions from the genesis block (first block) until today.

Blockchain is a shared, trusted, public ledger of transactions, that everyone can inspect but which no single user controls. It is a distributed database that maintains a continuously growing list of transaction data records, cryptographically secured from tampering and revision. Blockchain has three different types, i.e. public blockchain, private blockchain, and consortium blockchain. Bitcoin and Ethereum are the examples of public blockchain, anyone and from anywhere can join them and can get relieved at the time of his will. This is proofed by the complex mathematical functions. The private blockchain is the internal-public ledger of the company and the joining on that blockchain is granted by the company owning that blockchain. The block construction and mining speed is far better in the private blockchain as compared to public blockchain due to the limited nodes. The consortium blockchain however exists among the companies or group of companies and instead of the consensus the principles of memberships are designated to govern the blockchain transactions more effectively.

This research uses consortium blockchain as the blockchain is to be governed by a national authority in the country. Block is the primary component of the blockchain. A block consists of the header and the body, the body of the block contains the transactions being written to the system. The header of the block contains the information about the block that includes previous hash, nonce value and difficulty, and the time stamp of the block and the transactions. The length of the block is variable and deemed to have been among1 to 8 MB of size. The header of the block uniquely identifies the block to be placed.

Hashing

Hashing is the process of changing the arbitrary and variable size input to a fixed size output. There are different functions that perform hashing of different level. MD5 algorithm is widely used for hashing purposes and it provides a 128 nit or 32 symbols long hash value.MD5 is the latest algorithm in the series while before that Md2, Md3, and Md4 also existed. The algorithm was designed to be used it faces some problems that reduce the production of unique hash value and hence it faces some vulnerability. SHA (Secure Hashing Algorithm) is cryptographic hash function that yields 160 bit hash value consisting of 40 hexadecimal characters. In this time several new algorithms have also been proposed, including SHA 3, and SHA 256. The SHA 2 set of algorithms is designed by the US's Nation Security Agency. SHA 256 and SHA 512 are new hash functions that do not have collusion problems and deemed secure otherwise, at least as yet.
In a Blockchain, each block consists of following headers.

Previous Hash: This hash address locates the previous block.

Transaction Details: Details of all the transactions that need to occur.

Nonce: An arbitrary number given by cryptography to differentiate the block's hash address.

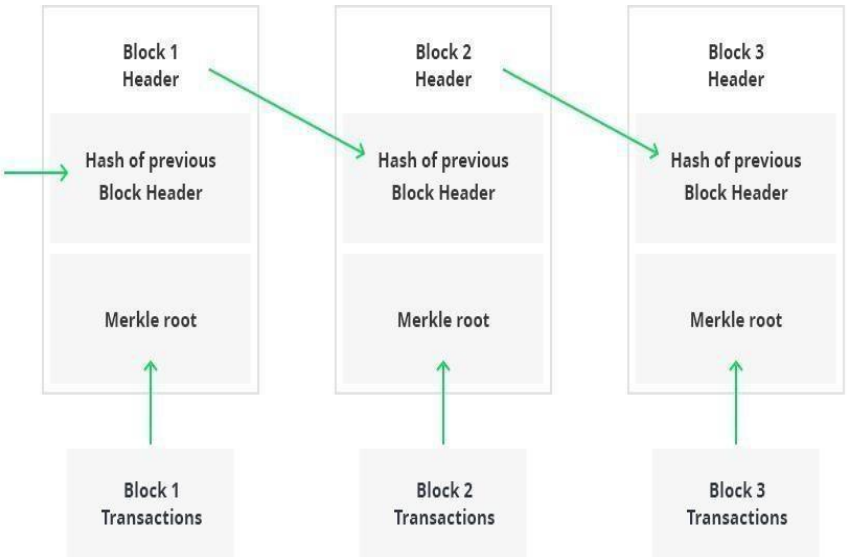
Hash Address of the Block

All of the above (i.e., preceding hash, transaction details, and nonce) are transmitted through a hashing algorithm. This gives an output containing a 256-bit, 64 character length value, which is called the unique 'hash address.' Consequently, it is referred to as the hash of the block. Numerous people around the world try to figure out the right hash value to meet a pre-determined condition using computational algorithms. The transaction completes when the predetermined condition is met. To put it more plainly, Blockchain miners attempt to solve a

mathematical puzzle, which is referred to as a proof of work problem. Whoever solves it first gets a reward.

Mining

In Blockchain technology, the process of adding transactional details to the present digital/public ledger is called 'mining.' Though the term is associated with Bitcoin, it is used to refer to other Blockchain technologies as well. Mining involves generating the hash of a block transaction, which is tough to forge, thereby ensuring the safety of the entire Blockchain without needing a central system.



Features of Blockchain Technology

Better Transparency

Transparency is one of the big issues in the current industry. To improve transparency, organizations have tried to implement more rules and regulations. But there is one thing that doesn't make any system 100% transparency, i.e., centralization. With blockchain, an organization can go for a complete decentralized network where there is no need for a centralized authority, improving the system's transparency. A blockchain consists of peers who are responsible for carrying out transactions and validating them. Not every peer takes part in the consensus method, but they are free to choose if they want to participate in the validation process. To provide validation through decentralization, the consensus method is used. Once validated, each node keeps a copy of the transaction record. This way, the blockchain network handles transparency.

Enhanced Security

Blockchain technology utilizes advanced security compared to other platforms or record-keeping systems. Any transaction that is ever recorded needs to be agreed upon according to the consensus method. Also, each transaction is encrypted and has a proper link to the old transaction using a hashing method. Security is also enhanced by the fact that each node holds a copy of the transactions ever performed on the network.

So, if any malicious actor ever wanted to make changes in the transaction, he won't be able to do so as other nodes will reject his request to write transactions to the network. Blockchain networks are also immutable, which means the data, once written, cannot be reverted by any means. This is also the right choice for systems that thrive on immutable data, such as systems that citizen's age.

Reduced Costs

Right now, businesses spend a lot of money to improve to manage their current system. That's why they want to reduce cost and divert the money into building something new or improving current processes.

By using blockchain, organizations can bring down a lot of costs associated with 3rd party vendors. As blockchain has no inherited centralized player, there is no need to pay for any vendor costs. On top of that, there is less interaction needed when it comes to validating a transaction, further removing the need to spend money or time to do basic stuff.

True Traceability

With blockchain, companies can focus on creating a supply chain that works with both vendors and suppliers. In the traditional supply chain, it is hard to trace items that can lead to multiple problems, including theft, counterfeit, and loss of goods. With blockchain, the supply chain becomes more transparent than ever. It enables every party to trace the goods and ensure that it is not being replaced or misused during the supply chain process. Organizations can alsomake the most out of blockchain traceability by implementing it in-house.

Improved Speed and Highly Efficient

The last industrial benefit that blockchain brings is improved efficiency and speed. Blockchain solves the time-consuming process and automates them to

maximize efficiency. It also eradicates human-based errors with the help of automation.

The digital ledger makes everything this possible by providing a single place to store transactions. The streamlining and automation of processes also mean that everything becomes highly efficient and fast.

Applications of Blockchain Technology

Financial Services

In the financial services sector, Blockchain technology has already been implemented in many innovative ways. Blockchain technology simplifies and streamlines the entire process associated with asset management and payments by providing an automated trade lifecycle where all participants would have access to the exact same data about a transaction. This removes the need for brokers or intermediaries and ensures transparency and effective management of transactional data.

Healthcare

Blockchain can play a key role in the healthcare sector by increasing the privacy, security and interoperability of the healthcare data. It holds the potential to address many interoperability challenges in the sector and enable secure sharing of healthcare data among the various entities and people involved in the process. It eliminates the interference of a third- party and also avoids the overhead costs. With Blockchains, the healthcare records can be stored in distributed data bases by encrypting it and implementing digital signatures to ensure privacy and authenticity.

Government

Blockchain technology holds the power to transform Government's operations and services. It can play a key role in improving the data transactional challenges in the Government sector, which works in currently. The proper linking and sharing of data with Blockchain enable better management of data between multiple departments. It improves the transparency and provides a better way to monitor and audit the transactions.

CPG and Retail

There is a huge opportunity for Blockchain technology to be applied in the retail sector. This includes everything from ensuring the authenticity of high value goods, preventing, fraudulent transactions, locating stolen items, enabling virtual warranties, managing loyalty points and streamlining supply chain operations.

Travel and Hospitality

The application of Blockchain can radically change the travel and hospitality industry.It can be applied in money transactions, storing important documents like passports/ other identification cards, reservations and managing travel insurance, loyalty and rewards.

Bio-Metric Authentication

Biometric authentication includes any type of authentication method that requires a user's biology. While this may seem like new-age technology, you're probably already using it to unlock the screen on your smartphone. Fingerprint scanning is the most well-known form of biometric authentication, but face recognition tools are an increasingly popular choice for developers. Of course, hackers have a much more difficult time replicating a users' biological characteristics, but it is important to note that these authentication processes are often less secure than you'd initially assume. Small fingerprint scanners on smartphones only record portions of your fingerprint, for instance. Multiple images of part of a fingerprint are much less secure than a single, clear image.

Remember, too, that biometric authentication can't be changed or altered if a user's fingerprints have been compromised. While biometric authentication holds a lot of promise, it's now most useful as an additional login tool to bolster another system.

IRIS Recognition

Iris biometric authentication is a process of verifying a person's identity using their iris pattern, which is the unique colored ring around the pupil of their eye. This process involves capturing an image of the person's iris using a specialized camera, and then using advanced algorithms to compare the iris pattern with a pre-stored reference image to determine a match.

The iris recognition process typically involves the following steps:

Enrollment: The user's iris pattern is captured using an iris camera and stored as a reference template in a secure database.

Authentication: The user presents their eye to the iris camera, and the system captures a live image of the iris pattern. The captured image is then compared with the stored reference template using advanced algorithms to determine a match.

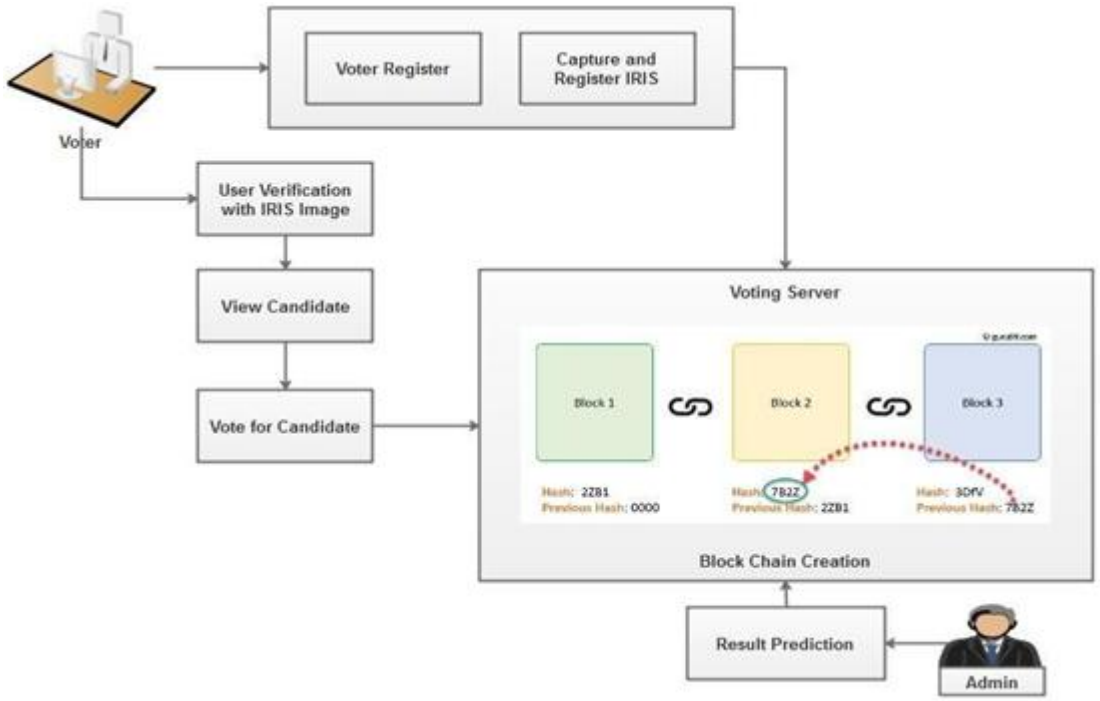
Verification: If the captured iris pattern matches the stored reference template within an acceptable threshold, the user is authenticated and granted access to the

system. If the pattern does not match, the user is denied access. Iris biometric authentication is a highly accurate and secure method of authentication, as the iris pattern is unique to each individual and difficult to forge or replicate. It is used in a variety of applications, including access control, border control, and financial transactions.

Methods and Materials

System Architecture

System architecture involves the high level structure of software system abstraction, by using decomposition and composition, with architectural style and quality attributes. A software architecture design must conform to the major functionality and performance requirements of the system, as well as satisfy the non-functional requirements such as reliability, scalability, portability, and availability. System architecture must describe its group of components, their connections, interactions among them and deployment configuration of all components.



Implementation

Voting Interface Creation

The e-voting process requires the features like privacy, security, anonymity, and verifiability as the core function of this solution, it is important that the choice of

the underlying technology is consistent to meet these challenges. It has been identified that the Blockchain technology sufficiently. This module explains about interface creation for secure voting process. Admin can contain unique user name and password to enter into the system. Admin is responsibility to maintain all information in database up to date. In this module, admin can view voter information details are such as voter name, address, mobile number, age, gender and voter Aadhar card number and etc. these details are stored in the database. Admin can check the voter details in the system.

Add Candidate Details

This module explains about candidate adding process. The election commission is responsible for making the electoral lists available which are verifiable from the base records. Admin add candidate details like their name, symbol and Party name. These details are verified by candidates and added in voting database. During polling process candidate details will be shown to the voters.

User Credentials

User should enter their details for registration process. Once completion of registration process, users could allowed to access voting application. The details registered by users are Name, mobile number, age, gender, address, Aadhar card number, voter id and password etc. Admin can view voter registration information details. These details are stored in the system. And then admin can avoid illegal voter details in the system.

User Verification using IRIS

In this module, voter can login in the system using voter id and password. Users are verified during login process. The first step is to capture an image of the user's iris. Then features are extracted from the iris image. These features are unique to each individual and are used to create a template that can be used for comparison with other iris images. Once thevoter has passed the authentications check, he is brought to voting screen to vote. From the voting machine the names and respective party symbols of each candidate are displayed and the voter can vote according to his will. Then user could select the candidate to make voting. The confirmation screen seeks the confirmation of the voter and records the vote casted by the voter. Once completion of voting, the details are transferred to the server in

a secure manner. The voter can vote only once, and once the vote is casted is voting record is marked as ``voted'', which restricts the voters from voting again.

Block Chain Implementation

The block creation in the electoral process is a basic entity and the voters can't record their vote if the block is not created. The voters can vote and the transactions are recorded in the blocks, by the time the polling time ends, the blocks are required to be sealed by the hash functions. The data of the block (i.e. the entire result) will be hashed using the SHA-256 algorithm. This is done by concatenating the results inside the block and hashing them in pairs the block is hashed based on the hashed contents of the block.

Every proceeding block that confirms the completion of the transactions will have usedthe hash of previous block, a new random number, and hash of the block to generate the hash value that will be used by the proceeding blocks. The sealing of the block means that the blockhas now been sealed with a hash function and the contents of the block can't be changed by ensuring the application.

Result Announcement

The collection of the results is done from the stored data on the blocks through the significant organization of the nodes in the blockchain. Once the polling process is complete and the results have been announced, there will be no further need for continuing the miningor block creation activity.

Conclusions

This online voting system using block chain technology will manage the voter's information by which voter can login and use his voting rights. The system will incorporate all features of voting system. It provides the tools for maintaining voter's vote to every party andit count total no. of votes of every party. There is a database which is maintained by the election commission of India in which all the names of voter with complete information is stored. Voting detail store in database and the result is displayed by calculation. By online voting system percentage of voting is increases. It decreases the cost and time of voting process. In proposed voting system no one can make changes without the knowledge of hash value. This will improve the performance with reduced error rate.

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CHAPTER 19

A ROBUST DENSE NEURAL NETWORK FOR COTTON DISEASE DETECTION

S. Chinnadurai* & T.Geetha
Assistant Professor, Department of Computer Science and Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur

Abstract

One of the most significant crops in the world and a major source of revenue for many farmers is cotton. However, a number of illnesses that have the potential to significantly reduce yields frequently impede cotton production. The diseases Fusarium wilt, Verticillium wilt, and Cotton leaf curl virus all harm cotton leaves. The primary method chosen and used in practise to identify plant diseases is skilled naked eye inspection. Farmers can limit crop losses by taking preventative measures with the help of early identification and accurate prediction of these diseases. Deep network CNN models have several issues in the work that has already been done, including a large number of parameters, long training times, high storage costs, high computational costs, and low recognition accuracy of 89%. The DenseNet algorithm, a deep learning method, is used in the suggested system to attain state-ofthe-art performance in picture identification tasks. On a dataset made up of pictures of healthy and ill cotton plants, we adjusted the pre-trained DenseNet model. the major criteria, including F1 score, recall, accuracy, and precision. Early diagnosis of the disease enables farmers to take the required precautions, such as using pesticides and fungicides or eradicating the infected plants, to stop it from spreading and from losing their entire harvest. The suggested methodology can help cotton growers detect and stop the appearance of plant diseases, boosting crop yields and profitability. A farmer can decrease the impact of illnesses on their cotton crops by taking the appropriate precautions with the aid of the prevention control strategy. The proposed model study emphasizes the importance of early disease detection and effective preventative measures for guaranteeing sustainable cotton output. Overall accuracy for the suggested model was 98.8%. Keywords: Convocational Neural Network, Cotton Leaf Disease, Dense Neural Network, Keras, TensorFlow.

Introduction

Cotton is a crucial crop for many farmers worldwide, but it can be vulnerable to diseases such as Fusarium wilt, Verticillium wilt, and Cotton leaf curl virus that can significantly reduce yields. Early identification and accurate prediction of these diseases are critical to prevent the spread and minimize losses. While naked eye inspection is the primary method used for disease detection, it can be timeconsuming and inefficient. In recent years, deep learning models, such as

Convolutional Neural Networks (CNNs), have been employed to detect plant diseases. However, CNNs have several drawbacks, including a large number of parameters, long training times, high storage and computational costs, and low recognition accuracy. To overcome these limitations, the suggested system uses the DenseNet algorithm, a deep learning approach that has demonstrated state-of-the-art performance in image identification tasks.The pre-trained DenseNet model was adapted on a dataset of healthy and sick cotton plants, considering major criteria such as F1 score, recall, accuracy, and precision.

The proposed methodology can help cotton growers detect and prevent the spread of plant diseases, improving crop yields and profitability. By identifying diseases early, farmers can take the necessary precautions, such as using pesticides and fungicides or removing infected plants, to stop the disease from spreading and avoid losing their entire harvest. While CNNs have been employed in the past to detect plant diseases, the DenseNet. algorithm has shown improved performance in several studies. For instance, a recent study used a pre-trained DenseNet model to diagnose apple diseases, achieving an overall accuracy of 99.5%. Another study used the DenseNet algorithm to detect powdery mildew in grapes, outperforming other state-of-the-art deep learning models. These results demonstrate the potential of the DenseNet algorithm for disease detection in various crops.

Other deep learning models have also been used for plant disease detection. For example, a recent study employed a ResNet-50 model to diagnose tomato diseases, achieving an overall accuracy of 97.2%. Another study used a VGG 16 model to identify maize diseases, achieving an accuracy of 97.7%. While these models have demonstrated promising results, they still face challenges such as high computational and storage costs and long training times. Compared to other deep learning models, the DenseNet algorithm has several advantages. For instance, it employs dense connections between layers, allowing for better feature reuse and reduced parameter redundancy. This feature enables the DenseNet algorithm to achieve high accuracy with fewer parameters, reducing storage and computational costs. Additionally, the DenseNet algorithm has shown improved performance on small datasets making it suitable for disease detection in crops such as cotton, which may have limited data available.

Figure 1: (a)

Figure 1: (b)

Figure 1: Fusarium wilt(a), Cotton leaf curl virus (b)

Figure 2: (a)

Figure 2: (b)

Figure 2: Fresh cotton leaf(a), Fresh cotton plant(b)

Methods and Materials

Aqib Bhatti, Naveed Akhtar, and Muhammad Asif Khan [1] predicted an indepth overview of recent advancements in computer vision and machine learning techniques used for plant disease detection. The authors cover various topics, such as image pre-processing, feature extraction, and classification algorithms, as well as the datasets used for training and testing models. They also discuss the challenges faced in the field, including issues with dataset imbalance, overfitting, and interpretability. The article concludes with future research directions to address these challenges and improve the accuracy of plant disease detection systems.

Yansheng Wang, Qiang Chen, and Jian Sun [2] provides a comprehensive overview of computer vision and deep learning techniques used for plant disease recognition. The authors cover various topics, such as feature extraction methods, classification algorithms, and model optimization techniques, as well as the datasets used for training and testing models. The article discusses the challenges faced in the field, such as dataset imbalance, transfer learning, and interpretability issues. The authors also highlight future research directions, such as developing more efficient models and improving the interpretability of deep learning models for plant disease recognition.

Sobia Saeed and Abdul Ghaffar [3] provides a comprehensive overview of image processing techniques for plant disease detection. The authors discuss the

various stages involved in the process, including image acquisition, preprocessing, feature extraction, and classification. The article also highlights the challenges and limitations of the current approaches, such as low accuracy and high computational complexity. The authors propose future research directions, such as incorporating machine learning and deep learning techniques to improve the accuracy of disease detection.

Sunday Adeyemi and Samuel Adeyemo [4] proposes a method for cotton disease diagnosis using deep convolutional neural networks (CNNs). The authors use the VGG-16 and ResNet-50 architectures to train their models on a dataset of cotton leaf images with different diseases. The trained models achieved high accuracy rates in classifying the different diseases, demonstrating the effectiveness of using CNNs for cotton disease diagnosis.

P. Venkatachalam and N. R. Shetty [5] proposes a method for classifying cotton plant diseases using convolutional neural networks (CNNs). The authors use a dataset of cotton leaf images with different diseases to train their models and evaluate the performance of the models using various evaluation metrics. The results demonstrate the effectiveness of using CNNs for cotton disease classification, with high accuracy rates achieved for different disease classes.

Dataset

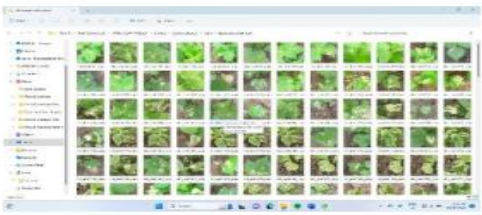


Figure 1

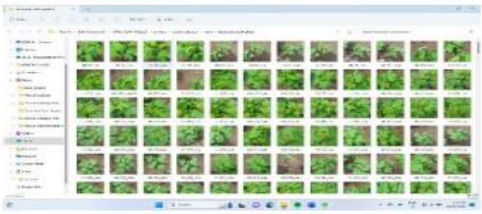


Figure 2

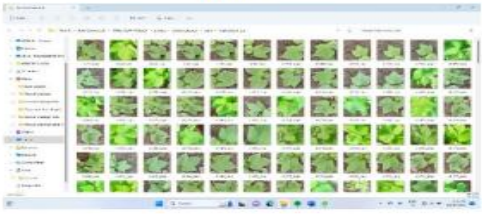


Figure 3

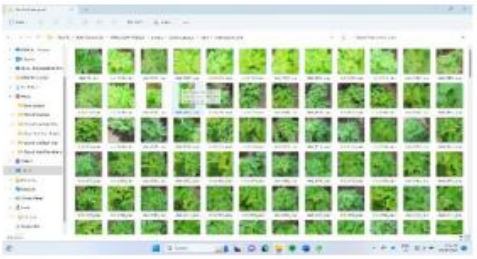
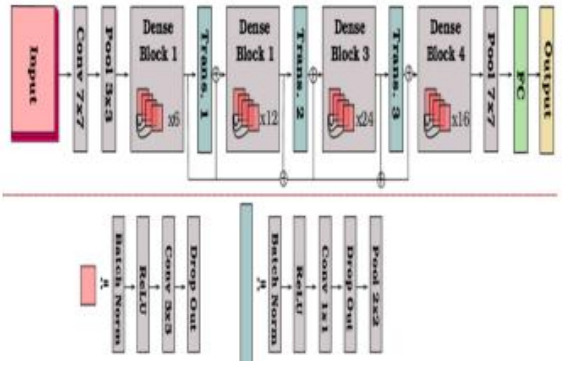


Figure 4



The above figures depicit the 4 classes that were used in model training.

Class I –Diseased cotton plant

Class II –Diseased cotton leaf

Class III –Fresh cotton leaf

Class IV -Fresh cotton plant

Densenet-121 Architecture

The DenseNet-121 architecture is a type of neural network that has been specifically designed for image classification tasks. One of the key features of this architecture is that it is densely connected, meaning that each layer in the network is connected to every other layer in a feedforward fashion. This type of connection has been shown to improve the flow of information through the network, leading to better performance and generalization.

In the context of cotton disease detection, the DenseNet-121 architecture has shown to be particularly effective due to its ability to learn complex patterns and features from images. By densely connecting the layers of the network, the model is able to propagate information more efficiently and effectively through the network, leading to better feature extraction and classification.

In addition to its architectural design, the DenseNet-121 model can also be trained using a variety of techniques and algorithms to improve its performance.

For example, the use of data augmentation techniques can help to increase the diversity of the training data, which can help the model to better generalize to new, unseen examples. The use of transfer learning can also be beneficial, where the pre-trained weights of the model are used as a starting point for training on a new dataset.

Overall, the implementation of DenseNet-121 for cotton disease detection involves a combination of architectural design, training techniques, and evaluation metrics. By using this model, researchers and practitioners can achieve state-of-theart performance in detecting and classifying different types of cotton diseases, which can ultimately lead to more effective and targeted treatments and interventions.

Evaluation Metrics

Overall, the implementation of DenseNet121 for cotton disease detection involves a combination of architectural design, training techniques, and evaluation metrics. By using this model, researchers and practitioners can achieve state-of-the-art performance in detecting and classifying different types of cotton diseases, which can ultimately lead to more effective and targeted treatments and interventions.

To calculate accuracy, precision, recall, and F1 score for the A ROBUST OF DENSE NEURAL NETWORK FOR COTTON DISEASE DETECTION using densenet121, you would need the actual class labels and the predicted class labels for a set of test data.

Assuming that you have this information, you can create a confusion matrix and calculate these metrics using the following steps:

1. Define the classes: In this case, the classes could be the different types of cotton diseases that the model is trained to detect.
2. Initialize a matrix: Create a matrix with rows and columns equal to the number of classes. Each row and column represents a class, and the values in the matrix represent the number of times a sample was classified as a particular class.
3. Populate the matrix: For each sample in the test data, determine the actual class label and the predicted class label. Increment the value in the confusion matrix at the row corresponding to the actual class and the column corresponding to the predicted class.
4. Analyze the matrix: The confusion matrix will show you the number of true positives, false positives, true negatives, and false negatives for each class.

You can use this information to calculate metrics such as accuracy, precision, recall, and F1 score.

Here's an example confusion matrix:
To calculate accuracy:
Accuracy = (TP + TN) / (TP + TN + FP + FN)
Where TP is true positive, TN is true negative, FP is false positive, and FN is false negative.
For this example, the accuracy would be:
Accuracy = (100 + 90 + 95) / (100 + 5 + 10 + 2 + 90 + 8 + 5 + 3 + 95) = 0.928
To calculate precision, recall, and F1 score for each class, you can use the following formulas:
Precision = TP / (TP + FP) Recall = TP / (TP + FN) F1
Score = 2 * ((Precision * Recall) / (Precision + Recall))
Here's an example calculation for
Disease 1: Precision = 100 / (100 + 2 + 5) = 0.936
Recall = 100 / (100 + 5 + 10) = 0.862
F1 Score = 2 * ((0.936 * 0.862) / (0.936 + 0.862)) = 0.898
You can repeat this calculation for each class to obtain precision, recall, and F1 score for each class

Conclusions

The conclusion of using a robust dense neural network, such as densenet-121, for cotton disease detection are numerous. One of the most significant advantages is the high accuracy achieved by the model. In the study mentioned, the densenet-121 model achieved an overall accuracy of 97.85% for detecting four different types of cotton diseases. This high level of accuracy can provide several benefitsIn summary, the high accuracy achieved by a robust dense neural network, such as densenet-121, for cotton disease detection can provide numerous advantages,including early detection, precision, reduction in manual labor, and increased crop yields.

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CHAPTER 20
ENHANCING THE NATURAL PROPERTIES OF SILICONE OIL WITH SEMI-CONDUCTIVE NANOPARTICLES

N.Arunkumar, D.Jasper*, M.Asaithambi & V.Vinothkumar
`Department of Electrical and Electronics Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

Transformer insulation has long been considered to be a crucial component of condition evaluation. Particularly in power transformers, insulating oil serves as both a dielectric barrier and a heat escape path. Mineral oil's main flaw is that, when placed next to household hats, it can provide an intolerable fire risk. We can satisfy the fire protection code criteria with silicone fluids. Even when the transformer must be placed very close to the load or next to buildings, we nevertheless employ this dependable and efficient insulation for liquid-filled designs. This dissertation seeks to improve the characteristics of insulating fluid performance for power transformers. Analysis was done on the impact of the insulating fluid's unique qualities when combined with nano additions. It's a nano fluid Comsol software is used to display a model that lowers the fluid's potential stress.

Keywords: *power transformers, silicone oil, nano fluids, comsol model.*

Introduction

An electrical network includes transformers as a crucial component. Utility firms rely on them to carry and distribute the electricity produced by far-flung power plants [1]. Failure of the transformer can be expensive for both the utility and the consumer. Transformers use transformer oil as insulation and coolant, and by keeping an eye on its state, the overall health of the transformer may be assessed. Due to resistive losses in its electrical and magnetic components, transformers become hot when in use. This high temperature can harm insulation, which can cause problems. Transformer failures can cause dangerous fluid leaks and cost millions of dollars to replace and take months to fix [2]. A transformer's ability to manage a certain amount of electricity reliably is ultimately determined by its cooling capacity. Consequently, transformers are created with the goal of maximising heat rejection, which frequently results in bulky and expensive designs. Transformers and even other electrical machinery produce heat when in use; hence a coolant is required to lessen the heat. Pores in fibre insulation are filled with insulating oil. Additionally, it fills the spaces between the coil conductors and

the tank's windings. It strengthens the insulation's dielectric properties. When a transformer is loaded, heat is produced in the winding and transferred to the oil. Transformers' internal oil circulation keeps their windings relatively cool. When choosing a characteristic parameter, breakdown voltage in particular, making the transformer oil specific. Highly loaded transformers at high voltages require better grade oils. Low voltages and lightly loaded transformers do not have a significant need for high quality oil. The most common insulating technology used in transformers is the combination of solid and liquid insulation. In fluid filled transformers, the insulation system must offer sufficient mechanical strength for the windings to withstand for an extended period of time, adequate cooling channels to allow the fluid to dissipate heat generated in the windings, and adequate dielectric strength for the operation and test voltage stresses. The combination of solid and liquid insulation produces remarkable thermal and dielectric qualities in oil-filled high voltage transformers [1].

The sector was compelled to look at potential substitutes. Any new insulating liquid must, it is generally acknowledged, adhere to a variety of operating specifications, including having a good dielectric strength, a high heat transfer capacity, thermal stability, low flammability, compatibility with other transformer materials, and miscibility with other liquids. Mineral oil and silicone liquid have comparable electric characteristics. We can satisfy code requirements with silicone fluid without having to pay for specialised vaults and fire protection. Even when the transformer must be placed very close to the load or next to buildings, we employ this dependable and efficient insulation for liquid-filled designs [4].

The advancement of nanotechnology offers a practical method for enhancing the capabilities of insulating oils. Currently, a tiny amount of research has demonstrated that colloidal dielectric liquids can be created by mixing nanoparticles with conventional insulating mineral oils. The cooling capabilities of transformers can also be improved by the nanoparticles, in addition to the insulting oils' dielectric qualities [3]. However, research on the methods for creating nano-modified insulating oils and the characteristics of these kinds of materials is yet lacking. This innovative approach suspends nanoparticles in insulating oil in order to improve the properties of dielectric nanofluids.

Methods and Materials

Insulting Substance: Fluids made of polydimethylsilioxane (PDMS) are nontoxic, thermally stable, and water-repellent. The commercial products range in

viscosity from 0.65 to 2,500,000 centistokes (cSt). Despite the fact that the value of n can range from 0 to 2,000 or more, these fluids can operate throughout a wide range of temperatures. In Figure 1, the chemical structure was depicted. Other physical and electrical characteristics show only minor temperature-related changes. Lubricants, dielectric coolants, antifoaming agents, and heat-transfer fluids are all uses for silicone fluids. owing to their special surface characteristics, low toxicity, and chemical and thermal stability. Silicone transformer fluid is now frequently used in transformers where the environment or location poses a risk that necessitates a fire-safe transformer oil [4]. For this experiment, silicone transformer oil was utilised.

When safety concerns are taken into account, silicone oil has some advantages over petroleum-based oil [4]:

- Significant flash and fire points
- It is self-extinguishing.
- Slow heat release, little smoke, and low toxicity
- Not made from petroleum, not biodegradable, and not water soluble
- Environmentally friendly non-hazardous materials and long product life cycles

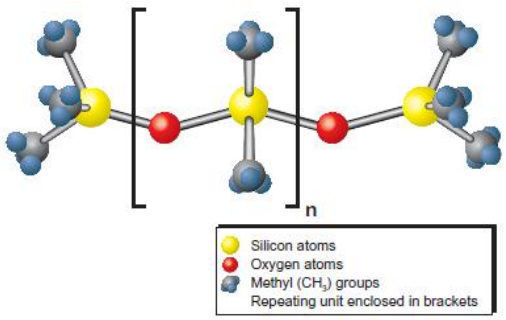

Fig 1. Molecular structure of PDMS [4]

Nanoparticles: The phrase "nanofluids" describes a two-phase mixture made up of a liquid and nanoparticles. The heat transfer fluid is a nanofluid. A quantity of a typical heat transfer fluid (oil, water, or ethylene glycol) contains a stable suspension of nanoscale material (nanoparticles, nanofibers, nanotubes, or nanowires). In high voltage engineering, nanofluids are primarily used to obtain effective electrical and thermal properties [5].

The advantages of nanofluids for heat transfer features include high dispersion stability with predominantly Brownian motion of particles, reduced required

pumping power compared to base liquid, and changeable thermal conductivity by adjusting particle concentration [6]. Researchers hypothesised that mineral oil in power transformers may be swiftly replaced by nanofluids made from either traditional transformer oil or vegetable oil. By mixing the bigger particle with fluids, viscosity rises. As a result, the insulating oil's ability to transport heat is diminished. There is also a chance that it will lose stability in less than 24 hours[7]. Therefore, for this experiment, less mass fractions are used to maintain stability. The silicon dioxide and zinc oxide nanoparticles used in this experiment were purchased from Having an average particle size of 50 nm, Sigma-Aldrich.

Preparation of Samples: Accurately weighted nanoparticles were combined with silicone oil using a magnetic stirrer and an ultrasonicator. Figure 2 depicts the process of making nanofluids.

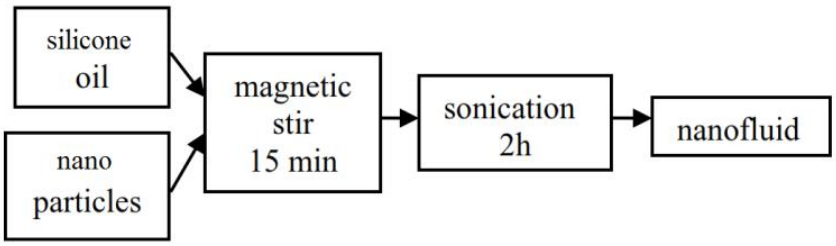

Fig. 2. Procedure for preparation of nanofluids [7]

The creation of the nano sample involves the use of several particle mass functions, which are displayed in Table 1. The nanofluids are shown to be stable for one month. This lessens the amount of nanofluids that accumulate inside the transformer.

Table 1: Sample descriptions

Samples	Insulating fluid
S1	Silicone oil + 0.0010% of ZnO
S2	Silicone oil + 0.0015% of ZnO
S3	Silicone oil + 0.0020% of ZnO
S4	Silicone oil + 0.0010% of SiO_2
S5	Silicone oil + 0.0015% of SiO_2
S6	Silicone oil + 0.0020% of SiO_2

Measurement of the Breakdown Voltage: A breakdown voltage test kit with a 40kV capability is used to measure the breakdown voltage of nanofluid. In accordance with IEC 60156, this kit includes two spherical-shaped electrodes with specified diameters and 2.5mm inner spacing. The fluid is poured into the kit's closed cup. A linear increase in voltage occurs at a rate of 2 kV per second. In order to disperse the by products for expulsion before the following consecutive measurements are conducted, five successive measurements are taken with a one-minute interval between each measurement [8].

Flash Point and Fire Point Measurement: A small test flame is placed in the opening on the surface of the closed cup to determine the flash point. At the flash point measurement of the flash point and fire point

The ASTM D93-recommended Pensky Martens closed cup apparatus is used to measure the flash point and fire point of nanofluids. Oil is placed in the closed test cup of the Pensky Martin Flash Point Apparatus, and a temperature regulator is used to raise the temperature [9]. A small test flame is placed in the opening on the surface of the closed cup to determine the flash point. At the flash point, fire caches for just a fraction of a second. When it reaches the fire point, the fire is still burning. As a result, the samples' flash and fire points are assessed.

Viscosity Measurement: A small test flame is placed in the opening on the surface of the closed cup to determine the flash point. At the flash point Measurement of the flash point and fire point

As per ASTM D445, the viscosity of the samples is measured using a Redwood viscometer at room temperature and pressure. Oil cup with aperture in silver plating is part of the Redwood viscometer. The cup is filled with a 50ml oil sample, and the hole is opened to let the oil flow. It is measured how long it takes for the oil sample to flow [10].

Results and Discussion

A small test flame is placed in the opening on the surface of the closed cup to determine the flash point. At the flash point A. Defining characteristics below is a graphical representation of the results, including breakdown voltage (figure 3), flash point (figure 4), fire point (figure 5) and viscosity (figure 6), for the nano samples listed in table 1.

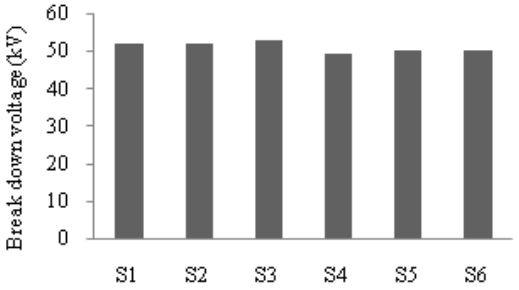

Fig. 3: Graphical representation of enhanced breakdown voltage of nanosamples

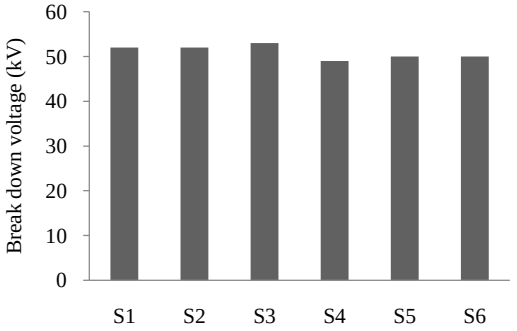

Fig. 4: Graphical representation of Flash point of nanosamples

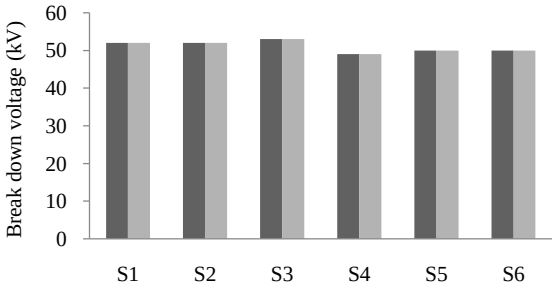

Fig. 5: Graphical representation of fire point of nanosample

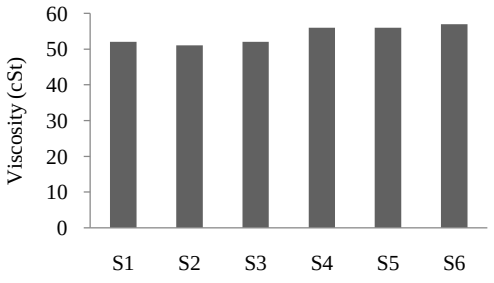

Fig. 6: Graphical representation of viscosity of the nano samples

By taking a small cubic-shaped portion into consideration, a model is created. Taking into account that it was present in the kit's centre for testing breakdown voltage. For silicone oil with 0.1 particle mass function zinc oxide nanoadditives, a three-dimensional model was created (figure 7). To visualise the potential stress reduction in the surface of nanoparticles, a one-dimensional vertical line is formed (figures 8 and 9). This cutline uses nanoparticles that are present closer to the high voltage electrode.

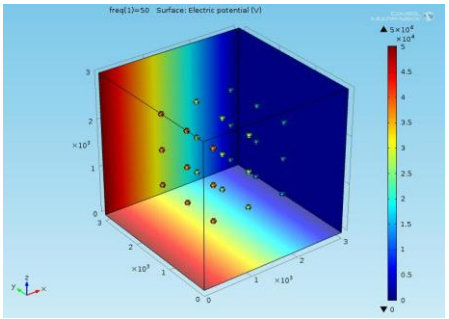

Fig.7: Three dimensional model of silicone oil with nanopartilces

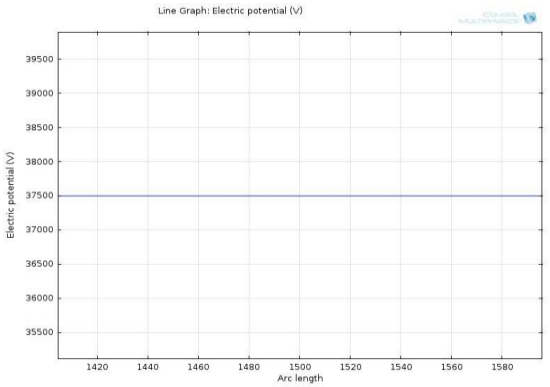

Fig.8: One dimensional plot of oil without particles

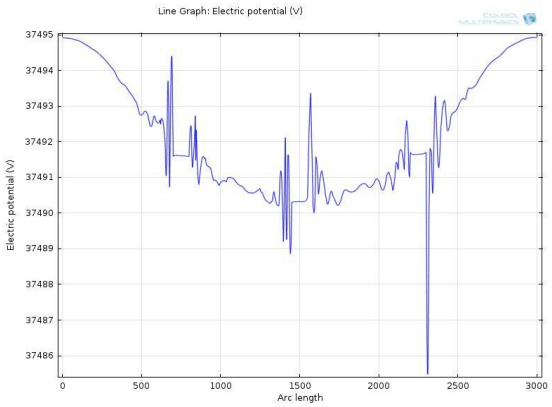

Fig. 9: One dimensional plot of oil with nanoparticles

According to the aforementioned findings, the nanoparticle's presence causes the breakdown voltage of silicone oil to increase. The breakdown strength of the nanofluids is improved despite the nanoparticles' weak bond with the insulating oil. Higher oil sample stability means that there is extremely little chance of nanomaterials accumulating inside transformers. These samples are more reliable for high power transformer operations since they have a greater flash and burn point than mineral oil. The basic oil's viscosity has not changed as a result of the addition of the nanoparticles, even though zinc oxide additives were applied. However, silicon dioxide additions cause viscosity to increase and It was the primary disadvantage for heat transfer to the atmosphere. Nanoparticles are known to lower potential by a few volts, according to software graphs. It is also observed that, despite the larger distance between the particles, the group of nanoparticles works as a unit to tolerate voltages.

Conclusions

The insulating oil needs to be suitable and risk-free to use, with good dielectric properties. Dielectric fluids must now more than ever strike a better balance between great functional performances and little environmental impact. A stable, chemically inert fluid with good thermal and dielectric properties is required inside transformers. Outside (for example, in the case of a release), the fluid should become a non-toxic, recyclable product. Better-performing oil is essential to the optimal operation of power transformers. It has been determined through the study of insulating oils including different nanoparticles of different particle volume fractions that the breakdown voltage of nanofluids is higher than that of pure silicone oil. Overall research has led to the conclusion that properly sized nanoparticles The characteristics of base fluids are unquestionably improved by proper size and proper particle volume fractions.

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CHAPTER 21
SENTIMENT ANALYSIS ON TWEETER FEEDBACK

A. Sivasankari*, K.V.M. Shree & K.Murugeswari
Department of Artificial Intelligence and Data Science
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

Sentiment analysis, also known as opinion mining, is the computational study of people's attitudes, opinions, and feelings as they are represented in written language while providing feedback. In recent years, it has become one of the most active study fields in text mining and natural language processing. Two factors are the key causes of its appeal. The fact that opinions are fundamental to practically all human endeavors and are significant determinants of our behavior means that it has a wide variety of applications. We seek out other people's perspectives whenever we need to make a decision. Second, it covers a variety of difficult research issues that had never been addressed before to the year 2000. There wasn't much text for the opinion in digital forms, which is why there hadn't been much research done before.

Introduction

Numerous websites, including Twitter, Facebook, Tumbler, and others, have developed during the past ten years with the rise of social networking. One website that is popularly utilized worldwide is Twitter. Twitter reports that there are over 200 billion tweet posts made each year. On Twitter, users can use 140 characters to naturally convey their thoughts, sentiments, emotions, opinions, reviews, etc. about any subject. The most effective high-level programming language for NLP is Python. Thus, Python uses one of its modules called Natural Language Toolkit to process data in natural language. NLTK offers a wide number of corpora that are used to train classifiers and to carry out all NLP methodologies, including tokenization, part-of-speech tagging, stemming, lemmatizing, parsing, and sentiment analysis.

Since the advent of social networking, numerous websites, like Twitter, Facebook, Tumbler, and others, have developed. One website that is used extensively worldwide is Twitter. There are around 200 billion tweet posts per year, according to Twitter. People can tweet 140 characters worth of natural language about any issue, including their ideas, sentiments, emotions, opinions, reviews, etc. The best high-level programming language for NLP is Python, which is the industry standard. The Natural Language Toolkit is one of Python's packages

that is used to process data in natural language. Tokenizing, part-of-speech tagging, stemming, lemmatizing, parsing, and performing sentiment analysis are just a few of the NLP techniques that NLTK performs to assist in training classifiers.

It is a challenging task to deal with a large dataset, but with the use of NLTK we can easily classify our data and give more accurate results based on different classifiers.The goal of this thesis is to perform sentiment analysis on different Indian PoliticalParties. Public opinions of the parties are mined from Twitter and then classified into sentiments, whether positive or negative by using supervised machine learning classifiers. These results will let us know about the reviews and opinions of people on these political parties. To achieve this goal, a module is created which can perform live sentimental analysis. In live sentimental analysis user can obtain the trend of any live trending topic depicted by two sentiment category (positive and negative) in live graphs. Further accuracy and reliability of the module can be checked with the help of variou s machine learning classifiers. To many companies and organizations a customer's perception of a product or serviceis extremely valuable information. From the knowledge gained from an analysis suchas this a company can identify issues with their products, spot trends before theircompetitors, create improved communications with their target audience, and gain valuable insight into how effective their marketing campaigns were. Through the knowledge companies gain valuable feedback which allows them to further develop the next generation oftheir product.

Here, we work on different political parties because in our country politicsplays a very vital role. Winning an election by any party is different from how that party works after winning. In the context of the sentiment analysis being carried out for this application, theresults will allow user to gain insight into how each party is being perceived by the public. This is very valuable information as public is uploading their expectations, opinions and views on the political parties. This really revolutionizes the feedback process. An application such as this has the potential to analyze the sentiment in realtime giving the users immediate feedback on how a party is being help in the eyes ofits audience. Such an application could be expanded to use clustering algorithms togiveinsight into particularmember or position.

Applications of Sentiment Analysis

Sentiment analysis has large amount of applications in the NLP domain. Due to theincrease in the sentiment analysis, social network data is on high demand. Many companies have already adopted the sentiment analysis for process of betterment. Some of major applications arementioned as following:

Word of Mouth (WOM)

The process by which knowledge is passed from one person to another is known as word of mouth (WOM). It would fundamentally aid in decision-making for the populace. Word-of-mouth has provided information about customer attitudes, views, and reactions to associated businesses, services, and products, including those that can be shared with many people. Sentiment Analysis will therefore be relevant in this situation. The user's decision-making process has become more simpler as a result of the abundance of viewpoints supplied through online review blogs, sites, and social networking platforms.

Voter's voice

Each political party often spends a sizable portion of the total budget on either voter sway or lobbying for their cause. Therefore, if politicians are aware of public opinions, reviews, and suggestions, they may act more effectively. This is how the process of Sentimental analysis benefits news analysts in addition to political parties. Additionally, the American and British governments have previously employed some of the same strategies.

Literature Survey

The topic of sentiment analysis has been the focus of numerous studies in the past. The most recent study in this field uses sentiment analysis to examine user-generated data from numerous social networking sites, including Facebook, Twitter, Amazon, and others. The majority of sentiment analysis research relies on machine learning algorithms, whose primary goals are to determine the polarity of text and determine if a given text is pro or con. This chapter will give an overview of some of the research that has been done to further our understanding of the subject.

Natural Language Toolkit (NLTK) is a library which comprises of several program modules, vast amount of structured files, various tutorials, problem sets, many statistics functions, ready-to-use machine learning classifiers, computational

linguistics courseware, etc. The fundamental objective of NLTK is to carry out natural language processing, i.e. to perform analysis on human language data. NLTK provides corpora which are used for training classifiers. New components are created and existing components are replaced by developers. More structured programs are also created, and datasets produce more sophisticated results.

For the U.S. presidential elections in 2012, it was these scholars who suggested a mechanism for real-time analysis of public responses. They gather the responses from the microblogging website Twitter. Twitter is one of the social media platforms where users may express their views, ideas, and opinions on any hot topic. Twitter comments from American election candidates generated a lot of data that was used to gauge public opinion of each contender and predict who would win.

The reactions people post on Twitter and the entire election cycle are connected in terms of feelings. They investigate sentiment analysis' impact on these public events as well. Additionally, they demonstrate how much quicker this live sentiment analysis is than traditional content.

P.Pang,L.Lee,S.Vaithyanathan*et al*[8]

They were the first to work on sentiment analysis. Their main aim was to classify textby overall sentiment, not just by topic e.g., classifying movie review either positive ornegative. They apply machine learning algorithm on movie review database whichresults that these algorithms out-perform human produced algorithms. The machinelearning algorithms they use are Naïve-Bayes, maximum entropy, and support vectormachines.They alsoconcludeby examining various factors that classification of sentiment is very challenging. They show supervised machine learning algorithms are the base for sentiment analysis.

P.Pang, L.Lee*etal* [9]

By collecting large amount of data has always been a key to find out what people isthinking or expecting. With the emergence in the field of social media, availability ofdata which is full of opinion resources is very high. Other resources such as blogs,review sites, messages, etc. are helping us to know what people can do and theiropinion about the topic. The sudden increase of work in the field of data mining andsentiment extraction deals with the computational power to solve the problem ofopinion mining or subjectivity in text. Hence various new systems are created based on different languages and commands that can deal directly with

opinion mining as the first class object and direct response or live research also becoming the area ofinterest.

They take a survey which covers that methodology and approaches that are used indirect response of opinion mining are more helpful than others. Their focus is onfunctions that can solve new challenges rising in sentiment analysis applications. Theyalso compared these new techniques to already present traditional analysis which isbasedon facts.

Problem Statement

Sentiment analysis is the process of removing characteristics from user-posted ideas, views, emotions, and opinions on social networking platforms. Natural language text is classified into classes like positive, negative, and neutral as a consequence of sentiment analysis. Social networking websites generate enormous amounts of unstructured data, which must be examined before it may provide any useful information. Therefore, in order to make sense of this enormous amount of data, sentiment analysis is used to extract features from the data and categorize them. Sentiment analysis is essential in today's environment because people are constantly influenced by the ideas and opinions of others. Today, whether somebody wants to buy something, cast a ballot, or watch to give voter to watch a movie, etc. then that person will first wants to know what are other people reviews, reactions and opinions about that product or candidate or movie onsocial media websites like Twitter, Facebook, Tumbler, etc. So there is a need of system that can automatically generate sentiment analysis from this huge amount ofdata.

Objectives

The primary goal is to do sentiment analysis on Indian political parties like the BJP, INC, and AAP so that people's opinions regarding these parties' developments, employees, policies, etc., which are taken from Twitter, may be determined.So, in order to accomplish this goal, we create a classifier based on supervised learning and run real-time sentiment analysis on data gathered from various political parties.

Methods

The following methods is applied to this goal:

A detailed examination of the methods and tools currently used in sentiment analysis.

Using the Twitter API to gather related info from Twitter

The pre-processing of Twitter data to make it suitable for mining.

To construct a classifier using several supervised machine learning methods.

Using huge datasets for classifier training and testing

Calculating the output of several classifiers using Twitter-sourced data.

Comparing the outcomes of each classifier and creating a graph to display the sentiment trend for various political parties, both positive and negative.

Methodology

To achieve this objective the following methodologies

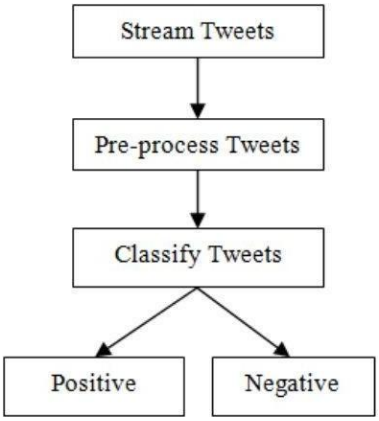
- A thorough study of existing approiach and techniques in the feild of sentiment analysis.
- collection of related data from Twitter with the help of TwitterAPI
- Pre- processing of data collected from Twitter so that it can be fit for mining.
- To build a classifier based on different supervised machine learning techniques
- Training and testing of build classifier using large data set collected from the twitter
- Comparing result of each classifier and plotting graph that showing the trend of positive negative sentiment for different political parties.

Implementation

Despite appearances, gathering data is not an easy task. For the purpose of gathering data, many choices must be made. We keep a dataset for training, testing, and sentiment analysis on Twitter in support of our argument. This chapter will look at data collection, storage, processing, and classification. Let's talk about our proposed architecture before we discuss these processes and the various datasets.

Architecture

Our objective is to perform sentiment analysis on Twitter-provided data. We are going to construct a classifier from various machine learning classifiers. When our classifier is prepared and trained, we will proceed as illustrated in Figure 4.1.



Processto classify tweets using build classifier

Step-1 First, using the Python Tweepy package, we will stream tweets into our built-in classifier.

Step-2 After that, these tweets are pre-processed to make them suitable for mining and feature extraction.

Step-3 After pre-processing, we input this data into our trained classifier, which categorizes them according to trained outcomes into the positive or negative class.

Since, Twitter is our source of data for analysis. We are going to stream the Tweets from Twitter in ourdatabase. For this weare going to use Twitter Application.

Twitter API (Application Programming Interface)

With the aid of the Twitter API, users can collect tweets from Twitter. REST API and Streaming API are the two types of APIs that Twitter offers. These distinctions are between them: While Streaming API offers tweets in real-time and connections for extended periods of time, REST APIs only support connections for brief periods of time and only a small amount of data can be collected at a time. For our analysis, we make use of Streaming API. We require a stable connection with an unlimited data rate in order to capture massive volumes of tweets.

DataCollection

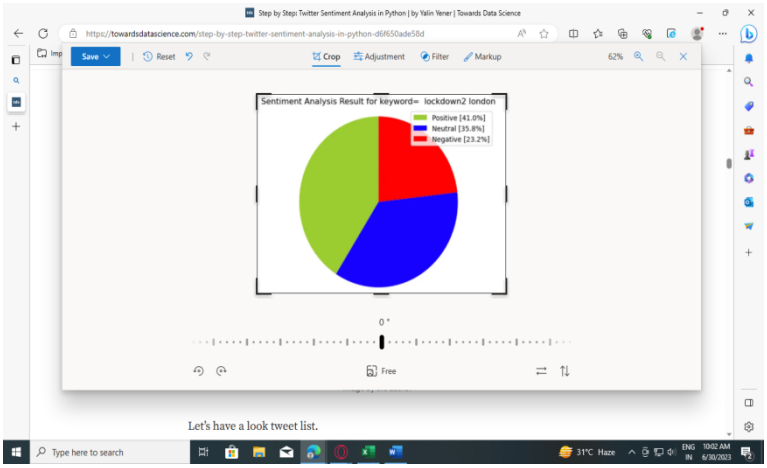
Twitter Data

We need a Twitter account before using the Twitter API. By entering the registration information on the twitter.com website, it is simple to create. You will then be given a username and password that you can use to log in. You can read and send tweets about any subject you're interested in after your account has been created.

Twitter offers a platform that allows us to access and use data from Twitter accounts for our own purposes. For this, we must sign in to the dev.twitter.com website using our Twitter credentials.

We can access and use data from Twitter accounts on a platform provided by Twitter for our own use. To do this, we need to login in using our Twitter accounts on the dev.twitter.com website. We first create an application on this website that will be used to stream tweets by providing the necessary data. After creating our API, we might discover more about our clients.

Results and Output



Conclusion

Twitter provides a platform through which we can access and utilize data from Twitter accounts for our own needs. We must do this by logging in with our Twitter credentials on the dev.twitter.com website. On this website, we first create an application that will be used to stream tweets by providing the necessary data. We may discover information about our clients after creating our API.

To determine people's opinions, attitudes, and emotional states, sentiment analysis is employed. People may hold either good or unfavorable opinions. Parts of speech are frequently utilized as a feature to derive the text's sentiment. An adjective is essential for separating out sentiment from different elements of speech. When an adjective and an adverb are used simultaneously, it might be challenging to determine the author's feelings and opinions.

The suggested approach retrieves the tweets from Twitter by user before performing sentiment analysis on the tweets. The technology may also determine

how frequently a given term appears in a tweet. To get the results, a supervised machine learning approach is used.

Twitter is a significant data source, which increases its appeal for sentiment research. We do analysis on approximately 15,000 tweets in total for each party .Additionally, we learn which of these parties' initial policies are enjoying greater public favor. According to public opinion, it was demonstrated that the BJP is the political force having the most success right now. Our classifier can be applied to other categories besides political parties, too. This classifier is all-purpose. Based on the tweets we gather with the aid of the term, it can be utilized for any purpose. It can be used for budgeting, advertising, reviewing, and many other things.

In the future, a web-based application could be created for our work.

- We can make improvements to our system so that it can handle statements with many interpretations.
- We can expand the classification categories as well to improve our outcomes.
- To make sentiment analysis more accessible to regional speakers, we can begin working on many languages including Hindi, Spanish, and Arabic.

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CHAPTER 22

INDUCTION MOTOR CONTROL BY EMPLOYING SEPIC CONVERTER FOR ELECTRICAL APPLICATIONS

S.Nalini, M.Bhuvaneswari* & A.Thamijunisha
Department of Electrical and Electronics Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

N.Chandrasekaran
Department of Electrical and Electronics Engineering
PSNA College of Engineering and Technology, Dindigul

Abstract

The conventional DC-DC converters are not compatible for medium and low voltage Induction Motor drive applications. These DC-DC converters are not applicable for power factor improvement, distortion of harmonics and constant output voltage. Advanced DC-DC converters such as SEPIC, Zeta and Landsman converters are used to limit the demerits of basic DC-DC converters. These converters work as Buck-Boost converters in accordance with load requirement and also used for the soft starting of squirrel cage induction motor. The outputs of these converters are fed to the three-phase Voltage Source Inverter (VSI) to run the AC induction motor drive. The SEPIC converter is used for Induction Motor drive applications and is simulated using the Simulink in MATAB software.

Keywords: *DC-DC converters, SEPIC converter, induction motor, Voltage source inverter.*

Introduction

Induction Motor

The induction motor works on the principle of Faraday's law of electromagnetic induction. The energy is transformed through the rotating magnetic fields in induction motor. The currents in the stator side create an electromagnetic field which interacts with the electromagnetic field in the rotor bars, and then the resultant torque will be obtained. The electrical energy is then converted into mechanical energy. Induction motors are mainly used for industrial applications due to their low price and easy maintenance.

The PMSM is popular because of its high power density, high efficiency and compact volume and the disadvantage is that the magnetic materials used in the PMSM are costly and they need good maintenance. The SRM is another type of machine for Electric Vehicle applications, because of its simple design, fault tolerant operation and wide control of speed at constant power. But, the demerits

of the SRM are its high torque ripples and low efficiency. As a result the induction motor is considered as the best option for most of Electric Vehicles applications.

Block Diagram and Its Description

The induction motor design is relatively simple and consists of two parts, a stator and a rotor. The rotor of a squirrel cage induction motor consists of aluminium bars which are short circuited by connecting them to two end rings. Rotor produces the induction current and magnetic field by itself. Hence the AC induction motor is robust, rugged and cheap for electrical drive systems .The SEPIC converter is able to either increase or decrease an input voltage by controlling the Duty Cycle of a pulse to the MOSFET. One way to do that is to directly control the Duty cycle using a potentiometer. The potentiometer allows the SEPIC to operate over a extended voltage range. The SEPIC converter runs on a large range of power with higher efficiency than simply decreasing the voltage with a potentiometer to control the output. Therefore, the SEPIC converter holds a single output without the need for control when using a SEPIC as part of a large circuit.

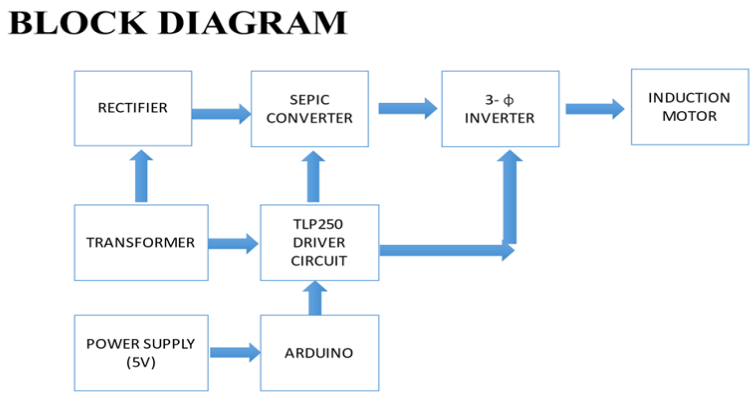

Fig.1. Block diagram of the proposed model

Arduino integrated development environment (ide) is a cross-platform application (for windows, macos, linux) that is written in functions from C and C++. It is used to write and upload programs to arduino compatible boards .Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called arduino ide

(integrated development environment), which is used to write and upload the computer code to the physical board.

Induction Motor Control Algorithms

The popularly used control methods for AC induction motors are field orientation control and direct torque control.

(i) Field Oriented Control (FOC)

The vector control techniques emerged around 1970 . Some types of vector control, such as rotor flux oriented, stator flux oriented and mutual flux oriented are introduced one after another. Based on the type of vector control, they are all related to duplicate a separately excited DC motor, in which the torque and magnetic field can be separately controlled.

The Field oriented control has the ability to control the field-producing and the torque-producing currents in a decoupled way.This type of control indicates the rotor flux-oriented type of vector control. In addition, the field-oriented control can be divided into indirect or direct field-oriented control, based on rotor flux orientation.

(ii) Direct Torque Control (DTC)

Direct Torque Control algorithm does not obey the well-developed DC motor control strategies. Instead of performing the coordinate transformations to decouple the torque and magnetic field, it involves a bang-bang control along with the hysteresis-controller. The bang-bang control works with the semiconductor inverter.

The DTC includes two hysteresis controllers. Before implementing the hysteresis-controller, the actual stator flux is calculated using the stator voltages and torque is calculated using the stator voltages and stator currents.

So the DTC control method depends on the stator variable parameters. When the stator voltage changes, the stator flux follows rapidly and the rotor flux changes slowly. This changes the angle between stator and rotor fluxes and thus the electromagnetic torque will be increased or decreased.

SEPIC Converter with Pwm Generation

Few converter applications needs only to boost or buck the voltage and can use the corresponding converters. Therefore the required output voltage follows the range of input voltage. When this case occurs, it is usually suitable to use a converter that can either decrease or increase the voltage. Buck-boost converters are

lower in cost, because they require only a single capacitor and an inductor. But these converters produce a high amount of ripples in input current. This ripple creates harmonics in many drive applications and these harmonics involves using a LC filter or a large capacitor. This leads to buck-boost converters, expensive or inefficient buck-boost. Another problem is that the usage of buck-boost converters inverts the voltage. The above problems can be solved by using Cuk converters with an extra inductor and capacitor. Both buck-boost and Cuk converters operation leads to higher amounts of electrical stress on the components, this results in failure of device or overheating. SEPIC converters are used to solve both of these problems topologies.

Operation of SEPIC Converter

All dc-dc converters operate by rapidly turning on and off a MOSFET, generally with a high frequency pulse. For the SEPIC, when the pulse is high/the MOSFET is on, inductor 1 is charged by the input voltage and inductor 2 is charged by capacitor 1. The diode is off and the output is maintained by capacitor 2. When the pulse is low/the MOSFET is off, the inductors output through the diode to the load and the capacitors are charged. The greater the percentage of time (duty cycle) the pulse is low, the greater the output will be. This is because the longer the inductors charge, the greater their voltage will be. However, if the pulse lasts too long, the capacitors will not be able to charge and the converter will fail as shown in Figure below,

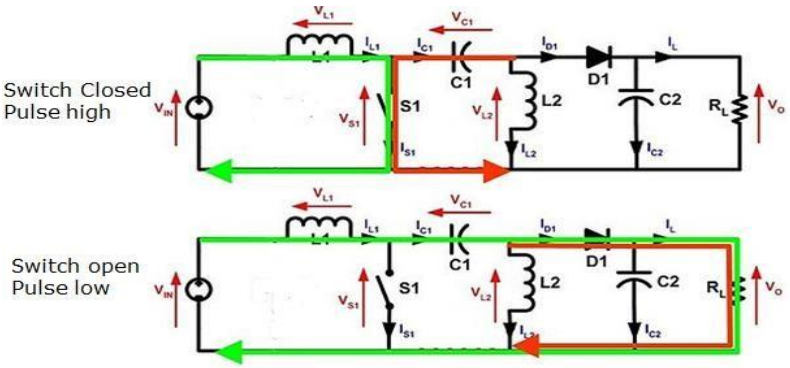

Fig. 2.SEPIC operation

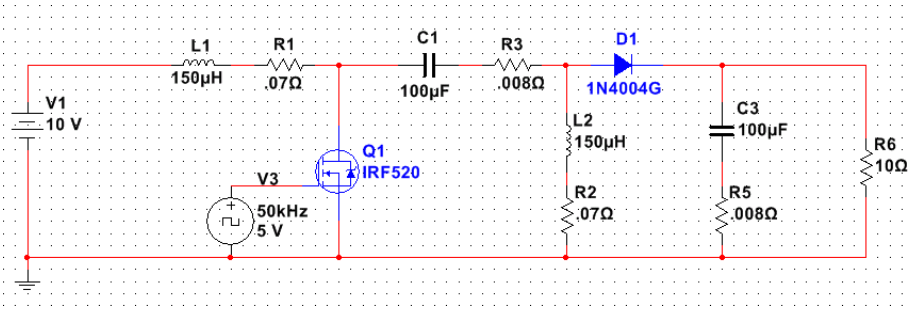

Fig. 3.SEPIC Simulation

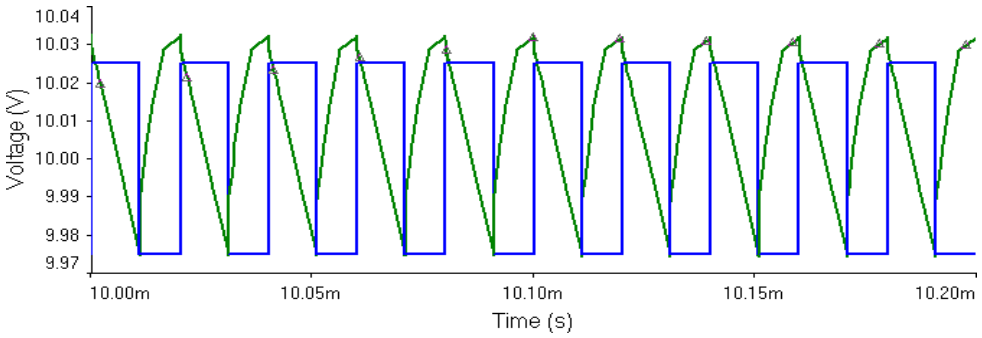

Fig. 4.Graph of Vout and Pulse

Inductor Calculation

The larger the inductors the better will be the operation of the circuit and reduction of ripples. Hence, larger inductors are more costlier and possess a larger internal resistance. This higher internal resistance will turn the converter less efficient. Selecting the appropriate converter requires choosing inductors that are just large enough to keep the current ripple and voltage.

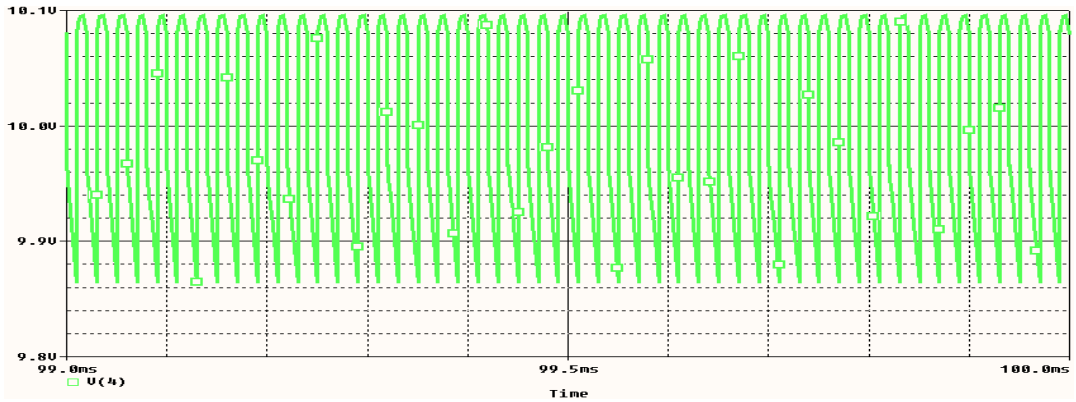

Fig. 5.Graph of Vout

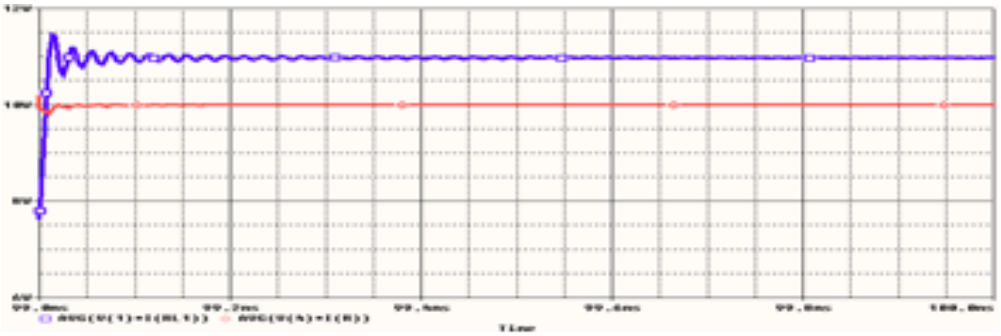

Fig. 6.Graph of Pout and Pin

The above graph shows that the efficiency of the Converter=Pin/Pout= .91

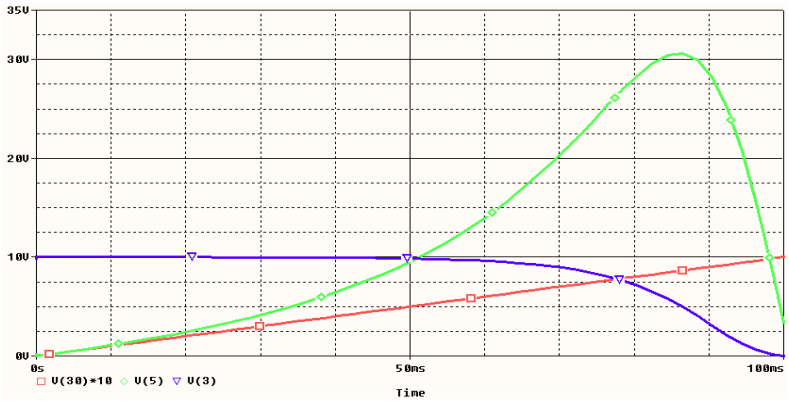

Fig.7.Graph of Vout, D and VCin with Vin=10V

The above graph shows that as D increases from 0 to 1, Vout increases exponentially, reaching Vin around D=.5. When D gets too high, VCin cannot stay charged and this causes Vout to drop as well.

Potentiometer Controlled PWM

The SEPIC converter is able to either increase or decrease an input voltage by controlling the Duty Cycle of a pulse to the MOSFET. One way to do that is to directly control the Duty cycle using a potentiometer. There are some applications for which this control method is suitable but it is insufficient for many other applications.

In order to drive the MOSFET, a pulse is needed. A 555 timer is used to produce a square wave with a set frequency and a Duty cycle≥50%. However, the duty cycle from 555 timer cannot be easily changed without switching resistors. In addition, the SEPIC requires a duty cycle below 50% to buck the voltage when the input

voltage is low. The pulse width will need to be modified separately from the 555 because the 555 cannot change or produce a duty cycle less than 50%.

The greater the signal, the greater the duty cycle of the comparator output will be. One way to control the signal is to step down voltage using a potentiometer, the signal can be kept in the same range as the triangle wave by using the same input that drives the 555 timer. The duty cycle will not change when the input or the output voltage changes which means there is full control of how much the SEPIC steps up or down the voltage. This has both advantages and disadvantages for the circuit.

The potentiometer allows the SEPIC to output a wide range of voltage from a wide range of input. This could be useful in battery applications that need to run on various levels of power. One example would be a flashlight with adjustable brightness. This SEPIC converter could allow it to run on a large range of power with greater efficiency than simply reducing the voltage with a potentiometer to control the output.

PWM Demonstration

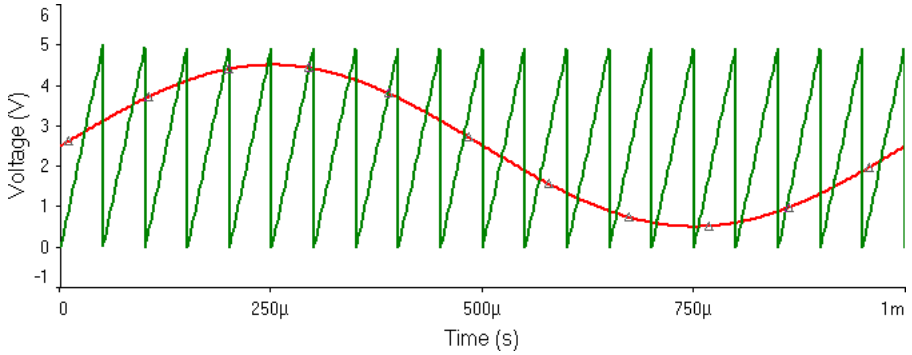

Fig.8.Graph of Triangle wave and Sinusoidal control wave

The pulse is high when the control signal is greater than the triangle wave. This results in a higher duty for high control signals.

Inverter Control and Pulse Width Modulation Technology

Inverter Control

The induction motor can be fed with a standard fixed frequency and fixed voltage source. Based on these conditions, the motor speed and slip is calculated using load torque. With no load, the slip values is low, so the rotor speed is close to synchronous speed. By the use of a variable frequency inverter in the induction

motor driving system, both the magnitude and frequency of the voltage inputs can be varied based on suitable control techniques.

A three phase inverter has three sets of power switching devices and various supporting components like capacitors to smooth switching surges. Two switches are used in one phase of the motor and they appear in one leg of the inverter. By turning on and off the switches, the current flow into the motor will be generated and controlled. Two switches in a leg are never turned on at the same time, otherwise this leg would be shorted. Therefore, eight combinations of switching state exist in a three phase inverter. In electromechanical systems, the losses in the power switches become a serious concern in which the switching frequency is typically controlled from 10 KHz to 20 KHz, therefore the switching losses can be reduced.

Pulse Width Modulation (PWM) Technology

The average value of voltage given to the load could be controlled by turning the switch between on and off at a very fast rate. As long as the switch is on, the higher the average value of the voltage output.

The main advantage of PWM technique is that power loss in the switching devices is less. By varying the width of the pulse , the output voltage can be efficiently controlled.

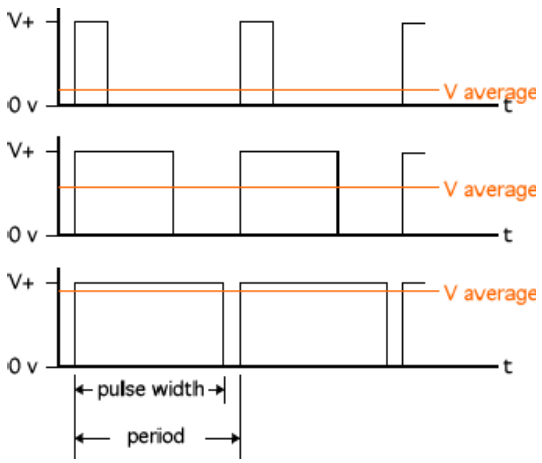

Fig.9. PWM techniques for time invariant signals

Simulation Results

The Simulink model of the proposed block diagram is shown in figure below,

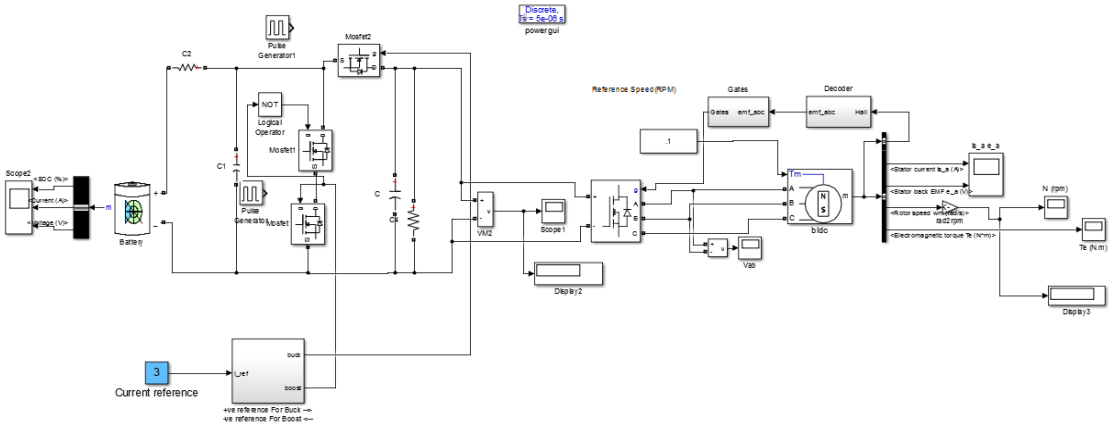

Fig.10.Simulink model of the proposed block digram

Controller Unit

The Simulink model of the controller unit is shown in figure below,

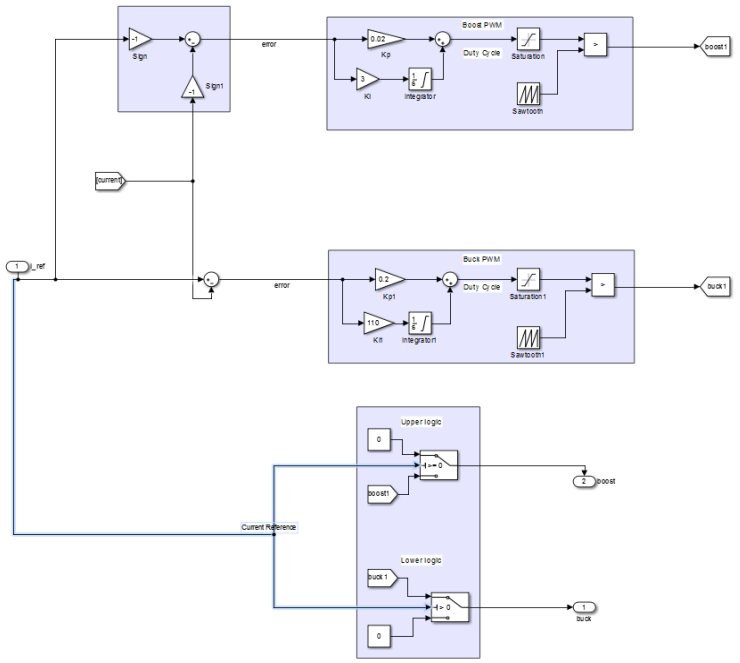

Fig.11. Simulink model of the controller unit

Hall Sensor

The Simulink model of the Hall sensor is shown in figure below,

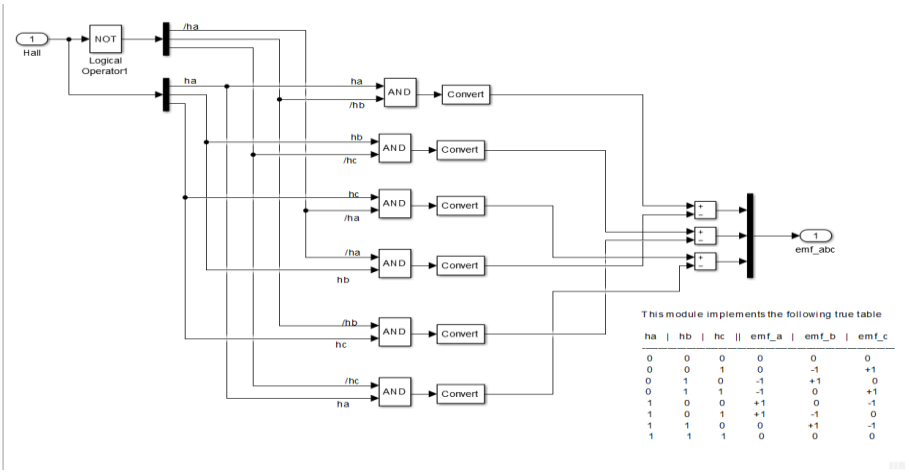

Fig.12. Simulink model of the Hall sensor

Motor Speed

The diagram below represents the output of motor speed

Fig.13. Simulink output of Motor speed

Stator Current and EMF

The diagram below represents the stator current and emf

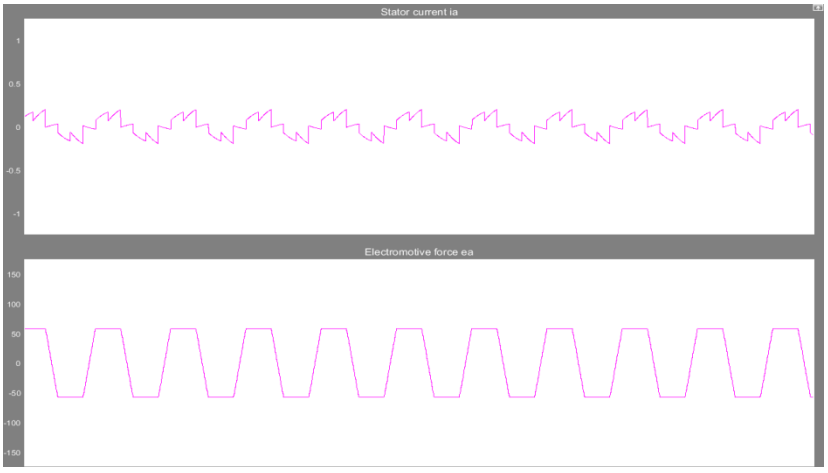

Fig.14. Simulink output of stator current and emf

Conclusion

The SEPIC converter can be effectively employed for induction motor control in electrical applications. Through modeling and analysis, it has been shown that the SEPIC converter can provide a stable and efficient voltage supply to the induction motor, resulting in improved motor performance and efficiency. The use of the SEPIC converter for induction motor control can also lead to reduced power consumption, improved power factor and reduced harmonic distortion. This makes it a promising technology for a wide range of electrical applications, including industrial and residential sectors. However, it is important to note that the implementation of SEPIC converters for induction motor control requires careful design and control strategies to ensure optimal performance and minimize losses. Additionally, further research can be conducted to explore the use of advanced control techniques and the integration of other power electronics components, such as energy storage systems, to further enhance the performance of the SEPIC converter. Overall, the results of the modeling and analysis, demonstrate the potential benefits of employing the SEPIC converter for induction motor control in electrical applications and further research and development in this area can help to optimize and improve the performance of this technology.

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CHAPTER 23

SMART ATTENDANCE MONITORING SYSTEM

M.Parameswari*, N.Saranya & P.Suriya
Department of Electrical and Electronics Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

Over the years the manual attendance management has been carried across most of educational institutions. In this proposed system is to overcome the problems of manual attendance, have developed "web-based attendance Management System". Attendance Management System is based on web server, which can be implemented on any computer. In This application, PHP is server-side language, MySQL and PHP is used as back-end design and HTML, CSS and JavaScript are used as front-end tools. The system communicates with database residing on a remote server. It calculates automatically, the attendance percentage of students without any manual paper-based work. The system facilitates the end users with interactive design and automated processing of attendance management. The attendance is taken in every organization. Traditional approach for attendance is, professor calls student name & record attendance. For each lecture this is wastage of time. The Automatic face detection and recognition proposed to attendance marking in database acts as the solution for the automatic attendance marking systemThe traditional manual recording of attendance carries a risk of human error. The manual capture of attendance takes a long time and we dedicate a great deal of time to attendance. In this proposed project "Attendance taking webpage" is present to reduce the time spent in manual work by our Staffs. Then the data are collected and streamed by data modeling. The objective of our project is to build attendance website that will be used for our respected staff members and their valuable time will be saved. This proposed system minimizes the number of duplicate entries and errors associated with time and attendance data.It is proposed to reduce paperwork and save time. This system is designed to increase security by automatically calculating attendance.

Keywords: *HTML, Attendance monitoring, cloud computing, PHP.*

Introduction

Attendance ManagementSystem is software developed for daily evaluation of students in their continuous assessment record, and performance in accordance with the principle of the institution. It is facilitated to access the performance and information of attendance of a particular Student in a particular semester of study. The information is sorted by the teachers, instructors and advisors, as provided by the student for a particular day throughout a complete semester. This system will also enable the evaluation of student regular presence in various lectures which will determine the eligibility of the student to sit for a semester examination.

Attendance management System basically has three main modules for proper functioning. First module is admin which hold the key for editing and updating information. The admin has absolute right to all the users which are the teachers and student. Second module is handled by the user which can be a teacher or instructor. This user has a right of making daily attendance, updating, editing and generating reports to the students. Third is handled by a user which is the student, he has less privilege to the access of the system; the student can only view his own record by providing his username and password.Our proposed system will be able to see the percentage of the attendance as well as to the students results. If any comment or change of class schedule the student can see in their own profile only.

This user can receive alert / message from his teachers related to his attendance performance. It is obvious that students with poor attendance will see their attendance in a red warning table that can make the student to be careful not to miss classes anymore.

Organizations of all sizes use attendance systems to record when student or employees start and stop work. Some organizations also keep detailed records of attendance issues such as who calls in sick and who comes in late. It is important to take the attendance of the students in the classroom automatically. The attendance monitoring system was created and it changed the way attendances were marked. The attendance monitoring system has made the lives of teachers and employers easier. When it comes to schools and universities, the attendance monitoring system is a great help for parents and teachers both. Parents are never uninformed of the dependability of their children in the class if the university is using an attendance monitoring system. The registers could easily be exploited by students and if information was mailed to the parents, there were high chances that mails could be made to disappear before parents even saw them.

Objectives

Create a Window application to be used in place of old paperbased user Employee Salary manage process. Use the technologies and Server technology used in here to create strong and secured database connectivity. Incorporate the server software within the code.

Web Services

Web service is a service offered by an electronic device to another electronic device, communicating with each other via the World Wide Web. In a Web service,

Web technology such as HTTP, originally designed for human-to-machine communication, is utilized for machine-to-machine communication, more specifically for machine readable file formats such as XML and JSON. In our Attendance Software, The Web service typically provides an object-oriented Web-based interface to database server, utilized by another Web server, or by a mobile application, that provides a user interface to the end user.

Availability of both Computer and Android Version

Our software can be used in either computer or mobile depending on User's choice, by signing in with both devices everything will work normally. People are always with their mobile phones, so where ever you are you can use your mobile to use our software in any situation and work splendid.

Cloud Computing

One such technology is Cloud Computing. In simple terms, cloud computing refers to the delivery of IT resources/computing services through the internet (i.e. the "Cloud"). From processing power and storage to software deployment and analytics, these services replace the traditional way of owning physical assets to offer innovation, competitive advantages, flexibility and sharing of resources. A fundamental concept of cloud computing is to allow users to reap all its benefits without being complete experts on each underlying technology. However, details such as service location and scaling options still remain important components within the cloud process which can be modified depending on the application's optimal conditions and user requirements.

The ability to scale is, without a doubt, the most crucial factor of cloud computing. Whether it is expanding your geographical reach or handling a growing number of users, web applications can be easily scaled up by either increasing the number of servers, upgrading hardware power or a mixture of both! This means there is no need to worry about secondary details as seen in traditional server hosting (e.g. network configuration, server load balancing etc.), allowing for strategic growth with fewer obstacles in your business.

Especially for first-tier cloud platform, this battle is making innovations spring at a pace we have never been before, especially with the emergence of Edge Computing solutions.

Cloud computing is a technology which uses one remote server and the internet to maintain various data and applications. Cloud computing provides important

cost effective IT resources as a cost on demand IT based on the actual usage of the customer. Because ofrapid growth, many companies are unable to handle their IT requirement even after having an in-house data center. Cloud services are used to improve IT capabilities without investing large amounts in new data centers. This technology helps companies with much more efficient computing by centralizing processing, storage, memory and bandwidth. Cloud computing segments: Applications, Storage, and Connectivity.

Existing System

This software has developed for daily attendance of students. It made easy to access the attendance information of a particular student. The information is stored through operators, and provided by teacher for related class. This software is helpful in evaluating the attendance eligibility of a student.

Its purpose was to computerize the tradition way of taking attendance and generating of report automatically at the end or between of the session. This project has developed as a desktop application for a specific institute. The technologies which have been used are, VB.NET language and for backend MS-Access. This system has same task and quality as upper software but here technology that used is, Language: ASP.NET, Backend: SQL.

It is a two-tier system which consists of a dedicated database, and a specially constructed Java Client Application. The upside of this solution is that the processing is no more centralized. On the contrary, the client application consumes the resources of the user running it locally. The only thing that is centralized is the database. Manipulate the database through Java Client Application by using JDBC API offered by the Oracle for connecting and retrieving data from data sources.

Drawbacks

In this model even though this system still lacks the ability to identify each student presentation class, there is still much more room for improvement.Another issue that has to be taken inconsideration in the future is a method to ensure users privacy.

Whenever an image is stored on our servers, it must be impossible for a person to use that image.

Proposed System

The proposed system makes higher learning institutions such as colleges and universities daily use a large amount of data that has to be communicated appropriately to students, faculty members, staff, students, faculty, and administrative staff. Student attendance is one the daily operations college and university lecturers perform. These single tasks take a lot of time to complete and often require competent man-power, costly equipment and material to manually perform very simple tasks. Consequently, much of the information is lost, duplicated, inappropriate, and revealed to third-parties, space and money wastage, and sometimes the information flow problems are arisen. Because the above-mentioned problems, managing student attendance during lecture periods has become a difficult challenge.

The ability to compute the attendance percentage becomes a major task as manual computation produces errors. Some other disadvantages of paper-based systems that have been reported in literature, include students not signing in, signing in another student's, unreadable signatures, and data management. Students who are inclined to skip classed know that manual attendance (i.e., calling roll, etc.) can be manipulated in their favor. Much of these cumbersome manual tasks a lecturer has to perform can be automated using various currently available programming and networking technologies. Instead of dealing with files, the use of a good database coupled together with a proper front-end design would not only reduce the operating cost but also make the task of the lecturer easier.

The most important thing is that an automated system of this sort can be customized to suit the needs of the patrons or users and provide good service to both of them. Another advantages of computerized student attendance systems is that the problems associated with gathering and maintaining paper-based attendance records has been overcome through the use of technology.

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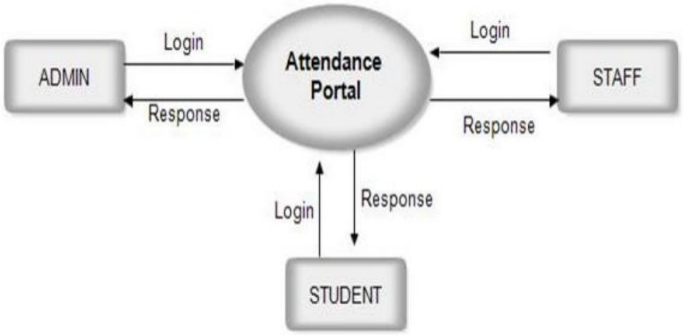

Figure 1

Advantages

The maintenance of the records is made efficient, as all the records are stored in the MySQL database, through which data can be retrieved easily. The editing is also made simpler. All of this resulted in decreasing staff work load, so malpractice has been reduced. The user has to just type in the required field and update the desired field.

Our main aim of the project was to get the correct information about a particular student attendance and the information system is designed and implemented to manage student's data and provide capabilities for tracking student attendance, grading student marks, giving information about timetable, lecture time, room number.

Css

Cascading Style Sheets (CSS) is a style sheet language. CSS is designed to enable the separation of presentation and content, including layout, colours, and fonts. This separation can improve content accessibility; provide more flexibility and control in the specification of presentation characteristics; enable multiple web pages to share formatting by specifying the relevant CSS in a separate .CSS file, which reduces complexity and repetition in the structural content; and enable the CSS file to be cached to improve the page load speed between the pages that share the file and its formatting.

Separation of formatting and content also makes it feasible to present the same markup page in different styles for different rendering methods, such as on-screen, in print, by voice (via speech-based browser or screen reader), and on Braille-based tactile devices. CSS also has rules for alternate formatting if the content is accessed on a mobile device.

Java script

JavaScript is a high-level, often just-in-time compiled language that conforms to the ECMAScript standard. It has dynamic typing, prototype-based object-orientation, and first-class functions. It is multi-paradigm, supporting event-driven, functional, and imperative programming styles. It has application programming interfaces (APIs) for working with text, dates, regular expressions, standard data structures.

PHP

It stands for PHP: Hypertext Pre-processor but, originally stood for Personal Home Page. Is a server side scripting language that designed for web development, as well as used for general purpose language. It was created in 1994 by RasmusLerdorf, in the present time the reference execution of PHP is produced by the PHP group.

In January 2013, PHP was installed on more than 240 million websites, and 2.1 million web servers. The PHP code can be combined with several web frameworks and templating engines or simply it can be mixed with HTML code.

The PHP code is generally processed by a PHP interpreter, which is commonly executed as native module of web server or a Common Gateway Interface (CGI) executable. After interpretation and execution of the PHP code, the results will be sent by web server to its client. Zend Engine has powered the standard PHP interpreter, which is free software liberated under the PHP license.

MY SQL

SQL stands for Structured Query Language. MySQL is an open source Relational Database Management System (RDBMS); it is a popular database for use in web applications, and is a central part of the greatly used LAMP (Linux, Apache, MySQL, Perl/PHP/Python) open-source web application software stack.

MySQL is used by many applications like, WordPress, Joomla, TYPO3, Drupal, MODX and other software. Numerous large scale websites including Google, YouTube, Facebook, Twitter, and Flickr are also using MySQL.

On all platforms excluding Windows, MySQL sends with no GUI (Graphical User Interface) to administer MySQL databases or managing the data held within the databases. Users may install MySQL Workbench by downloading separately or simply may use the command line tools. Numbers of third party GUI tools are also available.

Module Description

Overview

Student class attendance at the university and college level has been a subject of concern for many years. Poor class attendance is an issue in higher education in several countries as various universities adopt manual attendance recording which a tedious task is sometimes. Instead of focusing on teaching, faculty members are often stuck with completing formal duties, e.g. taking daily student attendance on sheets of papers. In today's competitive world, with increasing working hours and less classroom time, teachers need automated student attendance management information systems which help them manage precious class time efficiently.

Conclusion and Future Enhancement

Over the years the manual attendance management has been carried across most of educational institutions. To overcome the problems of manual attendance, our have developed "web-based attendance Management System". Attendance Management System is based on webserver, which can be implemented on any computer. In This application, PHP is server-side language, MySQL and PHP is used as back-end design and HTML, CSS and JavaScript are used as front-end tools.

The system communicates with database residing on a remote server. It calculates automatically, the attendance percentage of students without any manual paper-based work. The system facilitates the end users with interactive design and automated processing of attendance management.The attendance is taken in every organization.

The traditional manual recording of attendance carries a risk of human error. The manual capture of attendance takes a long time and we dedicate a great deal of time to attendance. In this proposed project "Attendance taking webpage" is present to reduce the time spent in manual work by our Staffs. Then the data is collected and streamed by data modeling.

The objective of our project is to build a attendance website that will be used for our respected staff members and their valuable time will be saved. This proposed system is capable of reduce the number of duplicate entries and errors associated with time and attendance data.It is proposed to reduce paperwork and save time.

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CHAPTER 24

IoT BASED MONITORING SYSTEM OF LIFE SAVING DRUG'S INFUSION

T. Boopathy, N. Khadar Basha*, A. Yogeshwaran & S. Nithiya
Department of Electronics and Communication Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

Moment's rapid-fire growth of senior populations and growing problems, coupled with the frequency of obstructive sleep apnea and other health-related issues, have affected numerous aspects of society. This has led to high demands for more robust healthcare monitoring and treatment installations. The Internet of Effects grounded real-time health monitoring system has contributed to brilliant human wealth both in civic and pastoral areas. In this paper, we present an IOT-based real-time health monitoring system that can measure, cover, and report people's health conditions online and offline from anywhere. One order of similarity is bias, which points out if the affected person gets right into a critical state. In our proposed system, we focus on covering and initiating alerts for doctors roughly.

Keywords: *IOT, Monitoring system, buzzer, LCD cell, Node MCU, Arduino, Sensors and controllers.*

Introduction

The number of Human deaths occurs due to incorrect care taken. In terms of technological advancement, humans are also getting veritably concerned about their health. So our health monitoring system is designed to help patient care, drive clinical performance and lower costs. During similar situation, health status of them is hard to descry. The sudden fall and increase in physiological parameters may beget unforeseen deaths and may lead to supposedly Life Hanging Events. Medical centre protocol case monitoring is a total result designed around the challenges of Data security. The end of the design is to incorporate sensitive functions in the tackle making it able of measuring the physiological parameters body temperature, pulsation rate, oxygen saturation, blood pressure negotiating the need of continuously landing data.

Internet of Things

The Internet of Things (IoT) is a network of objects, including cars and home appliances, which include connectivity, electronics, software, actuators, and

connectivity that enables connections, communication, and data exchange. The Internet of Things (IoT) refers to the expansion of Internet connectivity to a variety of conventionally non-internet-capable physical things and gadgets outside of regular devices, including desktops, laptops, smart phones, and tablets. These gadgets have technology built into them, so they can interact and communicate online and be monitored and controlled from a distance.

Health Monitoring Systems

In the recent times wireless technology has adding for the need of upholding varied sectors. In these recent times IoT graphed the utmost of industrial area especially automation and control. Biomedical is one of recent trend to give better health care. Not only in hospitals but also the particular health minding installations are opened by the IoT technology. So having smart system colourful parameters are observed that consumes power, cost and increase effectiveness. In according to this smart system, this paper is reviewed. In traditional system, doctors play an important part in health check up. For this process requires a lot of time for enrolment, appointment and also check up. Also reports are generated subsequently. Due to this lengthy process working people tend to ignore the checks or postpone it. This ultramodern approach reduces time consumption in the process. Health- covering systems have drawn a lot of attention from the research community and the industry during the last decade as it's refocused out by the multiple and annual increasing corresponding research and development efforts. As healthcare costs are adding and the world population is geriatric, there has been a need to cover a case's health status while he's out of the medical centre in his particular atmosphere. To address this demand, a variety of system prototypes and marketable products have been produced in the course of recent times, which aim at furnishing real- time feedback information about one's health condition, either to the stoner himself or to a medical centre or straight to a supervising professional physician, while being suitable to warn the individual in case of possible imminent health threatening conditions. In addition to that, monitoring system constitute a new means to address the issues of managing and covering habitual conditions, senior people, postoperative rehabilitation cases, and persons with special capacities. System of health monitoring may comprises colourful types of atomic detectors, wearable or indeed implantable. These biosensors are able of measuring significant physiological parameters like heart rate, blood pressure, body and skin temperature, oxygen saturation, respiration rate, etc. The obtained measures are

communicated either via a wireless or a wired link to a central node, for illustration, a Personal Digital Assistant or a microcontroller board, which may also in turn display the according information on a user interface or transmit the aggregated vital signs to a medical centre. The previous illustrates the fact that a medical system may encompass a wide variety of factors detectors materials, smart fabrics, actuators, power supplies, wireless communication modules and links, control and processing units, interface for the user, software, and advanced algorithms for data extracting and decision making.

Proposed System

Proposes a system for measuring the level of a patient's glucose bottle. The system can compute the amount of liquid in the bottle by using the weight load cell, and when the liquid level reaches its minimum level, the system will activate. This device includes sensors, including a temperature sensor and an accelerometer, to measure the patient's position and temperature. On the LCD, the measured sensor information is displayed. This device uses a buzzer to signal when it detects abnormal conditions. Through an IOT device, patient health information is uploaded to a web server. Our suggested system areas have greatly benefited from the cloud's ability to provide security, link to real-time data, and access performance metrics. The suggested model can follow the patient's location using various sensors, measure and display blood pressure, room temperature, body temperature, oxygen saturation, and heart rate, and communicate data both online and offline to mobile apps. Based on real-time monitoring, the system is exceptionally dependable and user-friendly.

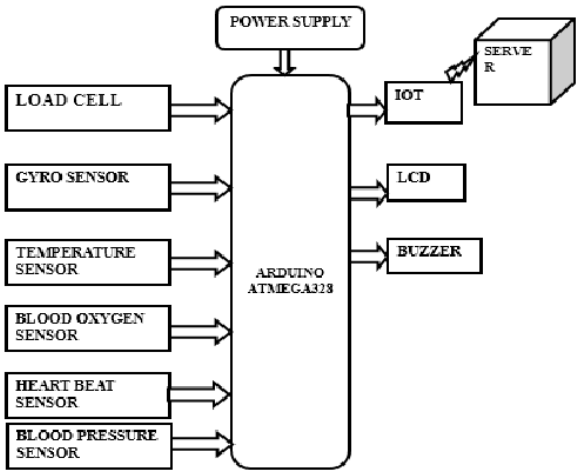

Fig 1: Proposed Block

Temperature Sensor

The relative humidity in the air is sensed, measured, and frequently reported by a humidity sensor. It gauges both air temperature and moisture content. The ratio of the actual moisture content of the air to the maximum amount of moisture that the air at that temperature can hold is known as the relative humidity, which is stated as a percentage. Relative humidity varies with variations in temperature because warmer air may store more moisture. The majority of humidity sensors measure the quantity of moisture in the air using capacitive technology. This kind of measurement depends on the creation of an electrical field between two electrical conductors and a non-conductive polymer sheet that is positioned in between them. As moisture from the air gathers on the film, the voltage levels between the two plates vary.

NodeMCU

In contrast to the $3 ESP8266 Wi-Fi modules, NodeMCU is an open-source hardware board with LUA-based interactive firmware for the Express ESP8622 Wi-Fi SoC that also includes a CP2102 TTL-to-USB chip for programming and debugging. It is also breadboard-compatible and can be powered by its micro USB port. A wireless SO made by Espressif Systems is called NodeMCU. It is built using a Wi-Fi module, the ESP8266-12E. It is a highly integrated chip designed to offer complete internet access in a compact form factor.
It may be directly programmed using a USB port using the Arduino IDE or LUA programming. By using simple programming, we can create a WiFi connection, specify input and output pins precisely to your needs, transform it into a web server, and much more. The WiFi equivalent of an Ethernet module is a NodeMCU. It combines the advantages of a microcontroller and a WiFi access point. The NodeMCU is a very potent tool for WiFi networking because of these features. It can function as a station or access point, run a web server, or connect to the internet to download or upload data.

Liquid Crystal Display

A flat panel display, electronic visual display, or video display that takes advantage of the light-modulating capabilities of liquid crystals is known as a liquid crystal display (LCD). Light is not directly emitted by liquid crystals. An LCD can show random images (as on a general-purpose computer display) or fixed graphics that can be shown or hidden, such as pre-programmed words, numbers,

and 7-segment displays like on a digital clock. They both make use of the same fundamental technology; however, different displays have larger elements, whereas random images are made up of a lot of tiny pixels. An LCD is a tiny, inexpensive display. A microcontroller can be easily interfaced thanks to an embedded controller (the black blob on the board's back). Many displays (HD 44780) use this controller as a standard; therefore, many microcontrollers (including the Arduino) have libraries that make displaying messages as simple as writing one line of code.

Buzzer

A buzzer or beeper is a signalling device that is primarily electronic and is found in cars, home appliances like microwaves, and game shows. It typically consists of a number of switches or sensors that are connected to a control unit that determines whether and which button was pressed or if a predetermined amount of time has passed. Upon detection, the control unit typically turns on a light next to the relevant button or control panel and emits a continuous or sporadic buzzing or beeping sound as a warning. The electromechanical technology on which this device was first built was exactly like an electric bell sans the metal that produces sound.

Load Cell

A load cell is a type of transducer, specifically a force transducer. It converts a force such as tension, compression, pressure, or torque into an electrical signal that can be measured and standardised. As the force applied to the load cell increases, the electrical signal changes proportionally. The most common types of load cell used are hydraulic, pneumatic, and strain gauge. Except for certain laboratories where precision mechanical balances are still used, strain gauge load cells dominate the weighing industry. Pneumatic load cells are sometimes used where intrinsic safety and hygiene are desired, and hydraulic load cells are considered in remote locations, as they do not require a power supply. Strain gage load cells offer accuracies from within 0.03% to 0.25% full scale and are suitable for almost all industrial applications.

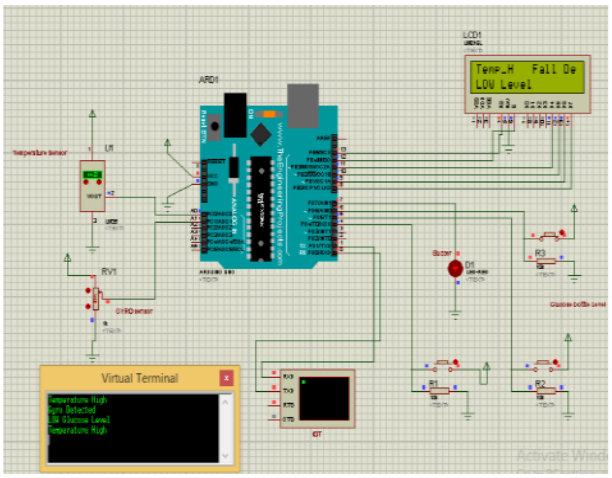

Fig 2: Circuit Diagram Layout

Communication

A computer, other Arduino/Genuino boards, or other microcontrollers can all be communicated with using the Arduino/Genuino Uno's many communication features. UART TTL (5V) serial communication is offered by the ATmega328 and is accessible on digital pins 0 (RX) and 1 (TX). There is no external driver required because the 16U2 firmware works with the built-in USB COM drivers. On Windows, however, an inf file is necessary. A serial monitor is provided by the Arduino Software (IDE) and enables simple text data to be delivered to and received from the board. When data is being communicated through the USB-to-serial chip and USB connection to the computer, the RX and TX LEDs on the board will blink (but not for serial communication on pins 0 and 1). On any of the digital pins of the Uno, a Software Serial library enables serial communication.

Results and Discussion

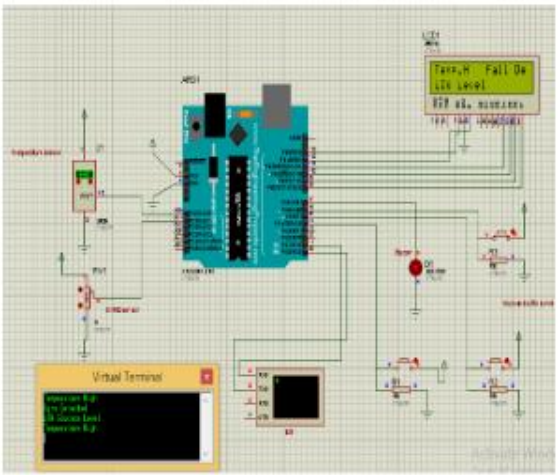

Fig 3: Output of the System

Features of simulation in Proteus Proteus's parts can be virtually recreated in several cases. There are two ways to simulate the Run simulator in advance frames. The circuit is simulated at regular speed using the "Run simulator" option. Up until you click this button again, the "Advance frame by frame" option advances to the following frame and weights: Debugging digital circuits may benefit from this. Microcontrollers such as the PIC24, dsPIC33, 8051, Arduino, and ARM7-based microcontrollers can all be mimicked. The user has the option of downloading the Proteus compilers or using a different compiler to dump hexfiles into Proteus' microcontroller.

It can even communicate with the simulation in real time by using switches, resistors, LDRs, etc. There are also virtual oscilloscopes, logic analyzers, voltmeters, and ammeters. Proteus' many parts can be virtually recreated. Both the run simulator and progress frame by frame can be simulated. If the circuit is light, the Run Simulator option simulates it at a regular speed. The option to advance frames at a time skips the previous frame and waits until you click this button again. For debugging digital circuits, this is helpful. Microcontroller simulation is another option.

Conclusions

The real-time remote IoT-based continuous glucose monitoring system described in this study can tell if a patient is having breathing problems or not, which is useful for identifying and monitoring sleep apnea conditions. The IoT-based architecture that has been created is a full system that extends from a sensor node to a back-end server. Through technology, medical professionals and carers may simply keep track of their patients from any location at any time using a web browser or a smart phone app. The system's sensor nodes are capable of collecting a variety of data (such as information on life-saving medications, body temperature, and line position, heart rate, and blood oxygen levels) and transmitting it wirelessly and energy-effectively to the gateway. We intend to incorporate a small, non-intrusive wireless sensor that is portable for seniors if future development goes as planned.

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CHAPTER 25

DATA TRANSMISSION BETWEEN VEHICLE TO VEHICLE COMMUNICATIONS USING VISIBLE LIGHT TECHNOLOGY FOR INTELLIGENT TRANSPORT SYSTEM

C.Sathish Kumar* & S.Nithya
Department of Electronics and Communication Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

R. Ragul Kannan & M.Rekha
Department of Biomedical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

This Essay discusses the most recent technology, known as LI-FI, which has seen significant growth over the years. With the use of transmitter and receiver circuits and LED bulbs, two vehicles can communicate using the LI-FI idea. This technology makes it possible to control traffic accidents and save a great number of lives. The two cars only communicate when they come into touch within a certain range, which is desired for the ultrasonic detector, which is a real-life chip device used to assess distance. Data are exchanged from one vehicle to another via tis LI-FI Any type of data can be transferred with LI-FI

Keywords: *Li-Fi(light fidelity),LED (Light Emitting Diode), LDR sensor(Light Dependent Resistor), VLC (Visible Light Communication)*

Introduction

Almost 5 billion mobile phones are connected to approximately 1.4 million cell, poll radio waves base stations. On a regular basis and regularly. Cell phones send more than 600TB of data. Nowadays, radio waves are used form remote correspondence. Yet there are limitations, accessibility, and security and efficiency issues with radio waves. For remote correspondence, range is a crucial need. With advances in technology and an increase in the number of customers, the problem is addressed by the current radio wave range, which leads to came up with the idea of transmitting information remotely through the light using LEDs or LI-FI. LI-FI is a relatively new invention that makes use of LED lights to speed up the transmission of information technology.

Another technique for remote correspondence that makes use of observable light is obvious light correspondence (VLC). Clear light LEDsare frequently used as

transmitters for visible light communication, and photodiodes and image sensors are frequently used as recipients. India is highly popular country with significant traffic problems, thus there is always problem with human traffic management if any emergency vehicle appears along a particular, in effective route. The suggested system proposes to use LI-FI for data transmission between two vehicles via led lights, which reduces traffic accidents and encourages safe driving.

Methods and Materials

Wherever a smart traffic transportation system is required, the proposed technology can be used. It is made up of two parts: the transmitter and the receiver. Data transmission from vehicle to vehicle using visible LED light. As a result, the suggested system's installation costs and environmental impacts are minimal. Vehicle-to-vehicle communication has proven to be the most effective method for reducing the number of accidents reported on a daily basis.

LED light is used in Li-Fi technology for vehicle-to-vehicle data transmission. Because the protocols that are utilized in this technology are being phased out, Li-Fi technology is not overly complex. The goal of this system's design is for it to be extremely dependable, allowing any necessary data flow between the vehicle's transmitter and receiver.

Li-Fi Transmitter

Fig.1 Li – Fi Data Transmitter

In the Li-Fi transmitter, transmitter receives the information from the controller and it modulates the data to a light signal, and sends to the receiver section. The transmitter section modulates the input signal with the desired time period and broadcasts the data in the form of 1’s and 0 are using an LED bulb. These 1s and 0s are nothing more than the bulb's flashes. The transmitter section's input

specifications are power supply DC +12V, data UART (universal asynchronous receiver transmitter), and input (TTL). With an LED bulb are the 1s and 0s. These 1s and 0s are nothing more than the bulb's flashes.

Before the signal is transferred to the speakers, an amplifier makes a larger replica of the original signal using input from a source, such as a laptop, turntable, or CD player.

Li-Fi Receiver

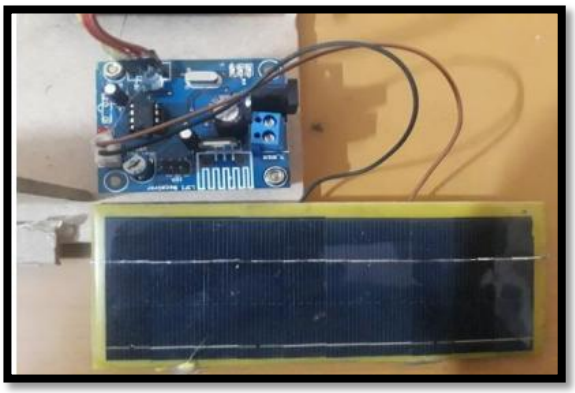

Fig.2 Li-Fi Data Receiver

The transmitter component sends the modulated data to the receiver section, which then demodulates the signal to restore the original data. In order to slow down the following vehicle, the receiver section uses a photodiode to detect these flashes. It then amplifies the signal and transmits it to the controller, where it is displayed on the LCD display. Bluetooth receiver takes the information that has been modulated from the transmitter portion and demodulates the signal to recover the original data. Using a photodiode, the receiver part captures these flashes amplifies the signal and outputs the result.

Results and Discussion

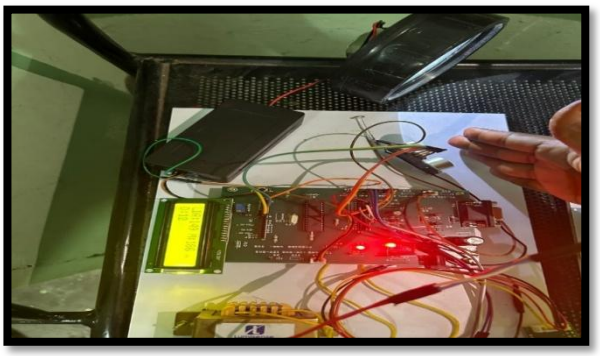

Fig.3 Transmitter Part

Here we have the Transmission between the kit with the signal of light for the communication purpose, and the communication is enabling for the data sharing without any direct connection between the vehicles, but the essential data's will be shared. Based on the distance between the vehicles the transmission speed will be calculated, and the different factors will be involved for the accuracy of data transmission like distance, path loss, weather, Speed, Angle, etc., The data transmission speed will be the range between 2 kb/s – 6 kb/s.

Consequently, the hardware is put together as illustrated in figure 4, with the microcontroller receiving a 12 volt power supply and the sensors portion receiving a 5 volt power supply. It transmits the desired data from one vehicle to another vehicle.

The most important thing in enabling the Communication is the way to encourage the intelligent Transport System in critical situations like heavy traffic, Narrow road maps, etc., if this communication keep in all the way in all the vehicles will lead to reduce the accidents in any type of hazards.

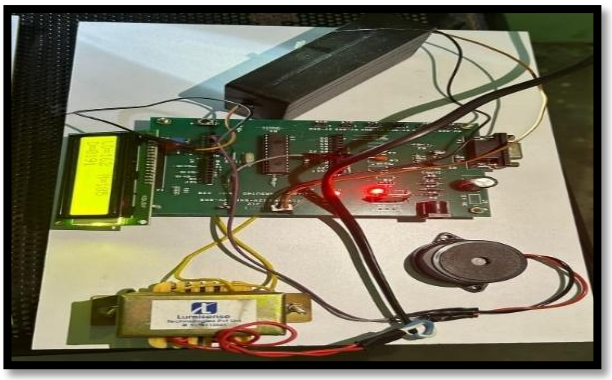

Fig.4Receiver Part

Conclusions

Our system's goal is to use light to connect automobiles to one another. Here, the Arduino transmitter is used to produce the light. The transmitter's light from the second vehicle is captured by the receiver. The recipient's output of light intensity determines the length of the vehicle. Measure the separation between side obstructions and the vehicle using the ultrasonic sensors. This kind of vehicle is very affordable and simple to maintain. The vehicle distance is precise, and the success rate is also high. We use light as a transmitting medium so it is non-radiative and environmentally benign. Despite the fact that this system uses Li-Fi technology and anticipates the front-end vehicle.

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CHAPTER 26

CROSS-LAYER DESIGN WITH MULTI-CARRIER CDMA IMPLEMENTATION

Shree K V M*
Department of Artificial Intelligence and Data Science
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

For effective video transmission via wireless networks, cross-layer design has become a trend. In this research, a cross-layer design strategy using MIMO (multiple-input multiple-output) antennas at the physical layer is given for multi-user scenarios. In Rayleigh fading channels, the effect of a multi-user system on bit error rate performance is shown. In a multi-user environment, the cross-layer adaptability between the physical, data link, and application layers functions well.

Keywords: *Multiple-input multiple-output (MIMO), Multi-carrier code-division multiple-access (MC-CDMA), Adaptive modulation coding(AMC).*

Introduction

Due to the intermittent nature of data flow and the unpredictable nature of the time-varying channel, streaming video via wireless networks is a difficult task. Multiple access approaches have been frequently used to give consumers access to the communication channel due to the constrained radio frequency capacity. Frequency Division Multiple Access (FDMA) was utilized by first-generation communication systems, while Time Division Multiple Access (TDMA) was also employed by second-generation systems.

A wide range of voice, data, and video services will be available to users of the upcoming generation of mobile communication systems. Applications for 3G systems range from utilizing a mobile videophone to watch movie previews and sports highlights to internet access and remote connections to corporate computer networks.

Beyond this, future generations of wireless systems will provide even higher data rates and greater flexibility. This will necessitate the use a transmission scheme which can accommodate very high data rate transmission over the hostile wireless channel.

Much research has been done on the use of wideband-CDMA for such systems. The main advantages of CDMA are well known, however, its capacity is limited by the other user's interference. In addition, CDMA systems are difficult to implement because they have a complex receiver structure and do not provide good spectral efficiency

The core of the presented work, which worked well in a Rayleigh scattering environment, is incorporating the benefits of MIMO to boost QoS. The cross-layer concept has now been expanded to include MC CDMA multi-user scenarios.

In order to meet the requirements of QoS capabilities for video transmission over wireless networks in a multi-user scenario, a cross-layer optimized framework has been presented in this chapter. This framework includes adaptation across application layer with other layers. The physical layer, data link layer, and application layer are all cooperatively optimized using the cross-layer design technique. The source coding at the application layer, MIMO transmit/receive diversity for multi-user using MC-CDMA, and ARQ at the data link layer are used in the transmission of video summaries.

System Model

In Figure 1, the system model is displayed. Physical layer, data link layer, and application layer make up this structure. Based on the CSI input, a system controller transmits optimization parameters. The video summary frames are kept in the buffer, as seen in Figure 1 on the transmitter side. In order to be transmitted at lower layers, the video summary frames are broken up into several packets. The ARQ performed at the data link layer retransmits the missed packets once more. The signal is transmitted from Nt antennas following the spreading process, and the reverse processes are carried out at the reception to obtain the original summary frames. The frames are kept in the buffer and the video clip if the fragmented packets are correctly received.

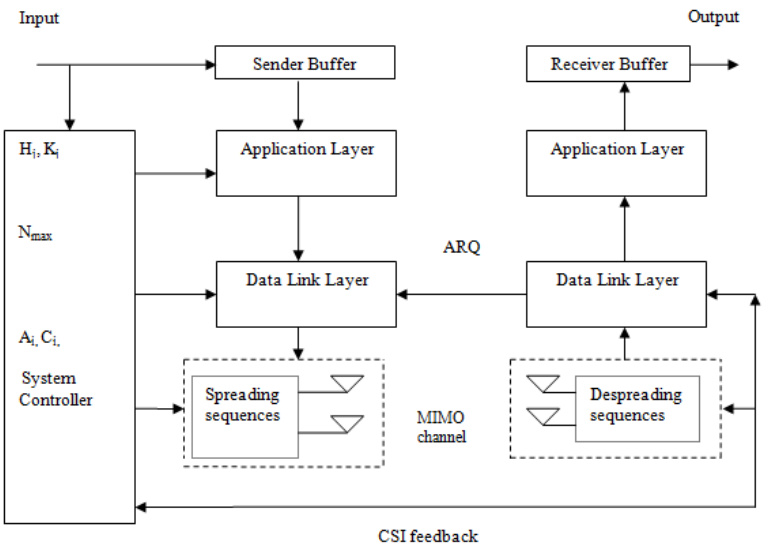

Figure 1. System Model

MC-CDMA Scheme

In the MC-CDMA system, each user's incoming bit stream is taken to be binary. This binary input stream is modified using binary phase shift keying (BPSK), which maps bits to symbols. The serial to parallel converter duplicates the symbols into N copies. Each copy that has been replicated is multiplied by the spreading sequence chip that corresponds to the specific user. Walsh Hadamard Code is the spreading sequence that is employed. When it comes to preserving the orthogonality between the sub-carriers, Walsh Hadamard Codes are ideal. On N distinct orthogonal sub-carrier frequencies, the N spread symbols are each modulated. In this, the IFFT block functions. To achieve multiple access, different users employ various code sets. In Figure 2, this is displayed.

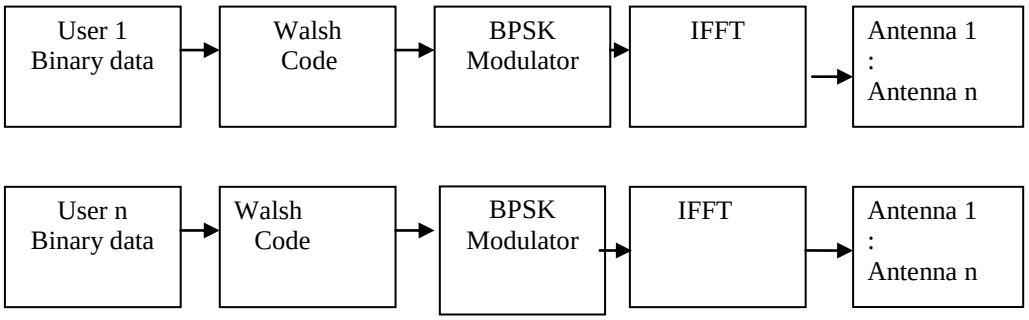

Figure 2 MC-CDMA simulation model of Transmitter

QoS Performance Analysis

The major goal is to account for packet loss and assess the video delivery quality using the anticipated end-to-end distortion. The comparison of a single-user system and a multi-user CDMA system forms the basis of the performance analysis.

MC-CDMA Bit Error Rate (BER) Analysis

The residue approach can be used to determine the bit error rate (BER) for the MC-CDMA system for binary phase-shift keying (BPSK) modulation with 'k' users.

$$\mathrm{BER_k}(\gamma) = \frac{(2c)^{N_c}}{[(N_c-1)!]^2}\sum_{k=0}^{N_c-1}\binom{N_c-1}{k}(N_c-1+k)!.(N_c-1+k)!(c+d)^{-(N_c-k)}(2d)^{-(N_c+k)} \quad (1)$$

where N_c denotes the number of subcarriers and the parameters 'c' and 'd' are defined by $\frac{1}{2c} = \frac{N_c}{4E_b/N_0} + \frac{k-1}{4}$,d= $\sqrt{c^2+2c}$.

The anticipated distortion and delay can be estimated by replacing the bit error rate $BER_k(\gamma)$ in terms of packet error rate and computing the average packet error rate. Consequently, the physical layer's typical delay can be calculated as

$$\overline{T} = \frac{1}{P_k} \sum_{k=1}^{K} \int_{\Gamma_k}^{\Gamma_{k+1}} \left(\frac{L_a}{R_k \cdot r} + T_{RTT} \right) P_{\Gamma}(\gamma) d\gamma \quad (2)$$

The delay constraint must meet the following criteria based on the maximum delay budget T_{MAX}, which is the predefined threshold value from $T_I + mT_F$:

$$T \leq T_{MAX} \quad (3)$$

Thus, it is possible to determine the actual expected distortion as

$$E[D] = \sum_{j=0}^{m-1} (1-P) d(f_m^j, \bar{f}_m^j) \quad (4)$$

The optimal solution as

$$S_\lambda = \min \{E[D] + \lambda T\} \quad (5)$$

The optimal solution 'S' becomes a function of 'λ' in the equation above. The ideal solution for delay constraint with least distortion summarization can be obtained by changing'λ' between zero and infinity.

Results and Analysis

This section compares the proposed solution for single user and multi-user scenarios using numerical results. A example test clip called "Glassgow" is used in the experiments, which are developed using H.264/AVCJM 10.2. The first 300 frames are condensed into 30 frames for ease of comparison. The quantization step sizes used to choose the video summary frames range from 10, 20, 30, 40, and 50. The transmitted bits for MC-CDMA simulation are set to 8, and the size of the Walsh codes is 2x2.There are 16 subcarriers, and BPSK is the modulation method.

Figure 3 displays the impacts of delay and distortion for a video summary with 30 frames for both a single user and a multi-user scenario. Figure 3 displays the plot of Equation (5). The charts are created by changing the "λ" values in Equation (5) from 0 to 10000. The parameters delay "T" and distortion profile "E [D]" are shown on the "x" and "y" axes, respectively. SNR is 10 dB on average, PL is 10-2, and Nmax is 3. The 'triangular' nodes relate to multi-user based on MC-CDMA, whereas the 'square' nodes display the distortion-delay pairings for a single user. It can be shown that as the number of users goes from 1.001% to 1.006%, there isn't much variance in distortion. Therefore, a 15% distortion gain is still attained utilizing.

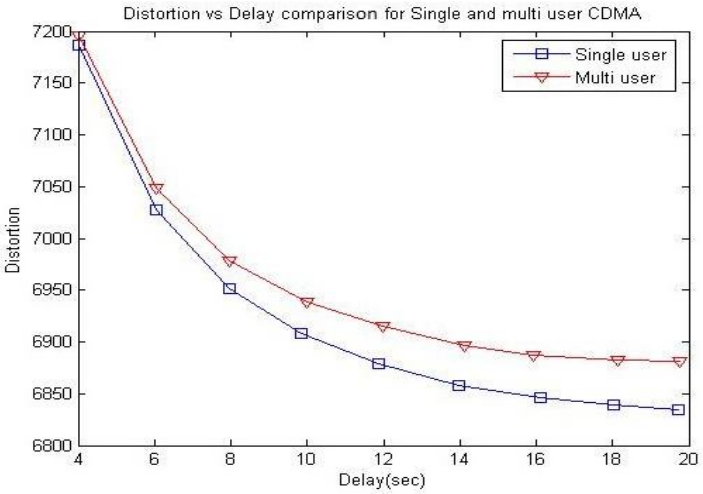

Figure 3. Distortion v_s Delay comparison for system model with single user and multi user CDMA

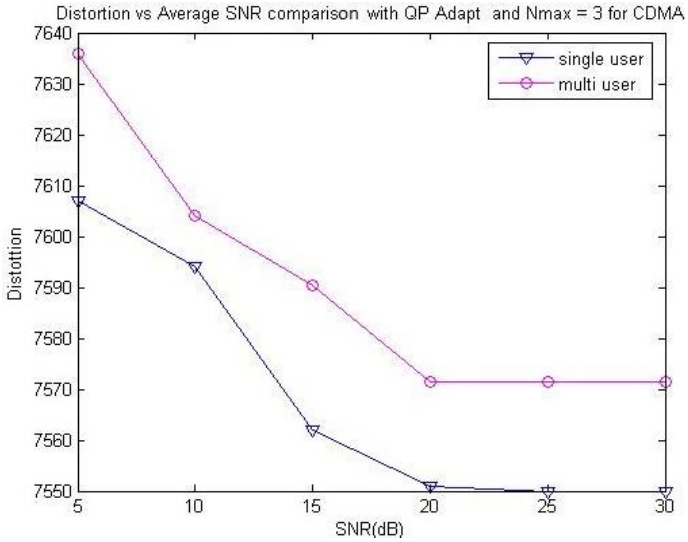

Figure4.Distortion vs.average SNR comparison for single user and multi user

Figure 4 compares distortion and SNR with QP adaptation, Nmax = 3, PL = 10, and L = 2. Equation (4) is used to plot the parameters distortion profile 'E [D]' on the 'y' axis and the average SNR '' on the 'x' axis. In the beginning, the distortion is lessened by raising the SNR values. Additionally, all SNR values have seen a consistent distortion level due to link adaptation work done by ARQ. The same conclusion can also be drawn if the size of the summary frames is greatly expanded.

Conclusion

When the cross-layer design is accomplished utilizing the coordination of MIMO combined with ARQ at the data link layer and source coding at the application layer, performance of MC-CDMA with MIMO is evaluated in this chapter in terms of average likelihood of bit error. To obtain the video summary with the least amount of delay and distortion, the optimization settings from all three layers are combined. The numerical findings demonstrate that the distortion profile of MIMO-diversity when used with MC-CDMA is lower than that of a single user.In a multi-user situation, the cross-layer system can still obtain a 15% distortion gain that is considerable. With a cross-layer optimization framework, the maximum transmission number has a significant impact on the quality of video transmission. The maximum number of transmissions allowed is higher with the same delay budget.

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NON- CIRCUIT ENGINEERING

CHAPTER 27

EXPERIMENTAL INVESTIGATIONS ON ELECTROCHEMICAL DISCHARGE MACHINING OF CERAMIC COMPOSITE

M.Vijay*, D.Katherrasan, G.Chandrasekar, P.Sundaresan & S.Balamurugan
Department of Robotics and Automation Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomus), Peramabalur

Abstract

The Zirconia-based ceramics are widely used in Automobile and Aerospace sectors because of their High-end mechanical properties such as improved hardness, durability, and strength characteristics. Many researches show that the machining of these composites is much harder than the traditional machining processes. Even though the machining was done but ended up with an unfinished surface finish, overcut, a high rate of tool wear, less material removal rate, huge time consumption, and damages. These difficulties become a great challenge to industrialists and researchers. The study is concerned with the machining performance of the ECDM while doing the machining of Zirconia composite by determining the multi-response parameters, the optimal combination of parameter levels. As response parameters, MRR and TWR were used. Experiments were carried out in accordance with the Box Bhenken Design. and response measurements were analysed. The outcomes showed that for simultaneously managing multiple response characteristics, applied voltage (V) is the most important governing input parameter, followed by Duty Cycle (%) and electrolyte concentration (wt%).

Keywords: *ECDM, MRR, TWR, RSM, Box Bhenken Design.*

Introduction

Electrochemical discharge machining is a revolutionary and extremely promising hybrid machining method that combines the concepts of electrical discharge machining (EDM) with electrochemical machining (ECM). In this method, material is removed through chemical etching and thermal spark erosion, followed by evaporation. The work material is removed as a result of the electrical discharge's intense thermal heating and melting of the substance. The chemical activity contributes to the achievement of the higher surface quality by causing further finer material removals. The combined effects of local Joule heating brought on by thermal heating are what cause the material loss in ECDM.[2-3] Howbeit, creation of microchannel in material like glass and ceramic through conventional techniques is a tedious task due to elevated material properties like high hardness

and brittleness [4] and therefore non-traditional machining methods are called for machining these glasses.

To produce micro-features in non-conductive materials such as pyrex glass, borosilicate glass, silica glass, silicon wafers, quartz, and ceramics, the electro chemical discharge machining (ECDM) process is currently emerging as a cost effective substitute for ultrasonic machining, laser ablation, and wet chemical etching [5]. Various process factors are explored in this study, and it is predicted that the electrolyte content reduces tool wear while boosting MRR. To obtain the highest material removal rate, the electrolyte concentration is increased to three levels in this study. [6] To optimize, they used various design of trials, such as the Taguchi design and the GA algorithm, in this work. In this study, we employed response surface methods to design experiments; [7] They employed ECDM to mill a glass workpiece using four parameters such as voltage, duty factor, electrolyte concentration, and temperature in this experiment. They employed response surface methods to construct trials, and they discovered that MRR increased with voltage and temperature. One of the critical machine configurations in this process is keeping the NaOH electrolyte stationary rather than in circulation. This experiment [8] demonstrates that a higher MRR is obtained when the electrolyte is in a stagnant position, thus we conducted the same [9] while milling.

Methods and Materials

Design of Experiments

To create a hole in the zirconia composite plate, the material is removed using the stainless steel tool. Electrolytes are preserved in a stagnant state in the stationary instrument. Three distinct characteristics, such as the applied voltage, duty cycle, and electrolytic concentration, have an influence on the material removal rate.

The Process Parameters

The process parameters ranges for the experiments are given below:

Electrode	Tungsten Carbide
Workpiece	Zirconia – Silicon Nitride Composite
Workpiece thickness	2 mm
Electrolyte	NaOH

Selection of Machining Parameters

To machine the hard to machine materials such as ceramics, the aforementioned process variables are tabulated in Table.1 and which were chosen based on trial study results.

Table:1 Parameters of machining

Name	Units	Low	High
Voltage	V	80	110
Electrolyte Concentration	% Wt	10	20
Duty Cycle	%	50	70

BoX-Bhenkan method is chosen as a Design of Experiment technique to carry the experimentation and the Table:1 show the corresponding details of it.

Material for Workpiece

Zirconia-silicon nitride composite is considered to be one of the hardest and most corrosive-resistant materials. The zirconia composite is a material with incredible features such as high resistance to indentation, high resistance to wear, excellent thermal stability, and improved chemical resistance, and it is also mentioned that these composite is strongly suggested to make wear-resistant coating. Furthermore, they discovered that MRR increases with increasing applied voltage and that overcut concerns were also highlighted [10]. The research's objective is to raise MRR while lowering TWR.

Electrochemical Discharge Machining (ECDM) Process

In their experimental study, they employed the ultrasonic machining [11] method and discovered that increased voltage contributes to tool wear [12] and the abrasive sludge creates destruction of the surface area. In this activity, the ECDM is employed to safeguard against un even machining caused by an abrasive sludge. Figure 1 represents the experimental layout for the ECDM.

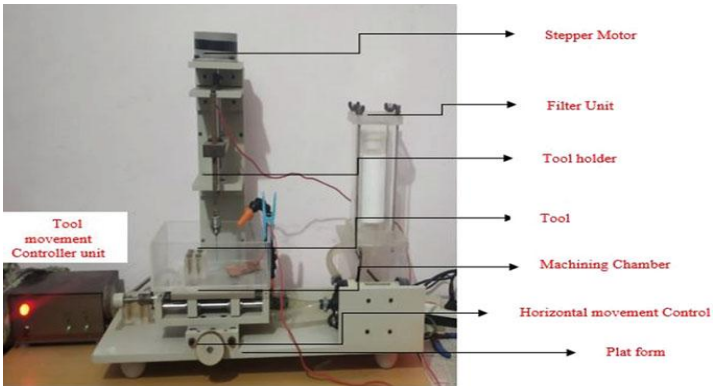

Figure 1: Machining setup

The workpiece is placed in the process chamber, which is previously filled with NaOH till it covers over the workpiece surface. A tool holder is attached to the stainless steel tool. The work table is moved in the X and Y directions using a hand wheel to machine the material.

Results and Discussion

The workpiece material is kept into the machining chamber as seen in Figure 2. The workpiece are placed just below the electrolyte level and where the spark is created. Electrification Discharge will release when the machining process starts, the electrolyte around the tool debases as a result of the reaction, creating gas bubbles. The bubbles then release the pressure energy and spark has created beyond the critical voltage, which leads to the material removal. Due to the spark, the electrode wears out and becomes contaminated. As a result, a brand-new electrode and brand-new electrolytic concentration solution are utilised for every experiment.

The MRR and TWR for the machining of zirconia composites are displayed in Table.2. To determine the rate of material removal and rate of tool wear, the workpiece and tool were inspected both before and after machining.

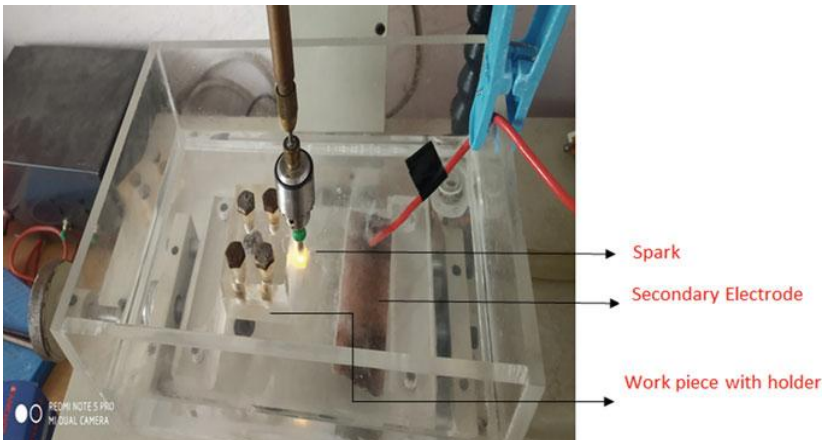

Figure 2: Machining of Workpiece

Observations During Experimentation

Time duration	30 min, (Each Cycle)
Tool	Tungsten Carbide
Tool diameter	1 mm

Regression equations obtained for the material removal rate and tool wear rate is given below in equation 1 & 2.

Table:2 Machining Performance

Run	VOLTAGE	EC	DUTY CYCLE	MRR	TWR
	V	%WT	%	µg/min	µg/min
1	90	15	60	334	571
2	100	10	60	335	286
3	90	15	60	325	474
4	80	20	60	211	529
5	90	10	70	241	319
6	100	15	70	370	592
7	90	20	50	353	551
8	90	15	60	330	476
9	80	10	60	211	283
10	90	15	60	357	495
11	90	15	60	334	441
12	80	15	70	210	569
13	90	20	70	259	547
14	100	20	60	370	617
15	80	15	50	210	579
16	100	15	50	355	603
17	90	10	50	219	293

Regression equations obtained for the MRR and TWR is given below. This equation helps to optimize the output parameters concerning input parameters.

$$MRR = +336.00 +73.50A+23.38B -7.12C+8.75AB+3.75AC-29.00BC-18.00A^2-36.25B^2 -31.75C^2 \quad (1)$$

$$TWR =+491.40+17.25A+132.88B+0.1250C+21.25AB-0.2500AC-7.50BC+47.80A^2-110.45 B^2+46.55C^2 \quad (2)$$

where A is voltage, B is electrolyte concentration, and C is duty cycle. Table 2 shows the result of the MRR & TWR of zirconia composite in µg/min. These table has proven that the zirconia composite can machined by ECDM process.

Conclusion

With the help of ECDM process, non-conductive materials including glass, ceramics, polymers, etc. can be machined effectively. These findings are derived from experimental research using zirconia composite machining:

1. The ECDM technology makes it feasible to efficiently machine electrically inert materials including glass, ceramic and polymer, etc.

2. The MRR and TWR of zirconia composite are greatly impacted by voltage in this followed by duty cycle study.
3. Voltage is the most influencing factor in the MRR, followed by electrolyte concentration and duty cycle.
4. Voltage plays a major role then followed by duty cycle and electrolyte concentration in the TWR.
5. Optimized MRR and TWR are found at electrolyte concentration is 10% wt., the applied voltage is 100 V, and the duty cycle is 60%.
6. Future research may be done to determine the overcut and roughness of the machined region.
7. In future the machining characteristics can be optimized with advanced machine learning and optimization methods.

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CHAPTER 28

THERMAL BARRIER COATING

S. Rajkumar*, K.Sathiyalingam, A. Mohamed Hamdan & D. Madhesh
Department of Aeronautical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur

Abstract

Thermal Barrier Coating (TBC) is a high-temperature surface engineering technology that improves the efficiency and sustainability of materials exposed to extreme thermal conditions.The coating works as an insulating barrier that separates the hot gas flow and the substrate, protecting it from thermal deterioration. TBC is often composed of many layers, comprising a bond coat and a ceramic topcoat.The bond coat promotes adequate adhesion between the substrate and the ceramic layer and prevent from corrosions, while the ceramic topcoat provides excellent thermal insulation.TBC research has the potential to revolutionize a variety of industries by enabling more dependable and long-term operation under harsh heat extremes.

Introduction

A variety of technical components exposed to high-temperature conditions benefit greatly from the performance and durability improvements provided by thermal barrier coatings (TBCs). In order to reduce heat transmission and safeguard underlying substrates from thermal deterioration, these coatings are made to provide thermal insulation. We shall examine the idea, components, application methods, and deposition processes of heat barrier coatings in this chapter.

Understanding Thermal Barrier Coatings

The multilayers of a thermal barrier coating are a metallic substrate, a bond coat, and a ceramic topcoat. TBCs' main job is to build a thermal barrier between the hot gas environment and the substrate, which lowers heat conduction and enhances thermal efficiency. TBCs offer higher power outputs and improved fuel efficiency by reducing the working temperatures of components like gas turbines, aircraft engines and industrial boilers.

Historical Background and Development of TBCs

The creation of thermal barrier coatings (TBCs) dates back to the early investigation of ceramic materials for high-temperature applications. TBCs have been around since the early 20th century, when researchers first started looking into how to employ ceramics for high-temperature applications. Alumina, magnesia, and zirconia were among the ceramic oxides that researchers looked into as prospective materials for use in thermal barrier applications. Significant advancements were made in the 1960s with the discovery of yttria-stabilized zirconia (YSZ). This substance demonstrated exceptional thermal insulating capabilities and high-temperature stability, which made it the perfect option for TBCs.

Researchers discovered in the 1970s that interdiffusion between the coating and substrate as well as the mismatch in thermal expansion coefficients made direct deposition of ceramic coatings onto metallic substrates difficult. The idea of bond coat systems was suggested to address these problems. The substrate was coated with a metallic bond coat, commonly made of nickel-aluminide (NiAl) or MCrAlY alloys (where M stands for nickel, cobalt, and iron). In order to provide strong adherence between the ceramic topcoat and the substrate, this bond coat worked as both an adhesive and a diffusion barrier.

Materials for Thermal Barrier Coatings

Ceramic Topcoats

The TBC system's ceramic topcoat, which is its outermost layer, offers the main thermal insulation. Partially stabilised zirconia (PSZ) or yttria-stabilized zirconia (YSZ) are frequently used as the topcoat. Due to low thermal conductivity and high thermal expansion coefficients, these materials can withstand thermal loads and control the propagation of cracks.

Yttria-Stabilized Zirconia (YSZ)

The ceramic component used in TBCs most frequently is yttria-stabilized zirconia (YSZ). Because of its high melting point and low thermal conductivity, it has good thermal barrier qualities. When YSZ cools, it goes through a phase transition from a tetragonal to a monoclinic crystal structure, adding compressive stresses and improving strain tolerance. The tetragonal phase is stabilized by the addition of yttria, which also ensures long-term stability at high temperatures and

stops the harmful phase transformation. Gas turbines, aeronautical applications, and industrial machinery all frequently use YSZ coatings.

Alumina (Al_2O_3)

Another ceramic substance utilized in TBCs is alumina, particularly in specialized applications. It has exceptional mechanical strength, chemical resistance, and thermal stability. When less thermal insulation is needed, alumina coatings can be used, but it's crucial to protect against high temperatures and corrosion. TBCs made of alumina are used in a variety of fields, including chemical processing, furnace linings, and some specialized engine parts.

Other Ceramic Materials

While the main ceramic components utilized in TBCs are YSZ, rare-earth-doped zirconia, and alumina, other ceramics have also been researched for particular uses. Several instances include:

- Gadolinium zirconate (Gd2Zr2O7): This ceramic material has outstanding phase stability and low thermal conductivity. For usage in advanced TBC systems, particularly in high-temperature settings, Gd2Zr2O7 coatings are being researched.
- Lanthanum zirconate (La2Zr2O7): La2Zr2O7 is thermally stable and has a low thermal conductivity. In some applications, it has showed promise as a potential alternative for YSZ because it offers better thermal barrier performance and endurance.
- Ceria (CeO^2): Due to their good chemical compatibility, high-temperature stability, and low thermal conductivity, ceria-based coatings have gained popularity. These coatings are being investigated for use in TBC applications in harsh environments, including as advanced power generation and aerospace propulsion systems.

Bond Coats

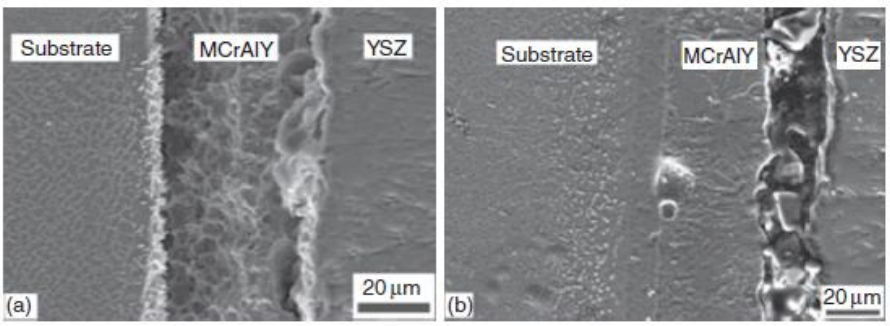
The bond coat is a layer in between the ceramic topcoat and the metallic substrate that acts as an adhesive. The material used to make it is typically oxidation-resistant, such as nickel-aluminum (NiAl) or MCrAlY (where M stands for a metal alloy made up of nickel, cobalt, and iron). The bond coat offers oxidation protection for the substrate and a sufficient surface for the ceramic topcoat's deposition.

Nickel-Aluminide (NiAl) Alloys

In TBC systems, nickel-aluminide (NiAl) alloys are frequently utilized as bond coatings. These intermetallic alloys, in particular the -NiAl phase, have strong adhesion to the substrate, good thermal expansion compatibility with ceramic coatings, and great oxidation resistance. When exposed to high temperatures, NiAl bond coatings produce a protective oxide layer that acts as a diffusion barrier to stop components from diffusing between the substrate and the ceramic layer. NiAl bond coatings are frequently utilized in industrial machinery, gas turbine engines, and aerospace applications.

MCrAlY Alloys (M: Nickel, Cobalt, Iron)

In TBC systems, bond coatings made of MCrAlY alloys—where M stands for nickel, cobalt, or iron—are also widely utilized. These alloys are intended to offer increased substrate adhesion, oxidation resistance, and thermal compatibility. When exposed to high temperatures, MCrAlY bond coatings develop a protective oxide scale that provides outstanding corrosion and oxidation resistance. The selection of the MCrAlY alloy composition relies on the requirements of the particular application, taking into account elements like the substrate material, temperature, and environmental conditions.



1.6 SEM cross-sectional micrographs of two-layered TBCs: (a) after thermal cycle testing at 1373 K for 30 h; (b) after thermal cycle testing at 1373 K for 300 h.

Figure 2.1: SEM cross-section of coating [11]

Other Metallic Materials

While the main metallic materials utilized as bond coatings in TBCs are NiAl, MCrAlY, and PtAl alloys, other possibilities have been investigated for particular applications. Several instances include:

- Platinum group metal (PGM) alloys: Due to their high-temperature stability, oxidation resistance, and adhesion to ceramic coatings, PGM alloys including rhodium (Rh) and palladium (Pd) alloys have showed promise for bond coat applications. These alloys are being researched for possible application in cutting-edge TBC systems.
- Other intermetallic alloys: Several intermetallic alloys have been investigated for bond coat applications, including iron-aluminides (FeAl), cobalt-aluminides (CoAl), and titanium-aluminides (TiAl). The features of these alloys, which include high-temperature stability, oxidation resistance, and adhesion to ceramic coatings, are combined in unusual ways.

Properties and Selection Criteria for Thermal Barrier Coating (TBC) Materials

The performance and durability of thermal barrier coatings (TBCs) depend on the properties and characteristics of the materials used.

Thermal Conductivity

Low thermal conductivity is one of the main requirements for TBC materials. TBCs are made to offer thermal insulation, which lessens the amount of heat that is transferred to the substrate underneath. Ceramic materials have low heat conductivity because of their ingrained crystal structure and microstructural characteristics, such as yttria-stabilized zirconia (YSZ). Improved thermal barrier performance is made possible by the TBC's higher insulating characteristics, which increase with decreasing heat conductivity.

Thermal Expansion Coefficient

Another essential characteristic for TBC materials is the thermal expansion coefficient. Thermal expansion and contraction occur as a result of the substantial temperature changes that TBCs experience when operating. Thermal stresses can be created by an imbalance in the thermal expansion coefficients between the TBC and the substrate, which could lead to coating breakdown. TBC materials should have a thermal expansion coefficient that closely resembles that of the substrate material in order to reduce these stresses. The thermal expansion coefficient of YSZ and other stabilizing oxides is intended to be comparable to that of typical substrate materials like nickel-based superalloys.

Phase Stability

For TBC materials, phase stability is crucial, especially at high temperatures. Changes in temperature and the environment can cause phase transitions in

ceramic materials like YSZ. Microcracks, spallation, and a reduction in the effectiveness of the thermal barrier can all result from uncontrolled phase changes. TBC materials are frequently doped or stabilised with additives (such as yttria) to maintain a stable phase, such as the tetragonal phase in the case of YSZ, to ensure long-term stability.

Mechanical Properties

For TBC materials, mechanical characteristics including strength, toughness, and strain tolerance are essential. During temperature cycling, vibration, and mechanical stresses while in use, TBCs are subjected to mechanical loading. For the TBC materials to sustain these mechanical loads without crack initiation or propagation, they must be sufficiently strong and tough. In order to account for the thermal expansion and contraction mismatch between the TBC and the substrate, a certain degree of strain tolerance is also desired.

Oxidation and Corrosion Resistance

TBC materials need to be extremely resistant to oxidation and corrosion in order to sustain challenging operating conditions. The performance of the TBC could be harmed by the development of oxides as a result of high-temperature oxidation. In situations where TBCs are exposed to hostile gases, chemicals, or moisture, corrosion resistance is especially crucial. To avoid oxidation and corrosion, TBC materials should have a protective oxide scale that is stable at high temperatures.

Adhesion and Bonding

For the coating system to function properly, there must be adhesion between the TBC and the bond coat as well as between the TBC and the substrate. The TBC's integrity and longevity are ensured by strong adhesion, which prevents spallation or delamination. To survive heat cycling, mechanical loads, and environmental exposure, TBC materials should have high bonding properties with the bond coat and the substrate.

Selection Criteria for TBC Materials

The particular needs of the application, the operating environment, and the substrate material all have a role in the selection of TBC materials. Important factors when selecting materials include:

- Compatibility with the substrate material in terms of thermal expansion coefficient and chemical interactions.

- High thermal insulation capability achieved through low thermal conductivity.
- Sufficient phase stability at operating temperatures to avoid phase transformations and microstructural degradation.
- Good mechanical properties, such as strength, toughness, and strain tolerance, to withstand thermal cycling and mechanical

Deposition Techniques for Thermal Barrier Coatings

The generation of high-quality thermal barrier coatings (TBCs) depends heavily on deposition processes.

Air Plasma Spraying (APS)

One of the most popular methods for depositing TBCs is air plasma spraying (APS). In APS, a plasma jet is produced by employing a high-frequency arc to ionize a gas, commonly argon. The plasma jet propels the molten ceramic particles onto the substrate, creating a coating. High deposition speeds, coating thickness flexibility, and the capacity to handle a variety of ceramic materials are just a few benefits provided by APS. In contrast to coatings created using conventional deposition methods, APS coatings might have relatively high porosity and reduced strain tolerance.

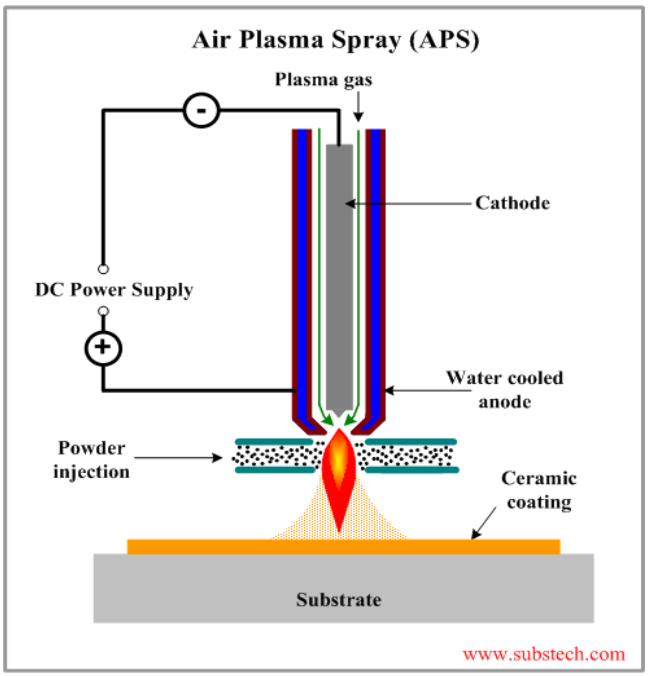


Figure 4.1:Air Plasma Spraying[13]

Electron Beam-Physical Vapor Deposition (EB-PVD)

The deposition method known as electron beam-physical vapour deposition (EB-PVD) is renowned for its capacity to create columnar microstructures with greater strain tolerance. In EB-PVD, ceramic material is evaporated from a source using an electron beam before being deposited as a vapour onto the substrate. Columnar grains are formed as the vapour condenses, creating a highly orientated, partly melted TBC. Low heat conductivity, superior strain tolerance, and spallation resistance are just a few benefits of EB-PVD coatings. They are often employed in aeronautical and gas turbine applications.

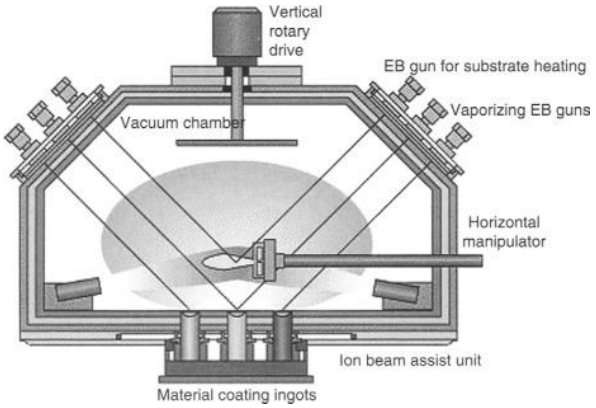


Figure 4.2:EB-PVD by Sciaky, Inc., for the Pennsylvania State University.

High-Velocity Oxygen Fuel (HVOF) Spraying

High-velocity oxygen fuel (HVOF) spraying is a thermal spray technology that creates high-velocity particles for coating deposition through a combustion process. In HVOF, oxygen is combined with a fuel gas (usually a hydrocarbon) and fired in a combustion chamber. As a result, a dense and adherent TBC is formed on the substrate by a high-pressure, high-velocity gas flow. Low porosity, strong bonds, and great corrosion resistance are all characteristics of HVOF coatings. This method is commonly used in commercial fields including aerospace and power generation.

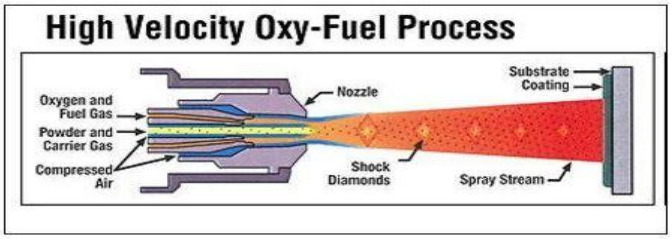


Figure 4.3: HVOF[14]

Solution Precursor Plasma Spray (SPPS)

The benefits of plasma spraying and solution precursor chemistry are combined in the relatively recent deposition process known as solution precursor plasma spray (SPPS). In SPPS, a plasma jet is injected with atomized precursor solution containing metal or ceramic precursors. The solvent is quickly vaporized by the plasma heat, leaving a molten precursor material behind that solidifies after deposition. High-quality, low-porous coatings with customized microstructures and composition control are possible with SPPS. Advanced TBC applications, such as the deposition of new compositions and multilayered coatings, have showed promise for this method.

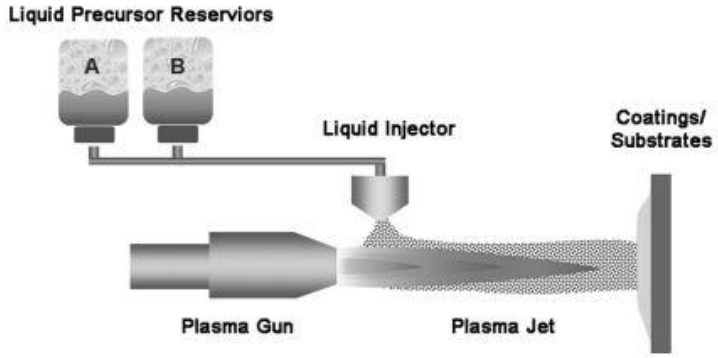


Figure 4.4: Solution Precursor Plasma Spray[12]

Physical Vapor Deposition (PVD)

TBCs have been deposited using physical vapor deposition (PVD) methods such sputtering and evaporation. In PVD, a target source of ceramic material is evaporated or sputtered, creating a vapor that condenses onto the substrate to produce a thin-film coating. The exact control over composition, microstructure, and thickness that PVD coatings provide is one of its benefits. Low porosity, high density, and strong adhesion are characteristics of these coatings. For specialized applications like electrical devices and thin-film coatings, PVD methods are frequently utilized.

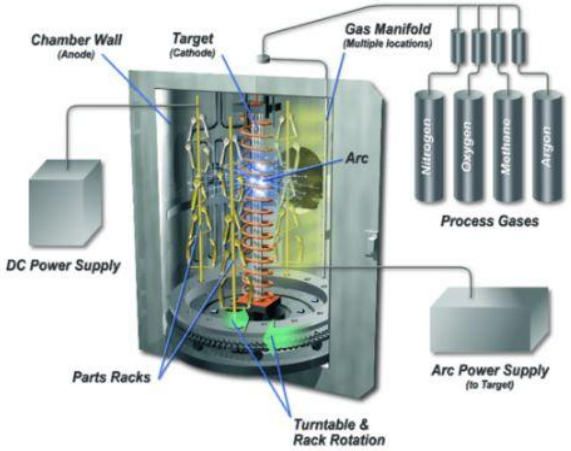


Figure 4.5: Physical Vapor Deposition[14]

Laser-Assisted Techniques

For TBC applications, laser-assisted deposition methods including as laser cladding and laser beam deposition have been researched. These processes include melting ceramic powder or wire using a laser beam, which is subsequently applied to the substrate surface. Localized deposition, a smaller heat-affected zone, and better control over microstructure and composition are just a few benefits of laser-assisted procedures. In industrial contexts, these approaches are being investigated for TBC repair and refurbishing.

Conclusion

Due to continuous research and development in improved materials, coating topologies, deposition processes, and environmental protection, the future of thermal barrier coatings (TBCs) is quite promising. The main areas of attention for future TBC developments are enhanced ceramic materials, multilayered and graded coatings, functionally graded materials, nanocomposite coatings, environmental barrier coatings, and advanced deposition processes. These developments are meant to improve TBC performance, increase strain tolerance, decrease thermal conductivity, improve thermal insulation, and prolong service life. These cutting-edge technologies will open the door for greater effectiveness, dependability, and longevity in high-temperature applications across several sectors as they continue to develop.

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CHAPTER 29

EXPERIMENTAL STUDY OF BAGASSE ASH INFUSED CEMENT AND GROUND GRANULATED BLAST FURNACE SLAG CONCRETE

R. Balaji & R. Jeevika*
Department of Civil Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

Concrete's basic components are cement, fine aggregate, coarse aggregate, and water. Concrete is the primary component of modern building. As infrastructure has evolved, concrete has assumed an increasingly significant role. Concrete is used extensively during the construction of infrastructure, including as buildings, industrial structures, bridges, and highways. Researchers are investigating potential new concrete ingredient substitutes in response to this requirement. It has been proven that substituting different mineral admixtures for cement increases concrete's strength and durability. Concrete admixtures are materials that are mixed with freshly-poured or already-hardened concrete to enhance particular properties like workability, durability, or early and final strength. Chemical admixtures reduce construction costs, change the characteristics of hardened concrete, and maintain the quality of concrete throughout mixing, transportation.

Keywords: *Cement, fine aggregate, coarse aggregate,bagasse ash and crushed granulated blast furnace slag.*

Introduction

Putting concrete, curing it, and handling a number of emergencies that could occur when working with concrete. Mineral admixtures increase concrete's strength, lower permeability, and other properties while also enhancing combination economics. Mineral admixtures alter the properties of the hardened concrete through hydraulic or pozzolanic activity. This study investigates the strength and physical properties of concrete mixes of M20 grade as well as how they respond to the addition of mineral admixtures such as sugar cane bagasse ash and crushed granulated blast furnace slag in place of some of the cement.

Ground Granulated Blast Furnaceand Quarry Sand

Granulated blast furnace is a byproduct of the blast furnace. The iron and steel industry in India frequently leaks slag into the environment. The two primary substances that make up slag are lime (OCa) and silica (SiO2). Portland cement also

contains these components. The primary component of slag is soluble in water and has an alkalinity similar to cement or concrete. If the steel industry grows, it will surely be difficult to dispose of this material as waste without posing significant environmental problems. GGBS hardens rather slowly on its own and must be activated by mixing it with Portland cement. However, concrete uses anything from 20 to 80% of GGBS. There are more GGBS the more the qualities made of concrete will require work [1–5].

Due to a number of environmental issues, hauling sand from rivers has been made illegal by the government. Natural sand is currently in short supply and hence substantially more expensive. The only long-term replacement for sand is quarry sand.

Objectives

- To identify the GGBS-based concrete mix that is the best optimised.
- To enhance the concrete's strength properties by replacing some of the cement with GGBS.
- To evaluate the differences in concrete workability between the use of GGBS and bagasse ash as a cement substitute.
- To examine concrete's structural behaviour as new materials are added or removed.
- To research concrete's new-concrete characteristics.
- To use GGBS to boost the compressive strength of pavement.

Properties of Materials

Particle size, specific gravity, and other physical and chemical characteristics all affect a material's qualities. In the event that two or more types of a material are available, it is also necessary to determine the compatibility and performance in their presence.

Before casting the specimen, the materials that would be utilized to make the concrete for this investigation were examined. Before casting the specimen, the initial tests for the concrete employed in this investigation were put to the test. The aforementioned materials were subjected to preliminary testing. Cement, Fine gravel, Coarse filler, Bagasse ash, GGBS, or ground granulated blast furnace slag, Water.

Cement

In this experiment, regular Portland cement of grade 53 is used. Cement is one of the most important components of concrete. Ordinary Portland Cement, grade 53, was utilized in this job. Tests for cement were undertaken, including those for fineness, consistency, setting time, soundness, the heat of hydration, tensile strength, and chemical composition, to examine the cement's properties in line with IS criteria. Various characterstics of cement are Specific gravity of cement is**3.1**Normal consistency of cement**29%**Initial setting time of cementis **30 minutes**Final setting time of cement is **10 hr.**

Fine Aggregate Test result value[15]

Specific gravity of sand =2.820

Cumulative percentage of retained = 4.23

Coarse Aggregate Test result value

Water absorption = 0.200

Aggregate impact value = 17.9%

Specific gravity of Aggregate G = 2.59

Cumulative percentage of retained =3.85

Bagasse Ash

Fig 1- Bagasse

Ash from bagasse, a waste product of the sugar industry. It is a material that comes in powder form and is comparable to fly ash, although the two materials' particle shapes are different.Due to the burning process and the existence of unburned carbonparticles, it is often black in colour. Comparatively speaking, ground bagasse ash has a low specific gravity of 2.31 to 2.68. It has a density range of 1.85 to 2.65 g/cm3. The specific gravity of bagasse ash decreases with an increase in LOI value. Bagasse ash is made up of erratic, abrasive particles. Bagasse ash particle size and surface roughness both rise with an increase in LOI value (Klathae et al., 2020). Bagasse ash had a similar particle size distribution to regular portland cement. Bagasse ash has a particle size range of 0 to 100 mm.

Chemical composition of bagasse ash and their percentages are listed below

1. Sio_2(silicon dioxide)percentage in bagasse ash**55.76**
2. Fe_2o_3 (ferric oxide) percentage in bagasse ash **0.72**
3. Al_2o_3 (aluminium oxide) percentage in bagasse ash**1.76**
4. Cao (calcium oxide) percentage in bagasse ash**1.68**
5. Mgo (magnesium oxide) percentage in bagasse ash**2.02**

Specific Gravity Test for Bagasse Ash

Specific gravity G =2.18

Sieve Analysis Test for Bagasse Ash

The portion of the ash that passes the 1.18 mm dia.

Ground Granulated Blast Furnace Slag (GGBS):

Setting timeWith GGBS =30 minutes

Specific gravity of GGBS = 2.84

Normal consistency of GGBS = 34%

Table 3: Chemical composition for GGBS

Chemical Constituent	Cement	GGBS
CaO	65%	40%
SiO_2	20%	35%
Al_2O_3	5%	10%
MgO	2%	8%

Fig 3

Fig 4

Water

Water is an essential component of concrete since it actively contributes to the chemical reaction with cement. The water cement ratio is 0.49. The amount of water

in the concrete affects a variety of charcteristics, including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage, and cracking potential.

Experimental Work

The major experimental study for this work was to compare the strength characteristics of GGBS and Bagasse ash in ordinary concrete mixers. Number of 36 concrete mould (cubes) of size (15cmX15cmX15cm) are tested, with 9 moulds casted for conventional concrete and 27 mouldsprepared for GGBS and Bagasse of various percentages.[13]

The partial replacement in concrete was determined using the optimal value study results. Cubes will be used for the Compressive test. Bagsse in the form of ash is a material that might be used in place of cement. The study's findings indicate that amorphous silica-rich materials can be utilized in place of cement in some applications. The use of such a material can boost compressive and flexural strengths.

Fig 5

Fig 6

Fig 7

Table 4: Mix design calculation

Constituents	Quantity kg	Mix proportion
Cement	5.36	
Coarse aggregate	16.08	1:1.5:3
Fine aggregate	8.04	
Water	3 Lit	

Table 5: Material admixtures

OPC	(GGBS)	BAGASSE ASH
100%	0%	0%
92%	4%	4%
84%	8%	8%
76%	12%	12%

Slump Cone Test

The concrete slump measurement establishes how fluid new concrete is before curing. It is used to evaluate the ease at which freshly mixed concrete flows and the workability of the concrete. It can be used to find a batch that was not properly mixed. The popularity of the test is a result of how simple the device and protocol are to use. In the field, the slump test is used to verify consistency among different concrete loads.

Table 6: Slump cone test result of concrete

S.No	Sample	Test result(mm)	Workability
1	Nominal mix	86	Medium workability
2	4% GGBS+ 4% Bagasse	80	Medium workability
3	8% GGBS+ 8% Bagasse	85	Medium workability
4	12% GGBS+ 12% Bagasse	87	Medium workability

Fig 8

Curing

Curing is a way of maintaining concrete at the optimum temperature and moisture content for an extended period of time in order for hydration to end up in the desired concrete qualities. Bentonite must be properly cured before it can to reach its maximum strength and durability. Concrete cure times range from seven to twenty-one days.[13]

Result and Discussions

Compressive Strength of Concrete

According to IS: 0516 (1959) recommendations. Cube dimensions are 150 mm X 150 mm X 150 mm (4 no.) in each of the concrete cubes casted with varied percentages of cocktail fibre.

The samples are collected after 7 days, 14 days, and 28 days of being stored outside and cleaned of surface wetness. The Compression testing machine was used to compress four samples from each concrete. The average strength of the cubes is presented as a consequence.

Fig 10

Table7:Compressive strength test result

%Replacement of cement	0%	8%	16%	24%
7 days	16.24	16.64	17.26	17.38
14 days	19.68	20.21	20.84	21.01
28 days	26.64	27.36	28.08	28.36

Split Tensile Strength Test

1. The "Brazilian Test" is another name for this assessment, which was created in Brazil in 1943. Indirect tension test methods include this.To conduct the test, a cylindrical specimen was placed horizontally between the loading faces of a compression testing machine. A load was applied along the vertical diameter of the cylinder until failure.

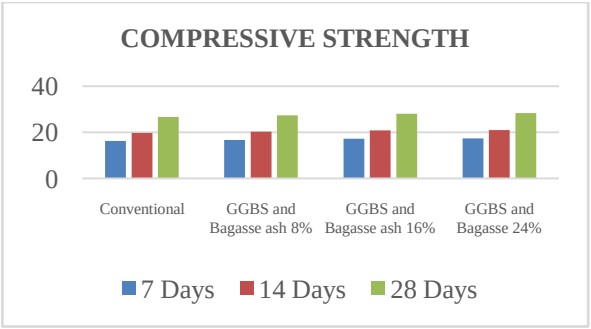

Fig 11- Compressive strength (N/mm²)

2. A compressive force was applied along two opposing edges of a concrete cylinder with dimensions of 150 mm in diameter and 300 mm in height.

3. The cylinder underwent consistent tensile stress over its entire length and compression near the loaded region.

2P/DL horizontal tensile stresswhere P is the cylinder's compressive load, L is the cylinder's length, and D is the cylinder's diameter. At this momentFollowing an examination, the split tensile strength test was performed on M20 grade concrete using various ratio samples at 7, 14, and 28 days. The force must be distributed evenly throughout the two loading rollers, and each of the rollers must be positioned so that the stress is applied linearly and without imposing any torsion stresses or limitations on the specimen. The load will be given to two identical rollers located at the third positions of the bearing span and separated at 20 or 13.3 cm center to center. The weight must be shared equally by the two loading rollers, and all rollers must remain positioned in this manner for an entire month.Modifications in split elasticity values at 7, 14, and 28 days of age.

Table 8:Split tensile strength testresult

MIX		28 Days
M_0	Nominal Mix	2.69
M_1	4% GGBS+ 4% Bagasse	2.85
M_2	8% GGBS+ 8% Bagasse	3.05
M_3	12% GGBS+ 12%Bagasse	3.16

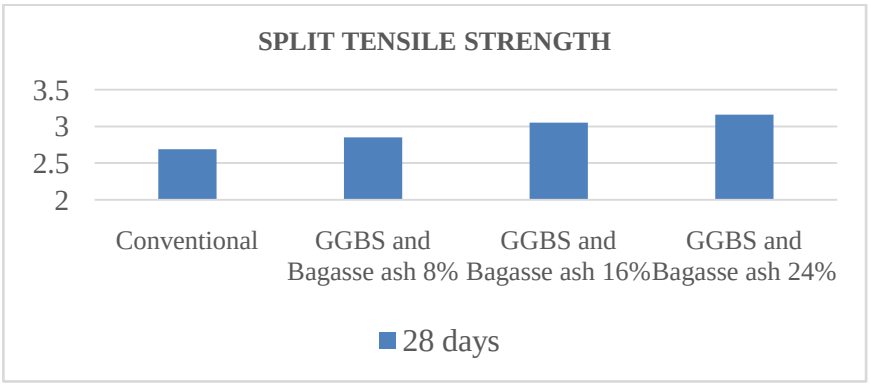

Fig-12 Split tensile strength test

Flexural Strength Test

To support the specimen, the testing machine's bed must have two metal rollers that are 38 mm in diameter, and these rollers must be positioned such that the distance from middle to the edge is 60 cm for 15.0 cm examples and 40 cm for 10.0 cm specimens. Two equivalent rollers installed at the third positions of the bearing

span, i.e. 20 or 13.3 cm center to center, must apply the load. The force must be equally distributed between the two loading rollers, and all roller must be positioned so that the load is applied axially and without putting the specimen under any twisting stresses or limitations.Fill the mould with concrete in three layers of about similar thickness to create the test specimen. Tamp each layer 35 times with the tamping bar as directed. Tamping should be evenly spread over the cross section of the beam mould and throughout the depth of each layer.

To provide support and loading points for the specimens, steel circular rollers having a cross section size of 38 mm will be used. The rollers need to be at least 10 mm higher than the test specimen's width. It will be four rollers in all, with each of them capable of spinning along their respective axes. The distance between the outer rollers The span (the distance between the inner rollers) must be three-dimensional in nature. In order for the system to be systematic, the inner rollers must be evenly distributed between the outer rollers.Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the specimen surfaces that will come into contact with the rollers.

Flexural strength, also known as modulus of rupture (fb), is calculated as Fb = pl/bd2 (where a > 20.0cm for 15.0cm specimens or > 13.0cm for 10cm specimens).

Depth of failure point (cm).I = supported length in centimetresp = maximum load (in kg).

At 28 days, ordinary concrete has a flexural strength of 3.2 N/mm2.The graph depicts the Flexural strength value deviation over 7, 14, and 28 days. For 28 days, the partial replacement of GGBS and Bagasse enhances Flexural strength at M2 (60% GGBS and 20% CS) while decreasing strength at M1 and M2

Table 9: Flexural strength test result

MIX		**28 Days**
M_0	Nominal Mix	3.2
M_1	4% GGBS+ 4% Bagasse	4.9
M_2	8% GGBS+ 8% Bagasse	5.3
M_3	12% GGBS+ 12% Bagasse	5.5

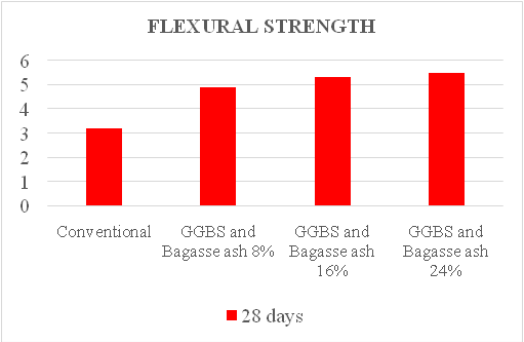

Fig 13: Flexural strength test

Conclusion

- When GGBS and bagasse ash are used in fresh, plain concrete as a partial replacement for cement, it has been found that the workability of the concrete is increased in comparison to concrete manufactured without GGBS and bagasse ash.
- The mixture, which substituted 4% of GGBS and 4% of bagasse ash for 8% of the cement, demonstrated good compressive and tensile strength qualities.This can be as a result of the superior composition and high quality of the CSH gel produced at this proportion.
- The mixture with 24% GGBS (12%) and bagasse ash (12%) substitution of cement has demonstrated good flexural strength.
- By using it in cost-effective building methods, the higher silica content can be used to prepare silica compounds and reduce environmental impact issues associated with the disposal of bagasse ash.
- The findings reveal that compared to concrete without bagasse ash, concrete with bagasse ash had significantly increased compressive strength, tensile strength, and flexural strength. It was discovered that bagasse ash might favourably substitute cement up to a maximum of 12%.
- Fresh concrete becomes more workable when some of the cement is replaced with bagasse ash, so little superplasticizer is needed. Low weight concrete can be made with these waste sources since bagasse ash concentration reduces as it increases.

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Legends of Figure

Figure No	Description
1	Bagasse Ash
2	Specific Gravity Test Image
3	Ground granulated blast furnace slag in consistency test
4&7	Ground granulated blast furnace slag
5	Firing process of baggase
6	Collecting of baggase ash
8&9	Slump cone test
10	Compressive test of cube
11	Compressive test Graph
12	Split tensile strength test graph
13	Flexural strength test graph

CHAPTER 30

AN EXPERIMENTAL INVESTIGATION OF GLASS POWDER AND COCONUT FIBER ASH IN SOIL STABILIZATION

S. Gopinathan & S.Sharmila*
Department of Civil Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

This study's primary goals are to research the usage of waste polypropylene fibres and coconut fibre ash materials in geotechnical applications and to assess the effects of these materials' effects on the shear strength of unsaturated soil through the use of unconfined compression tests. The findings from numerous experiments are compared, and conclusions about the suitability and efficiency of soil stabilisation as a cost-effective alternative to deep foundation or raft foundation are reached. Numerous applications, including slope stabilisation, subgrade and sub base, have shown success with the use of the randomly distributed fiber soil stabilisation technology. This ground rehabilitation method is rather straightforward and has a lot of potential as a practical, affordable solution to many geotechnical issues. In this investigation, soil samples without and with soil stabilisation were subjected to a number of compression experiments at various confining pressures. Plastic fibres resemble the roots of trees and other flora, and they provide a wonderful addition to soils and the stability of natural slopes.

Introduction

Any structure built on the ground needs a solid foundation to sustain the entire construction, which is why it is so crucial. The surrounding soil is extremely important for the strength of the foundation. Therefore, in order to work with soils, we must have a thorough understanding of both its characteristics and the forces that influence it. The soil stabilisation method aids in achieving the necessary qualities in a soil for the construction project. Although soil stabilisation was employed, it fell out of favour due to the use of antiquated techniques and a lack of adequate technique. Soil stabilisation has begun to take on a new form recently due to the rise in demand for infrastructure, raw resources, and fuel. It is becoming more widely used and reasonably priced as a method of soil improvement as better research, materials, and equipment become available.

Soil Stabilized with Glass and Coconut Fiber Ash

Powder waste and fibre ash can be mixed with soil using a self-propelled rotary mixer or in a concrete mixing plant. Fibres and powder trash may be incorporated into the soil either intentionally or randomly in various levels. In terms of its engineering qualities, an earth mass stabilised with discontinuous, randomly distributed powder waste and fibre ash is similar to earth reinforced with chemical compounds like lime and cement.

Stabilization

Stabilisation can boost a soil's shear strength and/or manage its shrinks well characteristics, which increases a subgrade's ability to sustain foundations and pavements by increasing the subgrade's load bearing capacity

Objective

- Three different percentages of fibre content (0%, 15%, and 25% by weight of clayey soil) are used in the clayey soil CBR testing on soils with varying plasticity indices.
- The features of strength and settling with condition.
- To determine whether substituting glass powder and coconut fibre ash with soil at different percentages increases soil strength.
- To boost the soil's capacity for bearing weight, add varying amounts of glass powder and coconut fibre ash.

Methods and Materials

Tests Conducted

The experimental work consists of the following steps:

1. Particle size distribution by sieve analysis
2. Specific gravity of soil
3. Determination of soil index properties (Atterberg Limits)
4. Unconfined compression test (UCS).
5. California Bearing Ratio test (CBR).

Materials

Soil sample

Coconut fibres ash

Glass powder

Fig 1

Fig 2

Following Steps are Carried Out While Mixing the Fiber to the Soil,

- In accordance with the standard proctor compaction tests, all soil samples are compacted to their respective maximum dry densities (MDD) and optimum moisture contents (OMC).
- The varied percentages of fibre reinforcement used in the current investigation are 0,0.15, and0.25.
- If fibre reinforcement was employed, the fibre content was first manually incorporated into the air-dried soil in small amounts, making sure that all the fibres were thoroughly mixed.

Sieve Analysis

The process of separating an aggregate sample into different fractions, each made up of particles of the same size, is known as sieve analysis.

Table 1

IS Sieve(mm)	RetainedWeight of Soil (gm)	%Retained	Cumulative % Retained(gm)	% Finer
4.75	251	50.2	50.2	49.8
2.36	82	16.4	66.6	33.4
1.18	58	11.6	78.2	21.8
0.6	22	4.4	82.6	17.4
0.3	35	7.0	89.6	10.4
0.15	32	6.4	96.0	4.0
0.075	17	3.4	99.4	0.6
Pan	3	0.6	100	0

Fig 3

Specific Gravity

Table 2

1.	Sand	2.63-2.67
2.	Silt	2.65-2.7
3.	Clay and silty clay	2.67-2.9
4.	Organic soil	≤2.0

Fig 4

Specific Gravity G = $\frac{w2-w1}{[\{w2-w2\}-\{w3-w4\}]}$

Average Specific Gravity of Soil=2.81

Classification of Soil According to Atterberg's Limit
Liquidlimit

Table 3

No.of Blows	Wet Soil(gm)	Dry Soil(gm)	Water (gm)	Moisture Content(%)
56	14	11	3	27.27
19	16	13	3	23.07
10	17	13	4	30.79

Fig 5

Unconfined Compression Strength Test

- Initial Length of sample:6.9cm
- Dia.Of sample:3.7cm
- Initial amount of soil taken:3.5kg
- Least count of dialgauge:0.01mm
- Proving ring constant:4.14N
- Initial cross sectional area of sample(A):$3.14 \times 1.85^2 = 1074 mm^2$
- Strain=Deformation/Original Length
- Corrected Area=A/(1−Strain

Table 4 UCS Test Result with 0%

Dialgauge reading	Strain(%)	Provingring reading	area	load(N)	AxialStress (kg/cm^2)
50	0.0033	9	19.72	40.81	0.0207
100	0.0067	16	19.82	69.19	0.0349
150	0.0100	22	19.92	92.11	0.0462
200	0.0133	25	20.03	106.12	0.0530
250	0.0167	27	20.13	114.27	0.0567
300	0.0200	26	20.24	108.44	0.0536
350	0.0233	23	20.34	99.11	0.0487

Table 5 UCS Test Result with 15%

Dialgauge reading	Strain(%)	Provingring reading	area	load(N)	AxialStress (kg/cm^2)
50	0.0033	13	19.72	54.8	0.0277
100	0.0067	20	19.82	82.79	0.0417
150	0.0100	26	19.92	109.6	0.0550
200	0.0133	29	20.03	122.43	0.0d12
250	0.0167	31	20.13	128.26	0.0639
300	0.0200	29	20.24	120.1	0.0593
350	0.0233	26	20.34	107.27	0.0527

Table 6 UCS Test Result with 25%

Dialgauge reading	Strain(%)	Provingring reading	area	load(N)	AxialStress(kg/cm^2)
50	0.0033	14	19.72	59.47	0.0302
100	0.0067	19	19.82	80.45	0.0406
150	0.0100	26	19.92	109.6	0.0550
200	0.0133	29	20.03	122.43	0.0612
250	0.0167	31	20.13	129.43	0.0643
300	0.0200	30	20.24	123.6	0.0611
350	0.0233	26	20.34	108.44	0.0533

California Bearing Ratiotest(CBR)

Table 7 CBR Test Results

Penetration (mm)	Load (kg) — 00%	Load(kg)—15%	Load(kg)—25%
0.5	160	175	180
1.0	165	180	185
1.5	170	185	190
2.0	175	190	195
2.5	180	195	200
3.0	190	200	210
4.0	210	220	220
5.0	235	245	245
7.5	260	275	275
10.0	275	285	285
12.5	290	300	300

CBR Value:

Unreinforced Soil=**13.138**
15%Plastic reinforced=**14.233**
25%Plastic reinforced=**14.598**

Result and Discussions

The tests were conducted and the observed results were . variation in unconfined compression test

UCS Test With 0%

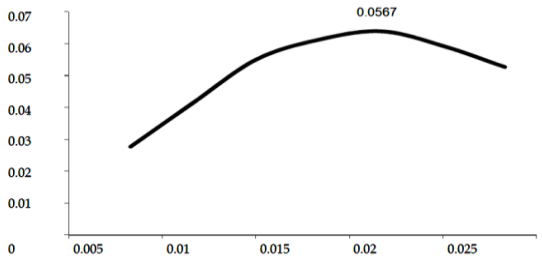

Fig 6

UCS Test With 15%

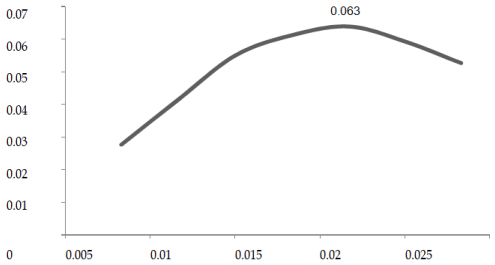

Fig 7

UCS Test with 25%

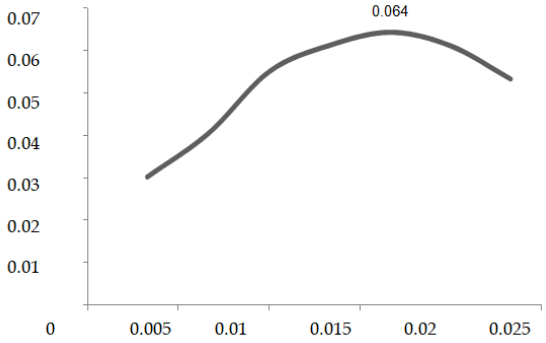

Fig 8

VARIATION IN CBR

CBR Value: Unreinforced Soil=13.138

15%Plastic reinforced=14.233

25%Plastic reinforced=14.598

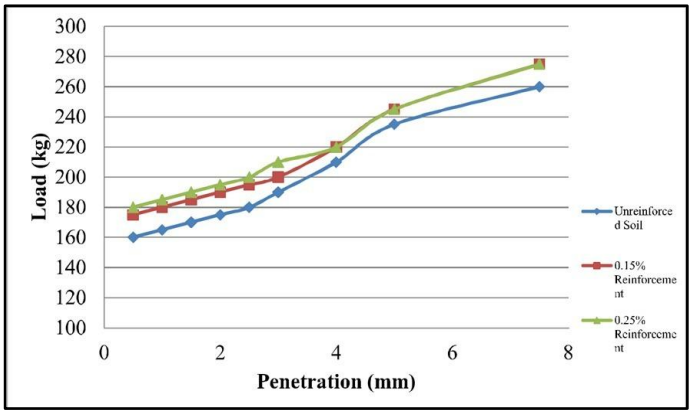

Fig 9

Conclusion

1. The cohesiveness value of stabilised soil is 0.16 kg/cm2, whereas that of 15% stabilised soil is 0.19 kg/cm2, representing an increase of 19.19%.
2. The cohesiveness value of stabilising soil is 0.16 kg/cm2, whereas soil that has been stabilised by 25% is 0.199 kg/cm2, an increase of 19.50%.
3. The stabilised soil's maximum Unconfined Compression Strength, based on a sample made using IS codes, is 0.0567 MPa.
4. The Unconfined Compression Strength soil, stabilised soil with 15% glass powder, 7% coconut fibres ash, and 8% is at a peak value of 0.0639 MPa, which is an increase of 11.26% from stabilised soil's 0.0567 MPa.
5. The Unconfined Compression Strength soil, stabilised soil with 25% of glass powder, 10%, and coconut fibre ash, 15%, is at a peak value of 0.0643 MPa, an increase of 12.10% from 0.0567 MPa for stabilised soil.
6. The CBR value increases when soil samples are combined with glass powder and coconut fibres.
7. The purpose of adding recycled glass powder and coconut fibre ash material was to raise the soil's CBR value.
8. The inclusion of glass powder and coconut fibre ash would enhance the CBR value and hence reduce the thickness of the subgrade

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10. Understanding theBasics ofSoil Stabilization:An Overviewof Materials and Techniques.

Legends of Figure

Figure No	Description
1	GLASS POWDER
2	COCONUT ASH
3	SIEVE SET
4	SPECIFIC GRAVITY
5	ATTERBERG LIMIT
6	UCS TEST 0%
7	UCS TEST 15%
8	UCS TEST 25%
9	CBR VALUE

CHAPTER 31

GLASS FIBER WRAPPING SYSTEM FOR RC ELEMENT STRENGTHENING

N.Sunmathi* & B.Manibalu
Department of Civil Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

The experimental analysis of reinforced concrete beams strengthened using glass fibre reinforced polymer (GFRP) serves as the foundation for the current study. Against static stresses, the behaviour of unenhanced and GFRP-enhanced beams is investigated. The performance of RC beams with GFRP composites in a variety of patterns can be assessed with the aid of experimental research methods. to assess for better performance the effectiveness of a shear reinforcement of RC beam utilising GFRP composites outside with epoxy resin glue.By using GFRP materials, it is possible to increase shear strength, stiffness, load carrying capacity, and elasticity. The strengthening plan ought to be economical. The efficacy along with the efficacy of each of the strengthening techniques utilising epoxy infused GFRP fabric are then studied using the approved experimental methodologies, with the number of layers, orientation, and distribution of fibres taken into account as parameters. The source of failure switched from shear to flexural failure in all GFRP-strengthened beams, and the ductile behaviour significantly improved. The beam enhanced with GFRP was seen to exhibit an improvement in shear strength, stiffness, load carrying capability, and ductility.

Keywords: *GFRP; Epoxy Resin; Flexural Test; M25 Grade Concrete; Fine Aggregate; Coarse Aggregate.*

Introduction

Glass fibre reinforced polymer composites are extensively used in a variety of sectors and are created utilising an an array of making procedures. Glass fibres extracted from heated glass were used by the ancient Egyptians to create the first containers. Continuous glass fibres were first developed in the 1930s for use in extreme temperatures electrical installations. Electronics, aviation, and vehicles are only a few of the modern uses for it. Great strength, flexibility, stiffness, and resistance to corrosion from chemicals are only a few of glass fibres' outstanding characteristics. The forms that can be used include rovings, chopped strands, yarns, fabrics, and mats, to name a few. Glass fibres are used in polymer composites for a variety of activities and exist in many distinct kinds with unique properties. A

lot of weak reinforced concrete (RC) constructions are strengthened using glass fibre reinforced polymer (GFRP) sheets and plates. The use of adhesively bonded composites to reinforce pre-existing concrete structures has progressively grown over the past few decades. Numerous studies have been conducted on the bond behaviour between GFRP reinforcement and concrete, and some of these studies have been incorporated into the design recommendations for concrete buildings reinforced with externally applied GFRP.

Shear-deficient beams come in two distinct types with stirrup pitch of 150 mm and 300 mm. The structural integrity of beams reinforced with exterior as well as interior wrapped GFRP were assessed under three-point bending monotonic stress. The performance of the externally wrapped (GFRP-epoxy bonded) RC beam was better than the inside wrapped beam. The tiny economic growth index, however, makes internal wrapping more appropriate as a strengthening tactic than outer covering. [1].

Numerous researchers from all around the world have widely used near-surface mounted (NSM) and fiber-reinforced polymer (FRP) strengthening materials to increase the shear and flexural strengths of reinforced concrete (RC) beams. The torque as strengthening research is few, nevertheless. Few research have focused on torsional strengthening, but none of them have combined torsion with shear and/or bending moment at the same time. In this work, reinforced concrete beams (RC beams) strengthened with FRP sheets in all kinds of geometries and NSM steel bars in variable spaces will be tested under combination torsion behaviour, with the bending moment measured and compared.. Seven beams were cast, each measuring 15 by 25 by 200 cm. Three of the beams received carbon FRP strengthening, three other beams received NSM steel bar strengthening, and one beam received no strengthening [2].

The purpose of the experimental study described in this paper was to determine whether it was feasible to use laminates made of externally bonded carbon-fiber-reinforced polymer (CFRP) to prolong the longevity of rusty reinforced concrete (RC) beams. 14 beams, each 200 mm long, were examined in total. Three beams were preserved against corrosion; two of them received CFRP laminate reinforcement, while one example was kept as a virgin. Using an impressed current approach, the remaining 11 beams were subjected to varying degrees of rusting injure, up to a 31 percent steel weight defeat. While the remaining five rusted beams were not restored, six of them were, using CFRP laminates. Finally, four-point bending tests

were performed on all specimens until they failed. The load-bearing capacity of RC beams was dramatically lowered by corrosion of the steel reinforcing. [3].

Fabric reinforced concrete (TRC) or fabric reinforced cementitious matrix (FRCM) supplies have been thoroughly studied in the global scientific community over the past 20 years because they represent an intriguing alternative to the modifying solution using fibre reinforced polymer (FRP) for enhancing the strength of members made of reinforced concrete. An up-to-date review of TRM's use in concrete structure strengthening is provided in this publication. First, a description of TRM's tensile and bond behaviour is given. The important parameters are then examined, and a summary of studies on the usage of TRM for retrofitting concrete or RC members for flexural, shear, confinement, and seismic retrofitting is included. Ferro cement is a type of thin-walled reinforced concrete that is typically built from hydraulic cement mortar and reinforced with thin, continuously laid-out layers of wire mesh. Metal or another suitable material may be used to make the mesh [4].

Using lever arms with equal static loads that transfer an equal amount of torsional moment to the beam, an aramid fiber-reinforced beam is tested for torsional moment. The beam has a cross area of 150 mm x 300 mm and is 1 m long. In this regard, nine conventional beams and three beams for torsional reinforcement were both designed. According to IS456-2000, the beam is torsionally engineered. Buildings that were previously developed utilising the codes lacked the necessary provisions for torsional reinforcement. This study examines how such conventional beams that have been wrapped with aramid fibre behave in torsion. These reinforced beams' torsional moments are contrasted with those of torsionally designed beams created in accordance with modern design regulations. [5].

The purpose of the current study is to determine whether basalt fibre sheets are effective shear strengthening materials for RC beams. Ten RC beams were investigated while being loaded from four different directions. In the current study, the effects of several parameters, including the width, orientation, and quantity of BFRP strips, the kind of strengthening schemes, the type of fibre sheets (glass and basalt), and the level of pre-loading, were examined. The results of the experiments revealed a 17–50% increase in the failure load of reinforced beams. Additionally, it has been noted from the current experiment that the enhancement in shear capacity declines with an increase in preload level and that the overall efficacy of basalt fibre sheets in improving shear capacity is 20% higher than that of the glass fibre sheets [6].

A sufficient number of studies have demonstrated that carbon fibre reinforcements improve retrofitting quality, however CFRP sheets need additional

investigation to determine whether they are a better alternative to heavier retrofitting approaches. The mesh and armature systems that the mortar matrix is intended to encase should be compatible with the fineness and makeup of the mortar matrix. It's possible for the matrix to have irregular fibres. The findings of an experimental investigation on the improvement of modified ferro cement wrapped columns and Carbon Fibre Reinforced Polymer sheet's load carrying ability wrapped columns. It uses a modified ferro cement wrapping that has been strengthened with two layers of welded steel meshes. Four column members were tested out of six short RCC square columns. Axial compressive load was applied to the specimens till failure. [7].

As the primary reinforcement for concrete in new projects as well as for strengthening degraded concrete elements, CFRP materials can be employed in a variety of combinations. high tensile strength, high fatigue resistance, and high stiffness to weight ratio.

Investigated was the efficacy of adding carbon nanotubes (CNTs) to restricted reinforced concrete (RC) columns to improve the strengthening efficiency. The preparation and axial concentric loading testing of fourteen large scale rectangular RC columns. By adding CNTs to the epoxy resin and/or covering the carbon fibre with a sizing agent that is rich in CNTs, it was possible to incorporate CNTs into the carbon fiber/epoxy composites. Analysis was done on the failure mechanisms, axial load-displacement responses, and microstructures of specimens that had been wrapped half, entirely, and completely [8].

One of the most often utilised building materials is concrete.There has been a constant search for improving the qualities of concrete due to the expanding demands for performance and durability of concrete. The purpose of this study was to better understand the structural behaviour of reinforced concrete (RC) columns covered in carbon fibre reinforced polymer (CFRP) sheets [9].

Particularly flexural parts reach their maximum bending flexibility. To investigate and test the impacts of carbon fibre mesh jacketing fibre reinforcement at the concrete beam's plastic hinge length under vertical monotonic load, experimental research was conducted. This study presents the findings of a practical and statistical study programme conducted on 12 masonry projects including Textile Reinforced Mortars (TRMs). Uniaxial compression tests were performed on thirty nine small-scale masonry 13 columns after they had been reinforced with TRM layers. The quantity of TRM layers, the area dimensional ratio, and the radius at corner were the 14 variables that were examined during the

tests. This experimental investigation's goal was to determine how the 16 aforementioned parameters affected the functionality of restricted masonry [10].

Methodology and Materials

The following technique was acquired based on the preliminary review, and the methodology flowchart is shown in Figure 1 [11-15].

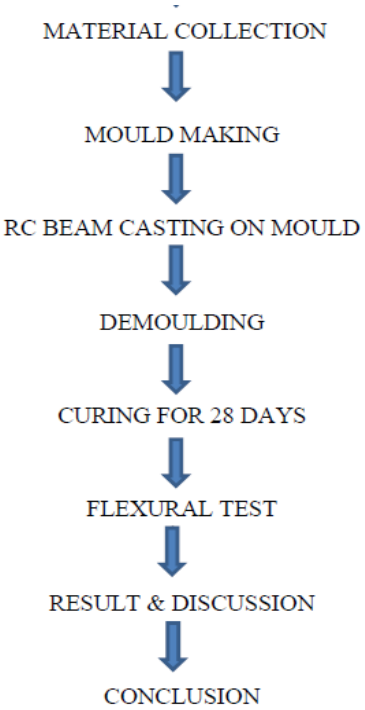

Fig 1. Methodology Flowchart

Cement

Ordinary Portland cement of grade 53 is utilised in this experimental study. Among the elements of concrete, cement is one of the most crucial. The qualities of the cement were examined using tests for cement like fineness, consistency, setting time, soundness, and heat of hydration.

Table 1. Properties of cement.

S.No	Test	Value	Permissible Limit
1	Specific Gravity	3.13	3.1-3.16 g/cc
2	Consistency Test	29 %	26-33 %
3	Initial Setting Time	32 min	30 (min)
4	Final Setting Time	10 hours	10 (hours)
5	Fineness	8.5%	10 max)

Fine Aggregate

Nearly all of the fragments in fine aggregates are comprised of natural sand or crushed stone and typically filter through a 3.26mm screen. The following characteristics of fine aggregate are determined and tabulated in Table 2.

Table 2. Properties of fine aggregate

S.No	Test	Value	Permissible Limit
1	Specific Gravity	2.82	2.50-3.0
2	Water Absorption	29 %	3% (max)
3	Fineness	8.5%	2.0-2.4

Coarse Aggregate

Any particle larger than 0.19 inches is considered a coarse aggregate, which typically has a diameter of between 3/8 and 1.5 inches and a size of 20 mm. Coarse aggregate is the substance that passes through an I.S. Sieve with a 4.75 mm mesh size. The material passing through a 4.75 mm I.S. filter but remaining on a 75-micron I.S. sieve is referred to as fine aggregate. The following characteristics of fine aggregate are determined and tabulated:

Table 3. Properties of coarse aggregate.

S.No	Test	Value	Permissible Limit
1.	Specific gravity	2.78	2.5-3.0
2.	Water Absorption	1.4 %	2% (max)
3.	Impact Value	17%	45% (max)

Water

Water is a vital ingredient of concrete since it actively participates to the chemical reaction with cement. The proportion of water to cement balance is 0.49. The total amount of water in the concrete affects a variety of fresh and hardened concrete properties, including workability, compressive strengths, penetration and water rigidity, durability and ageing, drying shrinkage, and fracture potential. The used water has a pH of 7.

Reinforcement

Fe 415 kind of steel has been employed, offering 150mm c/c spacing, 10mm main bar and 8mm stirrups.

GFRP

An even distribution of fibres, a smooth surface, a soft and flexible feel, a low binder and strainer content, a quick resin impregnation, and good mould obedience.

Table 4. Properties of GFRP.

S.no	Test	Value
1	Tensile Strength (MPa)	483–4580
2	Elastic Modulus (GPa)	35–86
3	Elongation (%)	1.2–5.0

Epoxy Resin

The family of basic elements or dried end products known as epoxy includes epoxy resins. Poly oxides, are another name for epoxy resins.

Fig 2. Epoxy Resin

Mix Design and Proportion

Grade : M25

Mix ratio: 1(cement): 1 (sand): 2 (aggregate)

W/C Ratio: 0.5

RC Beam: 4 (2 specimens for normal beam and 2 specimens for wrapped beam)

Beam size: 230 by 230 mm

Reinforcement Details

4 No's 10 mm dia main bars and 8mm dia @ 152.4 mm spacing is used.

Area of reinforcement:

0.04 bd = 0.04 x 0.230 x 0.230 = 0.0002116 m

Mix Proportion for Single Mix

9.045 kg of cement
17.065 kg of FA
26.5 kg of CA
4.5 litres of water

Results and Discussion

Flexural Test

The findings suggest that, when compared to the control beam, the load carrying capability of the laminated RC beam (RBC S 5) has risen by approximately 31%, 41%, and 33% at the first crack, yield, and final phases, respectively. This demonstrates the impact of GFRP lamination on the strengthened beam's load carrying capacity, which is consistent with expectations. It should be observed that, among the three stages mentioned above, the yield point sees the greatest increase in load. The maximum amount of growth, however, was unable to continue past the yield point, possibly as a result of the laminate's abrupt debonding.

However, the extremely high gain in load capacity brought on by GFRP lamination can be employed profitably in genuine structural engineering applications. It was observed that the ultimate load-carrying capacity of RC beams is greatly increased when GFRP laminates are used to strengthen them.

Table 5. Specimen Details

S. No.	Beam Designation	Adhesive	No of Layer	GFRP Laminate Thickness (MM)
1	RBC 0	-	-	-
2	RBC S 5	Epoxy	Single	5

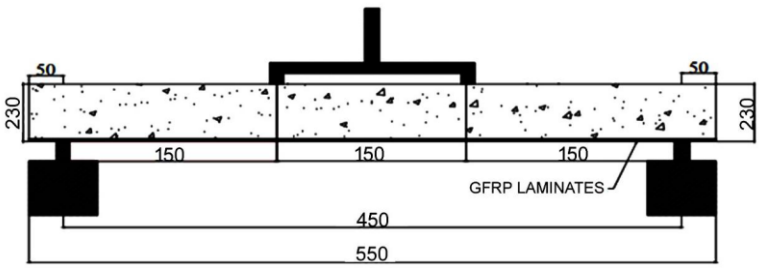

Fig 3. Schematic diagram of Experimental test setup

Table 6. Results RC Beams

S.No	Beam Designation	First Crack Load (kN)	First Crack Defection (mm)	Yield Load (kN)	Yield Load Defection (mm)
1	RBC 0	17.54	1.25	34.00	3.61
2	RBC S 5	24.00	1.50	49.00	3.86

S.No	Load at Debonding Initiation (kN)	Defection at Debonding Initiation (mm)	Ultimate Load (kN)	Ultimate Load Defection (mm)
1	RBC 0	17.54	1.25	34.00
2	RBC S 5	24.00	1.50	49.00

Ductility Behaviour

Carrying capacity for loads as well as deflection of the aforesaid beam. The ‘stoppering effect' of lamination on the tension face of the beam, despite the fact that the material employed for lamination is a lightweight and flexible material, has lowered the ductility of the beam (RBC S 5) by roughly 30% compared to the 'control beam (RBC 0)'.

Table 7. Ductility and failure mode of tested beams

S.No	Beam Designation	Ductility	Ductility Ratio	Mode OF Failure
1	RBC 0	2.38	1	Flexural failure
2	RBC S 5	1.67	0.70	Sudden debonding of GFRP laminates

Conclusions

1. Compared to the unlaminated RC beam, GFRP lamination has increased an RC beam's ability to support more weight during the first crack, yield, and ultimate stages.
2. The laminated GFRP beam with five mm thickness GFRP lamination of 1.5 percent Vf has a greatest result and shows high load-resistance
3. For a specific structural application, the permissibility of the aforementioned defection levels must be determined in relation to the applicable codal rules.
4. From an application standpoint, the laminated GFRC beam has more ductility than the laminated RC beam , which is very highly favourable.

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LEGENDS TO FIGURES

Figure 1:	Methodology Flowchart.
Figure 2:	Epoxy Resin
Figure 3:	Schematic diagram of Experimental test setup

CHAPTER 32
DESIGN OF A TELESCOPIC SAW FOR PRUNING TREES

R.Rajesh*, S.Suthagar, B.Ranjith kumar, S.Karpagarajan & K.Parameshwaran
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

Pruning is the cutting of young branches and growing on the main trunk of the tree. This activity aims to increase the free height of branches and reduce the main branches of the trunk. Pruning branches or twigs that are not needed makes the nutrition of the tree more concentrated for tree growth (main trunk and canopy or fruit). The pruning process requires cutting tools. One of the cutting tools that can be used is a saw. To make the pruning process easier, a saw can be applied from the ground or without climbing trees. Therefore it is necessary to design telescopic saws that can be used to prune. The design of a telescopic saw includes a saw blade, a saw blade, a connector for the saw frame, a telescopic rod, and a connector between the handles. The results showed that the telescopic saws from the design can be used to trim the palm fronds and teak branches properly. The dimensions are 304.8 cm long and 10 cm wide. The cutting rate of teak tree branches is 40.47 mm^2/son the tree and 77.89 mm/son the ground.Pruning is one of the most important tree maintenance activities which give a big impact on tree's health and structure. A well pruned.Trees are not only able to maintain tree health, but also will provide a safe environment and enhance the aesthetic value.On the other hand, improper pruning will danger the public. The aim of this study is to assess pruning knowledge among Kuala.Lumpur City Hall (DBKL) tree maintenance workers. Findings from this study will contribute to recommendations for changing.

Introduction

Pruning is one of the most important tree maintenance practices that should not be ignored because it gives a big impact on tree's health and structure (Clark and Matheny, 2010). By removing of diseased, broken, or dead branches on mature trees and young trees, it will protect the trees by preventing decay-producing fungi from penetrating Is needed for plantation or forestry plants. Pruning of hardwoods coming from forest plantations is becoming more and more important to replace scarce wood from tropical forest. Pruning is a routine maintenance activity carried out in the development of a plantation forest. Pruning activities in plantation forests are primarily intended for producing wood for carpentry. Pruning activities are closely related to the quality of the resulting stems where high economic value wood is expected, namely large wood with few knots, control growth and maintain desired shapes [1]. Trunks with many knots or loose knots will have a low value,

besides that the yield of sawn timber is also low [2] the pruning process requires cutting tools. One of the cutting tools that can be used is a saw. To facilitate the pruning process, a chainsaw is required which can be applied from the ground; without climbing trees. Pruning the oil palm plant is the process of removing the unproductive midrib; dry midribs of the oil palm plantations. Pruning is included in harvest preparation activities with the aim that it does not interfere with the harvesting process as well. Pruning is one of the techniques to improve plant growth and production [3]. Trimming the leaves on oil palm plants must be done, because it is not easy to fall out, even though it is old or dry, sometimes it only falls after a few years later [4]. Pruning the oil palm plantations is done since the immature plantations and continued until the plants have produced with the aim to influence the production of the oil palm. Implementing intensive pruning is important because inadequate interventions may threaten the growth, yield, and wood quality of T. grand is plantation [5]. Pruning leaves can also reduce the danger of fallen trees due to wind [6]. Pruning techniques are carried out regularly in accordance with the development or age of existing plants. Pruning is a regular part of the maintenance routine which helps to keep trees healthy [7]. Pruning of hardwoods coming from forest plantations is becoming more and more important to replace scarce wood from tropical forests [8].Furthermore, the fruits retained better quality characteristics in terms of size, weight, volume, color change, firmness, organoleptic rating, physiological loss in weight, spoilage, acid content, total soluble solids, sugars due to summer pruning [9].Shoot emergence was found earlier in pruned trees as compared to un pruned trees[10].While pruning teak is the pruning of young branches and growing on the main trunk of the tree. This activity aims to increase the free height of branches and reduce the main branches of the trunk. By eliminating unnecessary branches or twigs, tree nutrients will be more concentrated for tree growth (main trunk and canopy). Pruning may improve wood quality by preventing knot formation. This study aims to design and test the performance of telescopic saws that can be used to prune plantation (oil palm) and forest (teak) plants.

Objective

Designing of a 'Telescopic Saw' for pruning trees in a smart manner facilitating healthy environments.

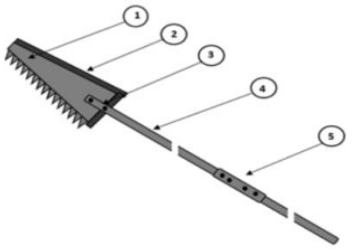
Working Principle

The cleaning liquid is mixed in the proper proportion, and it is poured into the reservoir through the top. The cleaning liquid is poured until the tanks are filled. Actuating the lever opens the valve. Cleaning liquid from the tank spills on the brush. After the required amount is delivered, the lever is released, and the machine is switched on. The brush gets drive from the motor through pulleys and belts. The brush applies pressure to the floor when the adjuster rod is unscrewed and the handle is moved in the required direction to clean a sufficient area. Again, the lever is operated to supply cleaning liquid whenever required. This process is repeated, so the floor is cleaned well. The cotton brush prevents damage to the mosaic and marble floors and gives a smooth surface finish and shine

Methods

Material and Tools

The tools used were workshop tools; including vise, hammer, Hacksaw, grinding machine and welding machine. The material used to make telescopic saws was 2 x 2 cm long iron rod 1 m long, 2 rods of 1 inch pipe size (size 4 m per rod), 7 pairs of bolt nuts of 7 pairs. The materials used for testing the tool were teak branches and palm fronds



Sketch of telescopic saw. (1) saw, (2) saw frame, (3) Stalk connector on the saw frame, (4) Telescopic rod, (5) Connector.

Structural and Functional Design

Telescopic saws included saw blades, frame saw blades, Connector rods on the saw frame, telescopic, and connector Between stalks. Functionally the saw blade functions as a branch cutter or midrib. The saw blade was designed to be sturdy, not flexible and sharp so that it can be used to cut branches or twigs or palm fronds. Elbow iron was chosen to be sturdy; did not flex when used to cut branches. The stem connector was made of perforated iron pipe; a place to put nuts and bolts. Pipe joints were designed to be able to unite pipes used as stems. Iron

pipe was chosen so that it can be grasped properly; so it can be used comfortably. Stalk connector made of iron pipe. Elbow iron selection was intended so that the connector can unite the pipe stems with precision. Structural telescopic saws include saw blades, saw blade frames, connector rods on the saw frame, telescopic, and connector between handles. The overall length of the telescopic saw was 645 cm. The saw blade used was a hand saw for wood with dimensions of length 45.72 cm (18 inches). The saw blade was made of 2 x 2 cm iron, with a length of 50 cm and a width of 12 cm. Connectors were made of 1 inch iron pipe with 3 holes perforated with 8 mm hole size; a place to install bolt nuts. The stem was made of 1 inch iron pipe, 3 m long. Saw blades are designed as many as 3 pieces, sothe overall length of the stalk was 6 m. The stalk connector was made of 1 inch iron pipe which is cut in half. Connector length of 20 cm. Connectors were given 4 holes with a diameter of 8 mm; this holes were useful for installing bolt nuts.

Performance Test

The performance test of telescopic saws in the form of a test of the success rate of cutting of teak branches and palm tree midrib. Test the speed of cutting of teak branches on trees and on the ground, the speed of cutting of oil palm fronds on trees and on the ground. The effectiveness of cutting (ε) is calculated from the comparison of cutting time in trees (tp) compared to cutting time on land (tt) multiplied by 100%.Connector.

Study Area

Kuala Lumpur is chosen as the area of the research because it is the capital and largest city in Malaysia. It is also the most urbanize state with 244 km² (94 sq. mi) of land area and has the highest population density (Department of Statistics Malaysia, 2010). As an urbanized area, it is important to have a sustainable tree pruning practices as there are many targets which will expose to risk if pruning tree was poorly done. Kuala Lumpur City Hall (DBKL) was given the responsibility of maintaining and preserving the landscape around the city of Kuala Lumpur under a shade tree management unit. This unit is carrying out maintenance on roadside trees only, excluding tree in a public park and residential area. There are 11 parliamentary (Table 1) guarded by eight groups of assistant agricultural officers, supervisors and laborers who do the pruning

Performance Test

The performance test of telescopic saws in the form of a test of the success rate of cutting of teak branches and palm tree midrib. Test the speed of cutting of teak branches on trees and on the ground, the speed of cutting of oil palm fronds on trees and on the ground. The effectiveness of cutting (ε) is calculated from the comparison of cutting time in trees (tp) compared to cutting time on land (tt) multiplied by 100%.

Results & Discussion

The results of the telescopic saw design are presented in Figure 2. This picture shows the parts of the telescopic saw including the saw blade, the saw frame, the connecting rod on the frame of the saw, telescopic, and the connector between the handles. Chainsaws used are wood saws that are used manually. The overall dimensions of the tool are 645 cm long and15 cm wide.This telescopic saw is the same as an ordinary hand saw; the difference between the two saws is that the telescopic saw is made long (Figure 4). The size of the stems can be adjusted as needed, the shortest stems are 3 m and can be extended in accordance with multiples; which is 6 m or 9 m.The performance test results show that the telescopic saws from the design can be used to cut the branches of teak trees and palm tree fronds well. The cutting process is easy; telescopic saws are pushed and pulled after the saw is right on the branch or midrib to be cut.The process of cutting teak branches is presented in Figure 3. This cutting can be done for branches that are less than 5 m high; considering that in this trial the saw shaft is 6 m long. If it is desired to cut the taller handle, it can be done by accommodating the handle of the sawThe average cutting rate of teak branches is 43.47 mm2 / second on trees and 77.89 mm2 / second on the ground. Cuts on the ground are faster than those in trees. This is due tocutting in the tree need greater caution compared to that done on the ground. The length of cutting to the branch area follows the linear equation y = 0.0184x + 45.812 for trees and y = -0.0174x + 73.777 for soil. This shows that cutting larger branches in the tree requires more time; conversely cutting in the tree requires more time; conversely cutting inof the palm fronds to the area of the twigs follows the linear equation y = 0.1347x -63.21 for trees and y = 0.0713x + 6.2291 for the soil.The effectiveness of cutting teak branches an average of 59.14% (Table 1) and oil palm fronds on average 74.24% (Table 2). This shows that the cutting of the palm fronds is more effective compared to teak branches. The effectiveness of

pruning is thought to be influenced by the softness or hardness of wood fibers. Pruning wood that has soft fibers is more effective than hard wood.

Demographic Information

Table 2 shows the frequency and percentage of respondent's demographic characteristics. All of the pruning workers are male and the majority of them are between 31-40 years old (50%). There are only two nations which are Malay (85.5%) and Indian (14.5%). For education level, most of them are SPM holders (58.1%), followed by PMR(21.0) and standard 6 (16.1). This result indicates that majority of them had low levels of education. A total of 32workers (51.7%) had served for more than 20 years shown that these people had a lot of experience with tree pruning. Only 2 of them are contract workers. The results also found that 8 out of 62 of pruning workers did not attend tree pruning course throughout their working period. It is important to follow the course so that workers' skills and knowledge can be improve.

Knowledge Level Score

Table 3 shows frequency and percentage of the respondent who gave the correct answer for each item regardingwith pruning knowledge. For the purpose of pruning landscape tree, seems that majority of them understand thepurpose of doing pruning when the majority of them (above 92%) gave correct answers to 7 out of 9 questions. Aswell as questions about pruning method when above 59 of them (95.2%) understand the types of pruning made on trees. However, 60 (96.8%) of them gave the wrong answer when they agree that pruning can be made on treesunder stress. The next question asks respondents to choose which one of trees with correct pruning technique. Atotal of 47 respondents does not know the bad consequences of doing flush cut on trees when only 15 (24.2%) of them gave the correct answer. While 55 of them agreed that too much raising cut on the tree is fine, and only 7(11.3%) of them gave the correct answer. Flush cut remove the branch collar which contain the protection zone.Apart from causing a large wound, it will cause wounds to heal slowly and give a chance to any insect to infest thewound or microorganism to invade quickly (Ow et. al., 2013). While too much crown raising only leave smallamount of foliage which will reduce photosynthesis process of trees.For wound/pruning cut condition after pruning, the majority of workers do not know which is the good conditionof branches after pruning. Most of them do not know the good condition of wound closure when only 34 (54.8%)

ofthem gave the correct answer while 24 (38.8%) of them agreed that sprout growth as a result of improper pruningare fine. Sprout growth occur as a result from flush cut pruning. Weak attachment from the sprout branches willincrease loading thus causing branch failure especially during severe wind or rain storms (Evans, 2000). Pruningequipment question shows that majority of them did not know the use of secateurs in pruning works when 33 ofthem define that secateurs can be used to prune small branches (diameter about 3cm length) and large (diametermore than 3cm length). This is because secateurs may never be used in their pruning works. However, above 80.7%gave the correct answer from 6 out of 7 questions of pruning equipment shows that workers understand the typesand good characteristics of pruning equipment. This shows that workers have the knowledge to choose the appropriate equipment and using only equipment in good condition during pruning. For questions regarding with pruning time, there are 3 questions with few correct answer. The majority of the workers agreed that pruning can bedone for trees in stress condition while 5 (8.1%) of them disagreed. Only 12 (29.3%) of them admit that pruning should be done for the young tree and 42 (67.7) gave the correct answer to avoid pruning on drought season.

Conclusion

Tree pruning practices should be emphasize and give attention to ensure the health and welfare of urban trees in the long term. Higher knowledge in pruning practice will produce a sense of awareness and good attitude in doing pruning work. Based on the result, the knowledge of the tree pruning workers especially on correct pruning technique and wound/pruning cut condition after pruning is still needed to be improved. Based on demographic data, it is recommended for Kuala Lumpur City Hall (DBKL) to expose all of their workers in the pruning course so that they can increase their knowledge and awareness in tree pruning. By increasing pruning knowledge it is hope that the quality of pruning practices will be improve to ensure the health of the trees and provide benefits to human's life.The telescopic saws from the design can be used to trim the palm fronds and teak branches properly. The dimensions are 645 cm long and 15 cm wide. The cutting rate of teak tree branches is 43.47 mm2/second on the tree and 77.89 mm2/second on the ground. The rate of cutting of oil palm fronds is 160.18 mm2/second in trees and 226.26 mm2/second in the ground. Cutting rates on the ground are faster than on trees. The rate of cutting of oil palm fronds is faster than teak branches. The effectiveness of cutting 59,14% teak branches

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CHAPTER 33
DESIGN AND A MODEL GENERATION FOR ROAD CLEANING

C.Sivakumar*, R.Anandan, R.Kalaiyarasan, D.Manikandan & P.Ramu
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract

This project deals with the design and generation of models for road cleaning. The aim of this project work is to develop and modernize processes for cleaning the floor with wet and dry methods. It is very useful for cleaning the floors. It can be used wet or dry; hence, it is widely used in houses, hospitals, auditoriums, shops, computer centers, etc. In modern times, interior decorations are playing an important role in our lives. Cleaning floors is very important for our health and reduces the manpower requirement. Hence, our project is very useful in our day-to-day lives.

Introduction

The street cleaner is very useful in cleaning streets and floors in hospitals, houses, auditoriums, shops, computer centers, etc.; it is very simple in construction and easy to operate. Anyone can operate this machine easily. It consists of a moist cotton brush; the brush cleans the floor and dries it with the aid of a small blower. Hence, it is very useful in hospitals, houses, etc. The time taken for cleaning is very short, and the cost is also very low. Maintenance costs are lower. Many types of machines are widely used for this purpose. But they are working under different principles, and the cost is also very high.

In our project, there is a very simple drive mechanism that is easy to operate for any person. The size of the machine is also portable, so we can transfer it from one place to another very easily. The floor cleaner is a simple, modern housekeeping device; even children can operate it easily and safely. It is a very important one for each and every house, hospital, etc.

Objective and Strategic Plans

Developing sophisticated and user friendly tool for cleaning floor with wet and dry

- Market Analysis to identify problems and requirements.
- Selection of suitable fabrication materials.
- Concept design of structure.
- Analysis of design and optimization.
- Start of production and fabrication.

- Testing and evaluation of overall performance.
- Incorporating necessary modifications
- Presentation and report formation.

Working Principle

The cleaning liquid is mixed in the proper proportion, and it is poured into the reservoir through the top. The cleaning liquid is poured until the tanks are filled. Actuating the lever opens the valve. Cleaning liquid from the tank spills on the brush. After the required amount is delivered, the lever is released, and the machine is switched on. The brush gets drive from the motor through pulleys and belts. The brush applies pressure to the floor when the adjuster rod is unscrewed and the handle is moved in the required direction to clean a sufficient area. Again, the lever is operated to supply cleaning liquid whenever required. This process is repeated, so the floor is cleaned well. The cotton brush prevents damage to the mosaic and marble floors and gives a smooth surface finish and shine

Methods

Shaft

The shaft is a common and important machine element. It is a rotating member that, in general, has a circular cross-section and is used to transmit power. The shaft may be hollow or solid.

The shaft is supported on bearings, and it rotates a set of gears or pulleys for the purpose of power transmission. The shaft is generally acted upon by bending moments, torsion, and axial forces. The design of the shaft primarily involves determining stresses at critical points in the shaft that arise due to the aforementioned loading. The other two similar forms of a shaft are an axle and a spindle. An axle is a non-rotating member used for supporting rotating wheels, etc., and does not transmit any torque. A spindle is simply defined as a short shaft. However, the design method remains the same for the axle and spindle as for the shaft. 8.1.2 Standard sizes of shafts Typical sizes of solid shafts that are available on the market are: Up to 25 mm 0.5-mm increments 25 to 50 mm 1.0 mm increments 50 to 100 mm 2.0 mm increments 100 to 200 mm. Since it is cold drawn, it has the

inherent characteristics of a smooth, bright finish. The amount of machining is, therefore, minimal. A better yield strength is also obtained. This is widely used for general purpose transmission shafts.

Alloy steel

Alloy steel, as one can understand, is a mixture of various elements with the parent steel to improve certain physical properties. To retain the total advantage of alloying materials, one requires heat treatment of the machine components after they have been manufactured. Nickel, chromium, and vanadium are some of the common alloying materials. However, alloy steel is expensive. These materials are used for relatively severe service conditions. When the situation demands great strength, alloy steels are used. They have fewer tendencies to crack, warp, or distort in heat treatment. Residual stresses are also lower compared to CS (carbon steel). In certain cases, the shaft needs to be wear-resistant, and then more attention has to be paid to making the surface of the shaft wear-resistant. The common types of surface hardening methods are: Hardening of the surface Case hardening and carburizing Cyaniding and nitrating.

Design considerations for shaft

For the design of shafts, the following two methods are adopted: Design based on strength In this method, design is carried out so that stress at any location of the shaft should not exceed the material yield stress. However, no consideration for shaft deflection and shaft twist is included. Design based on stiffness. The basic idea of design in such a case depends on the allowable deflection and twist of the shaft.

Design based on Strength

The stress at any point on the shaft depends on the nature of load acting on it.

The stresses which may be present are as follows. Basic stress equations:

Bending stress

$$\sigma_b = \frac{32M}{\pi d_0^3(1-k^4)}$$

Where,

M: Bending moment at the point of interest do: Outer diameter of the shaft

k: Ratio of inner to outer diametersof the shaft (k = 0 for a solid shaft because inner diameter iszero)

Axial Stress

$$\sigma_a = \frac{4\alpha F}{\pi d_0^2(1-k^2)}$$

Where,

F: Axial force (tensile or compressive)

α: Column- action factor(= 1.0 for tensile load)

The term α has been introduced in the equation. This is known as column action factor. What isa column action factor? This arises due the phenomenon of buckling of long slender members which are acted upon by axial compressive loads.

Here, α isdefined as,

$$\alpha = \frac{1}{1-0.0044(L/K)} \quad \text{for } L/K < 115$$

$$\alpha = \frac{\sigma_{yc}}{\pi^2 nE}\left(\frac{L}{K}\right)^2 \quad \text{for } L/K > 115$$

Where,

n = 1.0 for hinged end n = 2.25 for fixed end

n = 1.6 for ends partly restrained, as in bearing K = least radius of gyration,

L = shaft length

σyc= yield stress in compression Stress due to torsion

$$\tau_{xy} = \frac{16T}{\pi d_0^3(1-k^4)}$$

Where,

T: Torque on the shaft

xy τ : Shear stress due to torsion Combined Bending and Axial stress

Both bending and axial stresses are normal stresses, hence the net normal stress isgiven by,

$$\sigma_x = \left[\frac{32M}{\pi d_0^3(1-k^4)} \pm \frac{4\alpha F}{\pi d_0^2(1-k^2)}\right]$$

The net normal stress can be either positive or negative. Normally, shear stress due to torsion is only considered in a shaft and shear stress due to load on the shaft is neglected.

Maximum Shear Stress Theory

Design of the shaft mostly uses maximum shear stress theory. It states that a machine member fails when the maximum shear stress at a point exceeds the maximum allowable shear stress for the shaft material. Therefore,

$$\tau_{max} = \tau_{allowable} = \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2}$$

Substituting the values of σx and τxy in the above equation, the final formis,

$$\tau_{allowable} = \frac{16}{\pi d_0^3 (1-k^4)} \sqrt{\left\{M + \frac{\alpha F d_0 (1+k^2)}{8}\right\}^2 + T^2}$$

Therefore, the shaft diameter can be calculated in terms of external loads and material properties. However, the above equation is further standardized for steel shafting in terms of allowable design stress and load factors in ASME design code for shaft.

Specifications

Shaft diameter: 12mm Inner Diameter: 10mm Material: mild steel

Chain

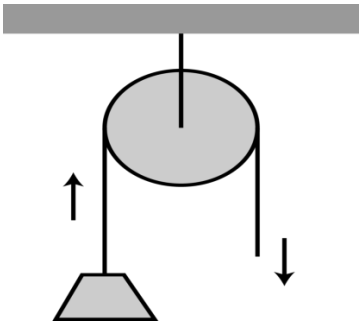
A belt is made up of a polymer material used to transmit power between two or more rotary shafts, mostly in parallel arrangement. Belts may be used to transmit power effectively. Belts are fitted over grooves in pulley sand and may also have twists between pulleys, and the shafts need not be parallel in all conditions. Flat belts, vee-belts, and round belts are some important types of belts. Here the V-belt has been looped over the driving motor and the driven wheel.

A belt is a loop of flexible material used to mechanically link two or more rotating shafts, most often in parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two-pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points. The belt drive can also be used to change the speed of rotation, either up or down, by using different-sized pulleys.

Pulley

A pulley is a wheel on an axle or shaft that is designed to support movement, change of direction of a taut cable or belt, or transfer of power between the shaft and cable or belt. In the case of a pulley supported by a frame or shell that does not

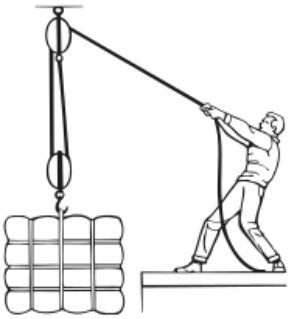
transfer power to a shaft but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave.



A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain. It is a simple machine that helps change the direction and point of application of a pulling force. Pulleys are usually used in sets designed to reduce the amount of force needed to lift a load. The magnitude of the force is reduced, but it must act over a longer distance. Consequently, the amount of work necessary for the load to reach a particular height is the same as the amount of work needed without the pulleys.

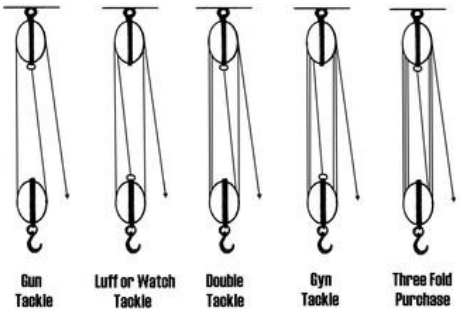
Block and Tackle

A block and tackle is a system of two or more pulleys with a rope or cable threaded between them, usually used to lift heavy loads.



Block and Pulley

A set of pulleys assembled so that they rotate independently on the same axle forma block.Two blocks with a rope attached to one of the blocks and threaded through the two sets of pulleys form a block and tackle. A block and tackle is assembled so one block is attached to fixed mounting point and the other is attached to the moving load. The ideal mechanical advantage of the block and tackle is equal to the number of parts of the rope that support the moving block.



Rope and Pulley Systems

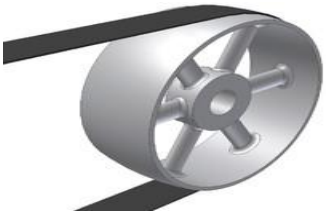
A machine consisting of a wheel over which a pulled rope or chain runs to change the direction of the pull used for lifting a load. Combinations of two or more pulleys working together reduce the force needed to lift a load.

Belt and Pulley

A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.

Chain and Pulley System

A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized. A belt drive is analogous to that of a chain drive, however a belt sheave may be smooth (devoid of discrete interlocking members as would be found on a chain sprocket, spur gear, or timing belt Flat belt on a belt pulley the mechanical advantage is approximately given by the ratio of the pitch diameter of the Sheaves only, not fixed exactly by the ratio of teeth as with gears and sprockets.

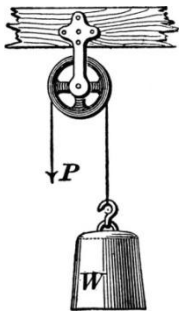


Different Types of Pulleys

Whenever the thought of pulleys come across our minds, the conventional picture that flashes is an assortment of some pulleys and ropes that pull up any large and heavy object. There is a common notion that pulleys are usually of one type with varying sizes. But this is not the case. There are various sizes and types of pulleys, but they are broadly classified into three main categories.

Immovable or Fixed Pulley

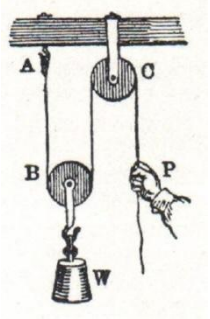
This is the simplest type of pulley system. In this, the wheel is fixed at a particular point like a pivot and works by changing the direction of the force applied.



Fixed Pulley

It is advantageous because you don't have to push an object or pull it directly to move it. But it requires a large effort to move the object and this is itsturn off when compared with other pulley systems.

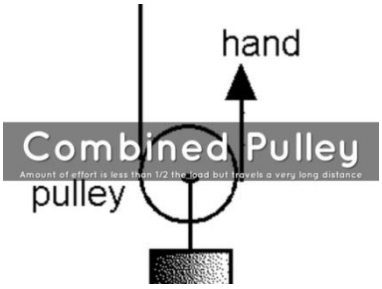
Movable Pulley



In this type of pulley, the wheel moves with the object it is displacing. This arrangement allows the pulley to lift the load with much lesser force. Only that much force is applied to the load as much as the force levied on the rope. Movable Pulley It usually multiplies the force actually applied to it by the user. Thus, with the application of a small force the load can be displaced thereby making the task easier.

Combined Pulley

These kinds of pulleys are a combination of both fixed and moveable pulleys. As such, they have the advantage of both of them. The user requires minimal application of force to lift an object without pushing or pulling it.



Combined Pulley Other than this conventional classification, there are also various types of pulleys that we never usually think about. These are highly modified and advanced to make a particular task easier.

Mechanism of a Working Pulley

One of the simplest types of pulley that can be explained is the pulley that has only one wheel. The end of the rope that has a weight attached to it is lifted up only when an equal amount of force is applied from the other end, either manually or mechanical

Example

If a weight of 100 Kg is attached to one end of the rope, then a force that is equal to 100 Kg needs to be applied on the other. But, this set- up is not helping as the force applied is the same amount as the weight that needs to be lifted. This is why more wheels are added to the set- up to ensure that the force applied is less than the weight that needs to be lifted. In the set- up described above, if one more pulley is added to the set- up, then the force required to lift off the 100 Kg weight reduces by half and only 50 Kg of force is required. So, keep on adding more wheels to the pulley set- up and you are lowering down the force that needs to be applied to lift off the weight. This is how a conventional and simple machine like a pulley is making life easier for us.

Advantages of Pulley

It is one of the simplest tools for heavy lifting. The force needs to move (lift) to heavy object reduce dramatically. It provides great support for the object. Force can be applied in any direction. It helps to change the direction force or movement. The

pulley system does not store energy while performing the work. Movable pulley – Pulley drive can also design so that it moves along with the load. There are a number of types of rope and pulley systems (combined pulley system). Multiple wheels are used to lift heavy objects.

Disadvantages of Pulley

The pulley work son friction. It may slip, then energy loss a sheet. To lift an object using combined pulley system, the actual distance traveled by the load increases (increase lifting distance). This means it takes more time to reach a required position when compared to movement without a pulley.

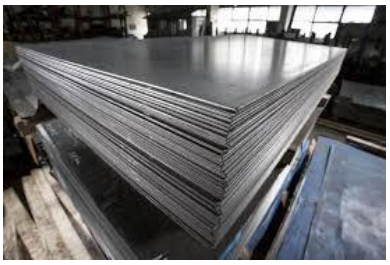
The drive elements experience continues tension on them, it causes the stretches. It may induce creep and fatigue of the rope (or any other drive element), eventually the rope breaks

Applications of Pulley

- A pulley system is used in an elevator to pull the weight of 5 people against gravity.
- A gym is one place where one can find a lot of machines using the pulley system.
- Flagpoles on a sailboat or a ship used a pulley system to hoist a flag or bring it down.
- Pulley systems are used in industrial machines across different applications from production floor to delivery room.

Results & Discussion

Sheetmetal

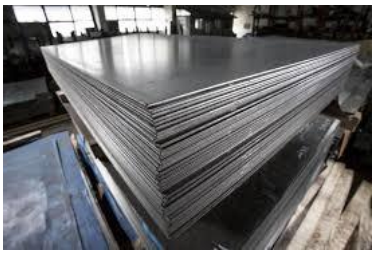


Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking, and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate. Sheet metal is

available in flat pieces or coiled strips. The coils are formed by running a continuous sheet of metal through a roll slitter. There are many different metals that can be made into sheet metal, such as aluminium, brass, copper, steel, tin, nickel, and titanium. For decorative uses, important sheet metals include silver, gold, and platinum (platinum sheet metal is also utilised as a catalyst). Sheet metal is used in automobile and truck (lorry) bodies, aeroplane fuselages and wings, medical tables, roofs for buildings (architecture), and many other applications. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines. Historically, an important use of sheet metal was in plate armour worn by cavalry, and sheet metal continues to have many decorative uses, including in horse tack. Sheet metal workers are also known as "tin bashers" (or "tin knockers"), a name derived from the hammering of panel seams when installing tin roofs.

Sheet metal is used to make the table. Material-Mild steel Size- 40*15 cm

Thickness - 1mm



Brush

A mop (such as a floor mop) is a mass or bundle of coarse strings or yarn, etc., or a piece of cloth, sponge, or other absorbent material attached to a pole or stick. It is used to soak up liquid, for cleaning floors and other surfaces, to mop up dust, or for other cleaning purposes. [1] The word is attested in English as early as 1496, but new refinements and variations of mop designs have been introduced from time to time. For example, American inventor Jacob Howe received a patent for a mop holder in 1893. A wet mop or moist mop is, in professional cleaning, used as the second step in the cleaning of a surface. The wet mop is swept over the surface to

dissolve and absorb fat, mud, and dried-in liquid contaminants. Professional wet mops consist of a flat sheet of microfiber textile or a sheet with a surface. A dry mop or dust mop is designed to pick up dry, loose contamination such as dust, earth, and sand from the surface of the floor. It consists of yarn and/or microfiber and is used as a first step in cleaning a floor. Is designed to pick up dry, loose contamination such as dust, earth, and sand from the surface of the floor. It consists of yarn and/or microfiber and is used as a first step in cleaning a floor.

Wheel

A tyre (American English) or tyre is a ring-shaped vehicle component that covers the wheel's rim to protect it and enable better vehicle performance. Most tyres, such as those for automobiles and bicycles, provide traction between the vehicle and the road while providing a flexible cushion that absorbs shock. The materials of modern pneumatic tyres are synthetic rubber, natural rubber, fabric, and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction, while the body provides containment for a quantity of compressed air. Before rubber was developed, the first versions of tyres were simply bands of metal that fitted around wooden wheels to prevent wear and tear. Early rubber tyres were solid (not pneumatic). Today, the majority of tyres are pneumatic inflatable structures, comprising a doughnut-shaped body of cords and wires encased in rubber and generally filled with compressed air to form an inflatable cushion. Pneumatic tyres are used on many types of vehicles, including cars, bicycles, motorcycles, buses, trucks, heavy equipment, and aircraft. Metal tyres are still used on locomotives and railcars, and solid rubber (or other polymer) tyres are still used in various non-automotive applications, such as some casters, carts, lawnmowers, and wheelbarrows.

A tire (American English) or tire (British English)is a ring- shaped vehicle component that covers the wheel’srimto protect it and enable better vehicle performance. Most tires, such as those for automobiles and bicycles, provide traction between the vehicle and the road while providing a flexible cushion that absorbs shock. The materials of modern pneumatic tires are synthetic rubber, natural rubber, fabric and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction while the body provides containment for a quantity of compressed air. Before rubber was developed, the first versions of tires were simply bands of metal that fitted around wooden wheels to prevent wear and tear. Early rubber tires were solid (not

pneumatic). Today, the majority of tires is pneumatic inflatable structures, comprising a doughnut- shaped body of cords and wires encased in rubber and generally filled with compressed air to form an inflatable cushion. Pneumatic tires are used on many types of vehicles, Including cars, bicycles, motorcycles, buses, trucks, heavy equipment, and aircraft. Metal tires are still used on locomotive sand railcars, and solid rubber (or other polymer) tires are still used in various non-automotive applications, such as some casters, carts, lawnmowers, and wheelbarrows.

Hub material: steel

Tire: rubber

Etymology and spelling:

Historically, the spelling was "tire" and is of French origin, which comes from the word tire, to pull. The reason for this naming is that originally "tire" referred to iron hoops or thick wires bound to carriage wheels. In French blacksmithing the word for a drawn iron rod is a tire, or pull. The same word was often used for any metal drawing or rolling process. In an article in the London Magazine/Intelligencer of 1853 "The Utility of Broad Wheels," it explains that the common practice was to bend two rods, called "tires," into hoops and bind them to the wheel, but it is preferable to use an iron band, called a "broad wheel" rather than the rods, because as the rods wear they bite into the wheel. Another early mention of a tire in English is in The Scots Magazine, Volume 15 By James Boswell (1753).Another origin of "tire" is provided by Online Etymology Dictionary, essentially that the word is a short form of "attire," and that a wheel with a tire isa dressed wheel. Some other etymologists may share this view. The spelling tire does not appear until the 1840s when the English began shrink fitting railway car wheels with malleable iron. Nevertheless, traditional publishers continued using tire. The Times newspaper in Britain was still using tire slate as 1905.The spelling tire, however, began to be commonly used in the 19th century for pneumatic tires in the

UK. The 1911Encyclopediastates that "[t]he spelling 'tire' is not now accepted by the best English authorities, and is unrecognized in the US", while Fowler's Modern English Usage of 1926 says that "there is nothing to be said for 'tyre', which is etymologically wrong, as well as needlessly divergent from our own [sc. British] older & the present American usage".However, over the course of the 20th century tyre became established as the standard British spelling.

History

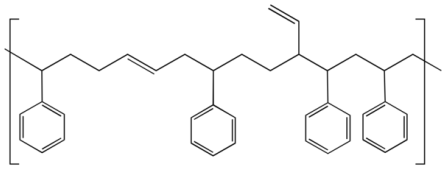
The earliest tires were bands of leather,[6] then iron, (later steel), placed on wooden wheels, used on cart sand wagons. The tire would be heated in a forge fire, placed over the wheel and quenched, causing the metal to contract and fit tightly on the wheel. A skilled worker, known as a wheelwright, carried out this work. The outer ring served to "tie" the wheel segments together for use, providing also a wear- resistant surface to the perimeter of the wheel. The word "tire" thus emerged as a variant spelling to refer to the metal bands used to tie wheels.

The first practical pneumatic tire was made in 1888[note 1] for his son Johnnie's tricycle, in May Street, Belfast by Scots- born John Boyd Dunlop, proprietor of one of Ireland's most prosperous veterinary practices. It was an effort to prevent the headaches his 10- year- old son was given by jarring while riding on rough pavements. His doctor, John, later Sir John Fagan, had prescribed cycling as an exercise for the boy and, a regular visitor, Fagan participated in the development of the first pneumatic schemes. In Dunlop's tire patent specification dated 31October 1888 his interest is only in its use in cycle sand light vehicles. In September 1890 he was made aware of an earlier development but the company kept the information to itself.

In 1892 Dunlop's patent was declared invalid because of prior art by forgotten fellow Scot Robert William Thomson of London (patents London 1845, France 1846, USA 1847), although Dunlop is credited with "realizing rubber could withstand the wear and tear of being a tire while retaining its resilience".[8] JB Dunlop and Harvey du Cros together worked through the ensuing considerable difficulties. They employed inventor Charles Kingston Welch and also acquired other right sand patents which allowed them to protect their business's position. The development of this technology hinged on myriad engineering advances. In terms of materials, the vulcanization of natural rubber which he patented in 1844 is credited to Charles Good year and Robert William Thomson. Synthetic rubbers were invented in the laboratories of Bayer in the 1920s.In 1946; Michelin developed

the radial tire method of construction. Michelin had bought the bankrupt Citroën automobile brand in 1934, so it was able to fit this new technology immediately. Because of its superiority in handling and fuel economy ,use of this technology quickly spread throughout Europe and Asia. In the U.S., the outdated bias- ply tire construction persisted, with market share of 87% as late as 1967.Delay was caused by tire and automobile manufacturers in America concerned about transition costs. In 1968, Consumer Reports, an influential American magazine, acknowledged the superiority of radial construction, setting off a rapid decline in Michelin's competitor technology. Even in the U.S., the radial tire now has a market share of 100% .Wheel support There are two aspects to how pneumatic tires support the rim of the wheel on which they are mounted .First, tension in the cords pull on the bead uniformly around the wheel, except where it is reduced above the contact patch. Second, the bead transfers that net force to the rim. Air pressure, via the ply cords, exert tensile force on the entire bead surrounding the wheel rim on which the tire is mounted, pulling outward in a 360- degree pattern. Thus the bead must have high tensile strength. With no force applied to the outer tread, the bead is pulled equally in all directions, thus no additional net force is applied to the tire bead and wheel rim. However, when the tread is pushed inward on one side, this releases some pressure on the corresponding sidewall ply pulling on the bead. Yet the sidewall ply on the other side continues to pull the bead in the opposite direction. Thus the still fully tensioned sidewall ply pulls the tire bead and wheel rim in the direction opposite to the tread displacement and matching the total force applied to push the tread inward. This sidewall ply to bead tension support is a big reason for cross-ply cord tire construction. The cross- ply cord arrangement orients the cords to more directly support the sling. However, with improved combinations of cord and rim material construction materials and manufacturing techniques, combined with ongoing focus and research on tire efficiency and durability, it became feasible to manufacture radial- ply cord tires, which for many applications aiming for high speed without excessive loads, outperform similar cross- ply cord tire designs with reduced tire temperature, decreased rolling resistance and greater longevity. Manufacturing Pneumatic tires are manufactured in about 450 tire factories around the world. Over one billion tires are manufactured annually, making the tire industry a major consumer of natural rubber. It is estimated that by 2015, 1.72 billion tires are expected to be sold globally. Tire production starts with bulk raw materials such as rubber, carbon black, and chemical sand produce numerous specialized components that are assembled and cured. Many kinds of rubber are

used, the most common being styrene- but adienecopolymer. This article describes the components assembled to make a tire, the various materials used, the manufacturing processes and machinery, and the overall business model.



Styrene- butadiene copolymer (chemical structure pictured) is the most popular material used in the production of rubber tire. In 2004, $80 billion of tires were sold worldwide, in 2010 it was$140 billion(approximately 34% growth adjusting for inflation).The top five tire manufacturing companies by revenue are Bridgestone, Michelin, Goodyear, Continental, and

Pirelli. Materials: the materials of modern pneumatic tires can be divided into two groups, the cords that make up the ply and the elastomeric which encases them.

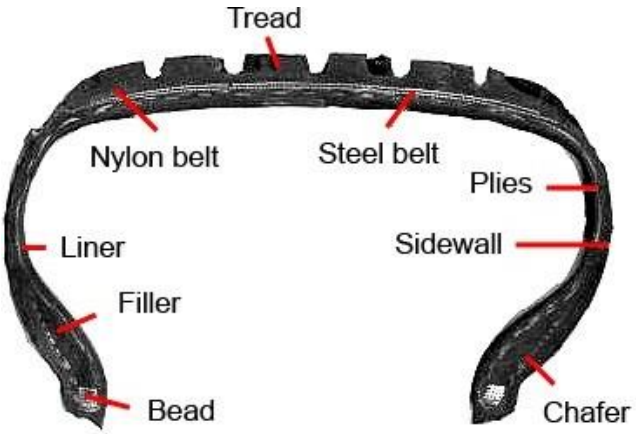
Cords The cords, which form the ply and bead and provide the tensile strength necessary to contain the inflation pressure, can be composed of steel, natural fibers such as cotton or silk, or synthetic fibers such as nylon or kevlar.Elastomer The elastomer, which forms the tread and encases the cords to protect them from abrasion and hold them in place, is a key component of pneumatic tire design. It can be composed of various composites of rubber material – the most common being styrene- but a diene copolymer with other chemical compound such as silica and carbon black. Rolling Resistance Optimizing rolling resistance in the elastomer material is a key challenge for reducing fuel consumption in the transportation sector. It is estimated that passenger vehicles consume approximately 5~15% of its fuel to overcome rolling resistance, while the estimate is understood to be higher for heavy trucks. However, there is a trade- off between rolling resistance and wet traction and grip: while low rolling resistance can be achieved by reducing the viscoelastic properties of the rubber compound (low tangent (δ)), it comes at the cost of wet traction and grip, which requires hysteresis and energy dissipation (high tangent (δ)). A low tangent (δ) value at 60 °C is used as an indicator of low rolling resistance, while a high tangent (δ) value at 0 °C is used as an indicator of high wet traction. Designing an elastomer material that can achieve both high wet

traction and low rolling resistance is key in achieving safety and fuel efficiency in the transportation sector.

The most common elastomer material used today is a styrene- butadiene copolymer. It combines butadiene, which is a highly rubbery polymer (Tg = −100 °C) that has low hysteresis and thus offers good rolling resistance, with styrene, which is a highly glass polymer (Tg= 100 °C) that has high hysteresis and thus offers good wet grip properties in addition to wear resistance.

Therefore, the ratio the two polymers in the styrene- butadiene copolymer is considered key in determining the glass transition temperature of the material, which is correlated to its grip and resistance properties. Materials science research efforts are underway to improve such properties of elastomers. For instance, this involves modifying the microstructure of the copolymer (for instance, using solution styrene butadiene rubber (SSBR) to control the addition of vinyl butadiene units) as well as the macrostructure of the polymer (such as the width of molecular weight distribution (MWD)).Current investigation also involves looking at the fictionalization of the elastomer through the addition of filler materials such as silica and carbon black, as well as testing other nano- fillers such as Nanocellulose crystals, carbonnanotubes, and graphene.

Components



Tire cross section showing components.

A tire carcass is composed of several parts: the tread, bead, sidewall, shoulder, and ply.

Two mountain bicycle tires with different tread patterns. The tread is the part of the tire that comes in contact with the road surface. The portion that is in contact with the road at a given instant in time is the contact patch. The tread is a thick rubber, or rubber/composite compound formulated to provide an appropriate

level of traction that does not wear away too quickly. The tread pattern is characterized by the geometrical shape of the grooves, lugs, voids and sips. Grooves run circumferentially around the tire, and are needed to channel away water. Lugs are that portion of the tread design that contacts the road surface. Voids are spaces between lugs that allow the lugs to flex and evacuate water. Tread patterns feature nonsymmetrical (or non- uniform) lug sizes circumferentially to minimize noise levels at discrete frequencies. Sipes are valleys cut across the tire, usually perpendicular to the grooves, which allow the water from the grooves to escape to the sides in an effort to prevent hydroplaning. Treads are often designed to meet specific product marketing positions.

High performance tires have small void ratios to provide more rubber in contact with the road for higher traction, but may be compounded with softer rubber that provides better traction, but wears quickly. Mud and snow (M&S) tires are designed with higher void ratios to channel away rain and mud, while providing better gripping performance.

The rain groove is a design element of the tread pattern specifically arranged to channel water away from the footprint. Rain grooves are circumferential in most truck tires. Many high performance passenger tires feature rain grooves that are angled from the center toward the sides of the tire. Some tire manufacturers claim that their tread pattern is designed to actively pump water out from under the tire by the action of the tread flexing. This results in a smoother ride in different types of weather. 6.1.4 Sipe Tread lugs often feature small narrow voids, or sipes, that improve the flexibility of the lug to deform as it traverses the footprint area. These reduce shear stress in the lug and reduce sheat build up. Testing of identical siped and unsiped tires showed measurable improvements in snow traction and ice braking performance, however diminishing and extending braking distances on wet and dry pavement by a few feet on siped tires. Off- road tire enthusiasts have been siping tires for years for greater traction, as many manufacturers now offer already siped off- road tires. 6.1.5 Wear bar Wear bars (or wear indicators) are raised features located at the bottom of the tread grooves that indicate the tire has reached its wear limit. When the tread lugs are worn to the point that the wear bars connect across the lugs, the tires are fully worn and should be taken out of service. Most wear bars indicate a remaining tread depth of 1.6 millimeters (0.063 in) and are deemed “worn out” at that point.[28] 6.2 Bead The bead is the part of the tire that contacts the rim on the wheel. The bead is typically reinforced with steel wire and compounded of high strength, low flexibility rubber. The bead seats tightly

against the two rims on the wheel to ensure that a tubeless tire holds air without leakage. The bead fit is tight to ensure the tire does not shift circumferentially as the wheel rotates. The width of the rim in relationship to the tire is a factor in the handling characteristics of an automobile, because the rim supports the tire's profile

Sidewall

Sidewall Uneven sidewall wear, down to fabric plies, due to significant under-inflation. The sidewall is that part of the tire that bridges between the tread and bead. The sidewall is largely rubber but reinforced with fabric or steel cords that provide for tensile strength and flexibility. The sidewall contains air pressure and transmits the torque applied by the drive axle to the tread to create traction but supports little of the weight of the vehicle, as is clear from the total collapse of the tire when punctured. Side walls are molded with manufacturer- specific detail, government mandated warning labels, and other consumer information, and sometimes decorative ornamentation, likes whitewalls.

Vehicle Application

Tires are classified into several standard types, based on the type of vehicle they serve. Since the manufacturing process, raw materials, and equipment vary according to the tire type, it is common for tire factories to specialize in one or more tire types. In most cases, factories manufacturing passenger and light truck radial tires are separate and distinct from those that off-the road tires.

Conclusion

This design of eco-friendly road cleaning system can be used to clean any kind of remote places. As the chain mechanism selected can consume much less power so it will be the power saving and cost saves as well. Also, there is a need of a brush which operates automatically. As well as provides new add one of sanitization of road. Successfully designed, analyzed and fabricated. This project works implements the manually operated eco-friendly road cleaner for road cleaning that reducing the cost, human efforts as well as time. It is the best alternative for automated road cleaning machine during power crisis. It is found that the existing road cleaning machines uses petrol and diesel. It can cause pollution and also the vibration produced in the machine causes noise pollution. While manual cleaning may cause healthy problem as the person directly comes in contact with dust. Also,

the shoulder problem due to continuously sweeping occurs. A manually operated eco-friendly road cleaner is an alternative concept for avoiding such problems. The manually operated eco-friendly road cleaner can work very efficiently with respect to covering area, time and cost of road cleaning process compared with the existing machineries. Also it is economical. It was seen while testing of machine, that the cleaning is less effective where the road seems to be very rough and damaged.

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CHAPTER 34

WALL CLIMBING ROBOT WITH PERMANENT MAGNETS FOR INSPECTION

J.Arunprasad*, R.Rajesh, R.Thirugnanasambantham, M.Chellappan & S.Sugumar
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur, India

R.Kiruthika
Department of Electronics and Communication Engineering
Dhanalakshmi Srinivasan University, Samyapuram

Abstract

A wall climbing robot (WCR) inspects walls made of ferrous, nonferrous, and concrete materials. Due to the ferrous material in the furnace walls, the magnetic-based WCR is primarily used to detect surface cracks, surface irregularities, and similar defects. Consequently, the furnace walls utilize more magnetization power, which causes an inertial problem when climbing and prevents the climber from reaching higher heights within the furnace and tanks. A miniature WCR equipped with a permanent magnetic adhesion mechanism has been fabricated for research purposes to move faster and to greater heights. Using a tool, the robot follows complex paths along specific wall surfaces at a specified speed using the modified WCR. The modified WCR is designed to move horizontally, vertically, and overhung positions. There is a clearance between the magnets and the surface so the wheel can roll between them rather than being directly adhered to the surface. The robot's Static force analysis has been conducted to derive design parameters about adhesion and locomotion mechanism.

Keywords: *Magnetic WCR, Permanent magnets, Complex path, indirect adhesion, Static force, Design parameters.*

1. Introduction

It is a special type of mobile robot that can climb walls. The wall climbing robot requires a special adhesion mechanism to support it to absorb the vertical walls, as the workspace of these robots often lies in the vertical plane. Developing a wall-climbing robot is, therefore, more challenging than a mobile robot because the workspace is often in the vertical plane. Robots that climb walls are attractive because they can enhance operational efficiency and protect human health and safety. The wall climbing robot has been developed for several decades and is now widely applied in many fields. This includes inspecting and maintaining storage tanks at nuclear power plants and petrochemical companies, ship hull welding and cleaning, fire rescue robots, and cleaning high-rise buildings. As a branch of the mobile robot family, climbing robots can traverse vertical walls and tops. In various environments, climbing robots may be used for exploration, surveillance, inspection, and military purposes.

There are numerous applications for climbing robots today, ranging from carrying aid for rescue to inspecting the nuclear industry and autonomous vehicles for space exploration. Typ-wheeled climbing robot designs pose a challenge, especially when using climbing robots for space exploration or exploring environments. Modern industrialization has created an unfriendly industrial environment, making climbing robots highly demanding. Climbing robots generally rely on a vacuum suction or magnetic attachment to adhere to surfaces. As a result, climbing robots cannot be used in a wide variety of environments that threaten humans or are inaccessible because they require smooth or magnetic surfaces to function.

2. Principle of locomotion

According to the locomotion mechanism, the wall climbing robots can be divided into four groups: wheeled locomotion, tracked locomotion, legged locomotion, and locomotion based on arms and grippers. According to the adhesion mechanism, the wall climbing robots can be divided into four groups: magnetic adhesion, vacuum sucker, propeller, and dry adhesion using nanofabrication techniques. Different adhesion mechanisms and locomotion mechanisms can be combined to form different types of wall-climbing robots [1-3].

The first wall climbing robot can be dated back to the 60s last century, developed by Nishi. This wall-climbing robot has a large volume and is very heavy, using a single vacuum-sucking cup. Later, around the 80s, the wall climbing robot was developed rapidly. Various wall climbing robots have recently been developed for wall cleaning, inspecting, maintenance, etc. This robot type is lightweight and elegant due to pneumatic actuators, but it still needs the following system to secure its safety. An increasing interest in developing special climbing robots has been witnessed in the last decade. Motivations are typically to increase the operation efficiency in dangerous environments or difficult-to-access places and to protect human health and safety in hazardous tasks [3-5].

Climbing robots with the ability to maneuver on vertical surfaces are currently being strongly requested by various industries and military authorities to perform dangerous operations such as inspection of high-rise buildings, spray painting and sandblasting of gas tanks, maintenance of nuclear facilities, aircraft inspection, surveillance and reconnaissance, assistance in firefighting and rescue. Operations, etc. Such capabilities of climbing robots would not only allow them to replace human workers in those dangerous duties and eliminate costly scaffolding [5-7].

Three main types of attachment mechanisms are used: suction, magnetic and dry adhesion mechanisms. Concerning the locomotive mechanism, climbing robots are of six categories: legged type, wheel-driven type, tracked type, translation type, cable-driven type, and combined type.

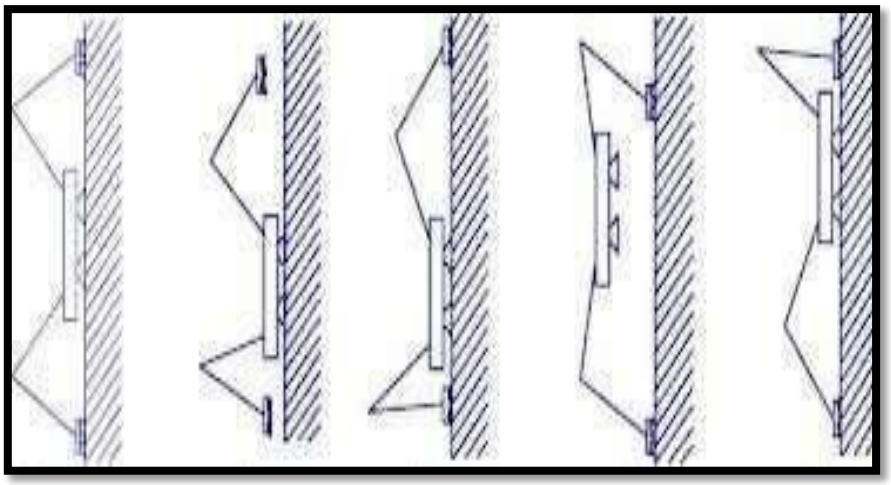

Figure 1. Legged Type Mechanism

Figure 1 shows the 2-legged type mechanism. From the adhesion point of view, climbing robots can be classified into five categories: suction type, magnetic type, gripping type, rail-guided type & biomimetic type.

2.1 Techniques for adhesion

In the suction type, the robot carries an onboard pump or vibration mechanism to create a vacuum inside cups pressed against the wall or ceiling. This effect depends on a smooth impervious surface to create enough force to hold the robot. Magnetic adhesion has been implemented in wall climbing robots for specific applications such as nuclear facilities or oil and gas tank inspection.

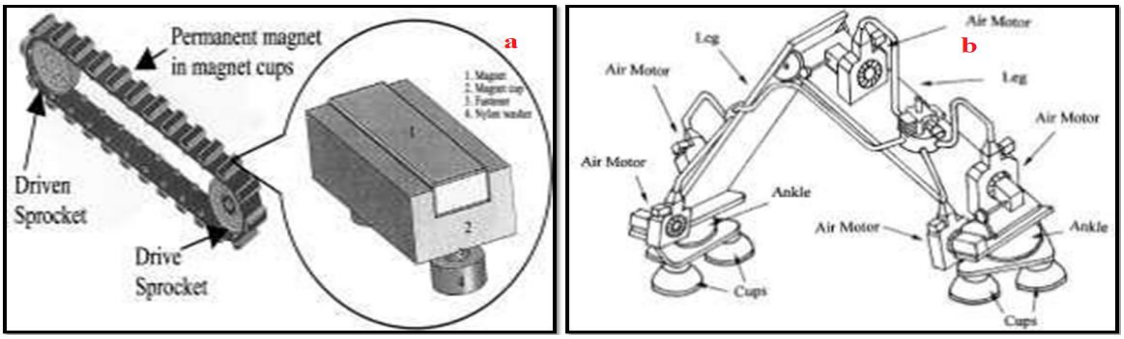

Figure 2 (a & b). Types of adhesion mechanism

The two systems, namely the Magnetic type and suction type adhesion system, are shown in figure 2. Magnetic attachment can be highly desirable for its inherent reliability in specific cases where the surface allows. Other novel adhesion mechanisms, like bio-inspired dry adhesion using synthetic fibrillar adhesives, have been reported but are very sensitive to contaminants on wall surfaces.

The magnetic WCR falls under three categories. They are chain-type locomotion, powered magnetic wheels. Air gap maintained magnetic adhesion. The WCR with multi-suction cups adopted a legged or crawling mechanism. For the WCRs with only a suction cup, a wheeled mechanism is usually adapted, and there is relative movement between the suction cup and the wall, called sliding suction cup because traditional suction cups cannot slide on the walls while staying attached. With a comparatively high velocity, the sliding sucker wheeled and fixed sucker tracked types cannot overcome obstacles. The fixed-sucker walking beam type can carry a relatively heavy payload, although it climbs slowly. Another sucker type is a multi-legged robot that adapts to walls with irregular obstacles [8-10].

The previous adhesion techniques make the robots suitable for moving on walls and ceilings. However, it is difficult for them to move on irregular surfaces and surfaces like wire meshes. To surpass this difficulty, some robots climb through artificial structures or natural environments by gripping themselves to the surface where they are moving over. These robots typically exhibit grippers or other specially designed gripping systems.

2.2 New adhesion principle

Here the new adhesion principle is that the arrangements have been made such that the magnets are not directly adhesive to the surface. Instead, there is a clearance between the magnet and the surface so that the wheels roll between the surface and the robot base.

2.2.1 Solid Modeling of Proposed WCR

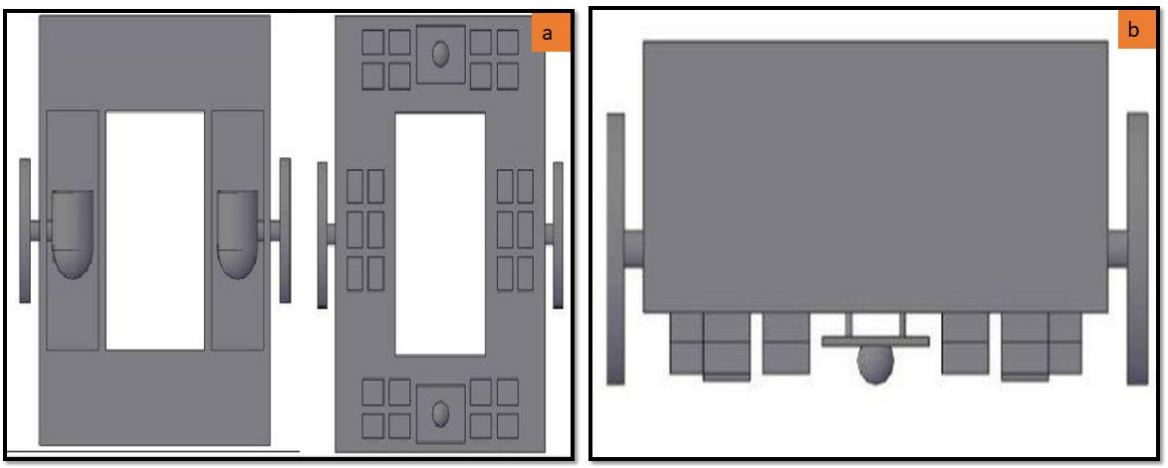

Figure 3. Isometric Views of the Proposed WCR

Figure 3 (a & b) shows the isometric views of the Proposed WCR. The model consists of permanent magnets attached to the robot body, two motors of 12 Nm torque, and caster wheels on the remaining side of the body. The battery that supplies the motor's power is

placed in the slots provided in the mechanical setup. There is a space in the robot as the volume of the inspection system is to be incorporated and installed with a tool for inspection. The robot is programmed so that it covers the entire part of the path and can be stopped for inspection [11].

2.3 Block diagram

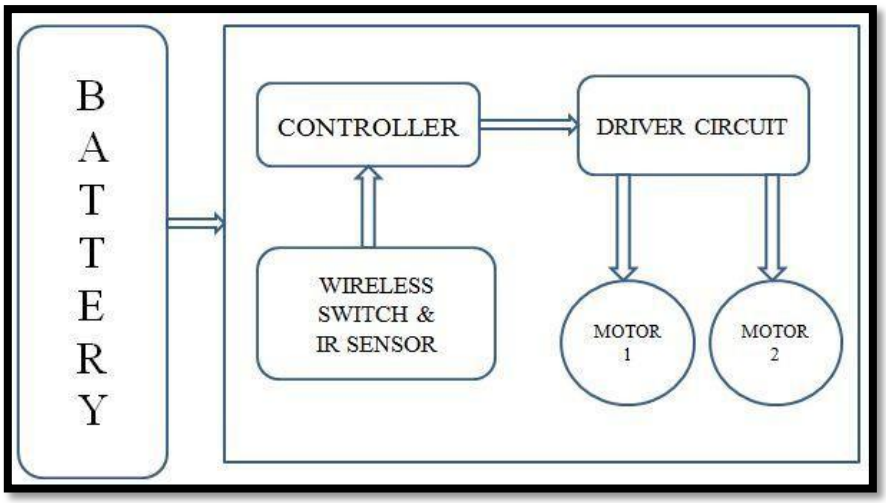

Figure 4. Block diagram

The block diagram of the Proposed WCR is shown in figure 4. The battery power is supplied to various components. These components are the microcontroller, driver circuit board, IR sensor, and Motors. The input from IR sensor is given to the microcontroller. Inputs from the real world will be sent to a microcontroller via an IR sensor. The data are processed in the microcontroller, and the required signals are sent to the actuator. The camera is interfaced with the robot, and video streaming is performed. Precise positioning of the robot is done by having wireless switches. The dimensions are as follows; for the robot's inspection device to be fixed, the space required is 300mm x180mm x100mm. The entire body, including the robot's inspection device, is 350mm x 480mm x 150mm. Depending upon the weight of each component, the permanent magnet is selected. Attraction force plays an important role in holding the setup in the wall from falling [12].

3. DESIGN OF PROPOSED WCR

3.1.1 Static friction on the vertical wall

Static friction is the friction resisting initial motion, while Dynamic Friction is the friction between objects already in motion. Static friction acts at the interface between two motionless surfaces. Static friction acts in the direction opposite to the external force tending to produce motion, and increases with the external force until motion is initiated.

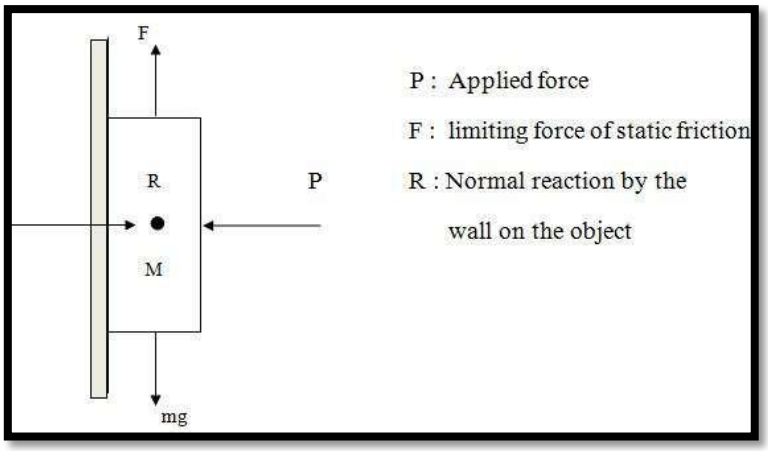

Figure 5. Static friction on a vertical surface

The static friction of an object on a vertical surface is shown in figure 5. Here g is the acceleration due to gravity opposing the object to climb up. M is the mass of the robot. F is the required limiting force of the maximum static friction force for the robot to climb up. R is the required normal from the wall. So, there should be an equal applied force of P to make the robot adhere to the surface [13-15].

3.1.2 Static balance analysis

Here the robot mass and payload of 10 kg are considered. For 4 wheels, the normal force due to frictional force of 10kg is given by.

$$F <= \mu (N1 + N2 + N3 + N4) \quad \ldots\ldots (1)$$

The normal force due to friction is given in equation (1). HereN1 to N4 is a normal force of four wheels.

$$F <= \mu N * 4 \quad \ldots\ldots (2)$$

The frictional force of the robot is given in equation (2). The robot's force is 10 kg, including the individual component mass and the payload.

By substituting the values, we get as,

$$10 <= 0.6 * N*4 \quad \ldots\ldots (3)$$

$$4*N >= 16.67 \text{ kg} \quad \ldots\ldots (4)$$

For the factor of safety, we take frictional force as 20 kg. Calculating the values in equation (4) gives us the normal force as 5 kg. Thus, to obtain normal force, the Holding force of the magnet should be around 20 kg to maintain friction between the wheel and the surface. Hence the holding force is 5 kg for one wheel [16].

Now calculate the acceleration force the motor requiresto drive the vehicle to climb up.

$$Facc = m * a \quad \ldots\ldots (5)$$

Were,

Facc is the accelerating force required for the robot, m is the robot's mass, and the payload a is the acceleration the robot can move. Equation (5) is the required acceleration for the robot.Now substituting the values in equation (6)

$$Facc = m * a \quad \text{.....(6)}$$
$$= 200\ N * (d^2v / dt^2) \quad \text{.....(7)}$$
$$= 200\ N * (2\ m / 1s^2) \quad \text{..... (8)}$$
$$= 400\ N \quad \text{.....(9)}$$

By substituting the values, we get force as 400 N for one wheel, considering two wheels 800N.

Now calculating torque, considering one wheel motor torque, we substitute the known values in equation (8)

T = (normal force F + acceleration force Facc) * co-eff. of friction* radius

$$= (100 + 400) * 0.6 * 0.04 \quad \text{..... (10)}$$
$$= 10\ Nm$$

From equation (10), the required torque of a motor can be calculated. By substituting the values, we get 10 Nm as the required torque for one motor. Considering a robot with a two-wheel drive, we get a torque of 20Nm.

3.2 Dynamic Balance Analysis

For the vehicle to climb upward, the following conditions should be satisfied. Since the robot contains two motors, the analysis made as

$$[(T1/r) + (T2/r)] > mg \quad \text{..... (11)}$$
$$(Teff/r) > (mg/2) \quad \text{..... (12)}$$

Equation (12) shows the dynamic balance analysis of the robot. Here T1 is the torque required for the first motor, T2 is the torque required for the second motor, and Teff is the effective torque of the two motors.

Substituting the known values then, we get as,

$$(8/0.04) > (10*10/2)$$
$$(14)\ 200 > 50$$

Thus, the required condition is satisfied. For any disturbance within 10kg, the Proposed WCR will maintain the static and dynamic balance so that the robot will not fall or deviate from its track. As the robot uniformly shares the magnets, the normal force is maintained independent of the weight of the individual components of the robot.

4. Selection of Magnets

In this project, permanent magnets are used. The permanent magnets are available in different sizes and with different magnetic strengths. Depending upon the attraction force needed, the magnets were chosen accordingly. A magnet is a material or object that

produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets.

Ferromagnetic materials can be divided into magnetically "soft" materials like annealed iron, which can be magnetized but do not tend to stay magnetized, and magnetically "hard" materials, which do. Permanent magnets are made from "hard" ferromagnetic materials such as alnico and ferrite that are subjected to special processing in a powerful magnetic field during manufacture to align their internal microcrystalline structure, making them very hard to demagnetize. To demagnetize a saturated magnet, a certain magnetic field must be applied; this threshold depends on the coercivity of the respective material. "Hard" materials have high coercivity, whereas "soft" materials have low coercivity.

Permanent magnets can largely be classified into the ferrite magnets, the samarium cobalt (Sm -Co) magnets, and the neodymium iron boron (Nd-Fe-B) magnets. The Sm-Co magnets are the most expensive, Nd- Fe-B magnets come next, and the ferrite magnets are relatively inexpensive. A good permanent magnet must have a large spontaneous magnetization in zero fields (i.e., a high retentivity) and a high coercive force to prevent its being easily demagnetized by an external field [17].

4.1 Calculation of Flux

Some notations are considered to calculate the flux coming from the magnet, and that should be applied.

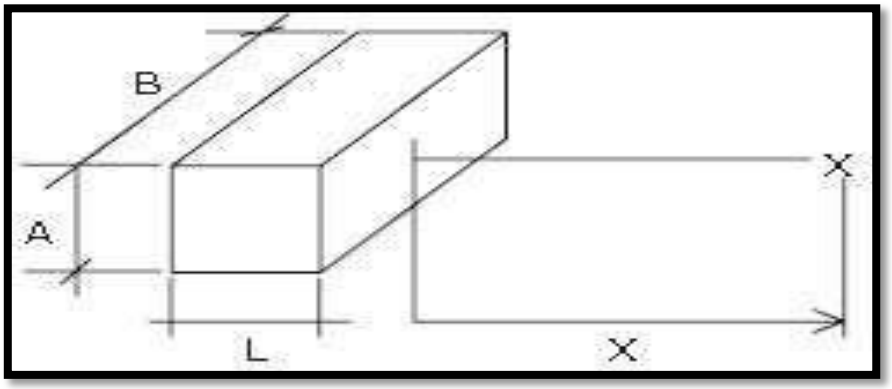

Figure 6. Dimensions of magnet

The dimensions of the magnet are shown in figure 6.

Were,

A – Width of the magnet

B – Length of the magnet

L – Thickness of the magnet

X – Distance between the surface and the wall

For the given dimension, the distance from which the flux is to be measured is calculated in equation (15).

$$B_x = \frac{B_r}{\pi}\left[\tan^{-1}\left(\frac{AB}{2X\sqrt{4X^2+A^2+B^2}}\right)-\tan^{-1}\left(\frac{AB}{2(L+X)\sqrt{4(L+X)^2+A^2+B^2}}\right)\right]$$

Were,

B_x total magnetic flux gauss

B_r residual flux density in gauss

B length of the magnet in mm

A width of the magnet in mm

L thickness of the magnet in mm

4.1 Calculation of Pull Force

The force required to pull a magnet free from a flat steel plate using force perpendicular to the surface. It is the limit of the holding power of a magnet.

$$F = 0.58\ B_r^2\ L_m\ (A)^{1/2} \text{ (approximate)} \qquad (16)$$

Were,

F - Force in kilogram

B_r - Residual magnetic flux in kilogauss L_m - Thickness of the magnet in mm

(A) - Pole area of the magnet in square mm

The pull force of the magnet is shown in equation (16). By substituting the values of the pull force for the dimension 254mm X 125mm X 125mm of Nd-Fe-B of grade 50, nickel plated gives a surface gauss of 5765 and pull force of 18 kg, for 1mm air gap distance, the same magnet produces gauss of 5105 and pull force of 10kg. Knowing the pull force, the required magnets are preferred. The required magnets are chosen to have the attraction force to attach the robot to the wall. With this force, the motor should be able to drive the vehicle against gravity in horizontal planes, vertical planes, and over-hung positions [18].

5. Results and discussion

A prototypic model is done for research purposes. The model size is 100mm x 60mm x 30 mm, carrying up to 2kg. It is operated with an 89C51 board, an xbee transmitter, and a receiver. For the transmitter, the user interface is made by Lab View.

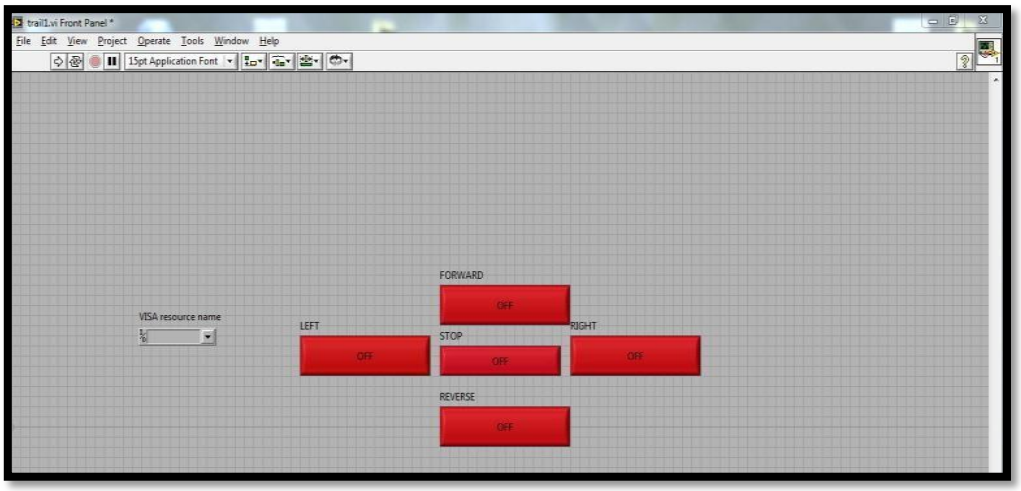

Figure 7. Frontend in Labview

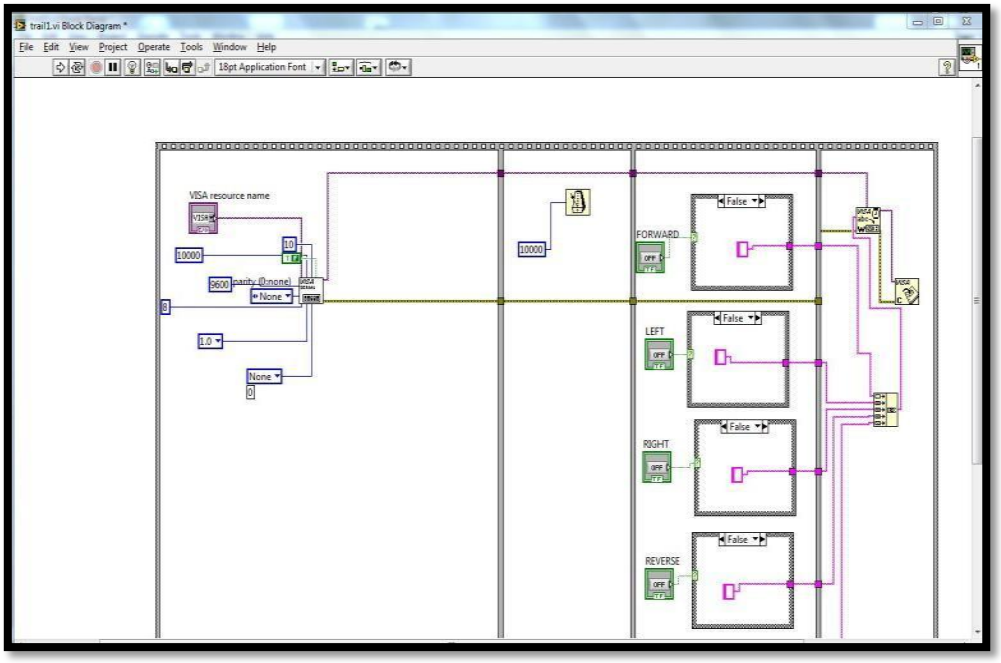

Figure 8.Functional View in Lab view

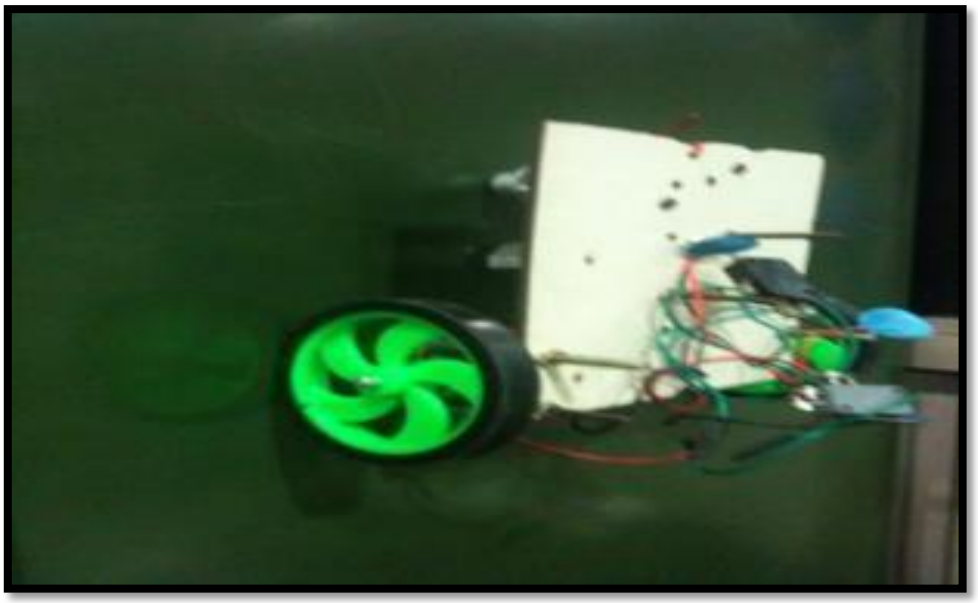

Figure 9. WCR is moving in various direction

The control and function view using the xbee module is indicated in figure 7 and 8. In the front end, the communication ports can be selected. The buttons are placed in the front end, and the embedded C program is coded in 89C51. The motors are driven using the optocoupler board. Further connections are given. Four directional controls and one-stop button control are made in the Labview front end. They are the Forward, Right, Left, Reverse, and stop button. When a button in a controlled space in Lab view is pressed, the wall climber moves in the required direction. A camera is fixed in the base so real-time streaming or the pathway can be stored and processed for future implementation. A small prototype is made for research purposes, shown in figure 9. Here, the camera is a pen-type in which the path can be stored.

Conclusion

This paper aims to design a wall climber using permanent magnets to inspect the furnace**.** A proposed wall climbing robot with a permanent magnetic adhesion mechanism for inspecting the furnace is put forward. The design and fabrication of the WCR prototype model were done successfully. Mathematical design calculations for static and dynamic force analysis, including the payload and robot workspace, are performed. Experimentation and testing are made through wireless links. A complete literature survey has been carried out successfully for WCR.

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CHAPTER 35
THERMOPHYSICAL PROPERTIES OF NANO ERYTHRITOL FOR PHOTOTHERMAL ENERGY CONVERSION AND STORAGE

P.Kalidos*
School of Engineering and Technology
Dhanalakshmi Srinivasan University, Samayapuram, Tamil Nadu, India

S.Anbu, K.Elangovan, K.Velmurugan & P.Arunkumar
Department of Mechanical Engineering
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu, India

Abstract

In this study, MWCNTs (Multi walled carbon nanotubes) and dispersed in erythritol of composition 1 and 3wt.% in the ratio of 1:1. Thermal cycling of the samples were done up to 50cycles. The characterization DSC, SEM, XRD, TGA were reported in this study. The optical absorbance of nanomaterial is reported in the wavelength ranges from 200 to 800 nm. The specific heat of the samples are reported, the drastic changes in the specific heat are observed at 120°C, and the corresponding values at 1 and 3wt.% is found to be 11.7 and 7.20 J/g K. The latent heat 1 and 3wt.% of the thermal cycled samples decreased from 330.29 to 329.17 J/g and 328.67 to 327.32 J/g. The FT-IR result reveals that there are no new bonds formed, and PCM doesn't chemically interact with the nanomaterials. The thermal degradation of all the samples is found between 290 to 320°C, respectively. The photothermal conversion performance of the pure PCM, 1wt.% and 3wt.% were done using a solar simulator with solar insolation of 975W/m². Compared to pure PCM, the temperature rise was higher for both nano-enhanced PCMs.

Keywords *:Phase change materials, Energy storage, Optical absorbance, hybrid nanomaterials.*

Introduction

Solar energy is one of the most precious energy source in today's world. Solar energy is being preferred due to its availability and easy accessibility. It is also known that the cost of fossil fuels is continuously rising. In orderto get rid of the harmful effects of fossil fuels, the world is moving towards renewable energy sources like solar, wind and geothermal energies. The current population of the world is 7 billion and is still growing with some studies predictingapopulation of 9 billion in 2040. This will make serious issues on supply demand equilibrium. The living standards of a country will be decided by the energy consumption per capita. The various factors responsible for the increased focus on renewable energies are increasing oil prices, rise in number of oil, gas and coal dependant

industries and pollutions due to burning of fossil fuels. Use of renewable energy could be a great way to overcome the above stated problems.The photothermalconversion of phase change materials were given more importance due to the phase change properties and energy storage applications. Lameck et al.[1] conducted experiments using Pentaerythritol (PE) phase change material (PCM). They compared the volume of PE and fin material (P/F) by varying the number of fins. The ratios are 6, 12 and 21 by loading different mass of PE (1.625, 1.670, 1.742 kg) in a thermal energy unit for charging and discharging. The temperature of the PCM was raised from 50 to 220°C to find its retention ability. The optimum ratio of P/F was found to be 12 for better cooking application.Harikrishnan et al. [2] used hybrid nanoparticles (50% TiO2 and 50% CuO) with paraffin as a phase change material. The mass percent of hybrid nanoparticles was varied from 0.25 to 1%, the dispersion stability was maintained by adding sodium dodecyl benzene sulfonate (SDBS). The spectra of paraffin and 1% mass of hybrid nanoparticles were analysed by FT-IR. There was a strong interaction between the composite PCM physically and not chemically. The maximum thermal conductivity enhancement was found to be 51.49% compared to pure paraffin, at the maximum mass of nanoparticles. Increasing the concentration beyond 1% led to agglomeration and reduced the thermal conductivity. The thermal stability of composite PCM was analysed up to 2000 cycles.Zhang et al. [3] revealed the thermal properties of phase change composites (Erythritol and short carbon fibres) using two kinds of SCFs (C5 and C25) of diameter 9 μm and nominal aspect ratios of 5 and 25. Different mass loadings of 1, 2, 4, 7 and 10% of SCFs were investigated in this study. The enthalpies of SCFs were close to each other indicating that the nominal aspect ratio has no role but the mass loading plays a major role in enthalpy values. The melting temperature, change in enthalpy and thermal conductivity were 118.2˚C, 340.4 J/g and 3.91 W/m K at 10 wt.% (C25/erythritol) and the maximum enhancement in thermal conductivity was 407.8.

Parameswaran et al. [4] investigated the thermal properties of organic ester - silver nanoparticles. The nanoparticles loading was from 0.1 to 5 wt%. The FTIR results showed only physical interaction between nanoparticles and organic ester. Thermal conductivity and degree of supercooling were measured and found to vary from 0.284 to 0.765 W/m K and 11.7 to 6.8%. During freezing and melting, the latent heat capacity was reduced by 7.88 and 8.91% respectively for minimum and maximum concentrations. CuO added with solid - solid Neopentylglycol PCM was experimentally studied by Praveen et al. [5]. The concentrations of the prepared

samples were 0.5, 1 and 3 wt%. The solid-solid transition enthalpy decreased from 3.1 to 9.6% when the concentration was increased from 0.5 to 3 wt.%. The maximum hermal conductivity at 3 wt% was 0.61 W/m K.

Thermal cycling stability and thermal conductivity of Erythritol/Expanded graphite (EG) composite were studied by Lee et al.[6]. Erythritol was heated up to its melting point of 120°C and EG was mixed and stirred for 5 minutes to form the composite. The maximum thermal conductivity was obtained for the composite was 3.418 W/m K.Singh et al. [7] added graphene nanoplatelets (GNN) of 1, 2, 3 wt.% with Myo-inostol (MI). The samples were thermal cycled up to 50 cycles for all the concentrations. The FT-IR spectrum showed MI-GNN was chemically stable and interacted physically before and after thermal cycling. Thermogravimetric analysis (TGA) was done up to 260°C and the loss of mass was found to be 2-3% even after 50 cycles. Suspension of Al_2O_3 and CuO nanomaterials of different concentrations (1, 2, 3 wt.%) with MI PCM was investigated by Singh et al. [8]. The result showed a reduction in melting temperature of 2 to 4°C for MI- Al_2O_3 and 0.5 to 1.1°C for MI-CuO after 50 cycles. The mass loss was found to be less than 3% for nano-MIs in the temperature range of 160 to 260°C.

The performance efficiency of the PCM was increased by Tang et al. [9].Authors investigated the optical absorbance and thermal Properties of (polyethene glycol) PEG/SiO_2 (silicon dioxide) doped with Ti_4O_7(titanium black). The optical absorbance was measured between the wavelength 300 to 800nm for different concentration of Ti_4O_7 with wt% of1,2,3and PEG/SiO_2 were analysed, pure titanium black shows more absorbance in the visible range at 500nm the value of absorbance was more than 1. Also, that result reveals increasing the wt. % of black titaniumrising in the value of absorbance.Xu et al. [10] reported the optical absorbance of paraffin wax (PW) mixed with hybrid nanoparticles Cu2O- Cu-MWCNTs (Copper oxide-copper-multi walled carbon nanotubes) by varying the wt.% of MWCNTs. Absorbance results showed a maximum absorbance of 2.6 at 300 nm wavelength and gradually reduced to 1.5 at 800 nm. Cu – MWCNTs of 6 wt.% showed no changes in the thermal properties even after 20 cycles.Sol-gel method was used to prepare composite PCM of polyethene glycol (PEG) and silica (SiO2) with Carbon fibre (CF) by Liu et al. [11]. The wt.% of the CF was varied from 1 to 5. The authors obtained a maximum optical absorbance of 0.7 in the wavelength range of 350 to 800 nm for the highest concentration of CF. The DSC result for 3 wt.% of CF gave a maximum latent heat of fusion and crystallization enthalpy of 142.6 and 154.4 J/g respectively.

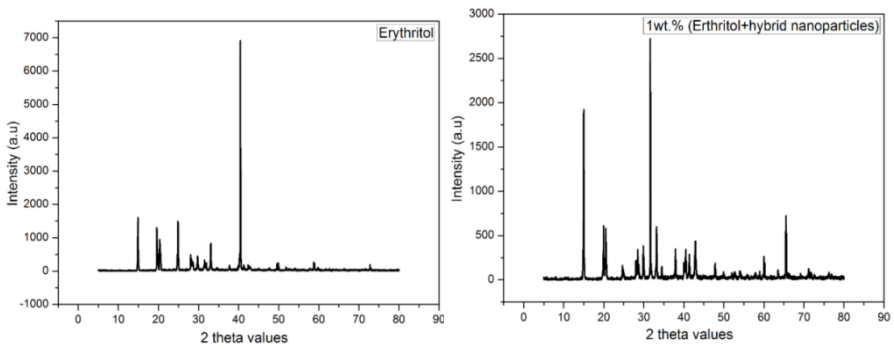
The thermal and chemical stability of Pentaerythritol (PE) with low melt alloys (Bi, Sn, Zn and In) were studied by Venkitaraj et al.[12]. They used 0.1 and 0.5 wt.% of PE – LMA and thermal cycling was done up to 100 cycles with a heating rate of 10°C/min. The thermal conductivity was increased by 3.77 and 17.27% compared with PE and decreased by 4.55 and 10.08% after 100 cycles.

Preparation of Hybrid PCM

The hybrid nano phase change materials (PCMs) were prepared using a low energy ball milling machine. For the preparation of the nano PCM samples with varying weight percentages (wt.%). The milling process involved placing three stainless steel balls within a steel container, which was then rotated at a predetermined speed of 200 rpm for a duration of 30 minutes. As a result of the centrifugal action exerted by the balls, a uniform mixing was achieved between the PCM and nanomaterials

XRD

The XRD pattern shows relative intensity and 2theta of the diffraction peaks. Using Debye-Scherer's relation $D = 0.9\lambda/W \cos\theta$ the average crystalline size (D) has been calculated. The strong peaks were found in the pure erythritol at 42 degrees, and for nanohybriderythritol, it is at 15 and 32 degrees shown in Figure. 1. The peaks observed in an XRD pattern correspond to the diffraction of X-rays by the crystal lattice.

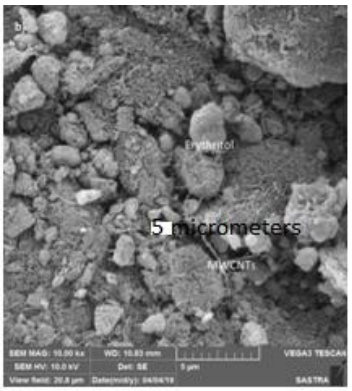


Figures. 1 XRD of erythritol and nanohybriderythritol

SEM

The morphology of nanoparticles, PCMs and nano hybrid PCMs are investigated using scanning electron microscope. The size of nanoparticles are studied and the results indicate spherical shape with diameter less than 100 nm.The

SEM analysis of erythritol shows irregular shapes (Figure 2). It is also observed that the mesh-like surface and spherical shape of nano additives are evenly dispersed which confirms that the CNT is finely mixed in erythritol.



DSC and TGA Results of Nano Hybrid Erythritol

The onset, transition and melting temperatures of the PCM are obtained by the DSC test using PerkinElmer DSC 6000. The test is carried out in the temperature range of 30 to 140°C with a heating rate of 5°C/min. in the nitrogen atmosphere.The DSC results (Figure 3) reveal the onset, peak and end temperatures of the samples, also shown in table 2. The latent heat of fusion for 1 and 3wt.%of the sample before thermal cycling (BTC) is 330.29 and 328.67 J/g. This indicates that the addition of nanomaterials to the erythritol decreases the latent heatcompared to pure erythritol. The latent heat further decreases with increasing wt.% of nanomaterials. The thermogravimetric analysis (TGA), which is the indication of thermal stability is shown in Figure 4. The weight loss versus temperature plots reveal the occurrence of single step degradation in the temperature ranges between 250 and 320°C.

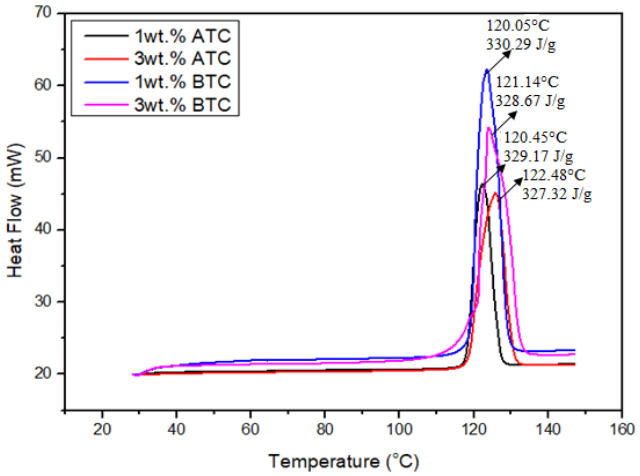


Figure 3. DSC plots of the sample

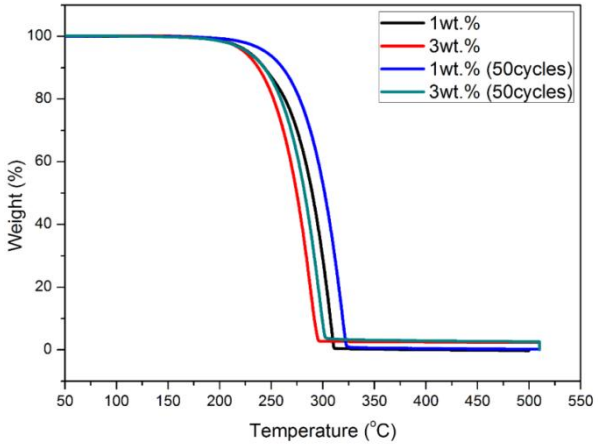


Figure 4.TGA plots of the sample

Specific Heat

Specific heat of the samplesare measured by modulated differential scanning calorimeter (DSC). Specific heat values of Nano PCMs are shown in Figure 5 and 6. The measurement temperature ranges between 30 and 120°C with a heating rate of 10°C/min. Aluminum sample holder of 49.71 g and a sample of 29.60 mg is used. Due to increase in temperature, the specificheat of the nanofluid increases from 1.85 to 2.19 J/g K. The specific heat variation of nano PCM (erythritol- MWCNT) at different temperatures is shown in Figure 5. A drastic change in the specific heat values are observed when the PCM samples reach close to the phase change temperature of around 120°Cfor both concentrations (1 and 3wt.%)and corresponding values are 13.60 and 16.76 J/g K respectively.

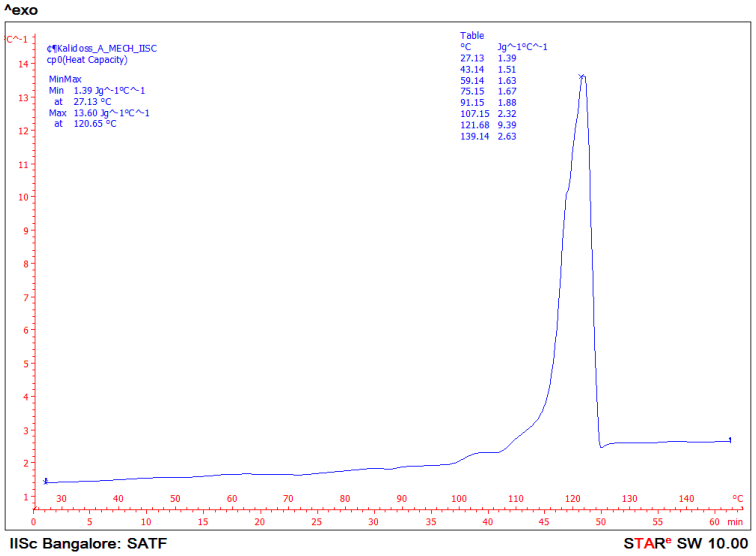


Figure 5. Specific heat values of 1wt.% nano PCM

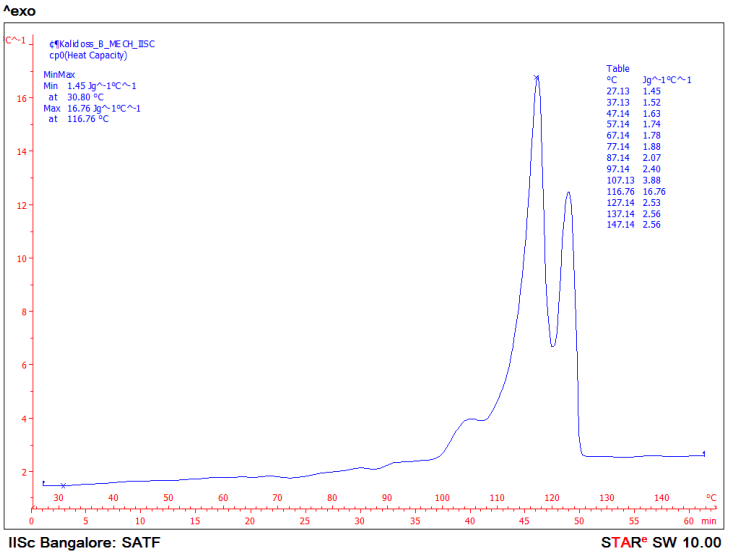


Figure 6 Specific heat values of 3 wt.% nano PCM

Light to Thermal Conversion Performance using Solar Simulator

The photothermal performance were analyzed using the LCS-100 small area solar simulator. The time/temperature plots were shown in fig. for the samples nano PCMs of 1 and 3 wt.%. The heat transfer process of the NPCM is higher than the pure pcm due to the thermal convection. The main reason for the thermal convection is due to the presence of nanoparticles, which produces the Brownian motion between the erythritol and the hybrid nanoparticles It is also important that the MWCNTs has higher thermal conductivity compared to other nanoparticles. The solar simulator was kept ON condition for 5 hrs, and the pure erythritol, 1 and

3 wt.%. nanohybriderythritol were irradiated under the solar irradiation of 975 W/m² the intensity is measured using CMP3 pyranometer shown in fig.7 . The photothermal conversion temperature is observed, compared to pure PCM, nano composite shows increasing trend in temperature, for pure erythritol, 1 and 3wt.% are 93.4, 112.7 and 120.5 °C is shown in fig. 8 respectively.

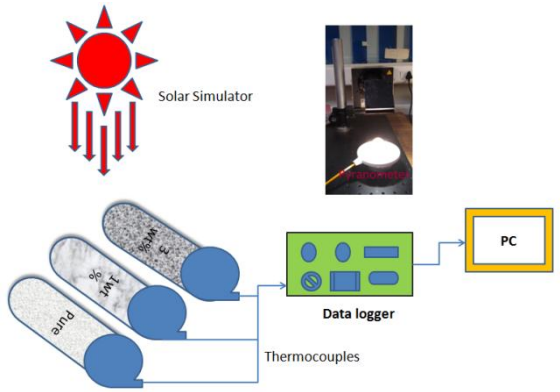


Figure.7. hybrid nano PCM under solar simulator

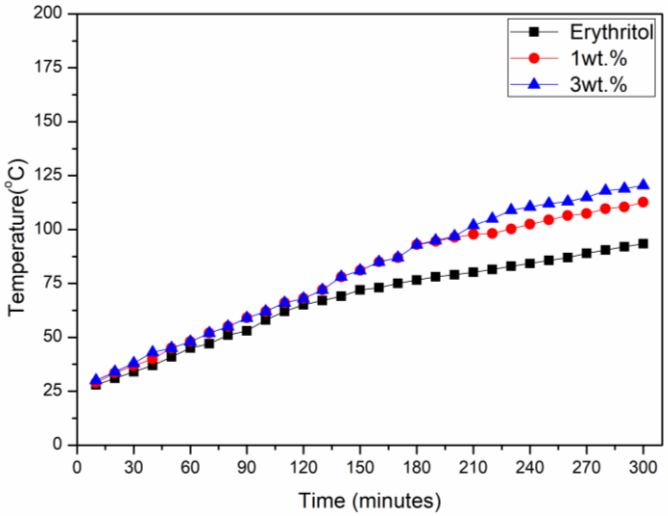


Figure. 8. Temperature plots for Pure and nano hybrid PCM

Uncertainty Analysis

The difference between actual and measured values of the experiments were evaluated and it is reported as error. The main parameter for thermal cycling is temperature, which is measured using K-type thermocouple and connected to datalogger (KEYSIGHT 34972A LXI). The bias error and resolution of the data logger used in this study is ±0.1°C and 0.1°C. The error in the data logger were found by using following equations and calculated as

$$e_{DAQ} = \sqrt{(e_{bias})^2 + (e_{precision})^2}$$

$$e_{DAQ} = \sqrt{(1.0)^2 + (0.05)^2}$$
$$e_{DAQ} = \pm 1°C$$

The k-type thermocouple used in this study were calibrated using drywell calibrator and the accuracy is ±0.25°C.

$$e_{thermocouple} = \sqrt{(e_{bias})^2 + (e_{precision})^2}$$
$$e_{thermocouple} = \sqrt{(2.2)^2 + (0.005)^2}$$
$$e_{thermocouple} = \pm 2.2°C$$

The overall uncertainties found by combining the errors of thermocouple, data logger and drywell calibrator are computed as

$$e_{Temp} = \sqrt{((e_{thermocouple})^2 + e_{DAQ})^2 + (e_{calibrator})^2}$$
$$e_{Temp} = 2.23°C$$

Conclusion

The thermophysical properties of a nano phase change material (PCM) for thermal energy storage have been extensively investigated. Specifically, the influence of nanomaterials, particularly in erythritol, was thoroughly examined during photothermal conversion. The results revealed that the nano PCM containing 3wt.% of nanomaterials achieved a maximum phase temperature of 125°C after 300 minutes. Additionally, the differential scanning calorimetry (DSC) test confirmed significant changes in the melting temperatures and latent heat of the samples. Moreover, the scanning electron microscopy (SEM) image displayed enhanced interaction erythritol and multi-walled carbon nanotubes (MWCNTs), as well as the formation of a nano-layer within the PCM.

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CHAPTER 36

APPLICATIONS OF THERMAL BARRIER COATING AND ADVANCED TECHNOLOGIES

S. Rajkumar*, T.Ayyasamy, A. Mohamed Hamdan & D. Katherasan
Department of Aeronautical Engineering
Dhanalakshmi Srinivasan Engineering College, Perambalur

Abstract

Thermal Barrier Coating (TBC) has evolved as an important surface engineering solution, with several applications in a variety of sectors, notably in high-temperature situations. This abstract gives a thorough review of TBC applications and the use of new technology to improve its performance. It emphasizes TBC's critical significance in aerospace, where it is widely used to protect against severe temperatures and thermal stresses in gas turbine engine components. Integration with modern technologies such as innovative ceramic materials, sophisticated deposition processes, and nanotechnology holds enormous promise for opening up new avenues of study and application in TBC.

Introduction

The manner in which high-temperature environments are handled in numerous sectors has been completely transformed by thermal barrier coatings (TBCs). These cutting-edge coatings have a wide range of uses and offer essential protection for parts subjected to very high temperatures. Thermal barrier coatings are essential for improving efficiency, prolonging service life, and assuring operational dependability in a variety of power generating facilities, including gas turbines, gas engines, and power plants.

In this chapter, we will look at the many uses of thermal barrier coatings and how they deal with the issues provided by high-temperature settings. We will look at the importance of thermal barrier coatings in important sectors, describe the specific benefits they give, and emphasise the critical qualities needed for effective application.

Applications of Thermal Barrier Coatings

Due to their remarkable thermal insulation qualities and capacity to shield components from hot surroundings, thermal barrier coatings (TBCs) have become more popular across a variety of sectors.

Gas Turbine Engines

Gas turbine engines are a prominent application for TBCs since they operate at high temperatures. Turbine blades, vanes, and combustor liners are among the hot section components that have TBCs applied to them to prevent thermal fatigue, oxidation, and hot corrosion. TBCs offer thermal insulation, which lowers heat transmission to underlying parts and boosts engine performance. TBCs are widely used in gas turbine engines in the aerospace and power generating sectors to improve performance, lengthen component lives, and save maintenance costs.

Industrial Gas Turbines

Power plants, oil and gas refineries, and other industrial facilities all use industrial gas turbines. TBCs are used to offer thermal protection and boost overall efficiency on combustion chambers, transition ducts, and turbine parts. Higher combustion temperatures are made possible by the coatings, which boost energy efficiency and enhance power production. The service life of industrial gas turbine parts is increased by the corrosion and erosion resistance provided by TBCs.

Automotive Industry

TBCs are used in high-performance engines, exhaust systems, and brake parts in the automobile industry. TBCs on exhaust manifolds and headers aid in lowering heat radiation, enhancing engine performance and lowering thermal stress on neighboring parts. TBC-coated brake rotors and calipers provide better thermal control, which lessens brake fade and improves braking performance. TBCs in the automobile industry help to improve durability, decrease emissions, and boost economy.

Aerospace Applications

TBCs are essential for aerospace applications like as rocket engines, hypersonic vehicles, and aviation engines. TBCs shield engine parts including turbine blades and combustion chambers from oxidation, thermal fatigue, and high temperatures. TBCs assist hypersonic vehicles in controlling the high thermal loads encountered during atmospheric re-entry. To increase engine efficiency, save weight, and guarantee the dependability and safety of crucial components, the aerospace industry uses TBCs.

Energy Generation

TBCs are used in heat exchangers, steam and gas turbines, and other energy producing components. These coatings offer corrosion protection and thermal insulation, which improve the effectiveness and longevity of energy producing machinery. TBCs on heat exchanger and boiler surfaces increase heat transfer effectiveness and inhibit corrosion. TBCs are used on receiver tubes in concentrated solar power (CSP) systems to resist high sun flux and preserve thermal stability.

Thermal Barrier Coatings in Other Industries

TBCs have uses outside of the aforementioned typical sectors. To lessen heat transmission and enhance casting quality, they are used in metal casting moulds. In order to improve thermal efficiency and lengthen equipment life, TBCs are frequently used in ceramic kilns and furnaces. TBCs are used in the nuclear industry to shield reactor parts from corrosive conditions and high temperatures. TBCs are also used in gas stoves and other home appliances, as well as in marine vessel exhaust systems and equipment for chemical processing.

Future Trends and Emerging Technologies in Thermal Barrier Coatings

The area of thermal barrier coatings (TBCs) has made considerable strides over the years, but it is still developing due to the introduction of fresh materials and technology. This chapter examines future developments and new technologies in TBCs, emphasizing prospective innovations and their ramifications.

Advanced Ceramic Materials

TBC research places a lot of emphasis on the creation of new ceramic materials with enhanced thermal and mechanical qualities. TBC performance is being improved by advancements in material composition, microstructure architecture, and production methods. As an illustration, the application of rare-earth zirconates, hafnates, and silicates as ceramic top coatings has promise for enhancing thermal stability, lowering thermal conductivity, and improving resistance to environmental deterioration. New ceramic materials and composites might be included into TBC systems to increase efficiency and durability in high-temperature applications.

Multilayered and Graded Coatings

Coatings that are multilayered and graded are becoming a popular method for enhancing TBC performance. These coatings have different compositions,

porosities, and thermal conductivities and are made up of many layers or graded structures. The layer architecture may be carefully designed in order to maximize the attributes of adhesion, strain tolerance, and thermal insulation. TBCs can sustain harsh working circumstances thanks to multilayered and graded coatings' improved resistance to heat cycling and spallation. Advanced coating structures that offer higher performance and longer service lives are being developed via ongoing research.

Functionally Graded Materials

FGMs, or functionally graded materials, are a potential development in TBC technology. FGMs are substances that continuously change along a gradient in composition, microstructure, or characteristics. FGMs can demonstrate optimized qualities for particular locations within the TBC system by customizing the composition and structure. To reduce thermal pressures at the bond interface, for instance, different thermal expansion coefficients can be used to build FGM bond coatings. In TBCs, FGMs have the potential to increase strain tolerance, decrease delamination, and improve overall performance.

Nanocomposite Coatings

Due to their distinct qualities and possible advantages, nanocomposite coatings that include nanoparticles into the TBC system are attracting more attention. The use of nanoparticles, such as functional or ceramic reinforcements, can increase material strength, lessen heat conductivity, and improve thermal cycling resistance. Utilizing the special qualities of nanoparticles, nanocomposite coatings give the chance to create higher performance and customized functionality. The current focus of research is on managing interfacial interactions, enhancing nanoparticle dispersion, and comprehending how nanoparticle size, shape, and distribution affect TBC characteristics.

Environmental Barrier Coatings

A specific kind of TBC called an environmental barrier coating (EBC) is made to shield underlying materials from adverse environmental factors such hot corrosion, high-temperature oxidation, and erosion. EBCs provide increased resistance to deterioration and can increase component longevity in harsh conditions. The goal of ongoing research is to create sophisticated EBC systems that include improved environmental protection with thermal insulation. Environmental barrier coatings

(EBCs), a specialized sort of TBC made to shield underlying materials from abrasive environmental conditions such high-temperature oxidation, hot corrosion, and erosion, may be included into these coatings. EBCs provide increased resistance to deterioration and can increase component longevity in harsh conditions. Research is being done now to create new EBC systems that include thermal insulation with improved environmental.

Advanced Deposition Techniques

TBC development is still fueled by improvements in deposition methods. New technologies provide better control over coating microstructure, decreased porosity, and increased adhesion. Examples include atmospheric plasma spraying (APS), solution precursor plasma spraying (SPPS), and advanced electron beam-physical vapor deposition (EB-PVD) approaches. These methods make it possible to create high-quality TBCs with customized features and more durability. More study is needed to increase coating uniformity, streamline deposition procedures, and investigate cutting-edge techniques for extensive industrial use.

Conclusion

The future of thermal barrier coatings looks bright. Technologists and researchers are always attempting to improve the performance, durability, and adaptability of their products. Ongoing developments in coating materials, deposition processes, and microstructural design are projected to solve present limits and push thermal barrier coating applications to new heights.

Finally, thermal barrier coatings have shown to be critical components in safeguarding materials from high-temperature situations. Their exceptional thermal insulation qualities, along with advances in materials, deposition processes, and characterization methodologies, continue to drive innovation and open up new doors. Thermal barrier coatings have a promising future, and their ongoing development will surely help to the improvement of many sectors by increasing efficiency, extending service life, and improving the performance of important components.

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MANAGEMENT STUDIES

CHAPTER 37

A STUDY ON ORGANISATIONAL CULTURE AND HOW IT AFFECTS EMPLOYEE ACTIONS IN LOGSKIM SOLUTION PVT. LTD., CHENNAI

Vimala R*, Atchaya A, Ummul Haseen S, Neelakanda Iyer M & Shanmuga Priya R

Department of Management Studies

Dhanalakshmi Srinivasan Engineering College (Autonomous), Thuraiyiur Road, Perambalur, Tamil Nadu

Abstract

A company's organizational culture includes its varied norms and beliefs. These obviously affect how well employees perform. Additionally, it has been observed that company culture influences employees' productivity and profitability. Their level of performance is influenced by his total influence, which increases productivity. Additionally, it has been observed that organizational culture influences how employees behave. About 30 participants participated in this research project, which was conducted to better understand how company culture affects employee performance. To further understand the effects of this organizational culture, these workers were chosen at random from a variety of organizations, including retail and industry. Furthermore, in order to comprehend this organizational culture, the researcher selected a 5% significant threshold. Thus, it can be concluded that organizational culture definitely affects employee behaviour and performance levels. Furthermore, in order to comprehend this organizational culture, the researcher selected a 5% significant threshold. Thus, it can be concluded that organizational culture definitely affects employee behaviour and performance levels.

Keywords: *Corporate Culture, Productivity, Staff Performance and Appraisal.*

Introduction

Meaning

Values and behaviours that "Contribute to the specific social and psychological environment of an organization" are included in organizational culture. Needle (2004) claims that organizational culture is the collective values, principles, and norms of the organization's members and is influenced by a variety of factors, including history, product, market, technology, strategy, employee type, management style, and national culture. Cultural traits include the organization's vision, norms, systems, symbols, language, assumptions, environment, location, beliefs, and habits.

Definition

The phrase "contribute to the unique social and psychological environment of an organization" refers to beliefs and behaviours that make up organizational culture. Needle (2004) argues that organizational culture represents the collective values, beliefs, and principles of organizational members and is a result of history, product, market, and technology, and strategy, type of employees, management style, and national culture. Cultural traits include the organization's vision, norms, systems, symbols, language, assumptions, environment, location, beliefs, and habits.

Review of Literature

- **Oliver RL, Anderson E (2022)** Her research evaluated how different organizational cultures affected employee levels. The study's fundamental assumptions were based on four cultural types: clan, adhocracy, market, and hierarchy. Examining entrepreneurial organizations and comprehending the impact of culture were among the study's goals. The essential elements of organizational culture comprised dominating traits, organizational leadership, group cohesiveness, strategic emphasis, and success factor. Important factors included job happiness, satisfaction with co-workers, managers, pay, and prospects for advancement. Clan and adhocracy demonstrated better levels of satisfaction than market and hierarchy, according to the study's findings.
- **Bowen J, Bowers MR (2021)** have also been discovered in the sector. Managerial outcomes may be negatively impacted by hierarchical values that place a strong emphasis on the internal operations of the business as well as on efficiency and control. This presumption assumes that individuals have a strong desire to preserve their autonomy and that, in response to an attempt to sway them, they react strongly and end up changing their attitudes and behaviours to the contrary of what is being encouraged or demanded.

Objectives of the Study

Primary Objectives

- To conduct research on organizational culture and how it affects employee behaviour at Chennai's Logskim Solutions Pvt. Ltd.

Secondary Objectives

- To analysis the existing culture of the organization and to find its impact on employee behaviour.
- To analysis the overall performance of the employees.
- To study the employees feel about the management.
- To learn about the organizational culture dynamically.
- To investigate the impact of culture on both employee and organizational performance.

Tools for Data Collection

Primary data

Primary data refers to newly obtained data. Primary data is mostly gathered by means of in-person interviews, questionnaires, etc.

Secondary data

Secondary data are those that are already in circulation. It was taken from the website and utilized in the company profile's introduction section.

Statistical Tools Used for Analysis

1. Percentage Analysis
2. Chi-Square Analysis
3. Correlation

1. Percentage Analysis

This technique is used to compare two or more data series, to characterize the relationship between the data series, or to describe how the data are distributed. To determine the percentage of the respondent's response, a percentage analysis test is conducted. In order to better comprehend the data, different percentages are identified in the tool's analysis and are presented as bar diagrams.

$$\text{Percentage of Respondents} = \frac{\text{Number of Respondents}}{\text{Total Respondents}}$$

Chi – Square Test

Chi-square analysis was conducted to determine the one-way relationship between socio demographic variables and the major programmatic aspects.

$$X^2 = \frac{(Oi-Ei)^2}{Ei}$$

$$E = \frac{RT}{CT} N$$

The calculated chi-square value is compared to the table value for the degrees of freedom (2 in this case) at a particular level of significance. The gap between theory and observation is regarded as significant when it reaches the declared level of the calculated value of 2. If not, it is not important.

Corellation

There are numerous varieties of correlation methods. The person or product moment correlation is the most prevalent type, and it is included in the survey systems' optional statistics module. Another variety of this type, known as partial correlation, is included in the module. The latter is advantageous when you wish to examine the link between two variables without taking into account any or two additional variables' effects.

$$r = \frac{\sum xy}{\sqrt{(\sum X^2)\,(\sum Y^2)}}$$

Testing of Hypothesis

Improvements in Working Condition/ Comfortable With Work Environment

The relationship between health insurance and accidents benefits to the employees and management solve all your grievances.

Improvements in Working Condition/Comfortable with Work Environment	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Strongly Agree	4	7	5	2	1	19
Agree	11	21	14	6	3	55
Neutral	5	12	13	4	1	25
Disagree	3	6	7	2	1	14
Strongly Disagree	1	3	2	1	0	7
Total	**19**	**41**	**47**	**13**	**6**	**120**

Source: Primary Data

Null Hypothesis

HO: Improvements in organizational working conditions and workplace comfort have no meaningful relationship to one another.

Alternative Hypothesis

H1: Improvements in the organization's working conditions and employee satisfaction with the workplace environment have a significant relationship.

Particular	Observed frequency (o)	Expected Frequency (E)	$(Oi-Ei)^2$	$(Oi-Ei)^2/E$
R1C1	4	4.1	0.01	0.002
R1C2	7	7.1	0.01	0.001
R1C3	5	4.7	0.09	0.019
R1C4	2	2.0	0	0
R1C5	1	0.9	0.01	0.011
R2C1	12	11.5	0.25	0.021
R2C2	21	20.6	0.16	0.007
R2C3	14	13.7	0.09	0.006
R2C4	6	5.9	0.01	0.001
R2C5	3	2.7	0.09	0.033
R3C1	5	5.4	0.16	0.029
R3C2	9	9.3	0.09	0.009
R3C3	6	6.2	0.04	0.006
R3C4	3	2.7	0.09	0.033
R3C5	1	1.2	0.04	0.033
R4C1	3	3.0	0	0
R4C2	5	5.2	0.04	0.007
R4C3	3	3.5	0.25	0.071
R4C4	1	1.5	0.25	0.166
R4C5	1	0.7	0.09	0.128
R5C1	1	1.5	0.25	0.166
R5C2	3	2.6	0.16	0.061
R5C3	2	1.7	0.09	0.055
R5C4	1	0.7	0.09	0.128
R5C5	0	0.3	0.09	0.3
Calculated value				**1.293**

DEGREE O FREEDOM (V) = (R-1) (C-1) = (5-1) (5-1)
= 16

Level of Significance = 5%
Table value (TV) = 16.196
Calculated value (CV) = 1.293
CV<TV = H0 is Accepted

Result

Given that the estimated value is lower than the value in the table. The null hypothesis is so accepted. The improvement of the organization's working conditions and employee satisfaction with the workplace are unrelated.

Correlation

The relationship between feeling satisfied with your own leadership abilities and giving your work the correct praise is depicted in the table.

X	Y	X^2	Y^2	XY
31	31	961	961	961
60	52	3600	2704	3120
16	19	256	361	304
10	10	100	100	100
3	8	9	64	24
∑X = 120	∑Y = 120	4,926	$\sum Y^2$= 4,190	∑XY = 4,509

$$r = \frac{\sum XY}{\sqrt{(\sum X^2)(\sum Y^2)}}$$

$$r = \frac{4509}{\sqrt{(4926)(4190)}}$$

$$r = \frac{4509}{4543.1}$$

r= 0.99

Result

This association is favourable. Appropriate work appreciation and confidence in your own leadership skills are related.

Findings

- 48% of those surveyed are content with their comfortable working conditions..
- 43% of respondents concur that they possess leadership potential.
- 47% of respondents concur that attention to detail is important.

Suggestions

The organizational culture, which takes into account many elements including communication, satisfaction, training, career development, establishment, appraisals, and recognition, is what determines how well individuals perform in their jobs. Since the senior management, officers, and staff are all members of the same organization, any change in their behavior will have an impact on both the performance of the organization as a whole and each individual employee. In this study, we discovered that businesses need to develop ways to instil particular values and behaviours that will boost productivity and support upholding a high quality of company image. These can be accomplished with an employee-focused management strategy that emphasizes individual growth, by giving employees the time and resources they need to build their skill sets and knowledge, which are crucial components of performance improvement. This will promote positivity and innovation within the establishment, improving the establishment's overall performance. Through an efficient, targeted approach to employee involvement and total participation in day-to-day operations, the establishment has a lot of room to enhance the existing technophobic and bureaucratic cultures. Thus lowering the five project delays and enhancing performance.

Conclusion

Everything from sales to recruiting becomes increasingly difficult in the fiercely competitive business world of today. Being a company that people want to work for and do business with is one approach to make it all easier. An effective organizational culture is one of their most valuable assets, as smart companies are aware of. When determining if an organization is a happy and healthy place to work, culture inside that organization is crucial. It is possible to affect subordinates'

behaviour and attitudes at work by promoting and expressing the organizational vision to them and gaining their acceptance of the vision.

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CHAPTER 38

A STUDY OF THE ORGANIZATION'S PROMOTION AND REWARD POLICY BY EMINENCE HR SOLUTIONS, CHENNAI

Baskar B*, Chandrasekaran M, Manish Ram, Chandan Kumar, Rakesh R & Vignesh M
Department of Management Studies
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

Both natural internal and external rewards can encourage employees. The reward framework must acknowledge the two sources of inspiration for it to be effective. Every reward system is predicated on the idea of attracting, holding, and advancing people. The reward system must include financial incentives, but there are other factors that motivate employees and affect their level of performance. It is essential to carefully analyze the rewards and systems employed and make sure the rewards are related to or in view of performance in order to ensure the incentive framework is appealing and promotes the desired habits. Any execution estimation methodology needs to be linked to compensation or some other form of reward in order to be effective. Execution compensation should not only be an annual pay-related tradition, but also a progressive administrative action. Influencing the advancement framework to be transparent to all parties involved regarding who may initiate and manage advancement cases. The use of motivators assumes that people's actions are related to their abilities and capacities to achieve significant long-term goals. Despite the fact that many associations are formed by choice, tradition, or agreement. Prizes should be seen as a payoff for execution since they are in fact compensated based on non-execution factors.

Keywords: *Promotion, Reward, Employees, and Training.*

Introduction

Employees might be motivated by both natural internal and external rewards. For the incentive framework to be effective, the two inspiration sources must be acknowledged. Every compensation system is built on the premise of drawing in, keeping, and developing individuals. Financial incentives must be a part of the reward system, but there are other elements that influence performance and inspire personnel. To guarantee that the incentive framework is appealing and encourages the desired behaviours, it is crucial to carefully examine the rewards and systems used and ensure that the awards are tied to or in view of performance. Any execution estimation methodology must be connected to payment or another type of reward in order to be successful. Not only should execution compensation be a yearly pay tradition, but also a proactive administrative measure. Ensuring that the

advancement framework is open and transparent to all parties in regards to who may start and oversee advancement instances. The usage of motivators is predicated on the idea that people's behaviour is correlated with their talents and aptitudes for achieving substantial long-term goals. Even though many associations are created through choice, custom, or agreement. Since prizes are actually paid based on non-execution variables, they should be viewed as a reward for execution.

Review of Literature

- **Belachew Kassahun (2022)** a very significant problem that impacts every corporate organization has been identified as employee motivation. One and two star rated industries should take into consideration the issue of motivation to please its employees and achieve success in order to provide exceptional service to their clients and to promote the development of tourism in the region. The benefits that one and it offer for their employees' compensation, promotions, recognition, and benefits as well as the kind and conditions of their employment. However, the company's incentive program is subpar, and the hotels did not treat their staff well. This indicates that the one and two star rated companies did not offer appropriate rewards for their personnel that included intrinsic and extrinsic that motivated them for improved performance.
- **Walters T.Ngwa (2021)** did a study to see how employee performance is affected by the reward system. The study evaluates how much profit sharing impacts employee loyalty. Firstly, it will be fascinating to look into how reward systems affect employee performance in service organizations because they are not a one-size-fits-all solution for every company. Routine tasks performed by employees tend to be less innovative and creative. There is less likelihood of working in groups and more specialization and task differentiation. It is crucial that study be conducted in this area with the goal of determining the ideal compensation structure for service firms. Second, a sizable portion of business expenses are made up of wages and salaries.

Objectives of the Study

Primary Objectives

- To learn about the organization's promotion and reward policies at Eminence Human Resource Solutions, Chennai

Secondary Objectives

- To analysis the reward system and reasons for employee perception to develop the retention plan of the company.
- To research how job performance and staff retention affect the company.
- To evaluate how satisfied they are with their work.
- To find the training needs for the employee development.
- To study the relationship between promotional policies and retention

Tools for Data Collection

Primary Data

It was collected through questionnaire further this data, are processed and tabulated using graphs the tables where analysed and the finding has been drawn accordingly.

Secondary Data

Since the % reduces everything to a common base and enables meaningful comparison, it refers to a particular form of ratio that is used to compare two or more data series.

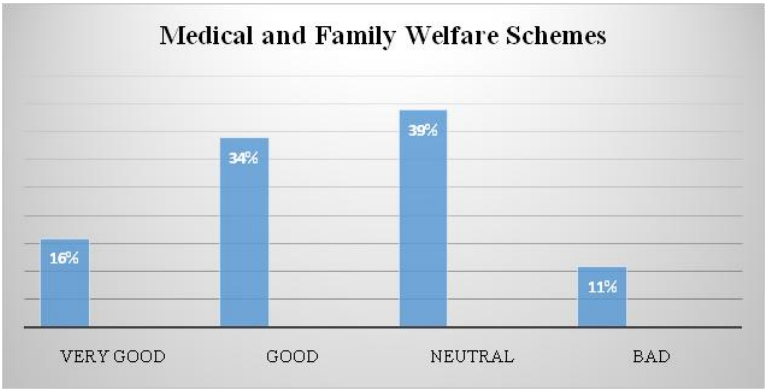
Statistical Tools

1. Percentage Analysis
2. Chi – Square Analysis
3. Correlation
4. Anova

Percentage Analysis

Medical and Family Welfare Schemes	No. of respondents	Percentage
Very Good	19	16%
Good	41	34%
Neutral	47	39%
Bad	13	11%
Total	**120**	**100%**

Source: Primary data



Interpretation

The table shows that rating towards the medical and family schemes. 16% of the employees are said rating is very good, 34% of the employees are said rating is good, 39% of the employees are said rating is neutral, and 11% of the employees are said rating is bad.

Chi – Square Analysis

The table depicts the Monthly Income of the respondents and medical and family welfare schemes.

Monthly Income /Medical and family welfare schemes	Very good	Good	Neutral	Bad	Total
Less thanRs.15000	3	7	9	2	**22**
Rs.15000 –20000	7	15	18	5	**45**
Rs.20000 -25000	5	12	13	4	**34**
AboveRs.25000	3	6	7	2	**19**
Total	**19**	**41**	**47**	**13**	**120**

Source: Primary data

Null Hypothesis

HO: Medical and family welfare programs had no significant association to the respondents' monthly income.

Alternative Hypothesis

H1: The respondents' monthly income and medical and family welfare programs have a significant association.

Degree of freedom : (r-1) (c-1)

: (4-1) (4-1)

: 9

Level of Significance: 5

Table value : 2.700

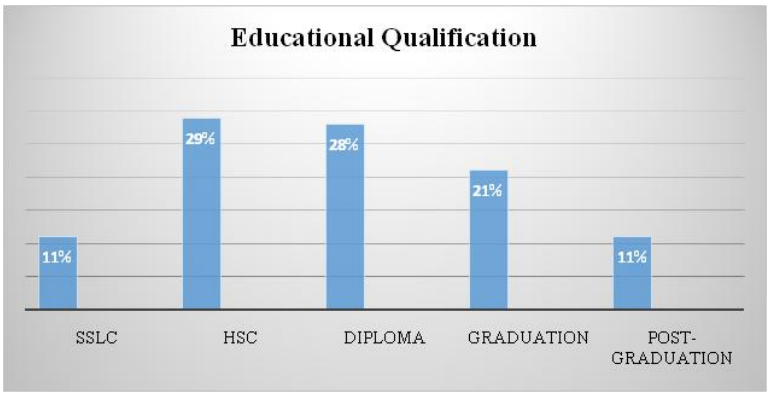
Calculated value : 0.289

Result

Because the estimated value is higher than the value in the table. Therefore, the null hypothesis is accepted. The respondents' monthly income and medical and family welfare programs have a significant association.

Educational Qualification	No. of Respondents	Percentage
SSLC	13	11%
HSC	35	29%
Diploma	34	28%
Graduation	25	21%
Post-Graduation	13	11%
Total	**120**	**100%**

Source: Primary data



Interpretation

The chart indicates that 11% of respondents are SSLC and post-graduation, 29% of employees have their HSC, 28% have a diploma, and the remaining 21% have their degree.

Correlation

The table shows that the educational qualification of respondents and organization adopts best methods of work

X	Y	X^2	Y^2	XY
13	30	169	900	390
35	36	1225	1296	1260
34	39	1156	1521	1326
25	10	625	100	250
13	5	169	25	65
X^2 =120	Y^2 =120	$\sum X^2$ =3344	$\sum Y^2$ =3842	$\sum XY$ =3291

$$r = \frac{\sum XY}{\sqrt{(\sum X^2)(\sum Y^2)}}$$

$$r = \frac{3291}{\sqrt{(3344)(3842)}}$$

$$r = \frac{3291}{3584.3}$$

$r = 0.91$

Result

This is a positive correlation. The factors influence relationship with educational qualification of respondents and organization adopts best methods of work.

Findings

1. 43% of the employees are receiving promotion.
2. 29% of the respondents are having their HSC education.
3. 33% of the employees are said agree for adequate support system provide in the company for doing their job.

Suggestion

- People are motivated by a variety of things, and what inspires one person may not necessarily inspire another. Therefore, businesses should consider the interests of every employee.

- Organizations should embrace more financial incentives for rewarding the staff because the majority of workers seek money benefits in rewards and recognition.
- Explaining to employees how they may influence the organization's objectives and propel the company to success. Describing the strategy for overseeing and recognizing both individual and group achievement.
- To ensure uniform skill and technical improvement, same opportunity must be provided to all organizational cadres of employees.

Conclusions

To summarize, the study finds a positive association between employee performance in business process outsourcing and wages, bonuses, commissions, and working conditions. Thus, rewards and employee motivation have a favourable association. Employee motivation is the goal of rewards, which will improve organizational performance. The organization needs to create a reward strategy based on the findings of the study on rewards and employee perception. This strategy should outline how the organization's reward policies and procedures should be created in a way that benefits both the employee and the organization. The reward should be successful in motivating the workforce in accordance with their needs, while the reward policies are driven by business requirements. We can conclude from this research that employees in any organization need to be regularly given the chance to pick up new talents in order to avoid boredom and be motivated to use the skills they have learned at work. We can also deduce that there are other factors involved, such as the fact that rewards other than money do not encourage workers. In essence, this means that the employees must be inspired by the nature of their work.

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CHAPTER 39

A STUDY ON IMPROVING EMPLOYEE ENGAGEMENT PARAMETERS IN BHARAT HEAVY ELECTRICALS LIMITED, TIRUCHIRAPPALLI

Suguna N*, Vijay N, Elamaran R, Abinaya A & Thangamalar P
Department of Management Studies
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract

The main objective is to study the improving worker involvement parameters. The study focuses in the improving worker involvement parameters in BHEL. Employee engagement has become a critical focus for many organizations, as it is linked to increased productivity, higher job satisfaction, and lower turnover rates. This abstract explores the different parameters that can be used to improve employee engagement, including communication, recognition, and work-life balance. Communication involves creating an open and transparent dialogue between management and employees, allowing for feedback and input. Recognition involves acknowledging employee's contributions, which can be done through formal programs or informal feedback. Work-life balance involves offering flexible schedules, remote work, and time off to support employees' personal and professional lives. By implementing these parameters, organizations can increase employee engagement, leading to improved performance and retention rates the total population of the organization is 3765 in BHEL TRICHY. The sample size of 120 employees was chosen from the total population. Accordingly, data was collected using a questionnaire. The study was limited to employees of BHEL, TRICHY. The findings show that this would improve the employee engagement parameters in the organization.

Keywords: *Work life balance, Job Satisfaction, Employees Contribution and Employee Engagement.*

Introduction

The main objective is to study the improving employee engagement parameters. The study focuses on the improving employee engagement parameters at BHEL. Employee engagement has become a critical focus for many organizations, as it is linked to increased productivity, higher job satisfaction, and lower turnover rates. This abstract explores the different parameters that can be used to improve employee engagement, including communication, recognition, and work-life balance. Communication involves creating an open and transparent dialogue between management and employees, allowing for feedback and input.

Recognition involves acknowledging employee's contributions, which can be done through formal programs or informal feedback. Work-life balance involves offering flexible schedules, remote work, and time off to support employees' personal and professional lives. By implementing these parameters, organizations can increase employee engagement, leading to improved performance and retention rates the total population of the organization is 3765 in BHEL TRICHY.

Review of Literature

- **Schaufeli, WB & Bakker, AB (2022)** It emphasized the need for HR professionals to think about how to fully utilize the "human capital" of their organizations in order to boost their effectiveness, quality, and innovation. He emphasized the fact that maintaining a competitive advantage is increasingly considered as being dependent on employee engagement. Among the advantages are enhanced profitability, higher productivity levels, greater innovation and creativity, decreased absenteeism and attrition rates, as well as higher levels of employee dedication, motivation, and morale. As a result, adopting employee engagement is best practice for any organization.
- **Rothbard, NP (2021)** He said that highly engaged workers are "willing to commit significant personal resources, in the form of time and effort, to the successful completion of their task," and that "engagement is at its highest when a person is channeling personal energies into physical, cognitive, and emotional labors." As it has been discovered, businesses with an engaged workforce are considerably more capable in tough economic times than those with disengaged employees, an increasing number of companies are now implementing employee engagement strategies and policies within their organizations.

Objectives of the Study

Primary Objectives

- A study on Improving Employee Engagement Parameters in BHEL - TIRUCHIRAPALLI.

Secondary Objectives

- To analyze demographic data (age, gender, job experience, and educational background) to determine the level of employee involvement

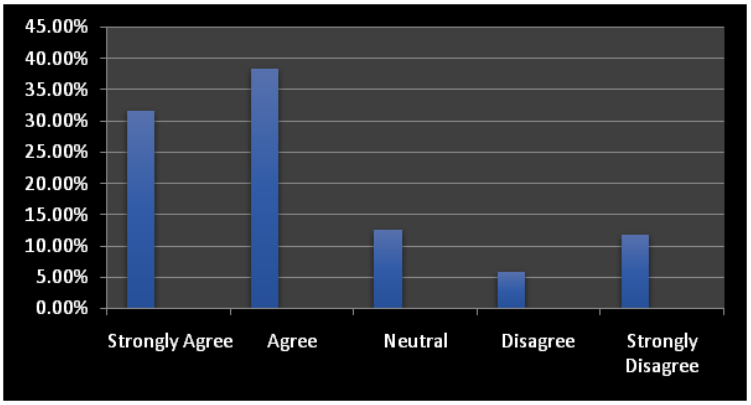
- To identify general practices that organizations use to engaged and select employees.
- To determine which employee engagement are most effective and is they easy to learn new method /technique.

Learn Easily if there is Any New Method/Technique to Adopt

S.No	New Method/Technique	No. of respondents	Percentage
1	Strongly Agree	38	31.7%
2	Agree	46	38.3%
3	Neutral	15	12.5%
4	Disagree	7	5.8%
5	Strongly Disagree	14	11.7%
	Total	**120**	**100%**

Source: Primary Data

Learn Easily if There is Any New Method/Technique to Adopt



Interpretation

According to the aforementioned table, 31.7% of respondents strongly agree will learn easily if there is any new method to adopt, 38.3% of the respondents are agree in learn easily if there is any new method/technique to adopt, 12.5% of the respondents are neutral in learn easily if there is any new method/technique to adopt, 5.8% of the respondents are disagree in learn easily if there is any new method/technique to adopt and remaining 11.7% of the respondents are strongly disagree in learn easily if there is any new method/technique to adopt. Majority 38.3% respondents are AGREE in learn easily if there is any method to adopt.

Chi -Square Test Analysis

Comparison of the Age of the Employees and Qualification of the Employees

Ho = There is no significant relationship between Age and Qualification**.**

H1**=**There is no significant relationship between Age and Qualification

Source: Primary Data

Qualification/Age	UG	PG	Technical Qualification	Others	Total
B/W 18-25	3	9	17	28	7
26-35	0	8	6	8	2
36-45	2	1	1	4	8
46-55	0	0	1	2	3
Total	**5**	**8**	**25**	**42**	**20**

O	E	(O-E)	(O-E)2	(O-E)2 /E)
13	13.95	-0.95	0.90	0.06
9	15.63	-6.63	43.96	2.81
17	13.95	3.05	9.30	0.67
28	23.45	4.55	20.70	0.88
10	6.66	3.34	11.16	1.68
8	7.46	0.54	0.29	0.04
6	6.66	-0.66	0.44	0.07
8	10.5	-2.5	6.25	0.60
2	3.75	-1.75	3.06	0.82
11	4.2	6.8	46.24	11.01
1	3.75	-2.75	7.56	2.02
4	6.3	-2.3	5.29	0.84
0	0.625	-0.625	0.39	0.63
0	0.7	-0.7	0.49	0.70
1	0.625	0.375	0.14	0.23
2	1.05	0.95	0.90	0.86
Total				**23.89**

Calculation

Degree of Freedom (D.F)

= (c-1) (r-1)

= (4-1) (4-1)

= 3(3)

= 9

Table value =16.92

Calculated value = 23.89

calculated value >Table value

23.89 > 9

Inference

Ho is rejected there is significant different between Age and Qualification

Correlation

Table Showing the Significant Relationship between Designation and Know Your Work Schedule

Know your Work Schedule (x)	38	46	18	4	14
Designation of the Employee (y)	47	38	35	0	0

S.No	X	Y	X2	Y2	XY
1.	38	47	1444	2209	1786
2	46	38	2116	1444	1748
3	18	35	324	1225	630
4.	4	0	16	0	0
5.	14	0	196	0	0
TOTAL	**120**	**120**	**4096**	**4878**	**4164**

N=5 ΣX=120 ΣY=120 ΣX2 =4096
ΣY2=4878 ΣXY=4164

$$r = \frac{n\,\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{n\,(\Sigma X2) - (\Sigma X)}\sqrt{n\,(\Sigma Y2) - (\Sigma Y)2}}$$

$$r = \frac{5\,(4164) - (120)(120)}{\sqrt{5\,(4096) - (120)2}\sqrt{5\,(4878) - (120)2}}$$

r = 0.82376

Inference

There is high positive correlation between satisfied level of designation(x) and know your work schedule (y).

Findings

- 38.3% of the respondents are agree in finish work with in time period.
- 46.7% of the respondents are agree in resolve any issues in the job.
- 37.5% of the respondents are agree in discuss with colleagues during working hours.
- 38.3% of the respondents are agree in work schedule

Suggestions

- It is found that 60% of employees are aware of the employee welfare measure the organization should take initiative to improve the level of awareness of employee welfare scheme.
- Provide opportunities for employees to learn and grow professionally.
- Communication is critical in any organisation and BHEL is no exception. Management should encourage all the employee to resolve the issue

Conclusion

This study focuses on raising BHEL staff engagement standards. The organization exhibits high levels of decision-making transparency and information sharing. The management favours a participatory style of decision-making. There is sufficient freedom to carry out one's duties, and there is room in the organization for one's professional and personal development. The organization's leadership is personable and considerate to the demands of the employees. Roles and obligations

must be fulfilled at the same time, and everyone is responsible for their work. The employee can create an environment that fosters the growth of the employees' abilities and provides possibilities.

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About the Editors

Dr.K.Elangovan is currently serving as the Principal of Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. He completed his higher studies and Research at esteemed institutions like the Government College of Engineering, Salem, and the National Institute of Technology, Tiruchirappalli. He has an impressive teaching background with over 23 years of experience in the field of Engineering and technology, and the extensive tenure undoubtedly grants him valuable knowledge and expertise in educating and shaping the minds of aspiring engineers and technologists. His research expertise primarily lies in the domains of manufacturing and metal forming, with a specific focus on sheet metal forming. The comprehensive analyses and findings from his research work have contributed to a deeper understanding of this problem and potential solutions. He has a remarkable research record, having published 11 articles in international journals. Additionally, he has authored three technical books, contributing to the dissemination of knowledge in the fields of Engineering and Technology. These publications reflect his dedication to advancing the academic and professional communities through scholarly contributions.

Dr.T.Sivaraman is right now working as a Dean – Research at Dhanalakshmi Srinivasan Engineering College, Dhanalakshmi Srinivasan Group of Institutions, Perambalur - 621212, Tamil Nadu, India. He received his Ph.D. in Chemistry from National Tsing Hua University, Taiwan, in 1999. As of now, he has more than 27 years of research experience in the areas of Toxinology, Cancer Biology, Computational Biology and Drug Design. As of July 2023, he has published > 100 research articles in reputed international journals (with a cumulative impact factor of > 212; > 1400 citations; h-index: 20; i10-index: 37), 5 books, and delivered more than 100 presentations at various scientific events to his credit to date. He has guided >80 research projects for students in the Science and Engineering Streams at all three higher educational levels. He has successfully completed a few research projects sponsored by funding agencies such as DBT, ICMR, and CSIR, New Delhi, India. He is on the Editorial Board and Reviewer of several reputed journals and is also a member of many International and National societies and organisations.

TRUELINE ACADEMIC AND RESEARCH CENTRE
7/232-26, Devi Towers, Vaikuntham, Salem - 637 103, Tamil Nadu India.
Email: truelinepublisher@gmail.com | Website: www.truelinepublisher.in
Contact: 91- 9578873584, 9025440986

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