The Institution of Engineers (India)
8 Gokhale Road, Kolkata 700020
A Scientific and Industrial Research Organisation
recognised by Department of Scientific and Industrial Research
Government of India
ISO 9001:2015 Certified
Volume 13 September 2024

Compendium on R&D Projects

under the grant-in-aid-scheme

The Institution of Engineers (India)

Notification for

R&D Grant-in-Aid

To promote appropriate technology, assist in building up design & research talents and, most importantly, to help in nurturing potential R&D venture amongst engineering students pursuing Diploma/UG/PG/PhD courses, The Institution of Engineers (India) had instituted the R&D Grant-in-Aid program way back in 2001.

Like every year, the Institution invites applications for funding R&D projects and research initiatives aimed at improving the life-style of common people from engineering students pursuing full time Diploma/UG/PG/PhD engineering program from AICTE/UGC/NAAC approved Institutions/Colleges/Universities. The application form and guidelines are available in our website https://www.ieindia.org. The projects should be carried out under the guidance of faculty members who are Corporate Members of IEI. Membership criteria for student(s), guide(s) and Institution(s) are as follows:

Project Category	Student/Applicant Membership	Guide(s) Membership	Institutional Membership
1. Diploma	Exempted [Membership of Student Chapter is desirable]	AMIE/MIE/FIE	Not Mandatory
	Preferably 'Student Member' (SMIE)	AMIE/MIE/FIE	Applicant's Institute should preferably be an Institutional Member with valid NIRF Rank
2. UG (BE/BTech/AMIE/Equivalent)	'Student Member' (SMIE)	AMIE/MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank
3. PG (ME/MTech/Equivalent)	AMIE/MIE/FIE	MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank
4. PhD	AMIE/MIE/FIE	MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank

The soft copy of the duly filled-up applications (in editable format), as per the proforma available in our website www.ieindia.org, should be sent through email to research@ieindia.org and one printed copy of the same should reach the following address:

Deputy Director (Technical)

The Institution of Engineers (India), 8 Gokhale Road, Kolkata 700 020

Applications received in format other than that available on our website will not be accepted. Application should be forwarded through the Guide, Head of the Department or Head of the Institution. Please note that preference will be given to project proposals received from Institutions who are members of The Institution of Engineers (India) and with NBA / NAAC Accreditation or valid NIRF Rank. Kindly go through the guidelines (visit link https://www.ieindia.org/webui/IEI-Activities.aspx#RnD-Initiative) carefully before filling up the application.

The grant is not intended for the faculty members who have access to other avenues of research funding. Proposals received will be scrutinized and the recipients of R&D Grant will be informed accordingly.

Message from the

President

It is a matter of great pride to present the *Compendium on R&D Project Outcomes*, a significant milestone in the ongoing journey encouraging innovation by The Institution of Engineers (India). This compendium is a reflection of our commitment to fostering a culture of research and development, which is crucial for the advancement of engineering and technology in our nation.

This compendium is a tapestry woven with outcomes of 21 research project encompassing a spectrum of technologies spreading across diverse field of engineering starting from Renewable Energy to Application of Nano material in Civil Engineering, Application of IoT in Agriculture, Composite Material, Waste Management, Robotics, Pollution Control, UAV and 3D Printing as well as Assistance for Visually Impaired to mention a few. However diverse the topics may be but the underlying objective is betterment of the society and development of the nation. The Institution of Engineers (India), recognized as a SIRO, remains steadfast in its mission to support and nurture research that will shape the future of our nation.

I would like to extend my deepest gratitude to the members of the Research and Development Committee (2023-24), whose guidance and oversight have been instrumental in the success of this endeavour. My appreciation also goes to the dedicated Secretariat team, whose hard work has contributed to the successful publication of this edition of Compendium.

Dr G Ranganath, FIE
President, The Institution of Engineers (India)

Message from Chairman
Committee for Advancement of Technology and Engineering

It is with great satisfaction that I extend my congratulations to all contributors of the *Compendium on R&D Project Outcomes*. This publication is a testament to the innovative spirit and technical prowess associated with The Institution of Engineers (India)

The projects featured in this compendium exemplify our collective commitment to pushing the boundaries of engineering and technology. Each initiative reflects the ingenuity and dedication of our researchers, whose work not only advances our field but also contributes to the progress of our nation.

I would like to express my sincere appreciation to the Research and Development Committee and all those involved in bringing this compendium to life. Your efforts have resulted in a valuable resource that will undoubtedly inspire future generations.

Let this compendium serve as a beacon for continued exploration and innovation, driving us toward a future where engineering and technology lead the way to sustainable growth and development.

Congratulations once again to all contributors.

Prof (Dr) Girish Shrikisan Mundada, FIE
Chairman, CATE, IEI

Message from Chairman
Research & Development Committee

It is with immense pride that I present the *Compendium on R&D Project Outcomes*, a reflection of the dedication and excellence demonstrated by the researchers within The Institution of Engineers (India). This compendium encapsulates the innovative spirit and technical expertise that are at the heart of our institution.

I extend my deepest gratitude to all the contributors who have poured their knowledge, creativity, and hard work into these projects. Your efforts are not only advancing the field of engineering but also playing a crucial role in shaping the future of our nation.

This compendium stands as a testament to what we can achieve through collaboration and a shared commitment to excellence in research and development. Let it inspire us all to continue striving for breakthroughs that will drive progress and innovation in our country.

Congratulations to everyone involved in this remarkable achievement.

Dr G Venkata Subbaiah, FIE
Chairman, RDC, IEI

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GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
Department of Scientific and Industrial Research
Technology Bhavan, New Mehrauli Road,
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F.No. 11/97/1988-TU-V

Date: 28th April 2022

The Secretary & Director General
The Institution of Engineers (India),
8, Ghokhale Road,
Kolkata – 700020, West Bengal

Subject : **Registration of Research Institution, other than a Hospital, for the purpose of availing Customs duty exemption in terms of Government Notifications No. 51/96-Customs dated 23.07.1996; No. 24/2007-Customs dated 01.03.2007; No. 43/2017-Customs dated 30.06.2017; No. 45/2017-Central Tax (Rate) & 47/2017-Integrated Tax (Rate) dated 14.11.2017; No. 9/2018-Central Tax (Rate), No. 09/2018-Union Territory Tax (Rate) & No. 10/2018-Integrated Tax (Rate) dated 25.01.2018; and State Tax (Rate) as applicable and all notification, as amended from time to time.**

CERTIFICATE OF REGISTRATION

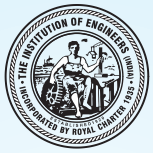
This is to certify that **The Institution of Engineers (India), Kolkata, West Bengal** is registered with the Department of Scientific and Industrial Research (DSIR) for the purpose of availing Customs duty exemption in terms of Government Notifications No. 51/96-Customs dated 23.07.1996; No. 24/2007-Customs dated 01.03.2007; No. 43/2017-Customs dated 30.06.2017; No. 45/2017-Central Tax (Rate) & 47/2017-Integrated Tax (Rate) dated 14.11.2017; No. 9/2018-Central Tax (Rate), No. 09/2018-Union Territory Tax (Rate) & No. 10/2018-Integrated Tax (Rate) dated 25.01.2018; and State Tax (Rate) as applicable and all notification, as amended from time to time. The Registration is subject to terms and conditions mentioned overleaf.

This Registration is valid upto **31.03.2025.**

Please acknowledge the receipt.

Yours faithfully,

(Dr. P.K. Dutta)
Scientist - 'F'



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(Established in 1920, Incorporated by Royal Charter 1935)

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A Century of Service to the Nation

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Contents

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Maj Gen (Dr) MJS Syali, VSM (Rted)
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Parametric Study on Evacuated Tube Solar Heater for Low Process Heating Applications

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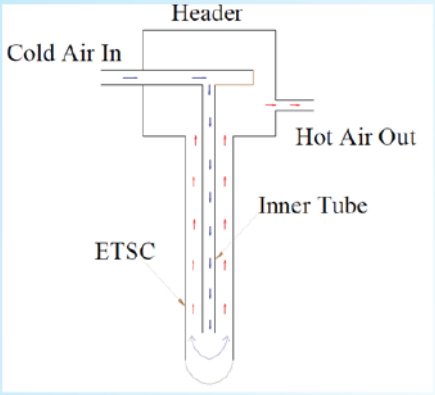

Schematic Diagram of the Project

Pictorial View of the Project

OBJECTIVES

- To design and fabricate a low cost evacuated tube solar air heater for low temperature process heating applications.
- To evaluate the performance of evacuated tube solar air heater by varying the mass flow rates and length and diameter of the coaxial tube.
- To enhance the performance of evacuated tube solar air heater by introducing the circular fins in the coaxial tube.
- To evaluate the energetic and enviro-economic analysis of the solar air heater.

ACHIEVEMENTS

- Comparing all the maximum outlet temperature of the air, it is found that the maximum outlet temperature is attained at a length of 1.5 m for coaxial inner tube at a flow rate of 100 kg/h. The maximum temperature difference is found to be 79◦C at a flow rate of 100 kg/h with a coaxial tube length of 1.5 m.
- Comparing all the maximum efficiencies at flow rate of 100 kg/h for different lengths of coaxial inner tubes, i.e. 1.5 and 0.75 m. The maximum efficiency is found to be 0.47 at a flow rate of 100 kg/h with a length of 1.5 m.
- Studying the relationship of lengths and mass flow rate with efficiencies and temperature differences, it is found that the efficiency and temperature difference increase with the length of aluminium tubes.

Development of Miniaturized Antenna Based on Fractal Geometry for Public Protection and Disaster Relief (PPDR) Communication

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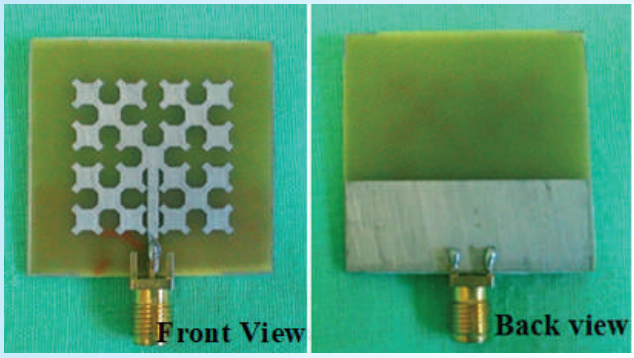
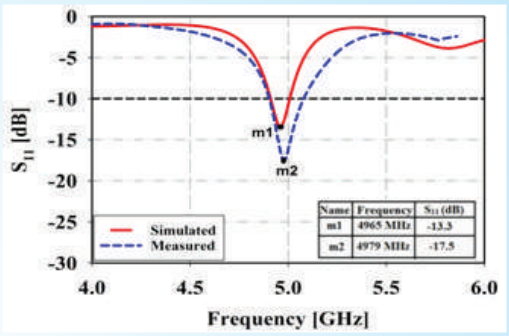


Photograph of the fabricated fractal Antenna



Simulated and measured S_{11} of fractal antenna

OBJECTIVES

The objective this project is to

- Design an antenna for emergency management system which should be devoted to Public Protection and Disaster Relief (PPDR) communication.
- To achieve the objective, basically a compact Sierpinski Knopp Fractal (SKF) antenna is proposed to operate at 4900 MHz.
- To attain miniaturization by utilizing Sierpinski Knopp curve. The proposed antenna consists of Sierpinski Knopp space-filling curve inspired radiating element, partial ground plane, and microstrip feed.
- To manufacture the proposed antenna using FR-4, a glass epoxy material and, examine by using the Agilent Vector Network Analyzer (VNA) under anechoic chamber.
- To achieve the experiment results to meet the desired specifications with good impedance matching.
- To prove the proposed antenna's suitability for Public Protection and Disaster Relief (PPDR)
- Communication.

ACHIEVEMENTS

In the modern world, communication plays a major role in rescue and relief operations during emergency or disaster situations, mainly in the countries which are highly prone to natural disasters like floods, earthquakes,

coastal cyclones and also, man made disasters like accidents, terrorist attacks, etc. Public Protection and Disaster Relief (PPDR) communications are one of the communication networks, which provide services to protect the life of the people, property and disaster recovery. They are highly dependent on radio communications. A proper radiator is necessary to support PPDR communications for timely response during the disaster. An antenna is one of the indispensable components, which performs the main part in the transmission and reception of information. Therefore, it should have a compact size with better performance. There is a great demand for developing an antenna with the above requirement in order to build reliable communication during an emergency condition. Thus we set our objective as to design a compact Sierpinski Knopp Fractal (SKF) antenna to operate at 4900 MHz antenna for emergency management system which should be devoted to Public Protection and Disaster Relief (PPDR) communication.

After completing the theoretical design process, simulations are carried out using ANSYS High Frequency Simulation Software. An optimized structural parameters are obtained by performing parametric analysis. The optimized footprint of the antenna found from the analysis is $35 \times 35 \times 1.6$ mm^3. The fabricated radiating element experimentally proved to exhibit the operating band ranging from 4900 MHz to 5080 MHz with a centre frequency of 4979 MHz. It also offers the bandwidth of 180 MHz and a gain of 1.6 dBi. Thus proved its suitability to support Public Protection and Disaster Relief (PPDR) communication.

The authors thankfully acknowledge the financial support provided by The Institution of Engineers (India) for carrying out Research & Development work in this subject

Published the antenna pattern in design patent.

The applied design patent has the application number : 342753-001. First Examination report response has been submitted and it is under amendment stage.

PUBLICATIONS

Papers published in journals / Papers presented in Seminars / M.Tech Thesis / Ph.D Thesis / Patent generated from this project

1. Dr. G. Indumathi, I. Paulkani (2020), Design of Sierpinski Knopp Inspired Fractal Antenna for Public Safety Applications. Wireless Pers Commun 114, 227–239 (2020). https://doi.org/10.1007/s11277-020-07360-9

2. Dr. G. Indumathi, I. Paulkani (2021), “Fractal Antenna for Public Protection and Disaster Relief (PPDR) communication”, Indian Patent Application Number:342753-001. (Status: First Examination report).

Engineering is an activity other than purely manual and physical work which brings about the utilization of the materials and laws of nature for the good of humanity.

R. E. Hellmund

Smart Farming: Application of Internet of Things (IoT) System using Artificial Intelligence (AI)

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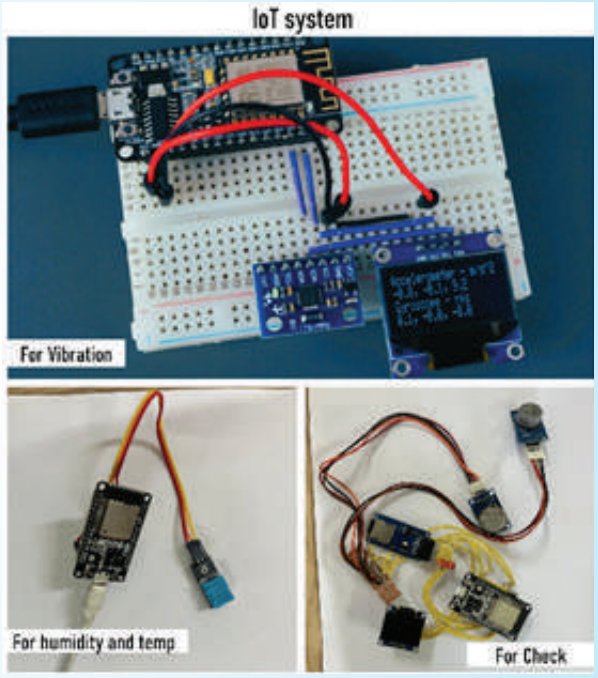

OBJECTIVES

The objectives of the proposed project study are as follows:

1. Investigating into the relative impact of various parameters on the human and machine health.
2. Design and Development of an IoT based system to assess and monitor human and machine health.
3. Remedial measures to enhance the human and machine health.

ACHIEVEMENTS

Indian agriculture is an important sector that forms the backbone of Indian economy, supporting the livelihoods for rural population. In India, a predominantly agrarian economy, the tractor is essential for modernizing farming practices that increases crop yields, and reducing manual labor, and transforming the agricultural

landscape. Tractor operators are plays a vital role in agriculture activities, from ploughing to harvesting of crop that enhance the productivity. During performing the various farm and transportation activities, operators are exposed with the several adverse health effects i.e., excess of noise, vibration, and emissions from the tractor. The current investigation was carried out during operational conditions on and off roads and in the field to assess the biodynamic behavior of tractor drivers for a comfortable ride. Examining the impact of different ride parameters, including RPM (3 levels), Gear (3 levels), and cushion (10 combinations) for the different subjects (5 subjects) among the various on-road (Loaded, Unloaded, Only tractor) and off-road (harrowing, cultivation, rotavation) operations in the northwest region of India. In the initial stage, dedicated sensors are attached to measure the noise (near to operator), vibrations (on seat, floor, head, hand and backrest of tractor seat), oximeter (for oxygen, and heartbeat) during performing the different off-road (Cultivation, Harrowing, and Rotavation) and on-road (Loader-trolley with full load, Unloader-trolley without load, and Only tractor) activities. All the vibration responses were measured along the 3 axes (x, y, and z). It is observed that maximum vibration along z-axis is exceeds exposure action value (EAV~0.5 m/s^2) for the selected on-road and off-road operations. Whereas, the hand-arm vibration (HAV) exceeds the daily action level among all the operations, i.e., EAV is 2.5m/s^2. Furthermore, the noise level exceeds the normal level for the daily exposure, i.e., 85 dB. Similarly, the heartbeat range is 101-151 bpm is recorded among all the operators for selected operations. In nutshell, a real-time sensing system is developed for the driver health and safety, an IoT system embedded with the microcontrollers (ESP32), tri-axial accelerometer (LSM90S1), temperature (DHT11), humidity (DHT22), heartbeat, gas measuring (MQ-6, MQ-5), noise (BOB-12758), sensors with the wireless transmission module is utilized. The ANOVA analysis indicates that the average speed and pulling force are significant parameters ($p \leq 0.05$) that influence the vibration, noise, and heartbeat response among all the on-road and off-road operations. The vibration exposure was more than the recommended exposure limits according to ISO 2631-1 (1997). From the outcomes of the study, it is depicted that the seat isolation capacity is very poor, especially in the off-road conditions. The outcomes of this study can be utilized for the operator safety for performing the various agriculture activities by optimizing the tractor design (such as suspension system, engine noise, seat design, etc.). This will enable the drivers to perform their tasks within the recommendations of safety regulations.

PUBLICATIONS

1. Prakash, C., Singh, L. P., & Gupta, A. (2023). Optimization of Daily Vibration Dose during Different Ride Parameters among Tractor Driving. SAE International Journal of Transportation Safety, 11(09-11-03-0009).
2. Prakash, C., Singh, L. P., Gupta, A., & Lohan, S. K. (2023) Advancements in smart farming: A comprehensive review of IoT, wireless communication, sensors, and hardware for agricultural automation. Sensors and Actuators A: Physical, 114605.
3. Prakash, C., Singh, L. P., & Gupta, A. (2023). Experiment and optimisation analysis of whole-body vibration among tractor drivers: a comprehensive study. Int. J. Heavy Vehicle Systems, Vol. x, No. x, xx (Accepted)
4. Prakash, C., Singh, L. P., & Gupta, A. (2023). Investigation into the Compressive Stress on Lumbar Spine among Tractor Drivers during different Ride Conditions. In IOP conference series: Earth and Environmental Science, 1084 (1), 012064.

Solar PVFED Modified Induction Motor Drive(MIMD)for Water Pumping Applications

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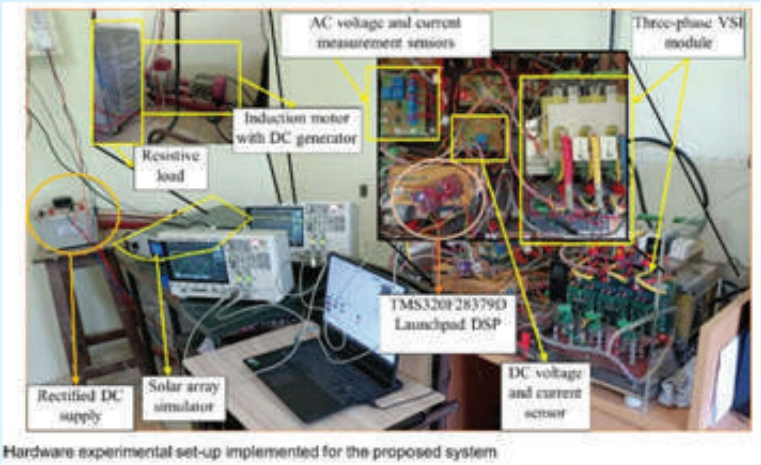

Advanced control of Induction Motor Drive Fed from Solar Photovoltaic Array Simulator

Open-Loop Testing of the Induction Motor Drive for Water Pumping Applications

OBJECTIVES

The evolution of renewable applications is diverging, and solar photovoltaic water pumping is a trending area of research. The agricultural lands in the remote villages lack the utility grid connection to pump the water and are using diesel-based water pumps for the same. Solar water pumping systems can be used during the day and can run without batteries. The growth rate has been tremendous for the installation of solar photovoltaic water pumps with increase in the predicaments of electric power in remote and rural areas. The core objectives of the suggested system are as follows:

- To develop and design a single-stage photovoltaic array motor drive for water pumping applications.
- To implement the sensor less approach for the control of motor by eliminating the voltage sensors at the motor input terminals and predicting the same from the SPVA voltage. Elimination of a motor current sensor and predicting it using three-phase current balance equation. Only four sensors are used and are given by one DC voltage sensor,one DC current sensor, two AC current sensor at the motor terminals.
- To eliminate the speed encoder by predicting it with the existing sensor measurements and using flux estimation.
- To develop an effective and simplified vector control for the control of motor-pump setup.
- To develop an effective simplified MPE algorithm as a torque reference to vector control. To develop MPE algorithm that works effectively for partial shading conditions also.
- To develop a hardware scaled prototype to validate the system

ACHIEVEMENTS

- A sensorless approach is tested with vector control of induction motor drive that employs a conventional method with PI controllers. The effect of system parameters on the PI controllers exists and may have a deteriorated performance over long term.
- Another vector control employing vectorial sliding mode control is used, which is a robust control algorithm and is not dependent control on system parameters. The control system does not require Clark and Park transformations. But the tuning parameters of the sliding mode control is a complex process and requires rigorous practices. While the PI controller tuning is a well-established method, its execution is simple in comparison with vector sliding mode control.
- A novel vectorial sliding mode control with the torque reference-based control was employed to control induction motor drive.
- A comparison of control methods and their specific features along with the proposed system are presented.
- Due to the non-availability of additional power sources at remote locations, the proposed solar photo voltaic array based water pumping motor drive is recommended for use as a portable water pumping system, as a future alternative for diesel engine water pumping system.

PUBLICATIONS

1. B. P. Rachaputi, J. Rathinadurai Louis, and M. Sridharan, (2022). Solar photo voltaic array fed single-stage sensorless vector control of induction motor drive for water pumping applications. Int. J. Energy Environ. Eng. (Springer).https://doi.org/10.1007/s40095-022-00540-2.
2. B. P. Rachaputi, J. Rathinadurai Louis, and M. Sridharan, (2023). Novel Sliding Mode Control of Single-stage induction motor drive for Solar Water Pumping Applications. Electrical Engineering., 2023. (Springer).https://doi.org/10.1007/s00202-023-01851-1.

Investigating the Properties of Concrete with Marine Algae as Natural Polymer

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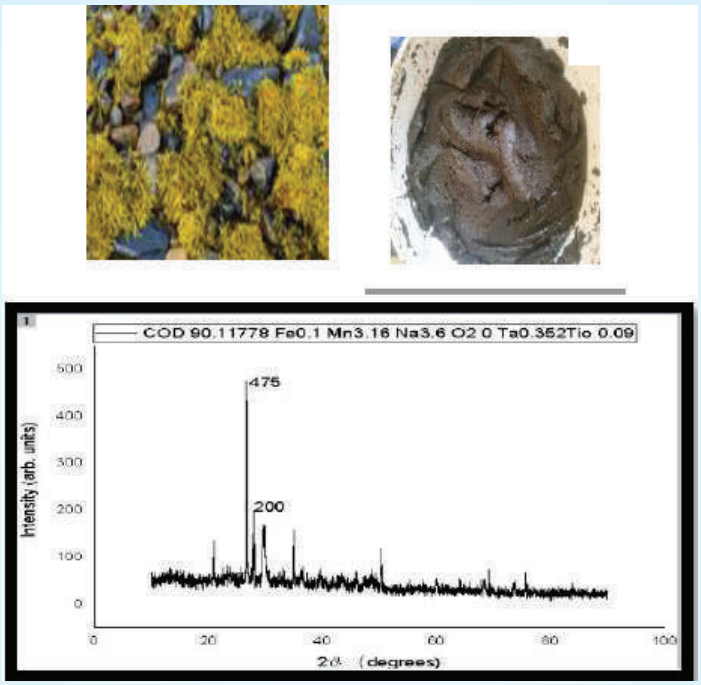
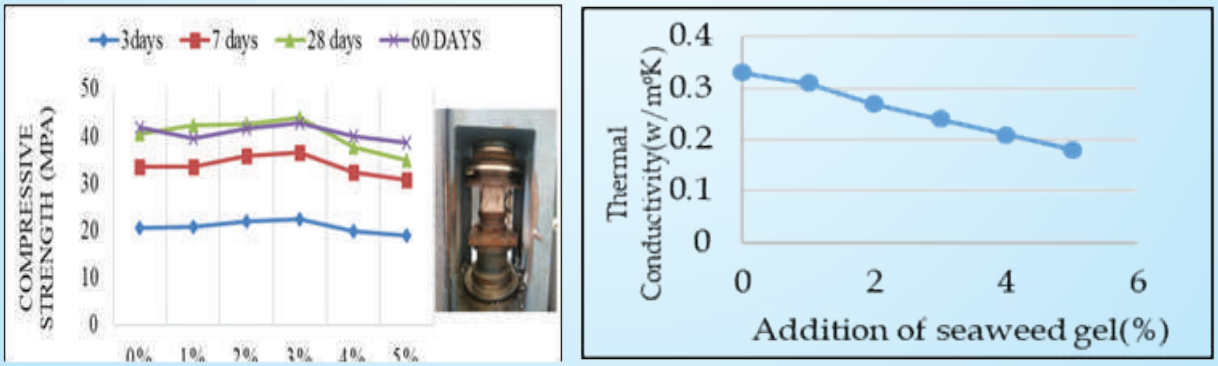


Sea weed gel with its XRD pattern



Variation of compressive strength and thermal conductivity of concrete with sea weed gel

OBJECTIVES

- Addition of seaweed gel in mortar and concrete as natural polymer at various proportions from 1 to 5% by weight of cement.
- To conduct the microscopic studies such as, SEM, FTIR and XRD on seaweed gel.
- To study the fresh state properties such as standard consistency, setting time of cement admixed with various proportions of sea weed gel.
- To study the workability and mechanical properties such as slump, compressive strength, flexural strength and thermal conductivity at various ages in mortar and concrete.
- To study the durability properties such as rapid chloride permeability, acid attack, sulphate attack and water absorption at various ages.

ACHIEVEMENTS

- XRD pattern of sea weed gel (S. wight ii) shows sharp peaks, confirms the crystalline nature of material. According to the FTIR data, the principal elements of the S. wight ii seaweed extract include carbohydrate and chlorophyll. The texture of these weed gel material showed a rubbery type material.
- In general, addition of sea weed gel improves the fresh state properties of cement and concrete up to 5 % of addition.
- Addition of sea weed gel up to 5 % increases the initial setting time of cement by about 3.33 times when compared to OPC. Hence, seaweed gel is a promising material to be used as retarder.
- The natural polymer of the bio-additive enhances the workability and decreases the water requirement of the concrete mix. The divalent Ca^{2+} ions link the polymeric chains of pectin present in seaweed gel and thus improve the plasticity of the concrete mix.
- Influence of sea weed gel addition on the compressive strength development was marginal by about 12% in cement mortar and concrete up to 4%. At 5% addition, comparable compressive strength of about 42MPa as that of conventional concrete was obtained.
- Flexural strength was increased by about 27% in addition of 3% sea weed gel when compared to conventional concrete.
- Water absorption and sorptivity of seaweed gel admixed concrete was reduced by about 27% and 74% respectively. The additive modified concretes have demonstrated better durability characteristics in terms of resisting chloride penetration with a drastic reduction in the Coulomb charges.
- Addition of seaweed gel significantly reduced the thermal conductivity of concrete by about 45% for 5% addition and hence improves the thermal properties of concrete.
- It is recommended to use 5% of sea weed gel as natural polymer in mortar / concrete to improve the fresh state and durability properties without affecting the strength properties of concrete.

Synergetic Effect of Silicon Nanostructure-Nickel Composites for Solid-state Hydrogen Energy Storage

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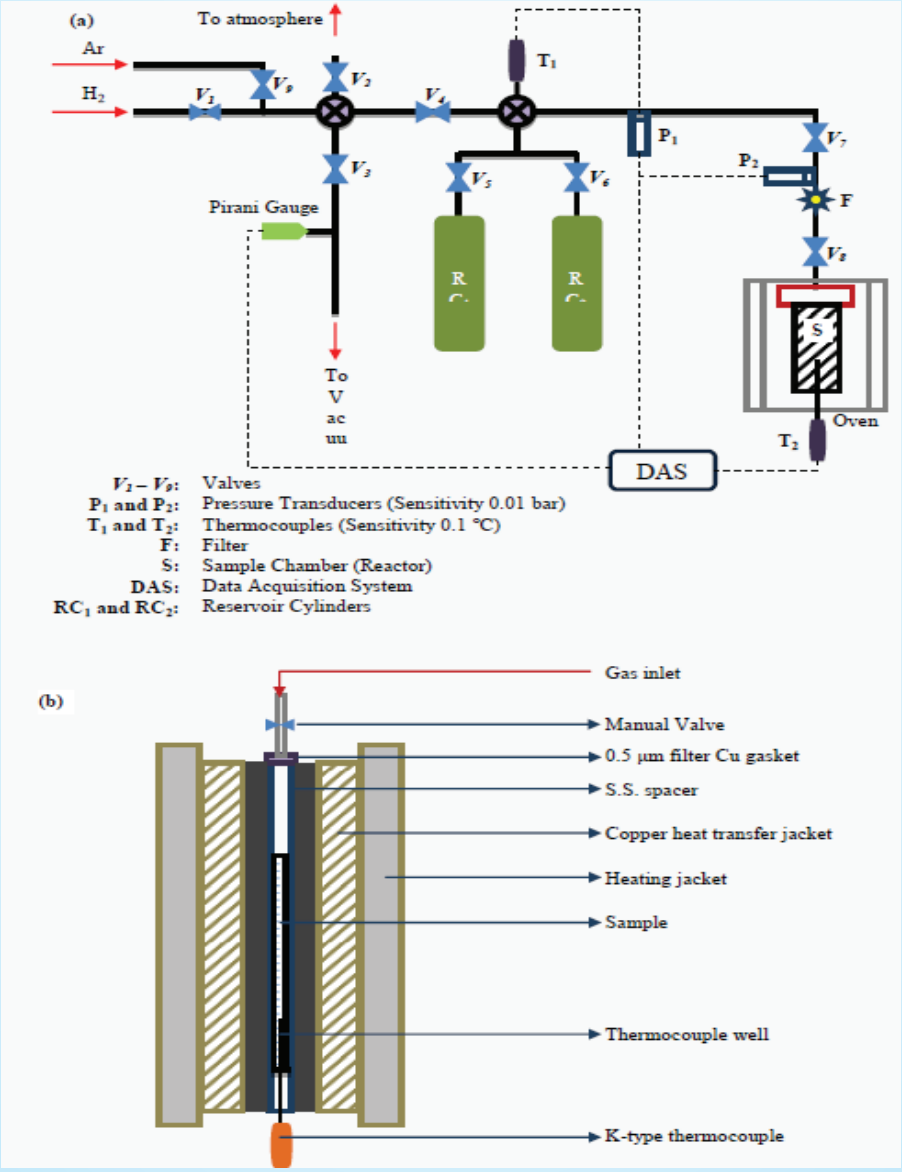

Fig. 1 Schematic of the (a) experimental setup for PCI measurement; (b) Cross-section view of the sample chamber/reactor (S) used for PCI measurement

OBJECTIVES

Among different hydrogen energy storage techniques, solid-state hydrogen storage demonstrates elevated bulk density and gravimetric capacity and addresses safety concerns. The work studies the synergetic effect of porous Silicon (PS) as the host storage material and Ni as the catalyst in the composite form. The PS fabricated by electrochemical anodization is ball-milled with Ni powder to prepare the composite. The composite shows an improved hydrogen storage capacity of 1.64 wt% at 40 bar and 120 °C. The capacity increases to 2.69 wt.% with the increase in pressure to 60 bar at 60 °C, indicating the large active surface. The synergetic effect of PS and Ni produces a synergetic effect that leads to the dissociation of molecules, improves hydrogen storage capacity, and reduces the temperature required for desorption.

Carbon nanostructures (i.e., graphene and graphene oxide (GO) based derivatives) are adequate for hydrogen storage due to their lightweight, low density, and large surface area. However, the poor storage capacity of carbon nanostructures under ambient conditions is the major bottleneck for practical applications. Using a

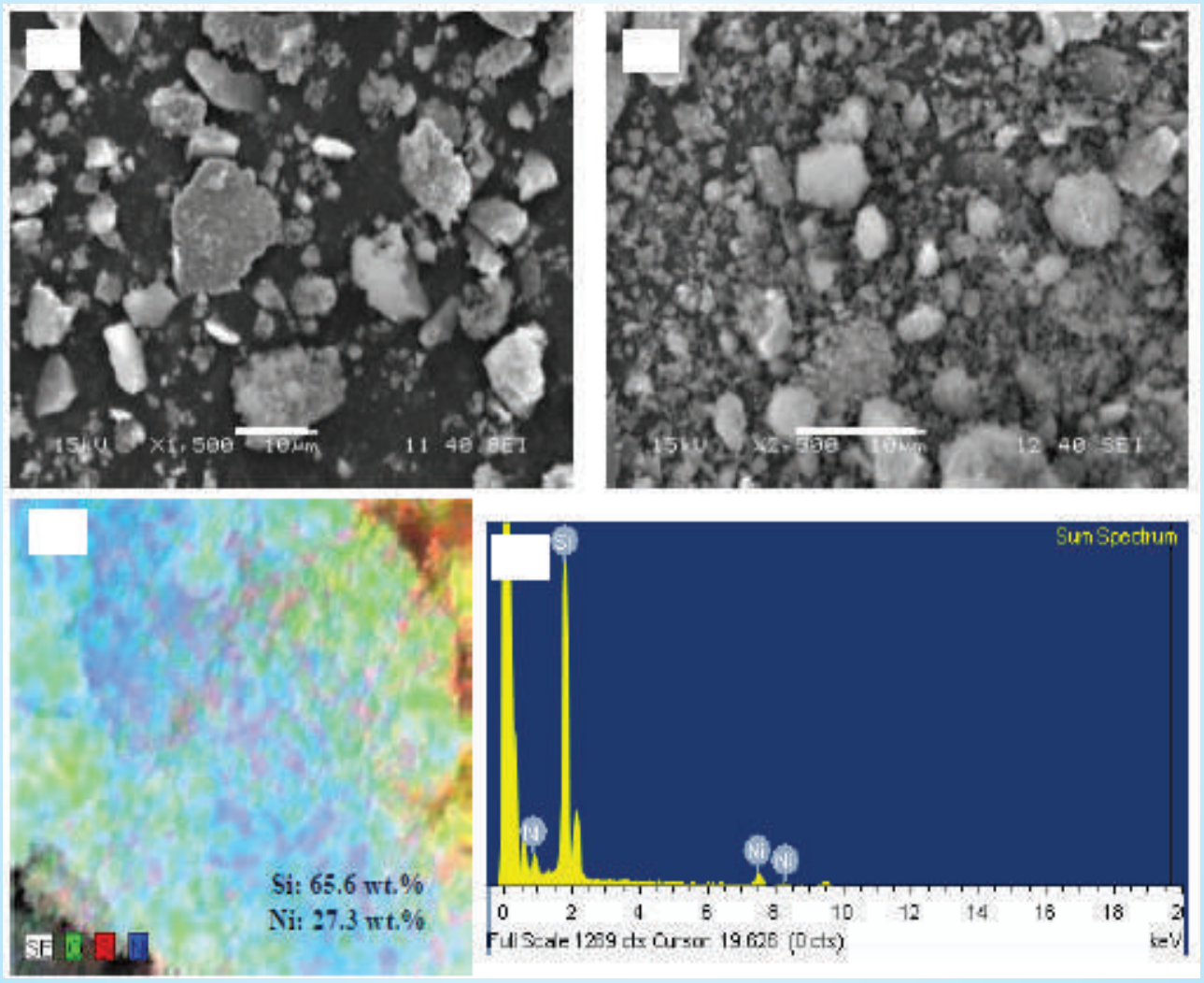

Fig. 2 PS-Ni composite powder pre-hydrogenation experiment; PS-Ni composite powder after post-hydrogenation (several adsorptions and desorption cycles); elementary mapping of PS-Ni composite showing Ni-decoration on PS; and EDX spectra of PS-Ni composite

cost-effective transition element like nickel as a catalyst holds significant potential for storing hydrogen in atomic and molecular forms, invoking the spillover mechanism. The current work evaluates a composition of TrGO, PS, and Ni, synthesized to take advantage of individual properties for hydrogen storage. The calculated specific surface area of TrGO is ~450 m^2 g^{-1}. The various phases in the composition are identified using X-ray diffraction. Raman spectroscopy quantifies the degree of disorder in the composition. The pressure-composition isotherms indicate hydrogen storage capacities of 6.53 wt.% and 2.43 wt.% for TrGO+PS and TrGO+PS+Ni compositions, respectively. Even though the wt.% of TrGO+PS+Ni decreases due to the higher Ni weight, dissociation improves the adsorption rate from 0.35 wt.% hr^{-1} to 0.53 wt.% hr^{-1}.

ACHIEVEMENTS

The work describes the synergetic effect of Ni as a catalyst on PS in promoting dissociative atomic hydrogen diffusion, improved hydrogen storage, and reduced thermal desorption energy. Ball-milling of PS and Ni form composite with a surface area of ~146 m^2/g. The PCI for the composite at 40 bar charging pressure and optimized 120 °C (above which the hydrogen uptake capacity starts decreasing due to the instability of hydrides) shows a hydrogen uptake of 1.64 wt.%. The further increase in the hydrogen uptake capacity with pressure (~2.69 wt.% at 60 °C and 60 bar) indicates a highly active site in the composite. The large surface area and high surface free energy of PS facilitate maximum unsaturated dangling sites to enhance solid-state hydrogen storage. The PCI desorption curves show ~0.5 wt.% of trapped hydrogen, further removed by increasing the desorption temperature. The hydrogen-treated composite shows drastic changes in the structure and composition after high-temperature heat-treated activation, followed by several cycles of hydrogen adsorption and desorption. The formation of high-energy crystalline phases like $Ni_{17}Si_3$ with $NiSi_2$, i.e., re-crystallization, increases the crystallinity in the composition from ~60% (pre-hydrogenation) to ~ 88% (post-hydrogenation). Due to the catalytic effect of Ni on PS, the average decomposition energy requirement reduces, facilitating desorption at a lowered temperature of 268 °C.

PUBLICATIONS

1. R. C. Muduli, Paresh Kale, "Synergetic effect of porous silicon–Nickel composite on its solid-state hydrogen energy storage properties,"International Journal of Hydrogen Energy 2023; V48, I90, 35185-35196; https://doi.org/10.1016/j.ijhydene.2023.05.268
2. R. C. Muduli, N. K. Nishad, D. Dashbabu, E. Anil Kumar, & P. Kale, "Synergistic Integration of Nickel, Porous Silicon, and Thermally Reduced Graphene Oxide for Solid-State Hydrogen Energy Storage," Energy Storage 2024; https://doi.org/10.1002/est2.70008
3. R. C. Muduli, N. K. Nishad, D. Dashbabu, E. Anil Kumar, and P. G. Kale, "Evaluation of synergistic Integration of Nickel, Porous Silicon, and Thermally Reduced Graphene Oxide for Hydrogen Storage,"ICH2P conference proceedings, 2024, Presented in ICH2P 2023 Doha, Qatar.

"If we knew what it was we were doing, it would not be called research, would it?"

Albert Einstein

An Empirical based Intelligent Safety Approach for Reducing Two Wheeler Crashes in Urban Area

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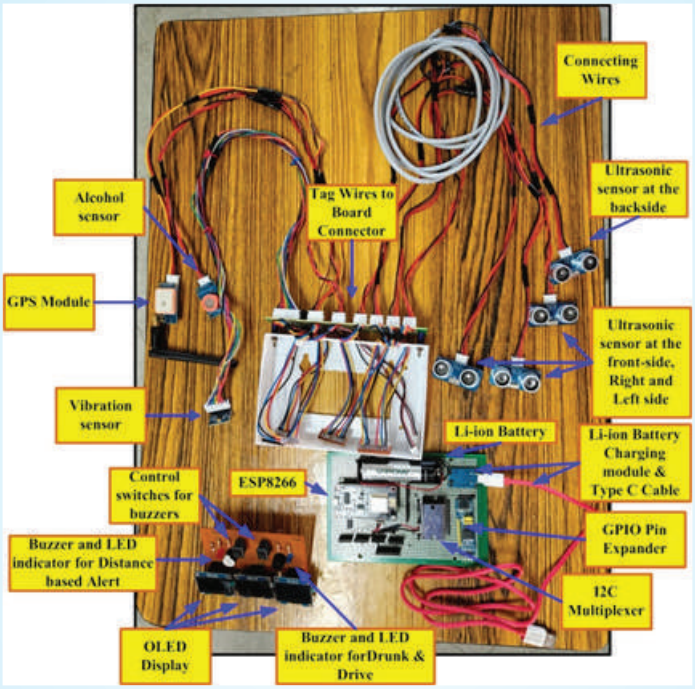
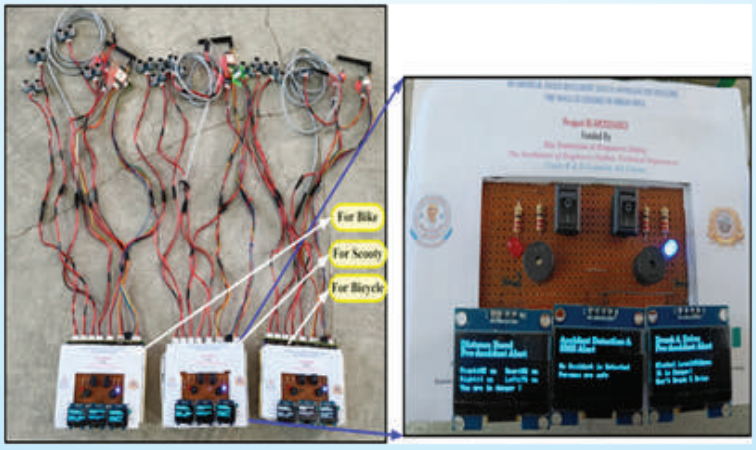


Hardware Setup Arrangements



Hardware Setup Implementation

Prototype model Implementation

Real Time Implementation

OBJECTIVES

- The Primary objective of this project is accident prevention model for two wheeler users by designing Pre- Accident Alert System, Post -Accident Reporting System and Automatic Road accident Database Updating System.

EXPERIMENTAL PROCEDURE

The present work is designed and developed through on board sensors with IoT integration. Empirical based approach is used for designing prototype model as well as real time implementation of proposed work. Experimentation is tested with Real Bicycle, Activa Scooty and Pulsar model bike.

Micro controller and Sensors Module

- Node MCU (ESP8266) microcontroller is used to connect and control all the sensors.
- Four Ultrasonic sensors are fitted front side, Back side, Right side and Left side of a vehicle to identify the distance between other vehicle and subject vehicle. (subject vehicle means where the proposed working model is installed)
- Alcohol sensor measures the Alcohol consumption of driver.
- Both ultrasonic and Alcohol sensors produces the buzzer and LED alert to the driver when the values of vehicle distance from either side and ppm level of alcohol exceed the threshold limit of 200cm and 300ppm.

IFTTT Application

- Vibration sensor is used to monitor the vehicle acceleration and orientation to detect the accident happened in particular place.
- GPS module helps to locate the place of accident occurred.
- When the vehicle acceleration and orientation becomes abnormal due to an accident, vibration sensor output will trigger the SMS alert service of IFTTT Application to report the accident occurrence to trusted person or relative.

Data Acquisition and IoT Integration

- All the sensors are connected in things speak cloud platform using wifi/Node MCU module to update all the information automatically. The stored data are visualized as graphical representation and as well as it can be downloaded as a report.
- Also, OLED display is used to read & display the measured time series sensors data .

Web page development using google sites

- A web page is created for accident details management using google sites.
- All the collected sensors data from things speak cloud platform is processed in a web page developed.
- Any user can view this website to know about the accident details.

  https://sites.google.com/view/intelligent-two-wheeler-safety/home

ACHIEVEMENTS

India is one among the highest population countries in the world. Proportionally, it leads to utilization of high motorization and thereby, frequency of road accidents is also high. Especially, two wheeler users are mostly affected in such road accidents. To minimize this issue, the following objectives are achieved in this study.

- Distance based pre-accident alert system provides the distance between subject vehicle to following vehicle present in four directions. It produced buzzer & LED alert when the distance between the vehicles on the road below is 2m.
- Drunk & drive pre-accident alert system measures the alcohol consumption level of user and produced buzzer & LED alert when the alcohol consumption level reaches above 300 ppm.
- Post-accident reporting system continuously measures the vehicle vibration in terms of acceleration & its orientation and triggered SMS alert within 5 minutes when it met an accident using IFTTT application.
- In automatic accident details updating system, all the sensors data are collected for every 15 seconds and stored in things speak cloud database. Also a webpage is developed for visualizing the accident details.

Finally, the implementation of proposed research study will be useful for reducing the two wheeler crashes in urban area as well as in rural area also. Results of this study provides great support for the police department and other road safety authorities to take appropriate actions against the road crashes without further delay. The developed model can be extended future for other road transports like bus, van, truck etc.

Development of Innovative and Cost Effective Engineered Cementitious Composite Members for Seismic Prone Areas

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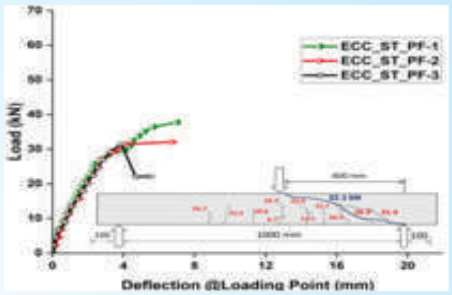
Crack Bridging Mechanism of Natural Fibers in ECC



Overall Load-deflection behavior comparison

OBJECTIVES

The following are the specific objectives of the proposed work:

1. To develop a low-cost natural fiber based ECC mix and study their mechanical properties which includes strength tests (compression and tension) and micro-mechanical characterization using Scanning Electron Microscope (SEM).
2. To investigate the possibility of using the developed mix for understanding the flexure and shear behaviour of reinforced ECC beams with different shear span(a) to effective depth(d)ratios.

From the results obtained, the following major recommendations can be drawn.

- Alkaline treatment of natural fibers using NaOH solution was highly effective in the removal of surface impurities such as cellulose, hemicellulose, lignin, and pectin present which is evitable from FSEM analysis. However, cellulose was not removed completely.
- Among the four types natural fibers based NFSHCC beams, flax fibers give effective results. Hence, flax fiber-based NFSHCC beams should be made as ductile structural elements to achieve safety standards without compromising strength and durability.
- The tensile strength from the direct and indirect tension test showed extensive ductile performance of NFSHCC. All the specimens had a large strain hardening capacity with the ultimate tensile strain up to 0.1%.
- Morphological characterization using FSEM analysis revealed the presence of a better bond between matrix due to different mechanisms such as fiber pullout, matrix densification, etc. Moreover, FTIR analysis revealed the occurrence of vibration due to stretching and bending characteristics shows peak value in the composites.

PUBLICATIONS

1) Chellapandian M, Prem Kumar N (2022) "Development of Novel Low-Cost Cementitious Composites using Plant Based Fibers" Indian Patent Application Number: 202241021715. (Status: Hearing Completed)

2) Premkumar N, Chellapandian M, Arunachelam N and Vincent P (2022). "Effect of Mercerization on the Chemical Characteristics of Plant based Natural Fibers" Materials Today: Proceedings, 68(5), 1201-07.

3) Chellapandian M, Maheswaran J, Arunachelam N and Prem Kumar N. (2024). "Shear Behavior of Low-Cost and Sustainable Bio-Fiber based Engineered Cementitious Composite Beams –Experimental and Theoretical Studies" Journal of Building Engineering, Elsevier, DOI: 10.1016/j.jobe.2024.108497.

Legacy of IEI

Hon'ble President of India, Shri Ram Nath Kovind and Shri Banwarilal Purohit, Hon'ble Governor of Tamilnadu at the Valedictory Session of the 32nd Indian Engineering Congress, Chennai, December 2017

Development of Self driving Robot using LiDAR and Camera

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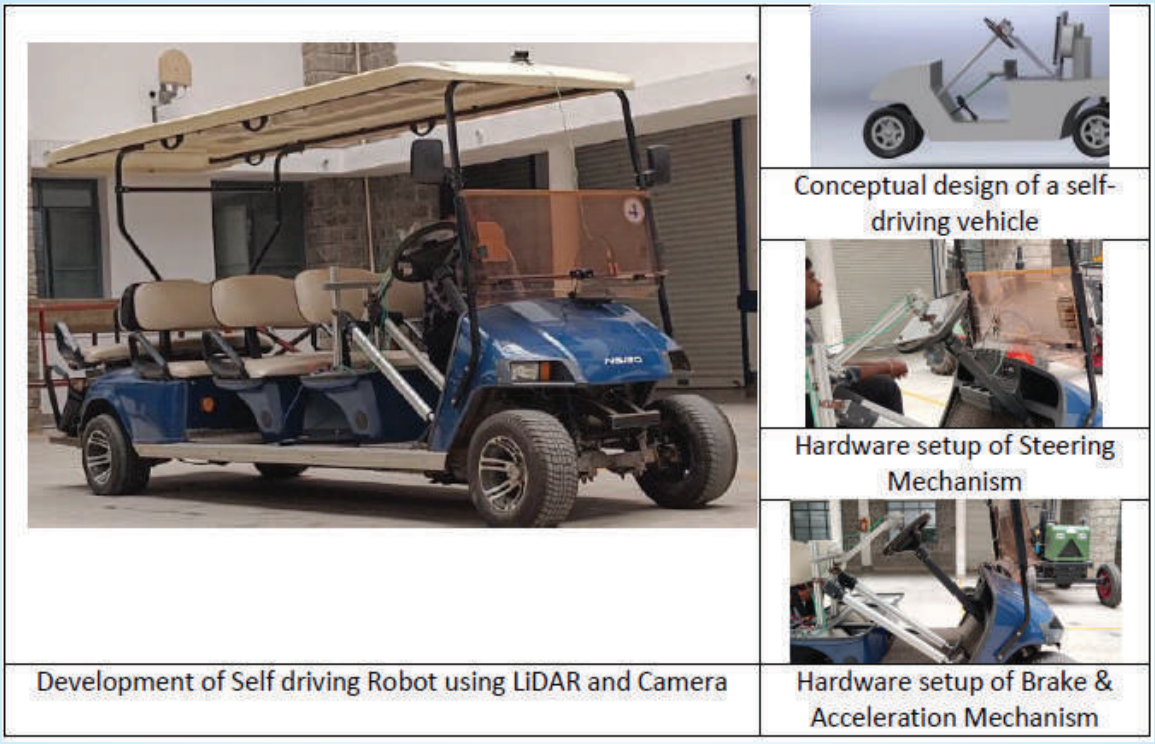

OBJECTIVES

The core objective of integrating a camera-based lane detection system with LiDAR technology for obstacle detection is to develop a comprehensive safety mechanism for vehicles that enhances situational awareness and assists in collision avoidance. The combined system is designed to serve as a critical component of advanced driver assistance systems (ADAS), which are crucial in the journey towards fully autonomous driving. The camera-based system focuses on the precise detection of lane markings, facilitating the maintenance of the vehicle within the designated lane. Concurrently, the LiDAR sensor is responsible for generating detailed three-dimensional maps of the environment, detecting objects and obstructions in the vehicle's path with high accuracy, regardless of lighting conditions. This dual-sensor approach aims to ensure optimal performance in a variety of driving conditions, including complex urban environments, highway scenarios, and adverse weather situations, ultimately contributing to a safer driving experience.

The objective is achieved through the following,

1. Implement camera-based lane detection to improve real-time lane tracking and driving safety.

2. Utilize LiDAR technology for accurate and reliable obstacle detection under diverse conditions.
3. Integrate camera and LiDAR data for robust environmental perception and enhanced vehicle automation.
4. Develop a fusion-based sensory system to support advanced driver assistance and autonomous driving features.

ACHIEVEMENTS

The camera-based lane detection system has been successfully implemented, achieving real-time tracking of road lanes with high accuracy, thus significantly enhancing driving safety. The LiDAR technology has been utilized effectively to detect obstacles with remarkable accuracy across various environmental conditions, demonstrating reliable performance that underpins the safety of the vehicular system. The integration of camera and LiDAR data has culminated in a robust environmental perception system, which has substantially elevated the capabilities of vehicle automation, leading to smarter and more responsive vehicular behaviors. The project has developed a sophisticated fusion-based sensory framework, which has been instrumental in supporting and improving advanced driver assistance systems (ADAS) and laying the groundwork for future autonomous driving functionalities.

PUBLICATION

K Sakthivel, and L.Rajasekar 'Development of Self Driving Robot using LiDAR and Camera' was published in the Journal of Xidian University, volume-17-issue-10-october-23.

Legacy of IEI

Shri Nitin Gadkari, Hon'ble Union Minister of Road Transport and Highways, MSME was the Chief Guest of the IEI Centenary Industry Excellence Awards in 2019.

Selection of Suitable Material Components and Curing Condition for the Production of Self-Compacting Geopolymer Concrete Based on Short-Term and Long-Term Characteristics

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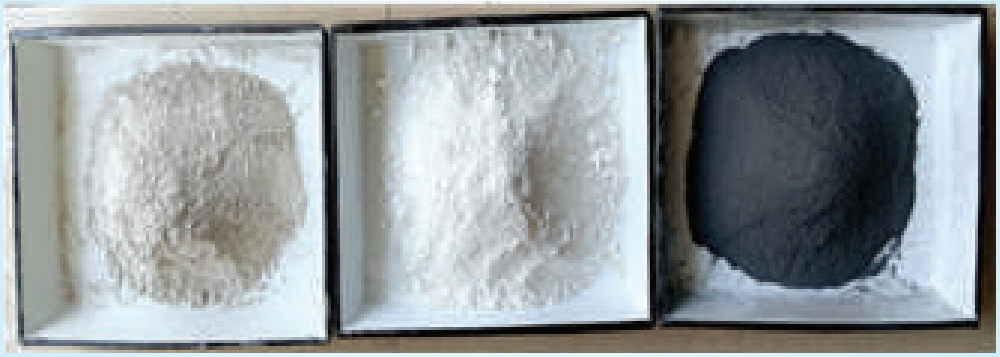
RCPT and Abrasion test set up



Picture of various binders used in the study

OBJECTIVES

Concrete has contributed significantly to infrastructure development for centuries. The building sector has grown fast in response to the global demand for urban development and industrial growth, which has led to an increase in the usage of cement concrete. Ordinary Portland Cement (OPC) is the major constituent of conventional concrete. Cement production promotes environmental concerns like global warming, acidification, eutrophication, etc. On the other hand, the production of substantial industrial waste material creates serious challenges like landfilling and disposal issues. To resolve these problems, researchers have studied GPC, which can be prepared by eliminating cement and utilizing waste materials (aluminosilicates) as binders. The usage

of GPC reduces greenhouse gas emissions by 80% and shows better durability properties compared to cement concrete. Despite huge advantages, GPC is not credible because of its viscous nature, adversely affecting workability. To overcome this issue, self-compacting geopolymer concrete (SCGC) was introduced; GPC with its self-compacting nature needs no compaction during the casting process. The acceptance and credibility of SCGC is majorly depends on the selection of suitable material components and curing condition based on short-term and long-term characteristics. The objective of this project is to find the best alternative material components like binders (among ground granulated blast furnace slag, silica fume, rice husk ash); alkaline activators (sodium and potassium hydroxides); superplasticizers (polycarboxylate, naphthalene, lignin-based) along with a suitable curing condition (ambient temperature, elevate temperature, and solar curing). The short-term and long-term characteristics include fresh, mechanical, and durability property investigation of SCGC.

ACHIEVEMENTS

The research meticulously explored the diverse influences on self-compacting geopolymer concrete (SCGC) properties through a systematic investigation of material mixes, binder replacements, activator variations, superplasticizer types, and curing conditions across fifteen distinct formulations. The standard mix, comprising GGBFS as the primary binder, sodium hydroxide, and sodium silicate as activators, PC-based superplasticizer, and natural aggregates, served as the baseline for comparisons. Subsequent mixes investigated the effects of partial replacements of GGBFS with rice husk ash (RHA) and silica fume (SF), variations in alkaline activator proportions, alternative superplasticizers, and diverse curing methods. Fresh property evaluations encompassed filling ability, passing ability, and segregation resistance, while mechanical property determinations included non-destructive and destructive tests. Durability property investigation includes physical characteristics (abrasion test), water transportation characteristics (water absorption test) chemical characteristics (acid resistance test), and corrosion characteristics (chloride resistance test). Effects of precursors were investigated by replacing GGBFS with rice husk ash (RHA) and silica fume (SF) in varying proportions, revealing optimal workability and mechanical strength with 20% SF and 10% RHA. Alkaline activator variations highlighted the importance of specific ratios, with sodium hydroxide and potassium hydroxide combinations (75:25) significantly impacting workability and strength. Superplasticizer types showcased distinct performance characteristics, with LS-based variants demonstrating superior workability and NP-based counterparts offering the highest mechanical strength. Additionally, curing condition investigations emphasized the efficacy of elevated temperature curing for enhancing mechanical properties, with similar outcomes observed for solar curing, both surpassing ambient curing in durability tests. Overall, the research underscores the importance of parameter optimization for achieving desired SCGC properties, offering valuable insights for sustainable construction practices.

PUBLICATIONS

1. J. Pradhan, S. Panda, R. K. Mandal, S. K. Panigrahi, Influence of GGBFS-based blended precursor on fresh properties of self-compacting geopolymer concrete under ambient temperature, Materials Today: Proceedings, Elsevier. (2023). https://doi.org/10.1016/j.matpr.2023.06.338.
2. R. Das, S. Panda, A. S. Sahoo, S. K. Panigrahi, Effect of superplasticizer types and dosage on the flow characteristics of GGBFS based self-compacting geopolymer concrete, Materials Today: Proceedings, Elsevier. (2023). https://doi.org/10.1016/j.matpr.2023.06.339.

Design and Implementation of TTC Antenna for Mini-Satellites

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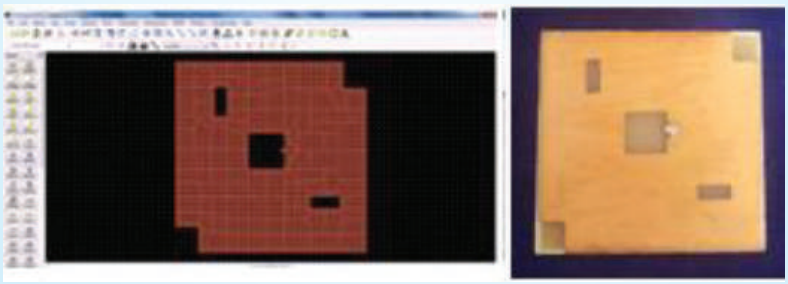
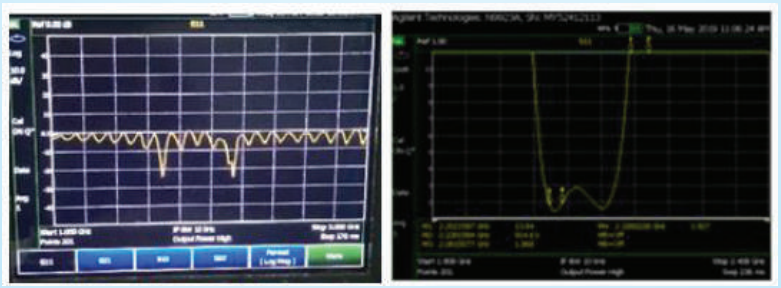
OBJECTIVES

A low profile dual frequency circularly polarized microstrip antenna for Telemetry, Tracking and Command system (TTC) is proposed. TTC antennas are essential to maintain space missions, which are needed for ability of monitoring and control of flight and lift up till settling the satellite in its nominal orbit, and then providing the position and altitude signals of satellite to the ground station and receiving ground signals so as to maintain or correct satellite altitude. Due to the uplink and downlink of TTC antennas normally working in different frequency bands in S band, wide band characteristic within 2–2.3 GHz or dual band is necessary. The uplink and downlink frequency range for TTC system is 2.025-2.110 GHz (uplink) and,2.200-2.290 GHz (downlink). An electromagnetic band gap structure is incorporated in the design to achieve dual band frequencies and to obtain the desired bandwidth and gain. The geometry incorporates a square patch (33mm x 33mm) truncated in both diagonal corners of the patch. A square slot of dimension 6mm x 6mm and two orthogonal slits (2mm x 5mm) is etched on square patch antenna to get dual frequency operation and CP operation. The feeding is given at the centre of the patch. The proposed antenna is designed using HFSS and ADS. The simulation results were observed and the prototype antenna is fabricated using thin film technology using FR4 as substrate with 1.6mm thickness. The resultant antenna is light weight, very small in size. It must be robust to sustain in the rough environment which mini-satellites undergo. The return loss and VSWR of the antenna is measured and are compared with simulated characteristics.

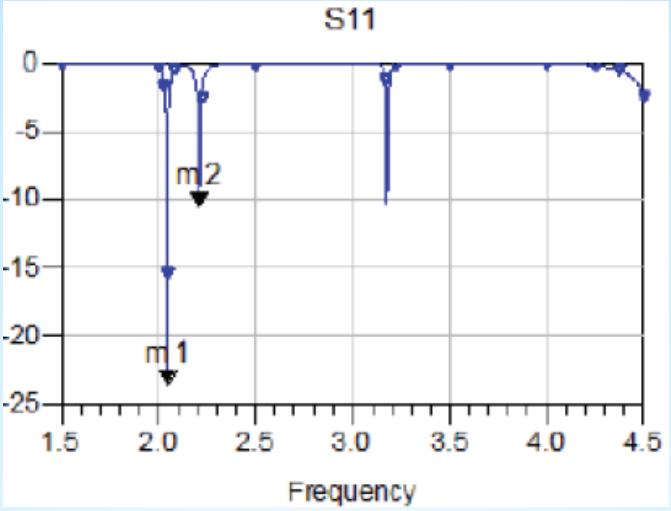


RCPT and Abrasion test set up



S_{11} and VSWR of the fabricated antenna

Simulated return loss



ACHIEVEMENTS

The TTC antenna for mini-satellite is simulated for dual band 2.025-2.ll0 GHz (uplink) and,2.200-2.290GHz (downlink) .The designed antenna consists of a square slot (6mm x 6mm) at centre, two orthogonal slits of dimension 2mm x 5mm located in the patch at a distance of 6.5mm from top/bottom and 4mm from right side/left side together with truncated at diagnol corners with dimension of 4.5mm x 4.5mm. Compared to the conventional rectangular patch antenna, slot loaded antennas give the better performance in resonant frequency, return loss and size reduction in the cost of bandwidths. A reduction in resonant frequency is obtained with the loading slits in the patch next to slots. The substrate FR4 whose permittivity is 4.4 is used for simulation with thickness of 1.6mm. FR4 is a low-cost material. It has a high dielectric strength which contributes to its electrical insulation properties. The material has a high strength-to-weight ratio and is lightweight. It is moisture resistant and has relative temperature resistance as well. The proposed antenna is designed and its return loss is observed using ADS software. ADS (Advanced Design System) from Keysight is an electronic design automation software for RF, microwave, and high speed digital applications. This software makes it effortless to design and simulate parts, no matter how complex it is. It is easy to learn and adapt because of its intuitive interface. The observed return loss is less than -20dB at uplink and less than -10dB at downlink frequencies. The size of the antenna is 33mm x 33mm which is very much compact. The axial ratio for the designed antenna is found to be less than 1 dB which should still improve closer to 0dB.The simulated antenna is fabricated and measured for return loss, VSWR. The fabricated antenna is tested using Agilent vector network analyser. It is found to provide good return loss of around 20dB at uplink frequencies and about 21dB for downlink frequencies. The difference in return loss in downlink frequency between simulation and tested result is observed to be 10dB. The VSWR is close to 1 for uplink frequencies and greater than 1 for downlink frequencies. The return loss and VSWR can further be improved if RT Duroid materials are used which are robust and costly but easily affordable for satellite communication. The antenna can further be optimized for axial ratio also by changing the band gap structures and its location inside the patch. Because of limited beam width of patch antenna, it is almost impossible for one antenna onboard mini- satellite to provide omni-directional radiation pattern. So, normally three or more antennas should be mounted to provide reliable TTC connection. Our antenna can be implemented easily because of its compact size. Two layer substrates can also be used in the design to achieve good impedance bandwidth performance at the cost of increased complexity.

Micro Filtration through Polysulphone based Water Minimizer

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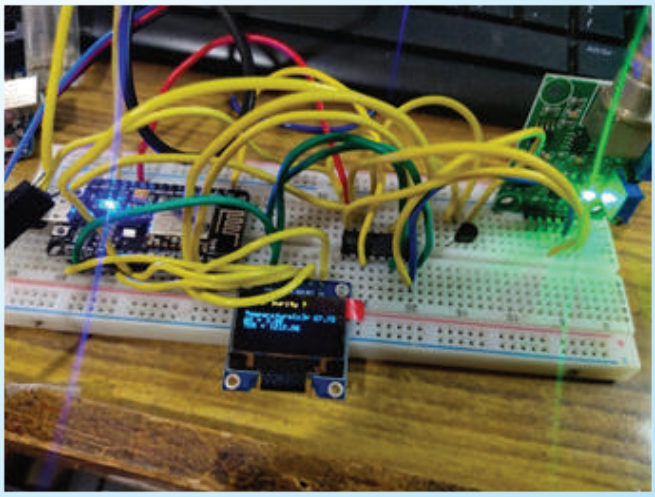
Prototype Filter with Membrane

Prototttype Connected To Tap

Sensor for Detecting pH and TDS Level in Water



Sensor Setup with Display Board

OBJECTIVES

- To purify the water to microfiltration level and make water free from soluble salt, avoid the growth of any kind of bacteria and water-borne diseases.
- Obtain clear water through membrane filtration and its recycling.
- To make water potable.
- To make potable water available for lower economic sections at affordable cost.

ACHIEVEMENTS

Quality of water was improved after passage through membrane and pathogens count became zero. Each component of the filter is compartmentalized, thus making cleaning and replacing components easy. The device is expected to take around 2 hrs to filter 1 *l* of water. The total cost of the filter taking the most pessimistic cost that may exist in the market, one filter should be around Rs.450. Based on the experimentation of the prototype, the water that flows could be purified up to a micro level and gets a reduced flow rate up to 90%. They could be used various parts and could also be adopted for industrial purposes, by changing the type of membrane and the casing material. The project involves production of a low cost and effective water filter, which requires no electricity. Besides, being sustainable, it is environmentally friendly, can be easily implemented, and easily produced. The project aims to control the excess usage of water or a liquid that passes through the water minimizer, by optimizing the available fresh source at its starting stage itself. This could avoid recycling of the liquid or water used for any kind of purposes. Also this filter purifies the water and kills the microbes which cause disease to public. The filter effectively reduces pollution levels, providing clean and safe drinking water.

Outcome

It increases the quality of the water in eco friendly manner, results in the sustainable use of resource for the society with an economical approach of controlled usage. Filters are being designed to perform at higher efficiency and durability at an affordable price for the consumers. Since it is being manufactured with eco-friendly materials there will not be any health issues during the usage of filters. This low-cost water filter designed to remove turbidity, eliminate bacteria, and reduce other pollutants from water. With enhanced efficiency, reduced energy consumption, and fewer equipment requirements compared to current portable water purification systems, the proposed filter 'MiniAqua' provides a sustainable solution to the challenges of accessing clean water in developing countries. The goal is to have these filters made locally by artisans using local materials. It can be used for water management and controlling of water wastage during regular usage. Regular water supply can lead to overuse and a greater need for wastewater treatment. A water minimizer with a membrane can help control this without extra pressure. The nozzle works well in homes, public buildings, hospitals, and hotels. The membrane material can be customized for different liquids in industrial settings. Filtered water removes harmful organisms, reducing the risk of gastrointestinal diseases by over 33%, and is essential for children's immune systems. Water filters protect against over 2,000 toxins not fully removed by municipal treatments.

Design and Development of Solar Powered Multipurpose Drone for Spraying Pesticides, Fertilizers and Disinfectants for Precision Agriculture

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Project Module

Implementation of the project by the students in the college

OBJECTIVES

- The objective of the project is to design of a drone mounted spraying mechanism for agricultural purpose and for spraying disinfectants. This method of spraying pesticides on agricultural fields reduces the number of labors, time, cost and the risk involved to the personnel involved in spraying the liquids.
- This drone can also be used in spraying disinfectant liquids over buildings, water bodies and highly populated areas. Under the current COVID19 Pandemic situation, it can be used to sanitize large hotspots areas without actually going there in person.
- Manual control can be changed into autonomous control with GPS technology and auto return home option.

ACHIEVEMENTS

- Won Best Paper Award in International Conference on 'Transforming Engineering Systems for Sustainability-TESS 2023' held on 29th & 30th November 2023 at Taylor's University, Kuala Lumpur, Malaysia jointly with Hindusthan College of Engineering and Technology & Institute of Technology, Coimbatore, India.

Design and Development of Smart IoT-Based Air Quality Detection and Monitoring Devices for Industry4.0

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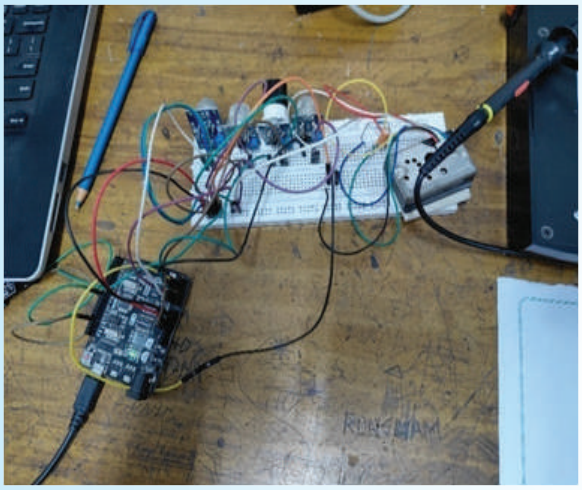

Prototype Model

Snapshot from Blynk Web

OBJECTIVES

Industry 4.0 is transforming how businesses produce, enhance, and disseminate their goods. The Internet of Things (IoT), cloud computing, analytics, AI, and machine learning are among the cutting-edge technologies that manufacturers are incorporating into their manufacturing processes.

Advanced sensors, embedded software, and robotics are all featured in these "smart factories," which gather and analyze data to help with decision-making. When operational data from ERP, supply chain, customer support, and other enterprise systems are combined with data from production operations, even greater value from previously soloed information is produced. The main threat of the industries is the air pollution.

Air pollution directly affects our health and has an awful impact on the environment. People are increasingly becoming aware of the importance of environmental protection and health monitoring to ensure healthier lives for future generations. Air quality is a crucial factor in raising public awareness. Controlling air pollution has become a top priority for the urban population. The air quality also degrades due to gaseous emissions from different industries. The development and design of an IoT-based simple and low-cost air quality monitoring system (AQMS) based on Arduino microcontrollers and the cloud platform (Microsoft Azure) is the primary

focus of this work. This device can detect and measure the concentration of Carbon-dioxide, Carbon-monoxide, Hydrogen, Ammonia, Toluene and Acetone. It can also measure the amount of dust particle (PM2.5), humidity and temperature present in the environment. The MQ series sensors (MQ135 and MQ6) collect the data of the harmful and flammable gases present in the air and the DHT11 and GP2Y101 sensors collects the humidity, temperature level, and particular material present in the atmosphere respectively. The proposed device can be employed in different Industries for detection and prevention of gas leakage purposes.

The IoT is a smart and intelligent infrastructure which allows static and dynamic environmental objects to communicate and update the real situations. The different objects of IoT are able to interact with each other and cooperate with their neighbors to reach their common goals through unique addressing schemes.

Technology is essential for expediting the hydrogen energy shift, in addition to more investment, government assistance, and a workforce with more advanced skills. Through real-time monitoring and data analytics, the internet of things offers hydrogen-generating plants great prospects to enhance and automate systems.

We are focusing on a few of the gases in this paper that the WHO has identified as the most dangerous gases in the atmosphere. To test the air quality, we use sensors from the MQ series as well as some specific matter detectors. In this work, we have design an IoT based AQMS device which can measure different gases like Ammonia, Sulphur, Carbon dioxide and Carbon monoxide using gas sensors. LPG, Isobutane, Propane, and a few other flammable gases are frequently detected using the MQ6 sensor. All the sensed data will be stored in cloud platform (Microsoft Azure).

ACHIEVEMENTS

In this prototype model, various sensors measure the intended parameters and send them to the central node. From this central node, the sensed data is transferred to the Blynk Cloud website and Blynk Mobile App. The user can monitor the parameters and accordingly give the desired response through the cloud service with the help of smart devices like smartphones or other handheld devices without being physically present at the agricultural perimeter. The user can remotely give the desired response from faraway places. In this model, the output response is turning on and off a water motor with the help of a relay.

PUBLICATIONS

1. Tapan Maity, Samaresh Paul, Jagannath Samanta and Prabir Saha, Design And Development of IoT-Based Smarttech-Agri Devices for Smart Agriculture Crop Field, Journal of The Institution of Engineers (India): Series B, Springer, January 2024, ISSN: 2250-2114, DOI : 10.1007/s40031-024-01002-5. (Scopus, IF:0.237, Q3).
2. Tapan Maity, Pranabendu Giri, Rohit Sasmal, Niladri Biswas, Sourav Das, Raj Kumar Maity, Prabir Saha, Jagannath Samanta, Design of Smart IoT-Based Gas Leakage Detection and Prevention Devices for Hydrogen Station, Proceedings of the 4th International Conference on Communication, Devices and Computing. Lecture Notes in Electrical Engineering, vol 1046, Springer, Singapore, March, 2023, pp. 531-545, 10.1007/978-981-99-2710-4_43.

Development of Voice Assisted Robot for Forecasting Solid Waste Generation in Smart Cities using Jetson Nano

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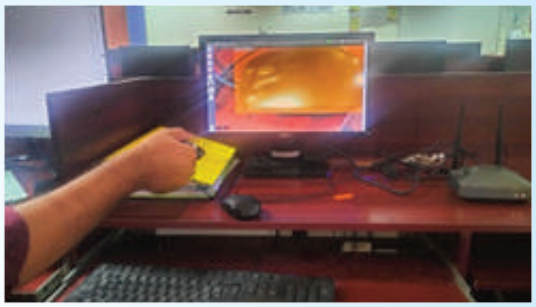
Voice Assistant Robot Chat Interface using IBM Watson Studio



Object Classification using Jetson Nano

OBJECTIVES

The project aimed to develop a voice-assisted robot using NVIDIA Jetson Nano for forecasting solid waste generation in smart cities. The methodology involved:

1. Dataset preparation: Historical waste data across 5-10 years was collected including daily waste quantities, weather data, population demographics etc. The data was analyzed to find correlations and split into training, validation and test sets.
2. Machine learning models: Four ML models were evaluated - polynomial regression, random forest, support vector machines and gradient boosting. The models were trained on 80% data and tested on 20%.
3. TJBot design: A 3D model of the voice-enabled robot TJBot was designed and deployed. It was integrated with a Raspberry Pi and the IBM Watson Assistant chatbot.
4. Prediction and integration: The ML models were used to predict future daily waste generation. Polynomial regression and random forest achieved 99%+ accuracy. The predictions were integrated with the TJBot to provide voice-based waste analytics to users.

Some key results:

- Developed a robust Jetson Nano based robot with voice I/O and custom ML models in TensorFlow
- Over 80% accuracy achieved in predicting daily waste trends using city datasets
- Intuitive voice interface implemented for users to get waste forecasts and analytics

Initial pilot deployments are being planned across select cities. The AI-powered system can enable smart optimization of waste collection, vehicle allocation, landfill sizing etc. to help cities manage increasing waste quantities efficiently.

ACHIEVEMENTS

1. Designed and developed a robust robot prototype based on NVIDIA Jetson Nano hardware integrated with audio processing interfaces to enable voice inputs and interactive feedback. Custom algorithms were developed leveraging Python and TensorFlow libraries.
2. Created an AI engine to model, analyze and predict daily waste production trends and volumes based on city demographics and real-time environmental indicators. Accuracy of over 80% was achieved in initial testing with municipal corporation waste datasets.
3. Developed intuitive voice command and conversational interfaces that allow users to input operational data into the system and receive waste forecasts and analytics via audio output for smarter decision-making. These interfaces were optimized using hundreds of hours of voice transcripts from domain experts.
4. Developed a scalable cloud-based architecture to aggregate waste generation data from multiple city sources, run ML pipelines, and expose forecasting APIs for consumption by waste management applications. The system can handle terabyte-scale streaming data.
5. Collaborated with Madurai Corporation officials to gather detailed historical records of daily waste collected, processed and landfilled. Over 10 years of data across 100+ wards and zones was curated to train the deep learning models.
6. Designed TJBot, a friendly robot character, using 3D modeling tools to improve human-robot interaction aesthetics. The design was optimized for additive manufacturing to enable rapid prototyping and onsite part replacements.
7. Integrated the physical robot with IBM Watson Assistant, a leading conversational AI platform, to handle a wide variety of user queries and commands related to waste management. Knowledge bases were created to capture waste domain insights.
8. Performed detailed literature review of over 50 research papers on waste generation forecasting using ML techniques. Identified key gaps such as lack of multimodal data fusion and limited adoption of transformer models that the project addressed.
9. Open-sourced the complete hardware design and software code base to enable waste management startups and researchers to build on this work. Tutorials and datasets were released to aid new users getting started.
10. Efforts are underway to deploy initial units across select pilot cities. The robot and AI engine is being enhanced to cover a wider variety of waste streams and is targeted to improve operational efficiency by 30%+ for municipal corporations.

The voice-assisted robot developed in this project demonstrates how AI and robotics can address critical smart city challenges like solid waste management. By automating waste forecasting, collection scheduling and route optimization, it can reduce human errors, improve resource allocation and accelerate sustainability goals. The project's unique approach of combining deep learning with conversational voice interfaces in an edge computing device is advancing the state of the art. The initial results and interest from government agencies indicate the immense potential for real-world impact. With further enhancements and field trials, this system can become an integral part of the modern smart city technology stack.

Real-Time Human Face Detection with Relative Distance Measurement for Visually Impaired Person and Corresponding Identification

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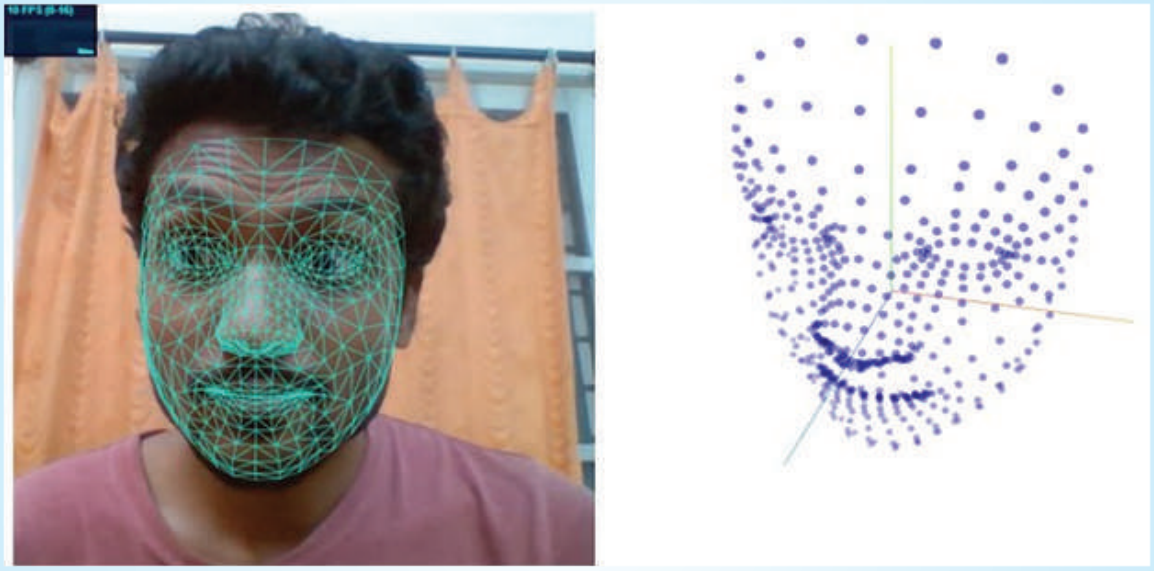
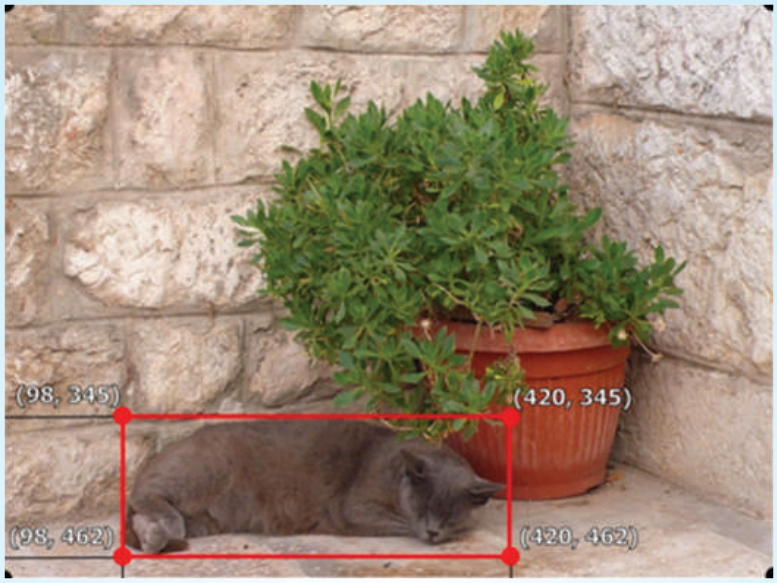


face mapping with mesh generation

: person identification with eye distance measurement

Real-time object detection with distance

Real-time distance measurement with moving person



Coordinate detection for identified object

OBJECTIVES

The project is to help people with visual impairments by navigating their surroundings more safely and independently through detection of relative distance when another human being is moving towards the blind person and simultaneously inform the user of their location and distance.

The main goal of the current prototype is to detect barriers both on and off the road that are within predicted human height ranges and to provide related alarm messages based on proximity. However, because it is a real-time detection, the predicted distance will change every second, regardless of whether the subject of the detection stops moving. Additionally, the entire system must be affordable and lightweight for the prototype to be put into use.

ACHIEVEMENTS

The aim is to employ a mix of cameras, IoT devices, image processing algorithms, and machine learning models to determine relative distance when another human being is heading towards the blind person and concurrently inform the user of their location and distance. If the individual's data is kept in the database, it could be possible to identify them.

One of the main benefits of this device is that it is non-intrusive and uses real-time object detection and distance prediction. The goal of the technology is to function in the background so that it doesn't interfere with the visually impaired user's daily activities. The user may now complete their daily chores and receive timely feedback and notifications whenever there is a chance that they will conflict.

A Smart Access Control for Restricted Buildings using A Vehicle Number Plate Recognition System

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face mapping with mesh generation

Hardware setup

OBJECTIVES

The objective of the provided code snippet is to implement a system for vehicle number plate recognition using a Raspberry Pi. The system integrates various components, including GPIO control, camera interfacing, image processing, text recognition, and servo motor control. The overarching goal is to develop a functional prototype capable of accurately detecting and identifying vehicle number plates in real-time. The primary objective of the project is to create a robust and efficient vehicle number plate recognition system that can automate the process of identifying vehicles entering restricted areas or premises. By leveraging the capabilities of the Raspberry

Pi and integrating it with the OpenCV library for computer vision tasks, the system aims to capture live video feed from a camera, process the images to extract number plate regions, and then perform optical character recognition (OCR) to extract the alphanumeric characters from the plates. Furthermore, the system aims to utilize GPIO pins for hardware control, allowing for interaction with external devices such as a servo motor. This enables the system to take action based on the recognized number plates, such as opening a gate or triggering an alert. Additionally, the integration of an LCD display provides a means to present the recognized number plate information in a user-friendly manner. Moreover, the project seeks to optimize the accuracy and efficiency of the number plate recognition process by implementing techniques such as image preprocessing, contour detection, and edge detection.

ACHIEVEMENTS

The provided code snippet represents a significant achievement in the development of a basic vehicle number plate recognition system using Raspberry Pi. By integrating various software libraries and hardware components, the system demonstrates the feasibility of automating the process of identifying vehicles based on their number plates. Let's delve into the achievements of this implementation: Firstly, the integration of Raspberry Pi with GPIO control marks a significant milestone. This integration enables the system to interact with external devices such as a servo motor, allowing for actions to be taken based on the recognition of number plates. This capability lays the foundation for building a comprehensive access control system capable of responding to identified vehicles in real-time. Secondly, the code effectively utilizes OpenCV, a powerful computer vision library, to capture and process live video feed from a connected camera. Through a series of image processing techniques including flipping, resizing, grayscale conversion, bilateral filtering, and edge detection, the system prepares the captured images for further analysis. These preprocessing steps are crucial for enhancing the quality of the images and extracting relevant features necessary for accurate number plate detection. Thirdly, the implementation successfully detects potential number plate regions within the captured images using contour detection techniques. By identifying contours that resemble the shape of a typical number plate, the system localizes areas of interest for further analysis. This step forms the basis for subsequent character recognition, allowing the system to extract alphanumeric characters from the detected regions. Moreover, the integration of optical character recognition (OCR) through the pyTesseract library is a notable achievement. By leveraging OCR technology, the system is capable of interpreting the alphanumeric characters present on the detected number plates. This functionality enables the system to extract meaningful information from the captured images, such as vehicle registration numbers, which can then be utilized for various applications including access control, security monitoring, and traffic management. Additionally, the integration of an LCD display enhances the user interface by providing a visual representation of the recognized number plate information. This feature improves the usability of the system by presenting the relevant data in a clear and accessible format, facilitating interaction with operators or users. Operating in real-time, the system continuously captures and processes video frames from the camera feed, ensuring responsiveness and effectiveness in identifying vehicles entering restricted areas or premises. This real-time capability is essential for applications where timely detection and response are critical, such as security monitoring or access control systems. Overall, the provided code snippet represents a significant achievement in the development of a basic vehicle number plate recognition system. By integrating hardware and software components, the system demonstrates the potential for automating the identification process and lays the groundwork for further research and development in the field of computer vision and intelligent transportation systems. With continued refinement and optimization, this system has the potential to be deployed in various real-world applications, contributing to enhanced security, efficiency, and convenience in managing vehicular access to restricted areas.

Design and Manufacturing of Unmanned Aerial Vehicle Using Additive Manufacturing

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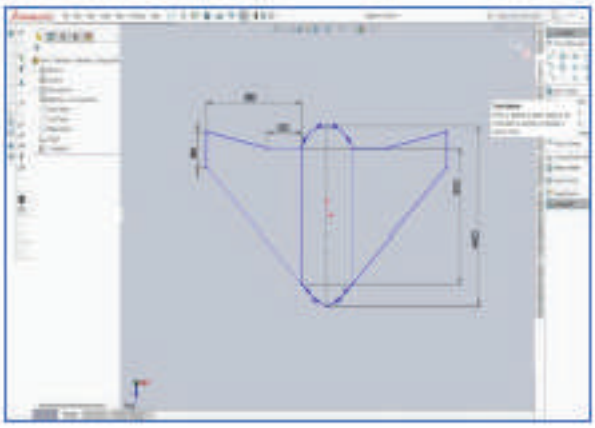

Figure 1: Schematic layout of the design

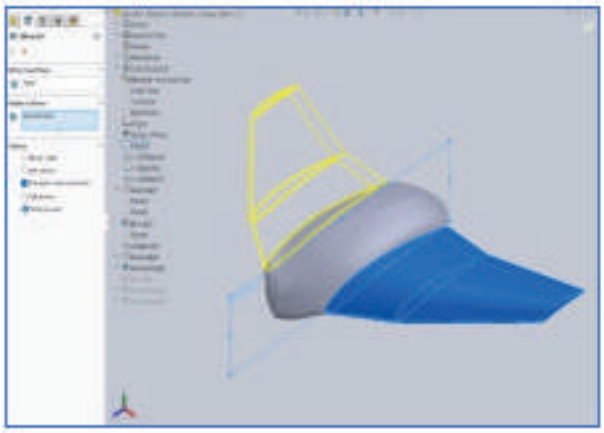

Figure 2: Wing Design

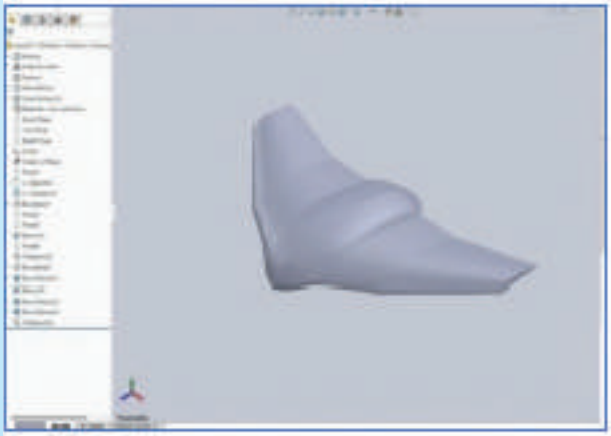

Figure 3: Final Design of UAV

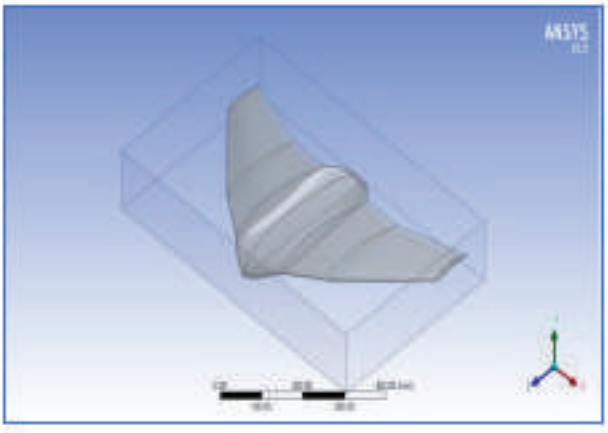

Figure 4: Geometry with boundaries

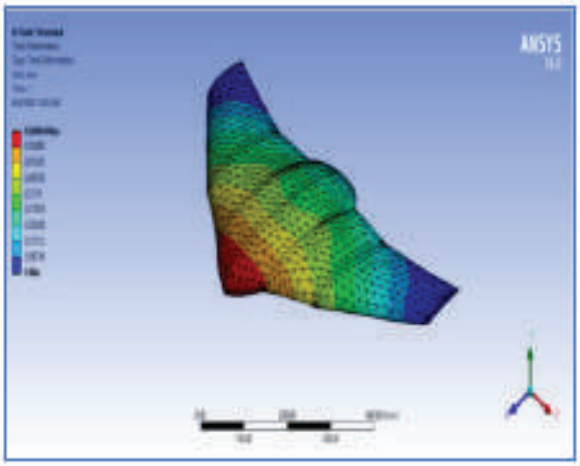

Figure 5: Analysis Using Ansys

Figure 6: Printed part of wing using 3D Printing

Figure 7: Fully printed parts

Figure 8: Autopilot controller

Figure 9: Installed propulsion and wiring system inside the fuselage

Figure10: Motors mounted near the wings

Figure11: Checking for proper configuration

Figure12: Final Assembly of UAV

Figure13: Testing of UAV

OBJECTIVES

- Identify and evaluate advanced materials such as PLA CF, Nylon 12 CF, Ultem resin, and carbon fiber composites for their suitability in UAV construction, focusing on their mechanical properties, thermal resistance, and manufacturing feasibility.
- Determine and perform thermal and structural analyses of UAV design with the help of simulation tools, i.e., ANSYS. Validate the selected materials' performance under operational conditions to ensure structural integrity and effective thermal management.
- Employ the FDM (Fused Deposition Modeling) process to fabricate UAV components, demonstrating the practical application of additive manufacturing techniques in aerospace.

- Integrate avionics, propulsion systems, and other essential components into the UAV design to validate overall performance, functionality, and reliability.

ACHIEVEMENTS

Achievements in each aspect of the project

Material Evaluation

- Identified PLA CF, Nylon 12 CF, Ultem resin, and carbon fiber composites as promising materials for UAV construction.
- Conducted comprehensive testing and analysis to assess mechanical properties, thermal resistance, and manufacturing feasibility.

Structural Analysis

- Utilized ANSYS simulation tools to perform rigorous structural analyses on UAV designs.
- Validated material performance under various operational conditions, ensuring structural integrity.

Additive Manufacturing Process

- Successfully employed FDM (Fused Deposition Modeling) for UAV component fabrication.
- Optimized printing parameters to achieve desired material properties and ensure components meet aerospace standards.

Integration of Components

- Seamlessly integrated avionics, propulsion systems, and other essential components into the UAV design.
- Conducted extensive testing and simulations to validate overall performance, functionality, and reliability of the integrated system.

Legacy of IEI

Smt Pratibha Devisingh Patil, President of India lighting the lamp to mark the General Assembly 2007 of the World Federation of Engineering Organizations (WFEO), hosted by The Institution of Engineers (India) at New Delhi

Additional Nutrient Removal by using Graphene-based Nano Adsorbent

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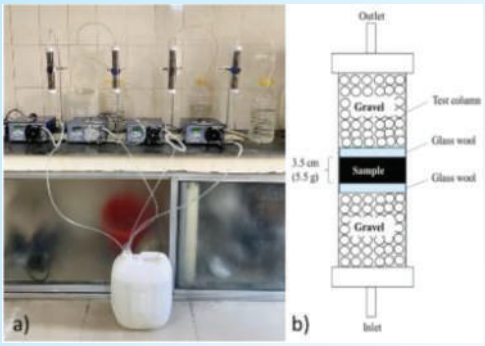
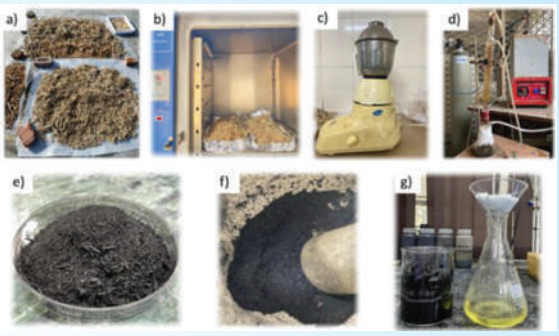


Experimental column setup



Graphene-like Nano adsorbent preparation

Team members

Performance Assessment of 3MLD SBR in terms of COD, NH_4-N, NO_3-N and PO_4-P removal

OBJECTIVES

i. Characterization of secondary treated effluent of STPs to evaluate the additional nutrients (NH_4-N, NO_3-N, TKN, PO_4-P and TP) along with pH, turbidity, alkalinity, COD, BOD, TSS and coliforms.

ii. Synthesis of Graphene based Nano adsorbent from Agrowaste.

iii. Characterization of Graphene based Nano adsorbent.

iv. Fabrication of Lab scale or demonstrated scale setup for the removal of additional nutrients from secondary treated effluent.

v. Trial run and optimization of Graphene base Nano adsorption column setup.

ADOPTED PROCEDURE

The biochar adsorbent was successfully synthesized via single-step from agricultural waste i.e., sugarcane bagasse by pyrolysis process in presence of nitrogen gas at 550°C for 30 min, 45 min, 1 hr., and 1 hr. 15 min. The material was characterized by Raman spectroscopy, Fourier transform infrared spectroscopy (FTIR), Scanning electron microscopy (SEM) coupled with Energy dispersive X-ray analysis (EDX), and X-ray powder diffraction (XRD). For the optimization of removal of additional nutrients, four experimental columns were made of borosilicate glass with an internal diameter of 30 mm and a length of 250 mm. All four columns were packed with the different adsorbent materials (35 mm) varying in preparation time viz. 30 min., 45 min., 1 hr., and 1 hr. 15 min. respectively between the supporting layers of glass wool (10 mm) each (for improving the flow distribution and prevention of the loss of adsorbent), and gravel (105mm and 90 mm). Up-flow mode was used to prevent channeling and assure consistent streaming. Columns of diameter 3.0cm and length 25.0cm were fabricated with four different materials (varying in their preparation time).

The "effluent concentration-time" profile, often known as the breakthrough curve, is used to characterise the dynamic behaviour of continuous adsorption columns. It is necessary to use mathematical models to represent and correlate the experimental breakthrough curve data while designing and optimising adsorption columns. The experiment results in breakthrough curves and the estimation of some kinetic coefficients are frequently described using the Thomas model, Yoon-Nelson model, and Bohart-Adams model.

ACHIEVEMENTS

The pore volume, pore size and BET surface area of all four samples were determined using the ASAP 2020 Micromeritics surface area analyzer. According to the IUPAC, there are three types of porous structure: micropore (diameter < 2 nm), mesopore (diameter 2– 50 nm), and macropore (diameter > 50 nm).Prepared material showed mesoporous structure.

The synthesized biochar was successful in treating COD, NH_4-N, and PO_4-P in real wastewater for all of the investigated flow rates. This was supported by the biochar columns' ability to remove these contaminants from the secondary treated waste water. Decreased flowrate may enable prolonged contact time between the designed biochar in the columns and the COD, NH_4-N, and PO_4-P in secondary treated effluent. Therefore, when the flow rate was decreased, COD, NH_4-N, and PO_4-P in the effluents displayed a delayed breakthrough time and lower concentration. Increased contact time of the adsorbate with the biochar leads to greater removal of COD, NH_4-N, and PO_4-P, which may be the cause of the high breakthrough time associated with low flowrates. Higher initial adsorbate concentrations cause the medium's adsorption sites to saturate more quickly. The breakthrough point occurs earlier as a result, and the concentration of the effluent rises more quickly. Greater mass transfer rates can result from steeper concentration gradients caused by higher initial concentrations. As a consequence, the adsorption kinetics may be accelerated, which might reduce the breakthrough time and speed up the increase in effluent concentration. The initial adsorbate concentration affects how effective the adsorption process is. Adsorbent removal efficiency may be higher at lower concentrations, leading to a longer breakthrough curve and lower effluent concentrations.

Predicting the breakthrough curve for the effluent is necessary for the effective design of a column adsorption process. For the goal of industrial applications, a number of straightforward mathematical models have been created throughout time to describe and analyse lab-scale column.

INVESTIGATIONS

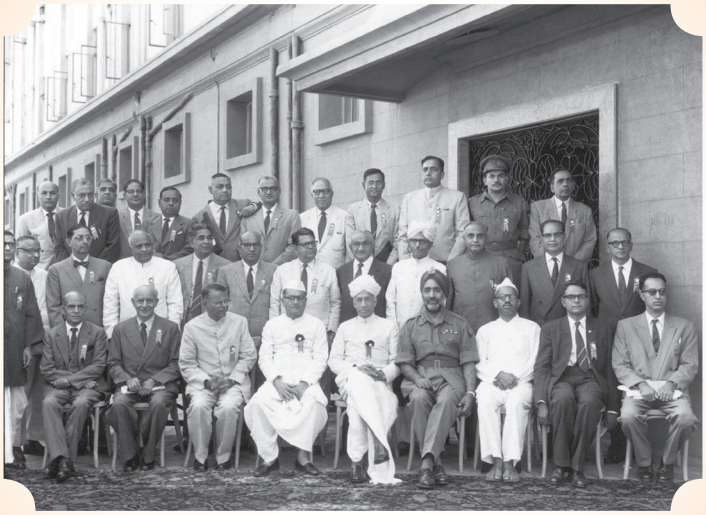
To determine the optimum model for forecasting the dynamic behaviour of the column, Thomas, Adams-Bohart, and Yoon-Nelson models were developed in this study. These models are useful for understanding and predicting the dynamic behavior of adsorption systems, optimizing process parameters, and designing efficient adsorption processes. The experimental data were fitted with different models such as the Thomas, Yoon-

Nelson and, Adam-Bohart models. Both Thomas and Yoon-Nelson model were found to show a good agreement with the experimental data as compared to Adam-Bohart model. It was concluded that the synthesized green adsorbent could effectively remove COD, NH_4-N, and PO_4-P according to the allowable limits for stringent discharge standards. The sorption of COD, NH_4-N, and PO_4-P was strongly dependent on flowrate and initial concentration of adsorbate. An increase in initial concentration of adsorbate resulted in increased uptake capacity while an increase in flowrate resulted in a reduced uptake capacity for COD, NH_4-N, and PO_4-P. This study has established the potential of using a free, locally and abundantly available waste material for the preparation of graphene like biochar in reducing COD, NH_4-N, and PO_4-P in real wastewater.

PUBLICATION

"Biogenic synthesis of Fe-doped Al_2O_3 nanoparticles using Eichhorniacrassipes for the remediation of toxicant Malachite green dye: Kinetic and thermodynamic studies" in Inorganic Chemistry Communications journal.

Legacy of IEI



Dr Sarvepalli Radhakrishnan (sitting 5th from left), President of India, with Council Members of IEI in 1962

3D-Printing of Bioactive Strontium-doped Hardystonite Scaffold for Bone Tissue Engineering

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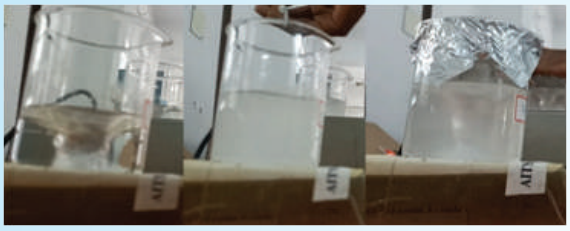
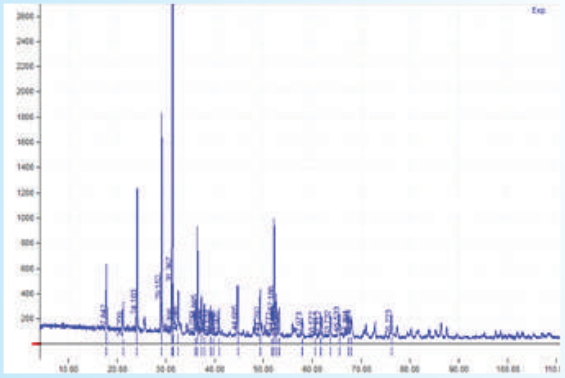
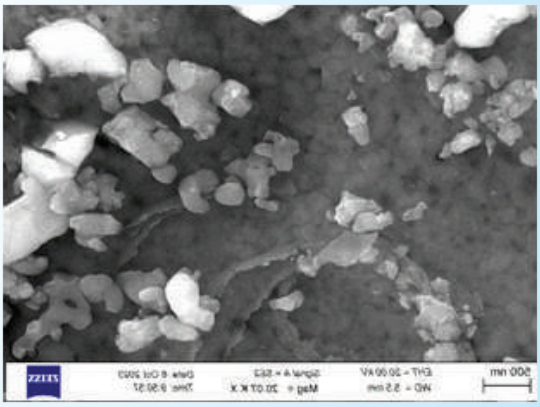


Synthesis of Strontium-doped Hardystonite using sol-gel method

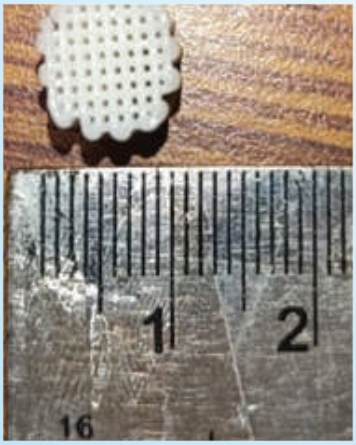
Synthesis of Strontium-doped Hardystonite using sol-gel method



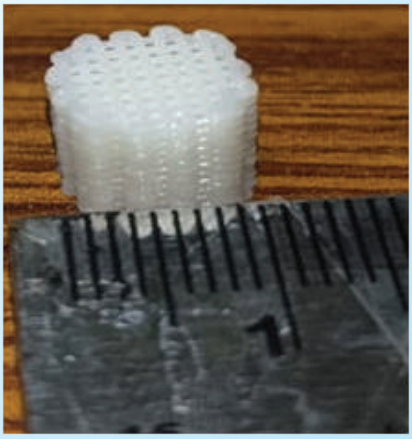
XRD pattern of synthesised powder



SEM image of synthesised powder



3D Printed PCL+ Strontium-doped Hardystonite samples



3D Printed PCL+ Strontium-doped Hardystonite samples

OBJECTIVES

1. Synthesis and Characterization of Hardystonite Calcium Silicate Doped with Strontium:
   - o To synthesize hardystonite calcium silicate ($Ca_2ZnSi_2O_7$) via the sol-gel method, ensuring high purity and phase stability.
   - o To incorporate strontium ions (Sr^{2+}) into the hardystonite structure to enhance its biological and mechanical properties.
   - o To analyze the phase composition, and microstructure of the strontium-doped hardystonite using X-ray diffraction (XRD), scanning electron microscopy (SEM)
2. Preparation of Hardystonite/ Polycaprolactone (PCL) Composite Material:
   - o To create a composite material by integrating the synthesized hardystonite bioceramic with polycaprolactone (PCL), aiming to combine the bioactivity of hardystonite with the flexibility and degradability of PCL.
   - o To optimize the mixing process for uniform dispersion of the hardystonite particles within the PCL matrix, ensuring consistent material properties.
3. 3D Printing of the Composite Material:
   - o To develop a method for 3D printing the hardystonite/PCL composite material, focusing on achieving precise control over the printing parameters for desired structural integrity and resolution.
   - o To optimize the printing process parameters of the prepared polymer composite material
   - o To fabricate 3D structures suitable for biomedical applications, particularly bone tissue engineering, assessing their mechanical properties and print quality.

By addressing these objectives, the study aims to contribute to the advancement of biomaterials for bone tissue engineering, offering a novel approach for developing multifunctional, bioactive, and structurally sound composites.

ACHIEVEMENTS

1. Successful Synthesis and Characterization of Strontium-Doped Hardystonite:
   - o Purity and Phase Stability: Achieved high-purity hardystonite calcium silicate ($Ca_2ZnSi_2O_7$) doped with strontium using the sol-gel method. XRD analysis confirmed the successful incorporation of strontium ions into the hardystonite structure without disrupting the desired phase.
   - o Microstructural Analysis: SEM analyses demonstrated a uniform distribution of strontium within the hardystonite matrix, highlighting its homogeneity and potential for enhanced biological properties.
2. Effective Preparation of Hardystonite/PCL Composite Material:
   - o Optimized Mixing Process: Developed a robust method for uniformly dispersing hardystonite particles within the PCL matrix, resulting in a composite material with consistent properties and enhanced bioactivity.
   - o Material Integration: Successfully integrated the hardystonite bioceramic with PCL, balancing the bioactivity of hardystonite with the flexibility and degradability of PCL to create a versatile composite material.

3. Precision 3D Printing of Composite Material:
   - o Parameter Optimization: Established optimal 3D printing parameters, including temperature, extrusion speed, and layer height, to achieve high-resolution and structurally sound 3D-printed composite structures.
   - o Fabrication of Biomedical Structures: Successfully fabricated complex 3D structures suitable for bone tissue engineering applications, demonstrating the feasibility of using the hardystonite/PCL composite in additive manufacturing processes.
4. Contributions to Biomaterials and Additive Manufacturing:
   - o Innovation in Material Development: Pioneered a novel approach to developing a multifunctional composite material that combines the bioactivity of ceramics with the versatility of polymers, advancing the field of biomaterials.
   - o Enhanced 3D Printing Techniques: Contributed to the knowledge base of 3D printing technology by demonstrating the successful fabrication of complex structures using a bioceramic/polymer composite, paving the way for future innovations in additive manufacturing for biomedical purposes.

These achievements underscore the successful synthesis, preparation, and application of the hardystonite/PCL composite material, highlighting its potential for advancing bone tissue engineering and related biomedical fields.

Legacy of IEI

Prime Minister Mrs Indira Gandhi cutting the Golden Jubilee Cake

Design and Development of a Low-Cost 3DMetal Printing System Using MIG Welding Machine for Medium-Scale Enterprises

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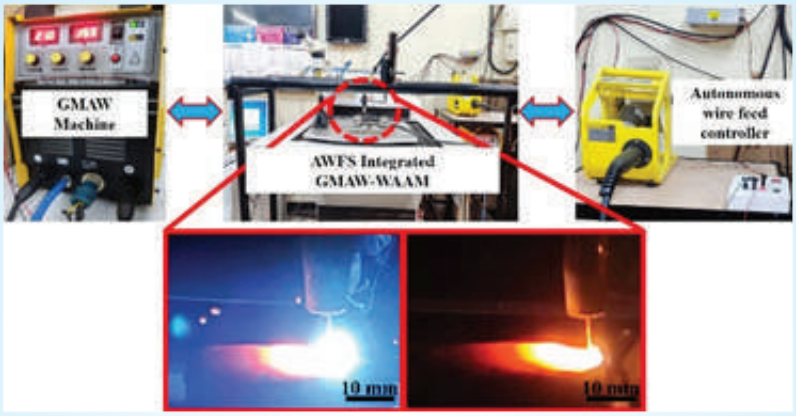
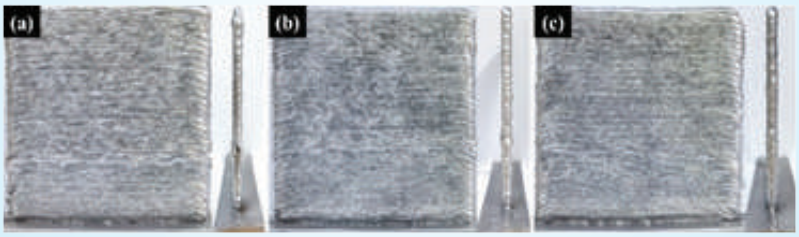


AWFS integrated GMAW-WAAM system



Macrostructural appearances of multi-layered structures
at IDT of (a) 2, (b) 3, and (c) 4 minutes

OBJECTIVE

Issues like high heat input, spatter, microstructural heterogeneity and mechanical anisotropy are primarily related to the uncontrolled wire feed speed (WFS) during conventional GMAW-based wire arc additive manufacturing (WAAM). To achieve control over WFS and arc current development, an autonomous wire feed system (AWFS) is developed and integrated into a GMAW power source. It fine-tunes the WFS irrespective of the welding current value. So, the operator has the flexibility to adjust the WFS autonomously based on the type of feedstock used and the area of applications. After the integration of AWFS with GMAW, single and multi-layered structures are fabricated (using ER70S-6 and 316L SS feedstock) to evaluate the effectiveness of the developed system. The importance of feedstock over the geometrical attributes of the deposit has also been evaluated. The fabricated multi-layered structures are examined through thermography analysis to ensure the thermal energy distribution and its corresponding impact on the microstructural evolutions and

mechanical performances.The implications of inter-layer dwell time (IDT) are also evaluated on the deposit's macrostructural, microstructural, and mechanical performances.

ACHIEVEMENTS

1. Development of a fine-tuned wire feed speed (WFS) that ensures a steady flow of arc current, maintaining consistent heat input and reducing the risk of wire protrusion, spatter, molten metal overflow, and uneven layer height.
2. Deposits with 316L SS with minimal features in terms of bead width, height, penetration, deposition area and dilution compared to the deposits with ER70S-6 feedstock. This distinctive variation is mainly attributed to the electrical resistivity of wire electrodes. The electrical resistivity of 316L SS wire (74×10-8 Ωm) is five times more than ER70S-6 (15×10-8 Ωm), so it develops less arc current even under identical deposition conditions. As a result, better control over heat input, molten metal fluidity, and cooling rate are achieved. That subsequently maintained the bead profile of 316L SS deposits (circular bead profile with a low error rate of 0.37%) even at high heat input conditions. Hence, it is established that wire electrode material has a vital role in deciding the flow of arc current and the level of heat input that subsequently controls the bead profile and deposition characteristics.
3. Fabrication of multi-layered ER70S-6 deposits with uniform thermal energy distribution, as confirmed by thermography analysis, which minimizes microstructural heterogeneity, as observed in micrographs. This leads to reduced mechanical anisotropy (less than 5%). With the integration of Adaptive Wire Feed Speed (AWFS) with Gas Metal Arc Welding-Wire Arc Additive Manufacturing (GMAW-WAAM), compressive residual stress develops in the deposits, thereby enhancing their mechanical strength. The IDT has a significant influence on the metallurgical and mechanical performances, as with increasing IDTs, the morphological attributes of the deposit are improved (straight side wall with low surface waviness) with a reduction in grain size that further boosts the hardness and mechanical performances (increased strength and wear resistance). Moreover, bulk texture analysis reveals consistent fiber texture evolution across different sections of the deposit, with minimal variation in texture intensity, indicating isotropic characteristics in the as-fabricated part.
4. Fabrication of multi-layered structures with316L SS feedstock showing a reduction in mechanical anisotropy (<5%). These improvements in the as-built part quality with varying feedstock are primarily indicative of the effectiveness of the developed AWFS-GMAW WAAM system.

PUBLICATIONS

1 Pattanayak S., Sahoo S.K., Sahoo A.K. (2023) Effect of electrode materials and process parameters on deposition characteristics during GMAW-AM. Materials and Manufacturing Processes, 38:14, 1809-1822. https://doi.org/10.1080/10426914.2023.2217895

2 Pattanayak S, Sahoo S.K., Prajapati A.K., Sahoo A.K., Upadhyay C., Satpathy M.P. (2024) Adaptive control of filler wire speed in wire arc additive manufacturing: impact of inter-layer dwell time on metallurgical and mechanical aspects of ER70S-6 deposits. The International Journal of Advanced Manufacturing Technology. https://doi.org/10.1007/s00170-024-13981-2

The Institution of Engineers (India)

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Ministry of Science & Technology, Govt. of India

IEI R&D Grant-in-Aid Scheme

INSTRUCTIONS TO AVOID REJECTION OF PROJECT PROPOSALS DURING INITIAL SCRUTINY

(I) MUST FURNISH THE FOLLOWING GENERAL INFORMATION PRECISELY

1. The project title should have clarity and must be relevant to the proposal.
2. Attach supporting documents for NBA / NAAC Accreditation or valid NIRF Rank for the Institutions.
3. Applications should be Institutional Members [IMs].
4. Do not include names of more than two guides for a single project proposal .
5. Both the guides should be Corporate Members (AMIE/MIE/FIE- for UG Project Proposals and MIE/FIE- for PG & PhD Project Proposals). In case they are not, they must send the membership form with requisite fees along with project proposal.
6. Guide(s) should be from the same Institution as that of the Applicant(s).
7. A guide will not be allowed to carry out more than one project simultaneously.
8. Maximum number of students/applicants that can apply for a single UG Project Proposal must be limited to five. In case of PG & PhD only one student per project is allowed.
9. UG Applicants should be Student Members (SMIEs) of the Institution, whereas, PG & PhD students must be Corporate Member. In case they are not, they must send the membership form with requisite fees along with project proposal.
10. The 'Completion Date of Study' (Item D) should not be earlier than 'Project Completion Date' (Item H) or should not exceed the maximum duration prescribed for each category.
11. Inclusion of different category of applicants (UG/PG/PhD) in a single project proposal is not permitted.
12. Only full time students pursuing a course in engineering at UG/PG/PhD is eligible for funding. Faculty Members or those who are pursuing part-time course in engineering will not be considered as students.
13. PG applicant must enclose 'Enrolment Certificate' whereas PhD applicant must enclose 'Enrolment Certificate' as well as 'Registration Certificate' along with project proposal.
14. Project proposal will be considered for scrutiny only when the soft copy sent via email is followed with a hard copy of the proposal which must be signed and sealed by all concerned in required places.

(II) MUST ESTABLISH NOVELTY & FINANCIAL FEASIBILITY OF THE PROPOSAL

1. 'Review of R&D in the proposed area' (Item G) should be well documented and must establish novelty/uniqueness of the proposal.
2. Under item 'G', a list of 'References' should be provided for the earlier works carried out in the area.
3. The Applicant's Institute must extend its infrastructural facilities or provide partial funding for carrying out the project.
4. Proposals receiving Industry Support in cash/kind will be given preference.
5. It is expected that the proposal must provide complete information about items being procured. Procurement under non-permissible heads will not be considered for funding. In order to avail maximum grant 'Details of Financial Requirements' [Item-O] must be filled up with reference to upper ceiling of funding available under various Heads.

(III) INFORMATION SHEET & PAYEE DETAILS MUST BE COMPREHENSIVE

1. The 'Information Sheet' must be completely filled along with Membership Numbers for Guides, Students & Institute. Contact Numbers and E-mail of Guide(s) and Students must be furnished.
2. Payee Details should include all requisite details along with the GST number of the Institution.
3. Project proposal should be accompanied by hard copy of cancelled cheque. The cancelled cheque should be from the same account against which payee details have been provided and should bear the name of signatory authority.
4. Request of transfer of grant to account other than Principal/Director/Registrar/Dean (R&D) will be not entertained.

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