

# The Institution of Engineers (India)

8 Gokhale Road, Kolkata 700020

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Government of India  
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## 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](http://www.ieindia.org), should be sent through email to [research@ieindia.org](mailto:research@ieindia.org) and one printed copy of the same should reach the following address:

**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*

I am happy to note that the Volume 10 of the Compendium on R&D Projects under the IEI Grant-in-Aid Scheme is being published.

The initiative to provide R&D Grant-in-Aid to the UG, PG and PhD Students was taken in 2001 with an objective to encourage the students to participate in the Research and Development activities and inculcate in them the interest for Research & Development. Through R&D, the institutions can really inculcate critical innovation skills in their students. Ability critical thinking will lead to innovation and create newer technology, techniques and knowledge which in turn results in economic development of the country.

The Institution of Engineers (India) recognized as a “Scientific and Industrial Research Organisation” (SIRO) is dedicated in the service of the nation for over hundred years. I am sanguine that this compendium will create more enthusiasm amongst the students and budding engineers for Research Activity.

Er Narendra Singh, FIE  
*President, IEI*



### Message from Chairman

### Committee for Advancement of Technology and Engineering

I am pleased to note that the Volume 10 of the compendium for R&D Grant-in-Aid is being published. The R&D Grant-in-Aid is provided to the UG, PG, PhD students of various engineering colleges by IEI with special emphasis to UG students. This is a unique feature of the R&D Grant-in-Aid that it is also extended to the UG students. The philosophy behind this is 'catch them young'. Once the young and budding engineers are encouraged to involve in R&D activity they will develop alternative thought process which is not possible through the stereo type and conventional curriculum only. This will create their mind set for Research Activity during the higher study too.



It is indeed interesting to see that the research works of the students has been collated in the form of a compendium highlighting the outcome of each project. I hope this compendium will encourage more students to come forward for benefitting from the R&D Grant-in-Aid scheme of IEI.

Prof Swapan Bhaumik, FIE  
Chairman, CATE, IEI



### Message from Chairman

### Research & Development Committee

It is my pleasure to note that the Volume 10 of the R&D Compendium is being published with 40 individual project reports from UG,PG and PhD students. The compendium is the show case of the research activities being taken up the students in emerging field the outcome of which will contribute to the development of the society.

The Institution of Engineers (India) has been recognized as a "Scientific and Industrial Research Organisation" (SIRO) due it's contribution towards encouraging the students in research activities through it's R&D Grant-in-Aid scheme.

I believe this compendium which has been beautifully designed with inputs and feedback from each of the student will be a very important document and source of encouragement to the future research scholars.

Dr Wooday P Krishna, FIE  
Chairman, RDC, IEI



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Date: 18<sup>th</sup> March, 2019

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**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 **31.03.2022**.

Please acknowledge the receipt.

Yours faithfully,

(Dr S.K. Deshpande)  
Scientist - 'G'



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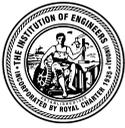
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# The Institution of Engineers (India)

Volume 10, September 2021

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## Compendium on R&D Projects under IEI Grant-in-Aid Scheme

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## Development of A High Performance Digital Controlled Reduced Switch Multilevel Inverter for Photovoltaic System

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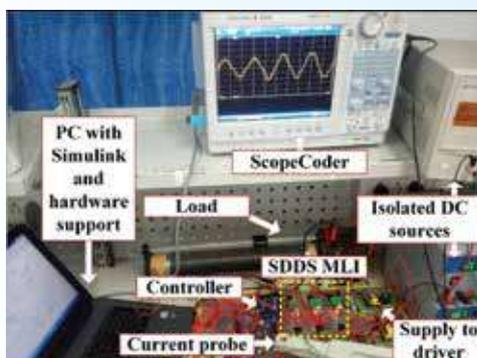
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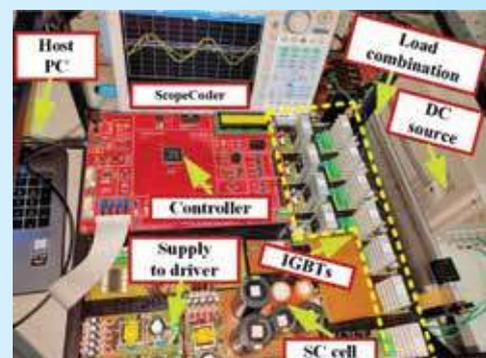
### OBJECTIVES

The key objectives can be outlined as follows:

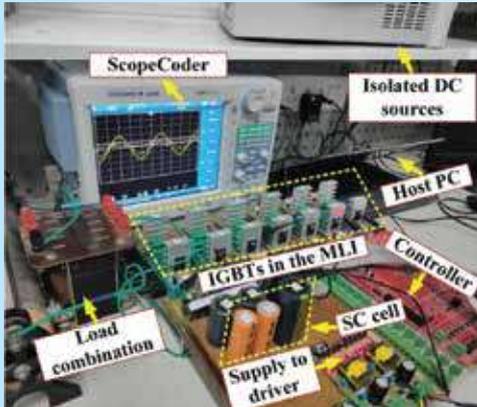
- ❖ To design different reduced switch multilevel inverter (RS MLI) configurations that can optimize the size and enhance the performance of the PV system.
- ❖ To develop a PV system with efficient MPPT controller and a boost converter.
- ❖ Analysis of different MPPT control approach to significantly extract maximum PV power in varying weather conditions.
- ❖ Development of cost-effective RS MLI interfacing with PV system.
- ❖ To compare the performance of developed MLI with state-of-art MLI topologies considering the switch count, number of sources, number of driver circuits, standing voltage, losses, and efficiency.
- ❖ To address the voltage balancing issues and power quality assessment of developed PV-based MLI system through different switching control techniques.
- ❖ Real-time verification of PV-based MLI system with different switching techniques for power quality improvement on a scaled laboratory prototype.
- ❖ To study dynamic analysis of the proposed system by incorporating novel control techniques in simulation and real-time.



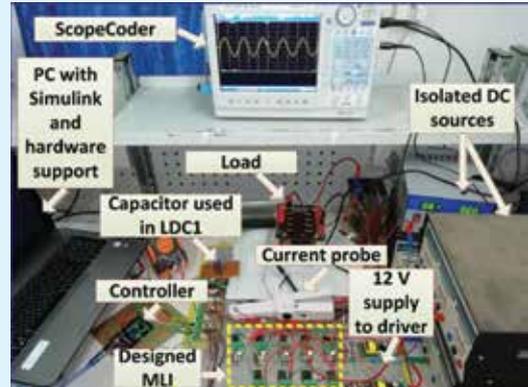
Reduced switch multilevel inverter (7-level) [1]



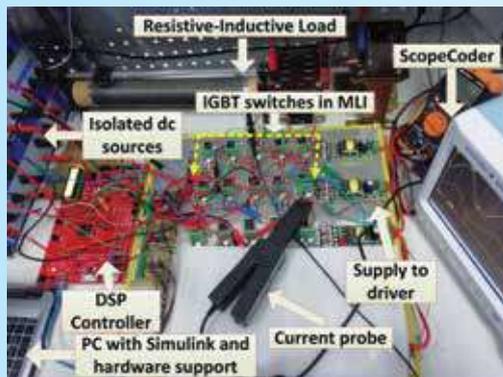
Reduced switch multilevel inverter (17-level) [2]



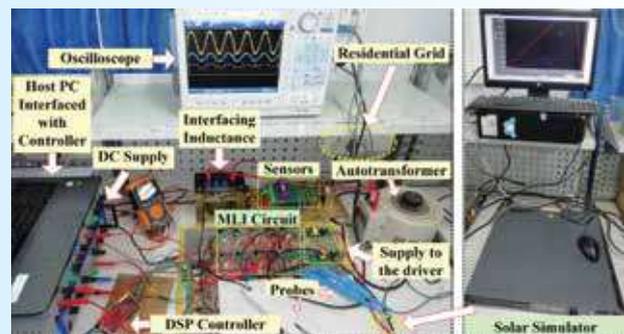
Reduced switch multilevel inverter (13-level) [3]



Reduced switch multilevel inverter (17-level) [4]



Reduced switch multilevel inverter (39-level) [5]



Reduced switch multilevel inverter with solar PV integration

## ACHIEVEMENTS

Complexity in designing the multilevel inverter (MLI) increases with the increase in switch count, the number of driver circuit and other passive components. From viewpoint of various industrial and RES applications, it would be lucrative if the size and cost of the MLI can be optimized. In recent years, continuous research effort has been made to optimize the MLIs in two wide varieties such as switched-dc/switched-diode MLI (SD-MLI) and switched-capacitor MLIs (SC-MLI). Further, these MLIs are based on single-dc source or multi-dc source type. Through this proposal novel MLI structures and its control techniques are proposed for photovoltaic (PV) applications.

### Switched-dc/switched-diode MLI (SD-MLI) structures and Control:

1. A novel switched-diode dual source single switch MLI (SDDS MLI) is developed in [1]. The generalized SDDS MLI is first designed using an asymmetric basic unit. Proposed SDDS MLI requires less switch count and driver circuit count compared to the few recently developed RS MLI topologies. A new selective harmonic elimination control technique is also derived to control the MLI which is investigated through various simulation and experimental tests.



2. A generalized cascaded SD-MLI structure is developed in [2] that can operate in both symmetric and asymmetric modes. Comparative assessment in terms of the number of components and voltage stress warrants the design superiority. A new selective harmonic elimination (SHE) control using flower pollination algorithm (FPA) is investigated for the developed asymmetrical MLI. Simulation and experimental tests using fundamental and high switching frequency control techniques are further conducted under dynamic environment to demonstrate the efficacy of the proposed methodology.
3. Another study in [4] proposes a hybrid asymmetrical structure suitable for PV application. The proposed MLI is assembled using a reduced switch H-bridge based (RSHB) MLI structure with  $n$  asymmetrical repeating units and different level doubling circuit (LDC) combinations. A 3.9 kW standalone solar PV system is considered for performance evaluation of the MLI structure applying both the selective harmonic elimination (SHE) and carrier-based pulse width modulation (PWM) control schemes. Theoretical and simulation findings are validated experimentally on a prototype of the proposed seventeen-level MLI.
4. A reduced component count multi-input MLI structure combined with different level boosting stages is proposed in [5]. Using  $n$  repeating units and level boosting stages, the proposed MLI structure can produce  $8n+15$  levels at the output instead of  $2n+1$  levels only without level boosting stages. Comparative analysis reveals that the proposed MLI is a cost-effective alternative to the conventional MLI. In addition, it has fewer switch requirements, low standing voltage, and less power loss. Extensive simulation of the proposed MLI is performed on MATLAB/Simulink environment under different dynamic conditions and validated experimentally on a prototype of the 39-level MLI developed in the laboratory.
5. Further, cascaded SD-MLI structures are proposed in [6] and [7] In view of switch count, source count, blocking voltage, loss, and design cost, the MLI topologies are compared. Under different modulation indices, change in frequency and load dynamic conditions, the simulation and dynamic testing are carried out on a prototype developed in the laboratory.

#### **Switched-capacitor MLI (SC-MLI) structures and Control:**

6. Multilevel inverters (MLIs) with self-balanced switched-capacitors (SC) have received wide recognition for increasing power capacity and power quality of the renewable energy systems [10]. A new SC-MLI structure using reduced number of switches and a single dc source is presented in [3]. By suitable charging-discharging patterns, the SCs are self-balanced and high voltage boosting is achieved. Comparative analysis with state-of-art MLIs in terms of the number of components, standing voltage, boosting factor, and cost factor demonstrate the merit of presented topology. Further, experimental results confirm the workability of the proposed MLI under linear, non-linear loading and dynamic test conditions using both the fundamental and high-frequency modulation schemes.
7. Literature [8] presents a new SC-based quadruple boost (SCQB) MLI using a reduced number of switches and a single dc source. With four times boosting capability, the proposed MLI can produce a nine-level output without the requiring additional balancing control. a novel switched-capacitor level boost (SCB) MLI using reduced number of switches and only two dc sources.
8. Further, a 17-level MLI is analyzed in [9] and its generalized structure is developed to increase the voltage levels. Two capacitors used in the 17-level structure possess self-balancing ability and the proposed topology works competently under highly inductive loading condition. Performance comparison with prior-art MLI structures manifest merits of the proposed MLI. Various simulation of the 17-level SCB MLI is carried out which is further validated experimentally applying the SHE control implemented on a DSP controller.



## PUBLICATIONS

### Journals :

1. K. P. Panda, S. S. Lee, and G. Panda, "Reduced Switch Cascaded Multilevel Inverter with New Selective Harmonic Elimination Control for Standalone Renewable Energy System," IEEE Transactions on Industry Applications, vol. 55, no. 6, pp. 7561–7574, 2019, doi: 10.1109/TIA.2019.2904923.
2. K. P. Panda, P. R. Bana, and G. Panda, "FPA Optimized Selective Harmonic Elimination in Symmetric-Asymmetric Reduced Switch Cascaded Multilevel Inverter," IEEE Transactions on Industry Applications, pp. 1–1, Early Access, 2020, doi: 10.1109/TIA.2020.2981601.
3. K. P. Panda, P. R. Bana, and G. Panda, "A Switched-Capacitor Self-Balanced High-Gain Multilevel Inverter Employing a Single DC Source," IEEE Transactions on Circuits and Systems II: Express Briefs, pp. 1–1, Early Access, 2020, doi: 10.1109/TCSII.2020.2975299.
4. P. R. Bana, K. P. Panda, and G. Panda, "Power Quality Performance Evaluation of Multilevel Inverter with Reduced Switching Devices and Minimum Standing Voltage," IEEE Trans. Ind. Inf., pp. 1–1, Early Access, 2019, doi: 10.1109/TII.2019.2953071.
5. P. R. Bana, K. P. Panda, and G. Panda, "Performance evaluation of a reduced components count single-phase asymmetric multilevel inverter with low standing voltage," International Transactions on Electrical Energy Systems, p. e12239, Early Access, 2020, doi: 10.1002/2050-7038.12430.

### Conferences:

6. K. P. Panda, P. R. Bana, and G. Panda, "Design and Control of A Switched-Diode Multilevel Inverter for Photovoltaic Application," in 2019 IEEE Milan PowerTech, Jun. 2019, pp. 1–6, doi: 10.1109/PTC.2019.8810526.
7. K. P. Panda, P. R. Bana, and G. Panda, "Design and Control of An Asymmetrical Cascaded Compact Module Multilevel Inverter for PV System," in TENCON 2019 - 2019 IEEE Region 10 Conference (TENCON), Oct. 2019, pp. 2616–2621, doi: 10.1109/TENCON.2019.8929608.
8. K. P. Panda, P. R. Bana, and G. Panda, "A Single Source Switched-Capacitor Based Multilevel Inverter for Photovoltaic Application," in IEEE PESGRE 2020 Conference, Kerala, India, Jan. 2020
9. P. R. Bana, K. P. Panda, and G. Panda, "Novel Reduced Source Switched-Capacitor Boost Multilevel Inverter for Photovoltaic Application," in IEEE PESGRE 2020 Conference, Kerala, India, Jan. 2020
10. K. P. Panda, P. R. Bana and G. Panda, "A Self-Balanced Switched-Capacitor Boost Seven Level Inverter for Photovoltaic Systems," in IEEE GUCON 2020 Conference, Greater Noida, India, Oct. 2020

"Technology innovation is starting to explode and having open-source material out there really helps this explosion. You get students and researchers involved and you get people coming through and building start ups based on open source products."

Tim Berners-Lee



## Improving Occupancy Comfort: Aerodynamic Investigation of Wind Forces on Building

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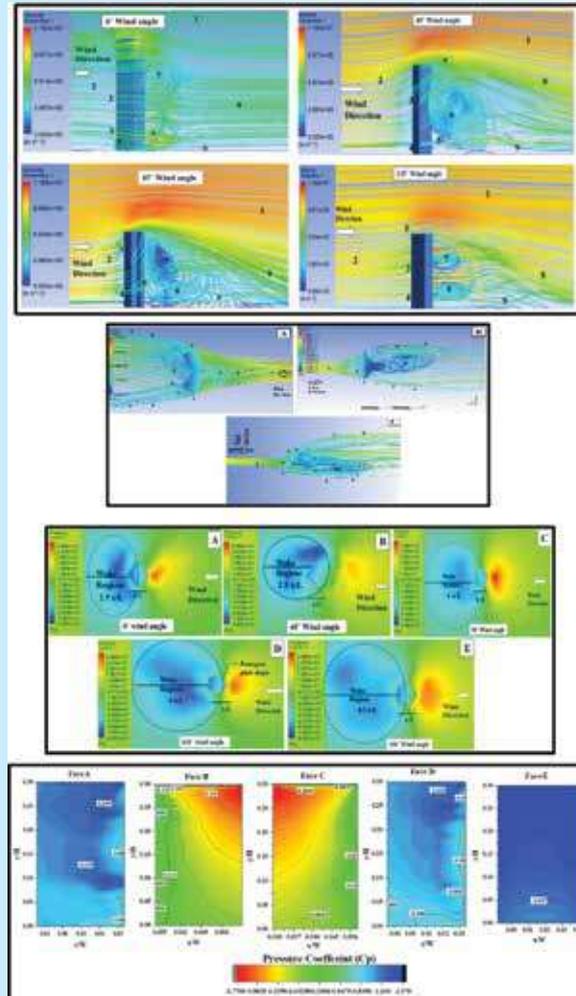
### OBJECTIVES

- To investigate the aerodynamic characteristics and mean pressure coefficient ( $C_p$ ) for non-conventional plan shaped tall buildings such as the Pentagon, T-Shape, Y-plan shape and square building (asymmetry in both the plan axis).
- To study the variation of the wind pressure at different building faces with the change in wind angle.
- To examine the aerodynamic coefficient for the pentagon, T, and Y plan shape building.
- To find the most critical wind angle and desirable wind angle for the building of plan shapes pentagon, T, and Y.
- To identify the wake formation around the buildings of plan pentagon, T and Y are identified.

### ACHIEVEMENTS

In this study, the aerodynamic behaviour of tall buildings with various shapes, and systematic wind pressure measurements were investigated to understand the effect of wind flow. The experimental and numerical analysis was performed for different non-prismatic shape tall buildings such as pentagon, L, T, C and Y and the pressure distribution on each face of the building are investigated for different wind angles. The error analysis R2, MAE,





RMSE, MAPE is carried out between the results obtained from wind tunnel testing and numerical analysis. From the above study, the following conclusions are drawn.

- Pentagon plan shape building experiences high positive pressure coefficient ( $C_p$ ) on face A at  $0^\circ$  wind angle and extreme negative pressure coefficient ( $C_p$ ) is observed on face A at  $180^\circ$  wind angle. In addition, a high drag and lift coefficient was observed at  $90^\circ$  and  $45^\circ$  wind angle respectively. For pentagon plan shape building the wind angles  $0^\circ$  and  $90^\circ$  are critical angles due to the occurrence of large twisting moments along Z-direction. It is worth mentioning that the most superfluous wind angles for pentagon plan shaped buildings are  $45^\circ$ ,  $135^\circ$ , and  $180^\circ$ .
- The face A and E of the T-plan shape building experiences a high positive pressure and extreme negative pressure, is observed in face E at  $0^\circ$  wind angle. In addition, high drag and lift coefficient is observed in  $45^\circ$  and  $135^\circ$  wind angle. For T-plan shape building  $45^\circ$  wind angle act a critical angle, since large twisting moment is created along Z-direction. And the most superfluous wind angles is  $90^\circ$ .
- The face A at  $0^\circ$  wind angle experiences high positive pressure for Y plan shape buildings. Similarly, a very high negative pressure was observed in face D at  $45^\circ$  wind angle. Also, a high drag and lift coefficient was observed in  $45^\circ$  wind angle. For Y-plan shape building  $90^\circ$  wind angle act a critical angle due to the large twisting moment along Z-direction. The most superfluous wind angles for Y plan shape building is  $0^\circ$  and  $45^\circ$ .



- A detailed wind flow behavior and the wake regions are identified for the building of shapes pentagon, T, and Y plan shapes at different wind angles.
- From the above findings, pentagon plan shaped buildings are more wind resistant than the other shapes buildings.

#### PUBLICATIONS

- Vigneshwaran Rajendran, Prabavathy “Investigations of Aerodynamic Coefficient for wind flow around Y-plan shape tall building” *Teknik Dergi*, 33(4): 2022. <https://dergipark.org.tr/en/pub/tekderg/issue/57835/699861> (SCI, Scopus Indexed)
- Vigneshwaran Rajendran, Prabavathy “Experimental Investigation on Aerodynamic characteristics for 3D Bluff bodies: Pentagon, T, C and L - shape buildings” *Technical Gazette*, Vol. 28/No. 6, Dec. 2021. Doi: 10.17559/TV-20200911070420. (Accepted, SCI, Scopus Indexed)
- Vigneshwaran Rajendran, Prabavathy, Shobankumar, “Interference effect study on wind pressure distribution in buildings using Computational Fluid Dynamics”, *Lecture notes in Mechanical Engineering (LNME)*, Springer Publisher. (Accepted, Scopus Indexed)
- Shobankumar, Prabavathy, Vigneshwaran, “Study of wind flow around pentagon plan shape tall building using CFD”, *Institute of Physics (IOP) Publisher*. (Accepted, Scopus Indexed)
- Vigneshwaran Rajendran, Prabavathy “Study on outdoor wind flow and mean wind pressure around the ‘T’ plan shape tall building”, *Journal of The Institution of Engineers (India) Series A. IEIA-D-21-00263* (Status: With Editor)

#### Paper Presented in Seminars/Conferences

- Mr.R.Vigneshwaran , Dr.S.Prabavathy, An Analytical Study on Wind Pressure Distribution on Rectangular Tall Building with Setback and Twist using Computational Fluid Dynamics, presented a paper on 35th Indian Engineering Congress during 18-20, December 2020.
- Mr.R.Vigneshwaran, Dr.S.Prabavathy, presented a paper under the title “Analytical study on wind pressure distribution around tall building of different shape using Computational Fluid Dynamics”, *International Conference on Modeling and Simulation in Civil Engineering (ICAMSC – 2019)* Organised by department of Civil Engineering, TKM College of Engineering, Kollam, during 11-13 December 2019.
- Mr.R.Vigneshwaran, Dr.S.Prabavathy, presented a paper under a title “Interference effect study on wind pressure distribution in buildings using CFD”, *International conference on Advances in Sustainable Technology (ICAST – 2020)*, Organized by School of Mechanical Engineering, at Lovely professional University, held on 6th to 7th November 2020.

Engineering is the science of economy, of conserving the energy, kinetic and potential, provided and stored up by nature for the use of man. It is the business of engineering to utilize this energy to the best advantage, so that there may be the least possible waste.

*William A. Smith, 1908*

## Sustainable and Cost Effective Monitoring System for Bridges in Rural Areas for Increased Life Time Performance

### Student

T Sathish Kumar  
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### Guide

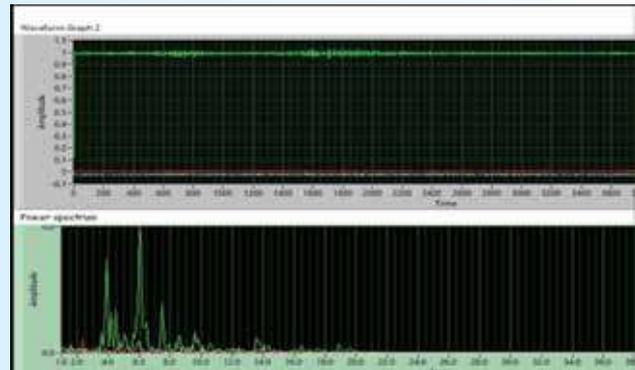
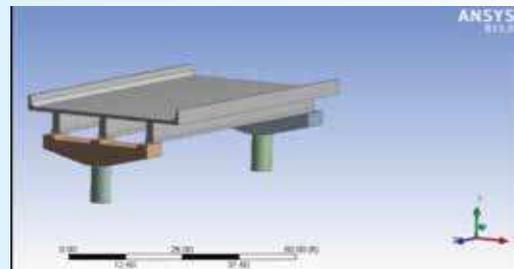
Dr Gulshan Taj M N A, *MIE*  
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### Institute

Sona College of Technology  
Junction Man Road, Salem



Experimental set up at bridge location



Deck layout in ABAQUS software b. Vibration response in Labview

### OBJECTIVES

- To develop and deploy wireless remote monitoring system that can monitor reliable, accurate sensor data of interest (vibration) in real-time mode in rural area bridges.
- To capture the vibration response of the rural area bridge under live traffic loading conditions.
- To assess the performance of the developed monitoring system into one of the bridges located in rural area of Salem district (Omalar Railway over Bridge).
- To study the feasibility of the system to large scale structures like multistory buildings, transmission towers, tunnels for enhancing their life cycle period.
- To facilitate interdisciplinary collaboration between diverse Engineering disciplines (Civil, Electronics and communication and Computer Science Engineering) that will further propose solution to complex Engineering problems in this area.



- To ensure the technology transfer and reach to rural people community for their better livelihood by means of proposed monitoring system.
- To propose suitable warning system/application through mobile phones with the help of acquired data before occurrence of any catastrophic failure.

#### ACHIEVEMENTS

- Project won best project award at the Project Expo held at Department of Civil Engineering, Sona College of Technology, Salem.
- Submitted for ISTE best project award in the year 2019 at regional convention
- Appreciated the concept by external viva members during the final viva voce examination held on 2.5.2019.

#### PUBLICATIONS

1. Gulshan Taj M.N.A., T.Sathish Kumar, Efficient and Effective Vibration Monitoring System for Bridge Structure: A Case Study at Railway over Bridge in Rural Area of Salem District, International Research Journal of Engineering and Technology (IRJET), 6(4), 3968-3972, April 2019.
2. Gulshan Taj M.N.A., T.Sathish Kumar, Health monitoring of bridges using IoT, PSG Institute of Technology and Applied Research, International conference on Industry 4.0 and advancements in Civil Engineering (i4ACE'19) held on 22.3.19.
3. Patent on "SOLAR POWERED PORTABLE WIRELESS VIBRATION MONITORING DEVICE FOR BRIDGES" is under progress. Patent searchability report is generated for further process.

## *Legacy of IEI*



Shri Pranab Mukherjee, President of India, in the Inaugural Session of 27th Indian Engineering Congress at New Delhi in 2012

## Design of Continuous Heterogeneous Photo Catalytic Reactor Immobilised with Nano Composites (as Nano Spheres) for the Degradation of Textile Dyes

### Student

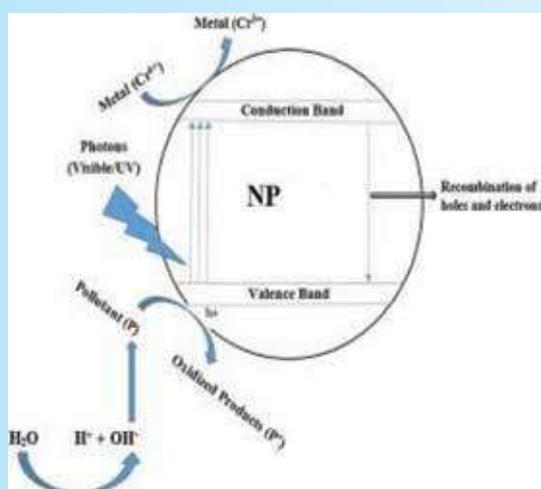
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### Guide

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### Institute

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IM 0005144



Degradation mechanism of TiO<sub>2</sub> Photocatalyst



Heber multi lamp photoreactor

### OBJECTIVES

1. Synthesis of Nanoparticles and Nanocomposites
  - Co – precipitation method - Fe<sub>3</sub>O<sub>4</sub> nanoparticles
  - Ultrasonic assisted synthesis - TiO<sub>2</sub> – Fe<sub>3</sub>O<sub>4</sub> Nanocomposites
2. Characterization of TiO<sub>2</sub>, Fe<sub>3</sub>O<sub>4</sub> nanoparticles and TiO<sub>2</sub> – Fe<sub>3</sub>O<sub>4</sub> Nanocomposites
  - UV – Visible absorption spectroscopy
  - XRD analysis
  - SEM – EDX analysis
3. Application of Nano catalyst in degradation of textile dyes
  - Degradation of Reactive Orange 16 by photocatalytic process
4. Optimization of process parameters
  - Effect of amount of TiO<sub>2</sub>



- Effect of concentration of RO16

In this study, the degradation of Reactive Orange 16 dye was carried out in heber multi lamp photo reactor using nano TiO<sub>2</sub>. All the experiments were performed at light intensity of 32W irradiated for 120min. The effect of amount of TiO<sub>2</sub> on degradation was studied under batch mode and optimized to be 30mg. The influence of initial concentration of dye was also studied by varying the concentration of Reactive Orange 16 from 50 – 150ppm. It was observed that at varied concentration of Reactive Orange 16, maximum degradation was achieved within 120min. This result indicates that if the concentration of Reactive Orange 16 was increased above 150ppm, maximum degradation could be achieved by increasing the irradiation time. This study also reports about morphological characteristics and elemental composition of TiO<sub>2</sub>, Fe<sub>3</sub>O<sub>4</sub> nanoparticles and TiO<sub>2</sub> - Fe<sub>3</sub>O<sub>4</sub> nanocomposite. Scanning Electron Microscopy images of nanoparticles and nanocomposites revealed broad distribution of particles forming several clusters. The composition of each element in nano TiO<sub>2</sub>, Fe<sub>3</sub>O<sub>4</sub> and TiO<sub>2</sub> - Fe<sub>3</sub>O<sub>4</sub> was determined from Energy Dispersive X – Ray analysis. It was observed that the atomic percentage of Fe is greater than Ti in nanocomposite and the accuracy of analysis was determined by calculating the average error% of TiO<sub>2</sub>, Fe<sub>3</sub>O<sub>4</sub> nanoparticles and TiO<sub>2</sub> - Fe<sub>3</sub>O<sub>4</sub> nanocomposite.

### ACHIEVEMENTS

#### Project Outcomes:

From the absorption spectrum the energy required for the transfer of electrons from valance band to conduction band was derived by plotting Tauc plot and extrapolating the linear part of the graphics to abscissa. The bandgap of TiO<sub>2</sub> NPs, Fe<sub>3</sub>O<sub>4</sub> NPs and TiO<sub>2</sub> - Fe<sub>3</sub>O<sub>4</sub> NCs are 3.5, 2.0 and 1.6 eV respectively. From the results it was evident that the bandgap of the synthesized nanocomposite was less than the bandgap of individual nanoparticles. The decrease in bandgap energy was due to the addition of Fe<sub>3</sub>O<sub>4</sub> which promotes the transfer of electrons resulting in decrease in the bandgap of thenanocomposite. From the XRD analysis, all the diffraction peaks of the nanocomposite were indexed to either cubic Fe<sub>3</sub>O<sub>4</sub> or anatase TiO<sub>2</sub> phase or both. All the characteristic diffraction peaks of Fe<sub>3</sub>O<sub>4</sub> were observed in the X – ray spectrum of NCs, which indicated the effect of crystal structure of Fe<sub>3</sub>O<sub>4</sub> NPs during the synthesis of NCs was negligible. It was observed that the peak intensities of TiO<sub>2</sub> phase at 2 theta value of 25.13, 47.883, 53.775, and 62.578 correspond to the anatase phase of TiO<sub>2</sub> NP. The decrease in peaks intensities may be due to modification in TiO<sub>2</sub> phase. No other diffraction peaks were observed, indicating that the synthesized composite consists of TiO<sub>2</sub> and Fe<sub>3</sub>O<sub>4</sub> NPs. The effect of TiO<sub>2</sub> and RO16 concentration on the photocatalytic degradation was investigated. As the amount of TiO<sub>2</sub> increased from 10 to 30mg the degradation increases from 41.44 to 98.63% at 120min irradiation time. By the addition of catalyst above 30mg, the percentage of degradation decreased from 98.63 to 90.75%. The decrease in the rate of degradation is due to increase in the amount of catalyst above its optimum value which decreases the penetration of UV light and reduce the formation of electron hole pairs. In this study the optimum amount of TiO<sub>2</sub> is found to be 30mg for degradation of 60mL of RO16. The initial concentration of dye has a significant effect on rate of degradation. The initial concentration of RO16 was varied from 50 to 150ppm. At 50ppm and 75ppm RO16 concentration, the degradation percentage reached maximum at 45min for 50ppm and 90min for 75ppm of RO16. By further increasing the irradiation time the rate of degradation decreased. After complete degradation of RO16 the turbidity of the reaction mixture containing the photocatalyst and water increases due to the interaction between TiO<sub>2</sub> and water molecules which increases the absorbance of the sample and thus lowering the percentage of degradation. At higher concentration of dye, the amount of dye molecule adsorbed on the active sites of the catalyst decreases the efficiency of TiO<sub>2</sub>. For all concentration of RO16 the percentage of degradation was above 95% at 120 min irradiation time and also it suggests that for higher concentration of RO16, complete degradation can be achieved by increasing the irradiation time.

#### Project Achievements:

This project was selected in Student Project Program (SPP), Institute of Scholars Awards 2020

## Design and Development of an IoT(Internet of Things) Based Intelligent Control System for a Six Degree off redeem Articulated Robot Arm

### Student

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### Guide

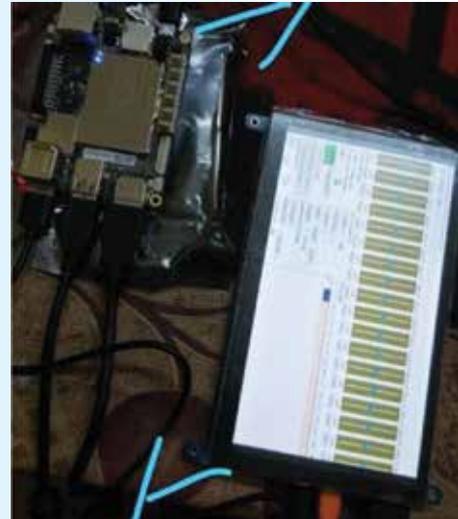
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### Institute

Birla Institute of Technology, Mesra  
Mesra, Ranchi, Jharkhand



The Robot Arm Being Controlled via Internet



HMI Control Display or the system in action

### OBJECTIVES

The following remains some of the most primary objectives of the project:

- To develop a highly inter operable robot control system that can easily operate with all the present communication standards
- Development of a robust PID based position control, that is manually tuned to nullify any external noises which will ensure a smooth motion profiles for the servomotors.
- Public availability and open-sourcing of all the code base used to make the project work.
- Development of a truly autonomous robot manipulator with in built condition monitoring so that it is aware of future break downs thereby saving both cost and time.
- Making an always-aware manipulate or which can constantly monitor and classify objects in its surroundings so as to work collaboratively with each and every entity of the same.



- Using multiple pretrained R-CNN models to find out which ones is best suited for the manipulator awareness purpose is an other major challenge. This iterative experimentation to find out the optimal neural-network model is realized using NVIDIA CUDA, CUDNN & Open CV.
- Using AI based voice recognition to control the robot arm using a person's voice commands
- Development of an a synchronous web-based simulator with real time forward and inverse kinematic visualization complimenting to the actual manipulator is also a major hurdle to be over come in this project. This is to be implemented using Java Script and Node JS.

### ACHIEVEMENTS

The motors can be considered as muscles of a robot, without which it cannot move at all. In this project, MG996R6vPWM Digital Servomotors are being used. The main-controller is based on two Atmel ATmega328P Microcontrollers in master-slave mode, which will handle hardware-level interrupts from user with a button-based teach pendant to control the robotic arm. The motors are driven using PWM drivers from Texas Instruments. TTL5VDC logic voltage will be used for control same for power supply. The robotic control system will also be integrated with speed control via potentiometers along with software-based PID control. The PID control logic will be written in Embedded C and. NET Programming Language which will essentially poll and analyze the feedbacks from quadrature rotary encoders fitted in the motors. Major sensors for position feed back are individual joint limit switches and the rotary encoders. The proportional (Kp), integral (Ki) and derivative (Kd) parameters are tuned according to the optimal system error rate by continuously mapping the PWM voltage signal width in a digital signal oscilloscope(DSO)and find the point with minimum variations. Special firm ware will also be written as application-level script so that user can tune PID parameters as per user requirements via serial(RS-232) based GUI terminal on any computer. Apart from these the controller will be integrated with emergency interlocks and diagnostic display that will display code-based errors for easy troubleshooting of the system. For the HMI display system, a 1 280x760 pixel I2C Touch Screen LEDHMI. Apart from these, the system is also equipped with a computer vision module which enables the robot to become context-aware i. e. recognizing objects in its surroundings, recognizing colors, cognitive reactions and soon. In conjunction with AI the robot is also fitted with intelligent interlocks using ultrasonic sensor array. It necessarily stops the manipulator whenever it detects an unidentified object within its working boundary, thereby avoiding accidents. Now comes the development of the IoT gateway system and the application software that will interact with the gateway-server system. The gateway is a WiFi IEEE802.11b/g/n/ac router that is port-forwarded to receive requests from any where in the internet. The server will be a Linux based headless computer with Broadcom processor having WiFi/Ethernet capabilities which will host an application (to be developed in-house) and can share the application in real time with any client over SSH (secure socket layer) protocol. The scalability of the system will be further increased by implementing custom sensors in the extra unused pins of the ATmega MCU. The system can be controlled via PC through serial, Bluetooth, via internet or heedlessly via the HMI which is handled by a LatteP and aSBC. Open CV public models, Microsoft COCO and YOLODarknetV3 pre trained RCNN models along with the. NETEmguCV wrapper for machine vision. Has been used for the machine vision part of the robot.

### PUBLICATION

Design and Development of a Web-Based Robotics Simulator, International Conference on Recent Advances in Computational Techniques-2020, Amity School of Engineering & Technology, Amity University Mumbai.

# Tribological Behaviour of Ceramic Biomaterials for Human Hip Prosthesis using Bio-Lubricant

## Student

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## Guide

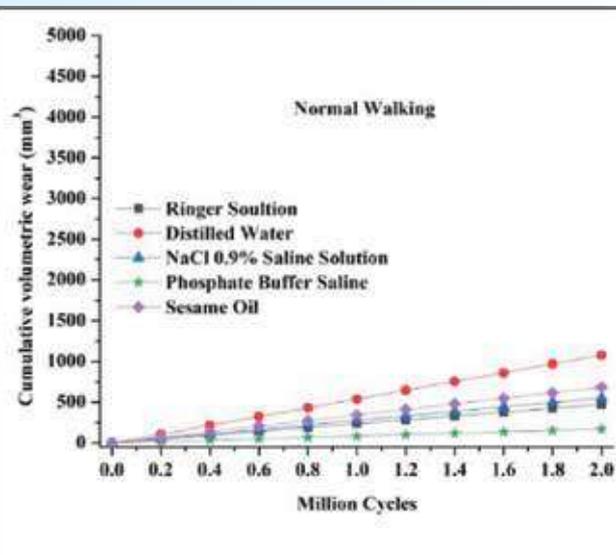
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## Institute

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Modified Pin-on-Disc Tribometer



Volumetric wear for normal walking

## OBJECTIVES

The objective of the study is focused on analyzing the wear and friction coefficients of Si<sub>3</sub>N<sub>4</sub> against titanium alloy grade 5 material using ball-on-disc tribometer for a sliding distance of 20 km with five different bio-lubricants. Later using finite element submodeling technique, wear is predicted for 2 years considering four different gait activities which includes normal walking, stairs down 25 kg, carrying 25 kg and lifting 40 kg. The initial phase of the study dealt with analyzing the wear and friction coefficients for above mentioned gait activities with different bio-lubricants. The volume loss of the material is calculated from ratio of mass loss of specimen to density. Each experiment is repeated thrice to get the average value of friction and wear coefficients. Later obtained friction coefficient is given as input to finite element (FE) model of femur head and acetabulum cup to estimate the contact pressure in second phase of work. The geometry of model is updated at interval of 0.2 million cycles to capture realistic pressure due to wear of femur head. Later the wear of the



Si<sub>3</sub>N<sub>4</sub> computed using Archard's wear law for various gait activities. The contact pressure obtained from submodeling is used to estimate the linear wear penetration. The linear wear penetration of the implant is found as product of wear coefficient obtained from BOD tribometer, contact pressure and sliding distance of femur head i.e Si<sub>3</sub>N<sub>4</sub> sliding inside titanium alloy acetabulum cup modeled using ANSYS. Using obtained linear wear, the volumetric wear of Si<sub>3</sub>N<sub>4</sub> is calculated as product of linear wear and contact area of material for 2 million cycles.

## ACHIEVEMENTS

### Friction and wear coefficient behavior

The friction and wear coefficient for five bio-lubricants range from 0.22 to 0.41. Among different bio-lubricants, sesame oil showed least friction coefficient of 0.22 and highest friction coefficient was observed for 0.9% NaCl saline solution. The reason for saline solution showing high friction coefficient was due to the corrosion effect of Cl<sup>-</sup> ion destroying the surface of Ti6Al4V leading to increased surface damage. Due to the reaction of Cl<sup>-</sup> ions with titanium alloy disc, which resulted in higher wear rate when saline solution was used as a bio-lubricant. This led to generation of more wear particles destroying surface of Ti6Al4V disc. In sesame oil, due to the presence of long chain molecules, with high viscosity, a lubricating layer was formed which reduced the friction at the interface of the contacting material. This was the main reason behind reduction in friction coefficient for sesame oil bio-lubricant when compared with other bio-lubricants. The reduced CoF was due to the increase in sliding distance, resulting in smooth surface area, even though applied load was found to be 20 N for the current study. The wear coefficient values for bio-lubricants range from  $3.33 \times 10^{-6}$  mm<sup>3</sup>/Nm to  $2.11 \times 10^{-5}$  mm<sup>3</sup>/Nm. Among the bio-lubricants, minimum and maximum wear coefficient were observed for phosphate buffer saline solution (PBS) and distilled water. The reason for reduced wear rate was the formation of tribofilm layer leading to lesser wear rate when compared with other bio-lubricants.

### Contact pressure analysis for gait activities

Using simplified submodel approach, the contact pressure plot for gait activities are computed. The stair down gait activity with 25 kg load showed a maximum contact pressure of 92.72 MPa, while normal walking gait activity showed a minimum contact pressure of 85.99 MPa. In the current study, more than 7% increase in contact pressure difference was observed for normal walking and stairs down gait activity with 25 kg load. Not much difference in contact pressure variation was observed between remaining gait activities other than the normal walking gait activity.

### Linear wear penetration for gait activities

The maximum cumulative linear wear was obtained for lifting 40 kg load gait when distilled water was used as bio-lubricant. The minimum cumulative linear wear was obtained for normal walking gait activity when PBS was used as a bio-lubricant. Comparing normal walking gait activity maximum cumulative linear wear with remaining gait activities, the following observations were noted. More than threefold increase in cumulative linear wear for lifting 40 kg gait activity, while 32.80 % and 21.54 % increase in cumulative linear wear was observed for carrying 25 kg and stair down 25 kg gait activities.

### Volumetric wear loss for gait activities

The maximum cumulative volumetric wear was observed for lifting a load of 40 kg while minimum volumetric wear was observed for normal walking gait activity. On comparing maximum volumetric wear of normal walking activity with remaining gait activities, lifting 40 kg activity showed more than threefold increase in wear. However, carrying 25 kg and stairs down 25 kg showed 38.75% and 32.88% increase in maximum wear when compared with normal walking gait activity.

## CONCLUSIONS

The realistic wear coefficient under five different bio-lubricants combined with submodeling technique was used to estimate the wear of C-o-M combination (Si<sub>3</sub>N<sub>4</sub> Vs Ti6Al4V) up to 2 million cycles.

- The coefficient of friction value was found to be low for sesame oil and high for 0.9% NaCl saline solution. At the same time, wear coefficient was found to be least for PBS solution while distilled water showed maximum wear coefficient for given load.
- The submodeling wear approach predicted the contact pressure in more accurate manner rather than global model approach. The computational time taken to predict wear using submodel was greatly reduced.
- More than 80% reduction in wear coefficient was observed between PBS and distilled water. The linear and volumetric wear was found to be minimum for all gait activities when PBS solution was used as bio-lubricant. The maximum linear and volumetric wear values are noted for distilled water bio-lubricant.
- For all five lubricants normal walking showed minimum linear and volumetric wear followed by stairs down 25 kg, carrying load 25 kg and lifting 40 kg gait activities.
- The findings confirmed that phosphate buffer saline solution could be used as a bio-lubricant especially for Si<sub>3</sub>N<sub>4</sub> material because of improved tribological properties or to predict wear in in-vivo testing procedure.

## PUBLICATIONS

- S Shankar, R Nithyaprakash, BR Santhosh, Ali Kaya Gur, Alokesh Pramanik, (2020), “Experimental and submodeling technique to investigate the wear of silicon nitride against Ti6Al4V alloy with bio-lubricants for various gait activities”, Tribology International,151, 106529.
- S Shankar, R Nithyaprakash, BR Santhosh, MS Uddin, A Pramanik (2020) “Finite element submodeling technique to analyze the contact pressure and wear of hard bearing couples in hip prosthesis”, Computer Methods in Biomechanics and Biomedical Engineering, 23(8),422-431.

## Legacy of IEI



**Shri V P Singh, Chief Minister of Uttar Pradesh inaugurating 60th Annual General Meeting & Diamond Jubilee Celebration of Uttar Pradesh State Centre of the Institution in 1981**

## Design and Fabrication of Foam Separation Column to Remove Chromium Heavy Metal from Leather Tannery Effluent

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### Guide

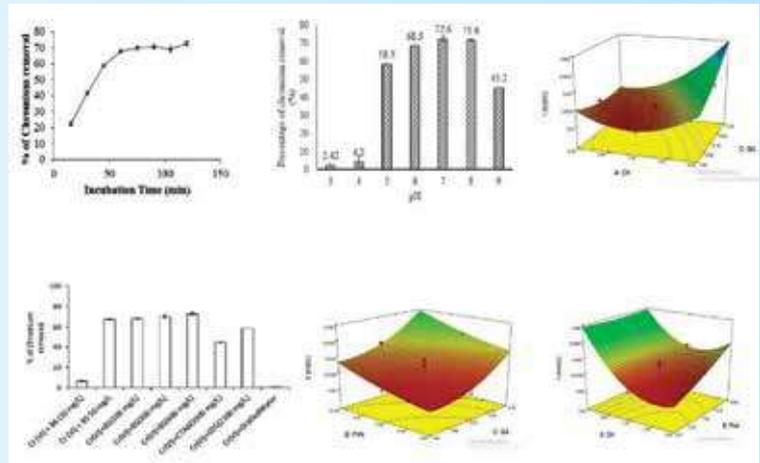
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### Institute

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IM 0005144



**Bubble column reactor for the integrated production of biosurfactant and Chromium metal recovery**



**Effect of parameters on the chromium removal from tannery effluent**

### OBJECTIVES

Owing to rapid industrialization in developing countries, heavy metal pollution in environment is become a big concern. Chromium is one of the hazardous heavy metals which has very low permissible limit in water. Chromium salts are intensively used in different industries such as leather tanning, electroplating, dyes and pigments manufacturing, and corrosion inhibition. As per CLRI report, a single tannery industry can cause the pollution of groundwater around the radius of 7–8 km. However, roughly, 2091 tanning industries are present in India resulted in causing cancer, asthma, liver damage, kidney malfunction, lung damage etc. Improper disposal of effluents containing Cr(VI), soluble form of chromium in aqueous can cause pollution in groundwater, rivers, and lakes that may lead to catastrophic consequences. Different methods based on membrane filtration, precipitation, electrochemical, ion exchange, adsorption, and biological separation have been developed to remediate heavy metals. However, long processing times, sludge formation, high costs and filtrate blockage



are some bottle neck that need to be addressed. Adsorptive bubble column methods have received a special attention now-a- days. It has greater advantages over other methods include simplicity of required equipment, can be efficient at low metal concentration, ease of operation, relatively small capital investment, and low energy consumption.

Considering the present scenario, harmfulness of the chromium ion, necessity for a novel design for complete removal, the present study focuses on the following objectives.

- To design and fabricate continuous adsorptive bubble separation column for recovery and reuse of heavy metal from industrial effluent
- To statistically optimize the process variables to achieve maximum chromium recovery from industrial wastewater through mathematical modelling.
- To establish kinetic model for chromium recovery from wastewater using adsorptive bubble separator.

### ACHIEVEMENTS

The socio-environmental problem of major cities in Tamilnadu, chromium contamination in the land and ground water was identified. The possible solution for the chromium removal has been attempted. The present study developed a better process of chromium removal through an integrated process.

An efficient agent, biosurfactant was identified for the removal of chromium. The production of biosurfactant in the designed bubble column reactor was carried out. It was found that 4.1 g/L of biosurfactant was produced by the microbial strain, *Pseudomonas aeruginosa*AMB AS7.

Thus produced biosurfactant was characterized. The result revealed that the critical micelle concentration of biosurfactant is 50 mg/L.

Further the chromium removal study was carried out. The proposed design of adsorptive bubble column was fabricated and the removal of chromium was optimized in the column. The comparison among the design was established. Besides, the statistical optimization tools were employed to study the impact of individual parameter as well as the interaction among the parameters. It was found the concentration of chromium in the effluent is one of the important factor that determine the efficiency. The result indicated that the maximum removal of 92.3 % chromium from tannery effluent through the proposed design was achieved. Biosurfactant assisted process yielded better removal than the chemical surfactants like SDS and CTAB. Only a minimum quantity of agent (50 mg/L) was required for the process. Beyond the cmc, there was no significant increase in the metal removal. In conclusion, the proposed design can also be implemented in treating other metal processing industry effluent as well as, textile dye industry effluent.

### PUBLICATION

Presented a paper entitled "Biosurfactant assisted chromium heavy metal removal from tannery industry effluent using adsorptive bubble column" in (Virtual) International conference on Environmental remediation technology conducted by Pondicherry University, Pondichery during 10-11/04/2020.

# Enzymatic Synthesis of Feruloyl Lipid as an Antioxidant Blend to Improve the Oxidative Stability of Biodiesel

## Student

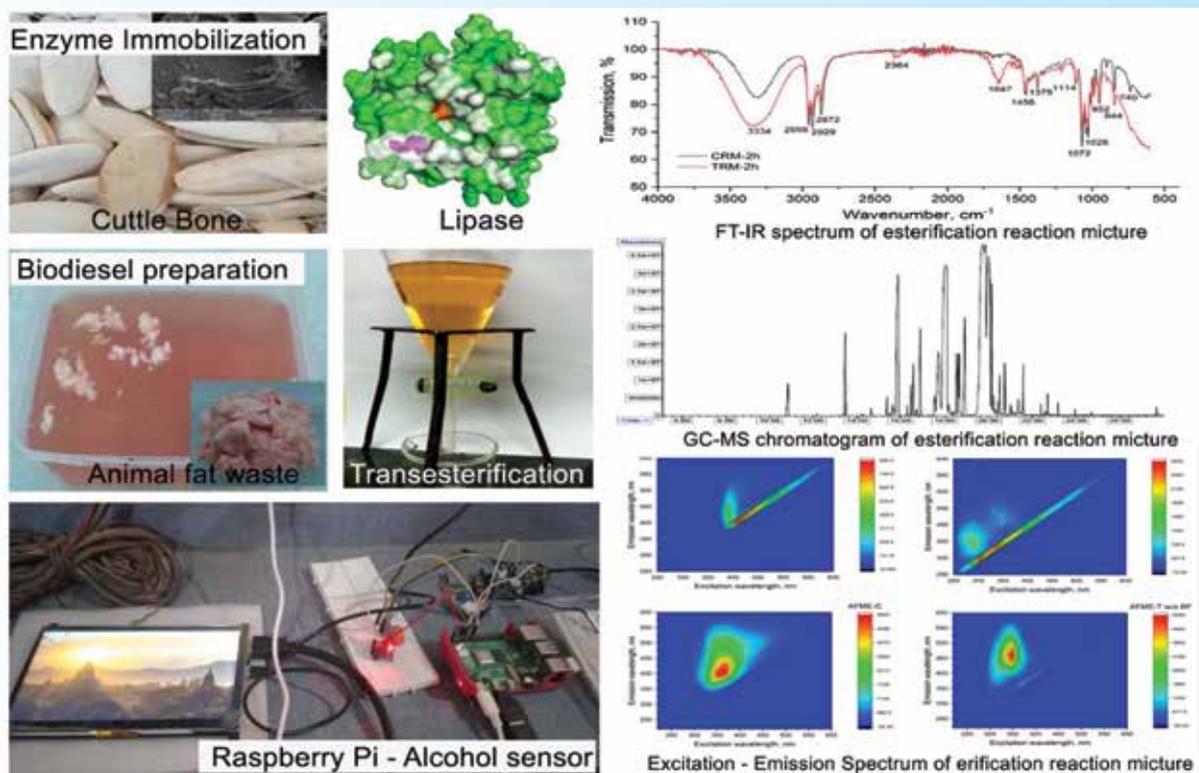
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## Guide

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## Institute

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IM 0005144



Graphical abstract of the work : Enzyme preparation / Biodiesel production / Biosensor fabrication / Biodiesel characterization in different analytical experiments

## OBJECTIVES

In spite of various benefits, there are some obstacles in the way of making biodiesel from waste oil into commercialization. An important technical aspect to be evaluated during storage of biodiesel is its quality during transport, storage and use, as biodiesel degradation may cause corrosion in engine and clogging of filters. Oxidation- formation of free radicals, formation and cleavage of peroxides, release of aldehydes and

carboxylic acids, which is a significant feature to be monitored in the production and usage of biodiesel. In order to vanquish the above problem and in the way to overcome that, phenolic compound-based antioxidants are converted to antioxidant esters, which are highly miscible in biodiesel. Considering these points, the following objectives are derived.

- To synthesis butyl ferulate using Rhizopusnevius lipase as catalyst and to evaluate its antioxidant property
- To determine the optimum blending process parameters of butyl ferulate with biodiesel and to investigate the oxidation stability
- To evaluate the diesel-biodiesel-antioxidant-blend in CI engine performance as well as in reduction of NoX emission.

#### ACHIEVEMENTS

- On successful completion of the project, new procedure or technique has been developed to monitor the esterification reaction during biodiesel production. This technique implies IoT with portable alcohol sensor.
- The project would transform animal fat waste from meat processing industry into fuel. Further, butyl ferulate has been identified as new and potent antioxidant additive for biodiesel to extend its shelf life.
- Comparative analysis of the fluorescence excitation-emission matrix profile of plain antioxidant blended biodiesel has been proposed as one of the analytical tool to monitor oxidative stability in biodiesel.

#### PUBLICATION

The project work has been presented in International Conference on Green Energy for Environmental Sustainability (ICGEES 2020) organized by NIT, Calicut on 6th August, 2020 via online.

### Legacy of IEI



Shri Atal Bihari Vajpayee, Hon'ble Prime Minister of India, greeted by Shri G P Lal, President of the Institution on the occasion of World Congress on Sustainable Development during January 20-23, 2000

## Design and Implementation of Prevent Gas Poisoning from Sewage Workers using Arduino

### Student

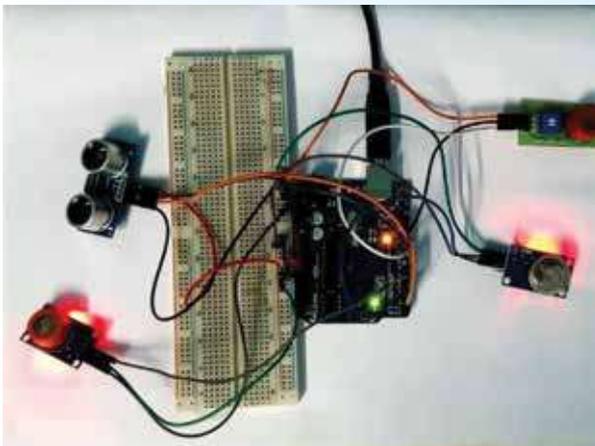
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### Institute

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Prototype model for Proposed method



LCD Display Unit

### OBJECTIVES

This project describes Arduino based safety system to rise above the invasive risks in sewage. In this smart device the toxic gas in sewage areas is detected using Arduino based design with a gas sensor. This device measures the concentration of toxic gas and pulse heart pulse rate for a person who works in a toxic gas zone. The measured quantity can be displayed on the device, at the same time when these parameters exceed the threshold level. The sewage agent is immediately alerted to the vibration sensor. On the other hand, the system has a long distance communication facility, which tends to send a text message using the GSM module, Type of disturbance and rejection in the network communication. A protective mask is provided to restore the oxygen supply to the person. This system is designed for sanitation workers. We can expand application use in oil wells and industries, etc. where toxic gas is found at the maximum level.

### ACHIEVEMENTS

Sewage management is major concern in India. With increasing population this is becoming one of the major reason for environment pollution. So This project converted into probable device and low cost, with some of add new different types of gas Sensors also included this device required to all the places or all kind of peoples etc. (Company, drainage, factory... )

**EXPERIMENTAL SETUP**

The working starts from the sensor units. This sensors when placed in sewage gas prone areas monitor the levels of individual gases present and send this data to the Arduino Mega. The sampled data is viewed on the LCD Display and also on the serial monitor of Arduino IDE. When the presence of sewage gas levels are more than that of the set threshold the system sends an alert message to the mobile. This system also offers a depth measurement option. We can see the distance on the serial monitor when placed inside a manhole.

GSM module and Ultrasonic sensor with the Arduino Mega. The power supply to the circuit is given from an external battery source of 12 VDC. The LCD display uses an I2C configuration in order to send the serial data which is obtained from the sensors to be displayed. The output from the sensors is analog hence we used Analog pins of the arduino to read the data. Ultrasonic sensor has 2 pins Echo and Trig both of which are digital hence used the digital pins of the arduino. GSM module uses simple serial communication by connecting its Rx, Tx to the Tx and Rx of arduino respectively. The power to arduino mega can be given from USB cable from PC.

**RESULTS**

Before testing the circuit the gas sensors must be calibrated by placing them in fresh air for some time. The system when tested near a drainage gave the following experimental results. The code worked properly by spitting out values of gases in ppm from the analog out of arduino and the SMS has been sent to the set phone number. Distance measurement from an ultrasonic sensor also worked fine. The below table show the values of gases present near that drainage (in PPM)

Sewage Gas	Normal Value (ppm)	Threshold Value (ppm)
Carbon Monoxide	350 - 400	1600
Methane	50 - 60	100000
Hydrogen Sulfide	20	120

Standard Values of Sewage Gases



Output of the system

**PUBLICATION**

N. Umaphathi, Sai Teja, Roshini, Sai Kiran (2020) “Design and Implementation of Prevent Gas Poisoning from Sewage Workers using Arduino” IEEE International Symposium on Sustainable Energy, Signal Processing & Cyber Security (IEEE-iSSSC 2020) – paper accepted.



## Laser-Based Smart Hardware Design for Power Saving

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Laser based Smart Hardware for Power Saving

Display showing switching off the device while exiting room

### OBJECTIVES

More than 8% of the electricity that we buy is probably wasted due to the design of equipment and the way it has been installed. This is in addition to the energy wasted by running equipment for longer than necessary. Electricity is the most expensive form of energy available – about 8 times the cost of coal and six times the cost of gas – this expensive fuel must be used wisely.

Domestic power consumption in India takes about 1/5th of the total power consumption, which is substantially high.

The main objective is aligned to prevent the electricity wastage, unnecessary working of equipment like air conditioner, blowers, coolers, lights bulbs etc.

In most of the public sector and private offices people generally forget to switch OFF the lights, fans and ACs while going outside, which results in heavy wastage of electricity.

## ACHIEVEMENTS

The project focuses upon power saving and its advantage is cost effective nature. The project has been built in a way so as to provide minimal computational devices such as GPUs, etc. instead of which simple Arduino based functionality and sensors have been installed to lower down the cost.

Another achievement is that it's a two-way device that adds a person when the person enters and removes the person from the total count when person exit from room. This enables the devices to maintain an exact count that is possible in a given practical situation.

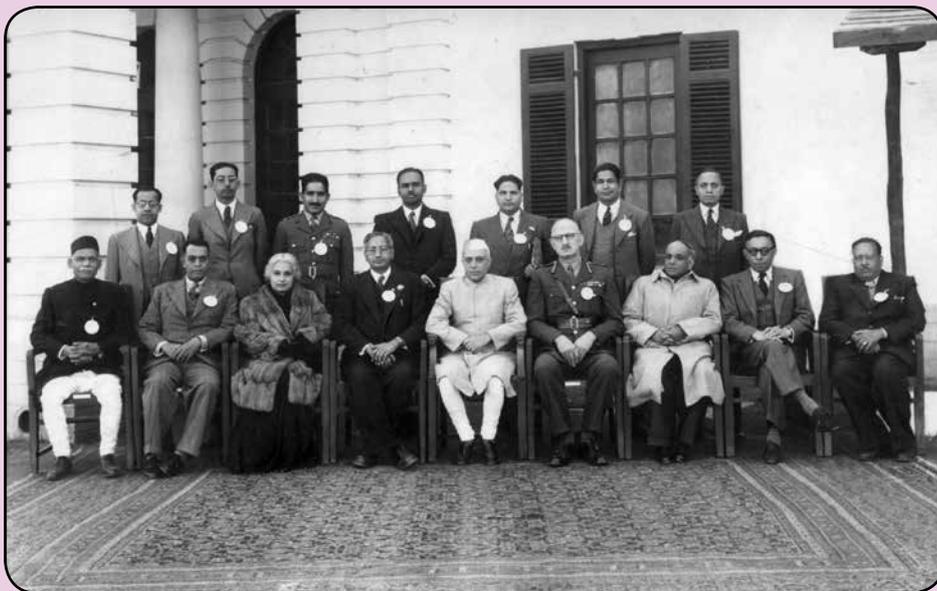
Apart from that it is very simpler to understand and comprehend from the point of view of a normal individual thereby making it more adaptive and easier to use and install.

Upon testing this hardware against a series of in/out, with multiple people going across the door, the average results obtained are extremely promising with an average efficiency of more than 80% when tested against a 1-meter door, with 2 people simultaneously with the assumption that the average width of the person to be 45-55 cm(which can also be changed) and not more than 2 people can pass through the door at the same time.

From improper and inefficient use of air conditioners (remaining on when no one is in room), this project leads to significant reduction in power consumption by switching off appliances when no one is in the room. By just installing this simple hardware, this project can protect and save our environment to some extent, from harmful gases and oxides released while in ON state.

Indirectly, by conserving electricity, we can contribute towards a better air quality and healthy life.

## Legacy of IEI



**Pandit Jawaharlal Nehru, First Prime Minister of India, during the Annual Meeting of Central India Centre of IEI in 1950**

## Prototype Hardware Design of a Vital Signs Monitoring System for Bio Medical Application

### Student

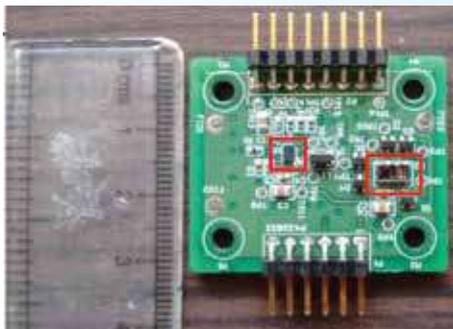
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### Guide

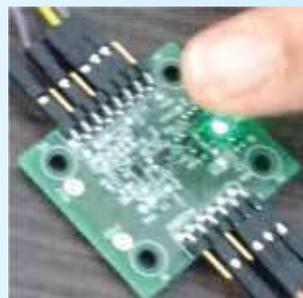
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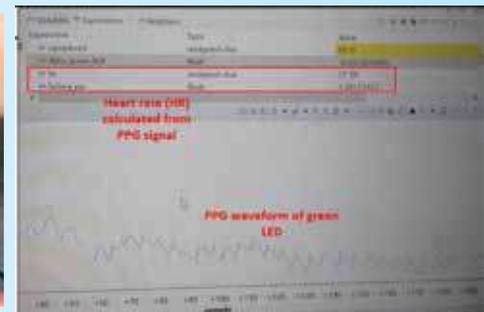
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Wrist sized biomedical sensor module custom fabricated using the funding amount. Its measures 3.1 cm x 3.5 cm. Highlighted ICs: Left : AFE4404 Right: SFH7050



A snapshot of the PPG waveform extracted during heart rate measurement. Green LED is illuminated and the finger is placed upon it



### OBJECTIVES

The technical objective of the project is to design a prototype vital signs monitoring device that records body parameters like spO<sub>2</sub>, heart rate using the principle of photoplethysmography (PPG). This device is widely used for basic diagnosis of health as well as by sports persons for monitoring body parameters. It is also widely applied currently as a first diagnosis modality for novel corona virus infection since blood oxygen drop is a vital sign of Covid-19 infection.

The thematic focus for the project is on “Skill development in circuit design and manufacturing” where in students involved in this project will be trained/mentored in designing complete electronic system module following robust, industry standard practices.

## ACHIEVEMENTS

1. We have successfully designed a fully functional biomedical hardware vital signs (HR and spO<sub>2</sub>) monitoring device starting from initial specification to final testing. By working in this project, students of our college were well exposed to industry-oriented circuit design skills and practices.
2. The prototype biomedical design includes a custom designed wrist-sized compact electronic sensor board housing the PPG sensor plus the signal processing IC (integrated circuit), a TI DK-TM4C123G micro controller for interfacing and programming the sensor board, a real-time running firmware package written in C language for data collection and post processing.
3. The two main components of this device namely biomedical electronic sensor board as well as the firmware design were custom developed by us during the course of this project using the IEI R&D Grant-in-aid funding amount.
4. The biomedical device is verified for its heart rate (HR) and spO<sub>2</sub> monitoring capabilities by testing them in real-time. The real-time HR and spO<sub>2</sub> monitoring results from the biomedical device are within the expected range for individuals.
5. This prototype is not just a hobby/demo hardware but a biomedical research prototype that will be utilized for real-time biomedical testing as well as for other future research and development purposes.

## Legacy of IEI



**Laying of Foundation Stone of IEI Headquarters Building by Shri Profulla Chandra Sen, Chief Minister of West Bengal in 1963**



## Design and Manufacturing of Fully Automised Paper Stamping Machine

### Student

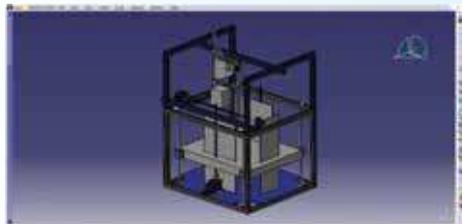
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This is stamping machine modeled in  
Catia v5 software



Manufactured Stamping Machine

### OBJECTIVES

Stamping Machine is one of the principle machines in stamping industry & printing industry. It is mainly used as the name indicates to stamp the logo or any other symbols. stamping mechanism of paper useful in many kinds of organization like Universities, Government offices, Post offices, Banks, Colleges etc.

This project aims at design and manufacturing of working model of fully automized stamping machine which will be used specially for stamping the Exam Answer Sheets. The machine will be easy to operate as it is fully automized. This machine has its uniqueness in term of its operations. A machine is composed mainly of three major drives required to upload the papers, to lift up the paper to its stamping position, to stamp, and to withdraw the papers. All these drives with defined time lag are programmed using Arduino controller, CNC shield and 4988 driver to work properly. A machine facilitates the stamping at any position on the paper. We have proposed a system which can work with good accuracy and also reduces time for stamping university answer sheets.

### ACHIEVEMENTS

Students have learned Catia v5 and also designed model in Catiav5. They also learned that how to transfer model from design to actual manufacturing. The recent technology that is Arduino kit, hardware and software is also learned by student and Guide both. Students manufactured various parts in the workshop by themselves. They decided and purchased the required material from outside. After manufacturing, they assembled the parts and even check the alignment. So they achieved learning of design software, Arduino (which is used in today's machinery for atomization), manufacturing, transfer of design to manufacturing, and assembly as per design.





different flow conditions (system pressure, water gas content, flow velocity) to bring out the behavior of cavitation-induced erosion.

4. Silt and cavitation studies are carried out to bring out the behavior of synergistic erosion.
5. Implementing multidimensional diagnostics for silt and cavitation for improving hydro turbine performance.

### ACHIEVEMENTS

In order to achieve these objectives, a specific research plan has been developed that brings out the roles played by silt and cavitation in bringing about erosion which helps in the development of new coating material that delays the aggressive erosion of the blade material. Towards this end, the work is conceptualized in 3 stages:

- a. Study of silt erosion of different materials,
- b. Study of accelerated cavitation damage, and
- c. Study of synergetic relationship between silt and cavitation erosion mechanisms by using a novel new test facility.

This approach, results in arriving at the suitable mechanistic model for erosion. Some of the benefits from this project are summarized as follows:

- a. These test results can also be used for studying improved designs of turbine blades which offer high hydrodynamic performance with lower silt and cavitation ill effects.
- b. It also helps in the development of various kinds of coatings/materials in order to relatively compare their silt and cavitation erosion resistance and ultimately grade them on the same basis.

A better understanding of the physics behind these phenomena resulting in the control of harmful effects of silt and cavitation is the key for future.

### PATENT

Establishment Novel slit and Cavitation Erosive Wear Test Facility for Testing of Material Used for Hydroturbine Components [Under preparation]

### PUBLICATIONS

Establishment Novel slit and Cavitation Erosive Wear Test Facility for Testing of Material Used for Hydroturbine Components [Under review in Wear Journal, 2021]

Engineering is the art of modelling materials we do not wholly understand, into shapes we cannot precisely analyse so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance.

Dr A R Dykes

## An Enhanced Wearable Pre-Impact Fall Warning and Protection System for Elderly People

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Various Hardware components

### OBJECTIVES

- ❖ To design and develop a fall warning system to warn the user and to send the SMS to caretaker.
- ❖ To design and develop the protection scheme for inflating airbag system during the occurrence of fall.
- ❖ To prevent the direct injuries in the hand and elbow and to monitor the health condition of the aged person.

### ACHIEVEMENTS

The proposed work has been published in the International Scientific Journal on Research in Engineering and Management (ISJREM) in its June issue Volume 5.

### PUBLICATIONS

V.Jamuna, D.Usha, R.Prathiksha ,R.SaiKeerthana(2020),“An Enhanced Wearable Pre-Impact Fall Warning and Protection System for Elderly People”. The paper has been publication in the ISJREM Journal’s June 2020 issue.



### WORKING AND RESULT

The device aims in protecting the hip region of a person when they experience a fall. This is achieved by inflating a 360-degree circular airbag so that the user’s entire hip region is protected. This is achieved with the help of a MEMS accelerometer sensor. This sensor senses the position of the person with respect to the human body’s axis, if it deviates a little more than x-axis, the MEMS accelerometer sensor provides an output. Here the characteristic output voltage of the sensor is less than 400mV for angles between 45 degree to 135 degree i.e. for normal human body position, for any value of angle which does not fall under this range the output of the sensor becomes greater than 400mV indicating a fall which gives a signal to the microcontroller to trigger the GSM module to send a emergency message to the user’s caretaker so that they can be informed about the incident, buzzer and the airbag module is triggered to deploy the airbag by activating the deployment mechanism. The deploying mechanism involves a punch mounted on a launcher with a spring and locking switch. The spring is compressed by screwing and when the locks witch is triggered by the actuator, the compressed spring expands and its punch accelerates towards the cartridge to release the CO2 from the cartridge thereby inflating the circular airbag and protecting the entire hip region.

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](http://www.ieindia.org), should be sent through email to [research@ieindia.org](mailto:research@ieindia.org) and one printed copy of the same should reach the following address:

**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.



## Imposing Severe Plastic Deformation on CP-Ti for Producing Ultra Fine Grain through Repetitive Corrugation and Straightening Technique for Biomedical Applications

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### PROCEDURE AND RESULTS

Repetitive Corrugation and Straightening Technique (RCS) is one of the popular techniques of Severe Plastic Deformation (SPD), a process of producing an ultrafine-grained (UFG) microstructure with two-step process on metallic sheet. The first step was corrugate the metallic sheet through designed two corrugated rollers to obtain more plastic deformation. The second step was straighten the work piece by conventional rolling. This work focused on the microstructural analysis and mechanical properties of commercially pure Titanium (CP-Ti) after processing by RCS. RCS process was carried out at room temperature by more number of pass with and without rotation of specimen. The microstructure studies were conducted before and after RCS with more number of passes under Scanning Electron Microscope. It is found that the microstructure distribution of RCS sample in combination with number of passes was more homogeneous compared to the microstructure of RCS sample without pass. The microhardness test was carried out by Vicker Hardness Tester. The results also showed an obvious reduction of grain size after the specimen was processed using RCS process. It was possible to process CP-Ti in RCS with 24 passes. The microhardness of the CP-Ti increased after RCS process with an increment about 36.2% for RCS with 10 passes as compared to commercially available Titanium. The wear studies were carried out by Pin on Disc apparatus. The minimum wear loss was obtained on specimen with 6 passes, 7.5min sliding time and 20N load condition and also for 12 passes, 7.5min, 40N load condition.

### OBJECTIVE

- To conduct a experiment of RCS on titanium with more number of passes and different thickness at room temperature
- To study the influence of rotation of specimen on microstructure during RCS with subsequent number of passes
- To conduct microstructural studies, physical and mechanical properties of commercially pure titanium before and after RCS
- To develop titanium with appropriate physical and mechanical properties which will be used for biomedical applications.



**Repetitive Corrugation and Straightening process and Annealing process**

**Testing Materials and Different type of passes in Titanium sheet**

## ACHIEVEMENTS

- Fabricated the Repetitive corrugation and Straightening machine
- Achieved uniform microstructure of CP-Ti through RCS process
- CP-Ti processed with different thickness and Rotation of specimen
- Achieved high hardness CP-Ti compared with Ti – 6Al-4V
- Tribological property has been increased for CP-Ti after RCS process
- Developed a good strength to weight ratio of CP-Ti for biomedical applications.

## PUBLICATIONS

Dr S Rajakarunakaran, Mr P Sureshkumar, Mr A Dhinesh Raja, Mr Muthukumar, Mr R Muthukumar, “Imposing Severe Plastic Deformation on CP-Ti for producing ultrafine grain through repetitive corrugation and straightening technique for Biomedical applications” at International Web Conference on Science Engineering & Technology (IWCSET-2020) held during May 15-16,2020.

## Corrosion Behaviour of Sintered Aluminium Metal Matrix Composites Reinforced with Aluminium Oxide

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Die and Punch



AA6061-AL<sub>2</sub>O<sub>3</sub> Mixture in die



Furnace



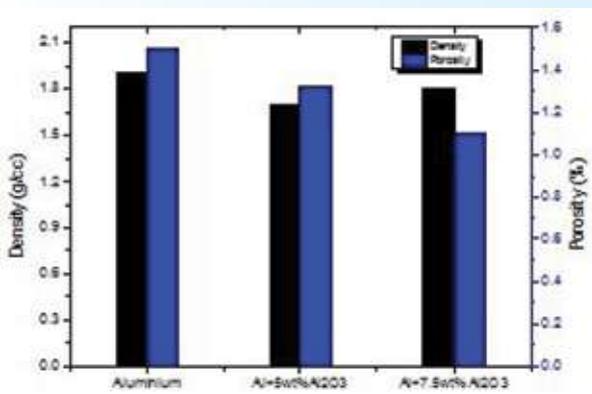
Hydraulic pellet press



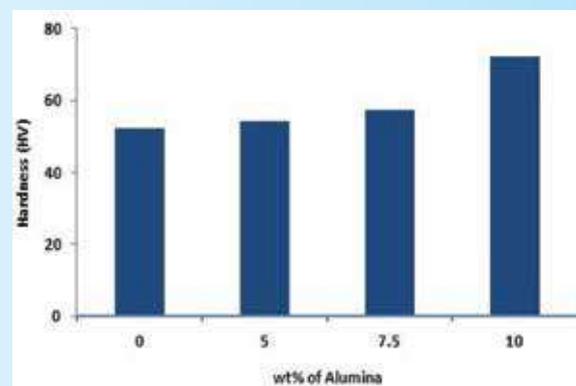
Green sample of composite



Sample prepared for hardness test



Variation of density and porosity of samples



Hardness with variation of alumina

## OBJECTIVE

Aluminium composites are commonly used for a variety of applications. These materials have their applications in the areas of aerospace, automotive, nuclear, biotechnology, marine, electronics, electrochemical and thermal applications. They are widely used in these fields because of its cost and excellent physical, chemical, mechanical and thermal properties. A few more excellent properties of aluminium includes low density, tremendous cast ability, high strength, high stiffness, very less thermal coefficient of expansion, very high tribological and corrosion resistance properties. Aluminium is considered as a thermodynamically reactive metal, and hence, a dense oxide layer is formed on exposure to air and water environment. The oxide layer thus formed prevents the metal from corrosion but in aqueous solutions, they undergo pitting corrosion due to some reactive elements such as chlorides and sulphates. When subjected to anodizing reaction, the reinforced elements dissolve faster than aluminium and form a heterogeneous coating, thus preventing corrosion. The present work is aimed at enhancing the corrosion resistance properties of aluminium alloys (Al6061) reinforced with alumina in an acidic environment. In manufacturing metal matrix composites, the dispersion of the reinforcement particles is a challenge. However, a uniform mixture of metal and non-metal compositions is impossible to obtain by traditional casting methods. Powder metallurgy overcomes the negative effects of liquid state processing methods such as stir casting. Powder metallurgy processing may be used to obtain metallic composite materials containing solid lubricants. In powder metallurgy, the reinforcement is homogeneously dispersed in the matrix for the fabrication of composites.

This study involves

- Preparation of aluminium based composite through powder metallurgy method wherein  $Al_2O_3$  is to be used as reinforcement.
- To evaluate the microstructure (SEM) of sintered composites.
- To investigate the mechanical properties of composites.
- To analyse the corrosion behaviour of the composites, chemical and electrochemical measurements techniques are to be adopted.

#### ACHIEVEMENTS

Aluminium and alumina composite has been successfully developed by powder metallurgy technique. The density, porosity, hardness, optical microstructure were evaluated. Corrosion behaviour has not been examined yet due to pandemic COVID 19 situation. As compared with aluminium alloy, the density of its composite has increased. The porosity of 7.5 wt%  $Al_2O_3$  composite is less compared to pure aluminium and its less percentage of reinforcement composite. Hardness value of composite is high compared to aluminium and its composite. It was observed that reinforcement of  $Al_2O_3$  distributed homogenously through out the aluminium matrix.

Other part of this project is required to evaluate the corrosion behaviour. Due to COVID 19 pandemic situation it was not possible to conduct any experiment regarding this and we could not able generate any experimental date. I have a plan to do this remaining part of the project after situation control.

### *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



## Development of Semi-autonomous Wide-area Surveillance System for Multiple Emergency Situations

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starting phase of flight



during landing with payload



under controlled flight



closing down the propellers



at very high altitude



## OBJECTIVE

Several drone-based surveillance system are already developed/proposed for monitoring environmental and disaster conditions along with video embedding facility. But for most of the cases, a particular type of activity is concerned for design, which restricts its reusability. More precisely, along with real-time monitoring, payload flexibility is not considered. This feature, if embedded, can serve for the diseased people, precisely who are staying alone. Also it can work out for fire breakout cases, by spreading compressed CO<sub>2</sub>. Civil security is also taken care, and thus a multi-purpose surveillance system is the needs of the hours, which not only provides medical facility to the remotest area, but also work with tandem for the protection of civilians through various means.

## ACHIEVEMENTS

We have developed a semi-autonomous wide area surveillance UAV/drone which is capable of carrying payload. The drone has the feature of real-time monitoring and coordination along with payload flexibility. The outcome is successful in the terms of controlling the flight in such a way that it can easily pass a very smaller region which has width less than the width of the drone in normal operating condition. Our UAV monitoring systems will provide a number of benefits to users focused on public safety and civil security. Proper calibration is made for take-off flight condition and also for final PID value setting. This is a major step for making a completely autonomous drone in near future.

The complete system has capable of surveillance along with 1 kg payload in the testing stage. The total system can be easily controlled in such a way so that it can make a passage through a very small area which is less wide than the system itself. Also due to the attachment of the camera, it is able to take the pictures during the flight. However, quality of the picture completely depends on the resolution of the camera. Also the environmental condition matters while taking the pictures.

The surveillance system has now working fine under testing conditions along with payload. Real-time monitoring and coordination along with payload flexibility has been achieved. Though it is semi-autonomous wide area surveillance UAV, but further fine tuning can make it a fully operational system under any condition. Since it can also be flown at very low altitude, so slow movement can help it to take pictures at the particles closest to the ground.

The semi-autonomous wide area surveillance UAV, as proposed in the motivation section of this project, is implemented at very low cost with the feature of carrying payload as well as taking pictures in real-time basis. The total system is developed within INR 15,000/- (approximately) which speaks clearly in favor of the work. This type of low cost unmanned vehicle is hardly reported, as evident from the literature review of this project. All the images can be stored in cloud which can later be accessed easily. Therefore, this work may be considered as a real-time monitoring along with surveillance. However, the major drawback is the weather condition while taking the picture. This problem can be eradicated using a very high resolution camera, which also has the negative impact on the cost function.



## Implementation of IoT Based Intelligent Irrigation System for Smart Farming & Water Saving

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Part of the actual implementation of the Grid



Login screen of the Krishi Sahayogi Web and Mobile Application

### OBJECTIVE

Irrigation plays a key role in maintaining the economic balance of the developing and underdeveloped agricultural-based countries like India. As agriculture is one of the most stable and important factors contributing to the nation's GDP. Agriculture [1-4] also plays a significant role in international import and export and provides raw material to industries on a national as well as on a global level. Thus, many countries are now focusing more and more on agriculture to keep their economic growth stable. The major problems associated with agriculture if not tackled correctly can affect not only the local consumers but also in a worst-case scenario that can affect the nation's GDP. In any type of cultivation, it is necessary to make sure that an adequate amount of water is supplied to the plants. Again, soil health also depends on moisture level, humidity, temperature, etc. To tackle all these issues modern research recommends two of the most promising tools of today's modern era i.e., Internet of Things (IoT) and Artificial Intelligence-Machine Learning (AI-ML).

In our proposed and the developed solution presented here, we have deployed an array of sensors to measure the temperature, soil moisture, humidity, and water usage to automate the traditional agricultural system more smartly as agriculture is one of the most important factors contributing to a nation's GDP. Our project's significant contribution is to identify the predicted amount of water is required for a particular field for a particular time duration, as all the water consumption details of the field are stored in the cloud. Hence, it is possible to find out using the Artificial Intelligence-Machine Learning (AI-ML) tool and can be accessed through our web

and mobile application the day-wise or month-wise or season-wise water consumption requirement. Again, the moisture content of the soil is measured by the soil moisture sensor, which triggers the pump via the microcontroller when the moisture content in the soil goes below the threshold.

#### ACHIEVEMENTS

1. Reduce the wastage of water in order to suppress the rising problems of water scarcity in India.
2. To automate the process of manual irrigation and make it fast and efficient.
3. With the help of modern Machine Learning and automation, provide the right amount of water to the field.
4. The accuracy of our machine learning model is 77.9%.
5. 21.48% of water-saving was possible using the ML tools.

#### PUBLICATINOS

- [1] Roy, R., et al. (2020). Android things: A comprehensive solution from things to smart display and speaker. In Proceedings of International Conference on IoT Inclusive Life (ICIIL 2019), NITTTR Chandigarh, India (pp. 339-352). Springer, Singapore.
- [2] Biswas, S., et al. (2021). Smart Farming & Water Saving Based Intelligent Irrigation System Implementation using the Internet of Things. In Recent Trends in Computational Intelligence Enabled Research, Elsevier (Accepted, Press).

## Legacy of IEI



Lord Irwin, Viceroy and Governor General of India, laying the Foundation Stone of the First Institution Building in 1930



## Automatic Book Reading System for Visually Impaired Person using Deep Learning

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### PROCEDURE

The proposed system continuously captures images, locates textual characters and extracts contents within, and converts it into speech and reads it aloud to the user using deep learning approach. The text image of reading book will be captured by camera and converts into character using character recognition technique. Then, the text will be converted to referenced audio using deep learning algorithm. The character recognition technique involves Binarization of image, Line segmentation, Word segmentation, Character segmentation and Character Recognition. The characteristics are extracted from each shape and characters are identified. The captured text images send to Text- To-Speech (TTS) module. TTS module is programmed in the raspberry pi 4 that processed the captured input text image to speech with required styled audio using deep learning approach. The proposed model used a Deep Recurrent Neural Network (DNN) to generate quality audio. Initially the model gets trained by feeding various audio files. The audio files are recordings of real human speakers. The proposed training model will be analyzed and learn to generate reference audio samples.

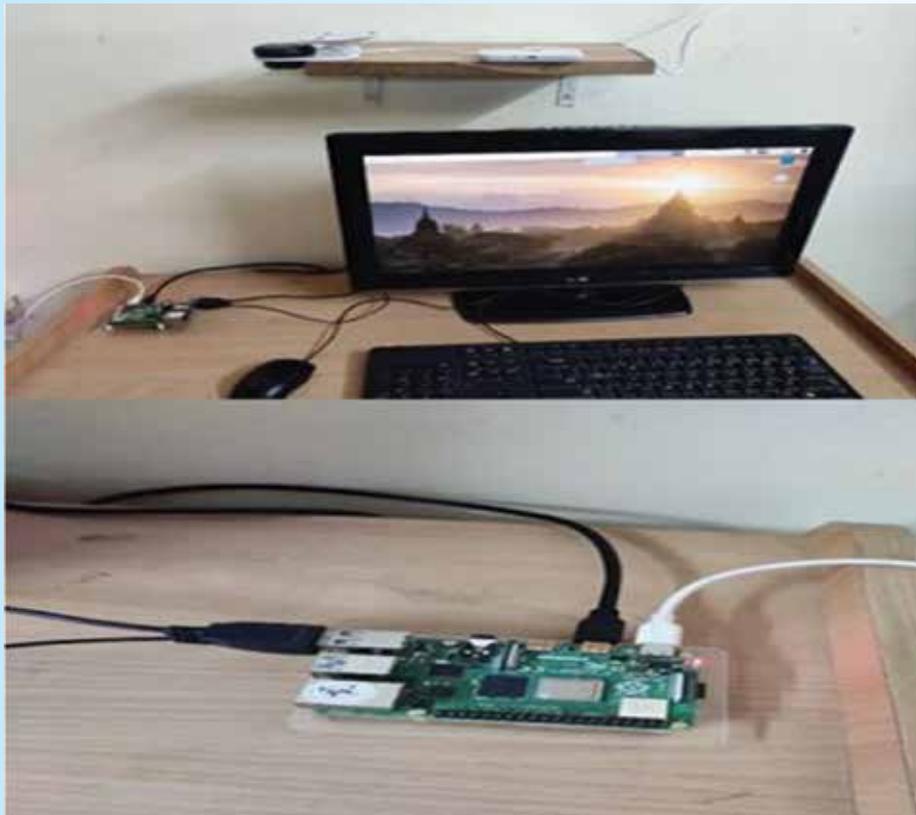
### Components used

- Raspberry pi
- IP Camera
- Motor,
- VGGNET
- Speaker
- Accessories

### Procedure

- Capture the image which contains text from Mobile with help of Raspberry pi and camera module
- The captured image text converted into speech using Recurrent Neural Networks
- Also, the captured text is displayed in monitor
- The proposed Book reading System model is provided 98% of accuracy in testing stage.

Thus, the objective of this project to design and develop a system for visually impaired people to read book without assistance and to generate human fidelity speech that satisfies the desired style conditions with multiple tasks including style transfer, emotion modelling, and fitting a new speaker's voice was designed and had a trial implementation. The proposed system will integrate to cloud storage that store the audio of the book from start to end for any user can read the book. Also, plan to develop a system to read softcopy automatically. It is also planned to develop a Deep Read system using Internet of Things for easy access.



Components of the proposed system



Fabricated Book reading system using 3D printing



Capture a text image and converted into speech



### OBJECTIVE

- To design and develop a system for visually impaired people to read book without assistance.
- To design an algorithm convert from captured image to text.
- To train a deep learning model to convert from text to speech.

### ACHIEVEMENTS

- Fabricated the a prototype for book reading system using 3D printing
- Fabricated a prototype for Book reading System
- Designed and Trained Deep learning model to convert image to text
- Implemented text to speech system after image processing
- Developed a good strength to weight ratio of CP-Ti for biomedical applications

### PUBLICATIONS

K Vijayalakshmi, M Kaliappan, R Siva Ranjini, M Sasi Rekha, R Selva Ishwarya, “Automatic Book Reading System For Visually Impaired Person Using Deep Learning” at National Web Conference on Challenges and Innovation in Engineering and Technology(NWCCIET-2021) held during March 19-20,2021.

## Legacy of IEI



His Excellency The President of India Dr Sarvepalli Radhakrishnan visited Hyderabad on 12th November, 1966 and unveiled the Statue of Bharat Ratna Sir Mokshagundam Visvesvaraya erected in AP State Centre on the Raj Bhavan Road, Hyderabad

## Manufacturing of Light weight Fire Retardant Composite Battery Carton/Boxes for E-Vehicles

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Fabricated hybrid fiber laminate



Compact book press compression mould setup used to fabricate the proposed hybrid composite

### OBJECTIVE

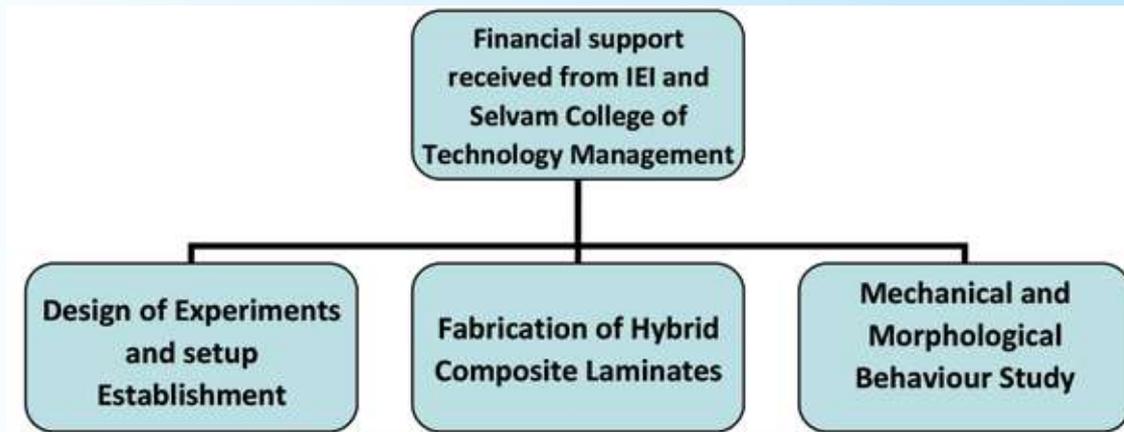
The main objective of the proposed project is to develop Light weight and high strength flame retardant fiber-reinforced polymer composite battery boxes and separators for the featured electric vehicle mobility. The most commercial and economical E-Glass fibers were utilized along with the phenolic resin matrices, Fire retardant additives like Aluminium Trihydroxide, Magnesium hydroxide, to grab the optimum hybrid structure.

The battery casing and separator was processed through Book press compression moulding (Funded by IEI – Kolkata, Grant in Aid Scheme, 2018) and vacuum assisted resin transfer moulding setups. These setups are well known for the fabrication of quality composite laminates that possess lower defects and even surface finish throughout the section. It is also cost economic and most feasible way to produce near net-shaped Fiber-reinforced polymer composite parts. This proposed project includes the following major milestones.



- Fabricating advanced E-Glass fiber reinforced phenolic composite structures with fire retardant additives.
- Mechanical Characterization of fabricated composites to identify optimum composite configuration that possess maximum strength.

#### ACHIEVEMENTS



#### PUBLICATION

M.S. Santhosh, R. Sasikumar, R. Muthu kumar, A. Sukumaran, E. Vasanth. “Advanced Fire Retardant Composites for Automobile Applications, IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE) – Submitted.

### Legacy of IEI



Prime Minister Mrs Indira Gandhi cutting the Golden Jubilee Cake

## Experimental Analysis and Optimization of Friction Welding Parameters on Dissimilar Metals

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### Guide

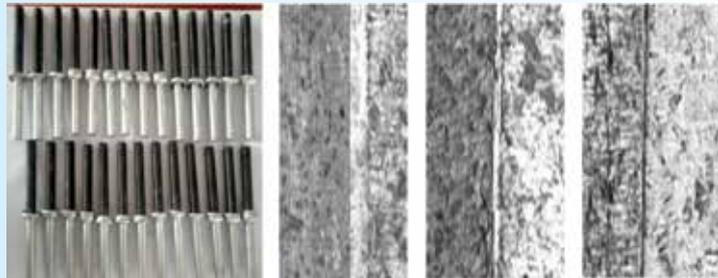
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KUKA - Friction welding machine



Welded test pieces

SEM images for the optimal result

### OBJECTIVE

Welding is one of the manufacturing methods used to combine materials such as ferrous, non-ferrous metals and thermoplastics, respectively, with a similar or different mixture. The base metal is melted during the welding process, and filler material is applied to effectively create a joint. But the efficiency of these conventional welding processes is compromised by the heat affected zone and it contributes to the welded joint being affected. Based on the above factors, many researchers as well as the welding industry are drawn to friction welding. Due to the friction between the metals, the ends are heated to the molten state and the axial load is added to connect the work parts. The friction welding process is a type of solid state welding process.

The efficiency of friction welding is measured by the job's rotational speed, the axial pressure applied and the time of disturbance that depends on the material of the work piece, the work piece dimensions, the hardness and other input parameters of the friction welding system. To improve the efficiency of the method, both experimental and theoretical research is required. For fusion welding, solid state welding is one of the better alternatives. One form of solid state welding is rotary friction welding. Two dissimilar specimens are used to create the joint in rotary friction welding. Based on different process parameters, the specimens are EN353 alloy steel and Aluminum Alloy 6351. In the friction welding unit, the welding is carried out and tests must be performed.

The Objectives are listed below :

Optimal value of the results obtained will be confirmed and proposed to welding industries.



To maximize axial shortening.

To maximize hardness and temperature.

The input parameters to be considered are heating pressure, heating time, upset pressure, upset time and rotational speed.

The output parameters axial shortening, hardness and temperature are considered to measure the performance of the input process.

To optimize the friction welding parameters using design of experiment (DOE) approach and improve the experimental efficiency using intelligent techniques like Grey relational analysis method.

The grain structures of the welded joints have to be analysed by the SEM analysis.

### ACHIEVEMENTS

As per the literature review, the efficiency of the welded specimen is increased and time and expense are minimised by an experimental investigation. Weight, heating pressure, heating time, upset pressure, upset time, rotational speed and temperature are the input process parameters considered for the experimental investigations. Axial shortening, hardness, and temperature produced during welding are the output responses.

In order to study the influence of process parameters on the welding strength and efficiency of the welded sample, the literature evaluation on the friction welding process is crucial. The dissimilar materials Aluminium alloy 6351 and EN353 alloy steel is used for the method of friction welding in this experimental research work. In this proposed work, combinations of related metals are tried. This project's main scope is briefly clarified.

- ❖ Based on literature survey, L27 orthogonal array is selected for the experimental investigation.
- ❖ Friction welding about 27 welding joints are made based on different input process parameters and the results are tabulated for the investigation.
- ❖ To investigate the effect of mechanical properties like axial shortening, hardness, temperature and to analyze the results from the experimental investigation to validate the experimental outputs.
- ❖ Application of Design of Experiment (DOE) is used to develop a mathematical relationship between the welding process parameters and the output variables.
- ❖ The combined objective of effective optimal solution for axial shortening, hardness test and the temperature for welding are evaluated, compared and optimized using Grey Relational Analysis (GRA) Techniques.
- ❖ The grain structures of the welded joint have been analysed for the best optimal solution by the SEM analysis method.
- ❖ These investigational studies helps in the applications of dissimilar materials Aluminium alloy 6351 and EN353 alloy steel in the field of Automobile for manufacturing camshaft, gears, gudgeon pin, shafts, pinions and other parts.
- ❖ In this research work, welding, testing, optimizing and analyzing the results on dissimilar materials Aluminium alloy 6351 and EN353 is done successfully using the friction welding machine and other testing machines. The research findings help in the identification of optimal input process parameters for dissimilar materials Aluminium alloy 6351 and EN353 alloy steel and its applications.

In the KUKA continuous drive friction welding unit, the friction welding process is carried out on dissimilar materials of aluminium alloy 6351 and EN353 based on the selected input process parameters. The weight,



length and hardness of the specimen is noted before combining the material. The heat produced between the interface is measured using the temperature gun during the friction welding process.

To determine the optimum process parameters of the welded joints, the obtained values are tabulated. The joints are then tested using the digital vernier calliper for their axial shortening, the hardness in the joint using the Rockwell hardness machine and the temperature using the temperature gun. The axial shortening, hardness tests and the temperature are carried out in the mechanical equipments available in our college.

- ❖ Taguchi design of experiment is effectively used in this investigation.
- ❖ Heating time plays a major role in the friction welded joints.
- ❖ The optimal level of axial shortening for this experimental work is heating pressure of 18bar, heating time of 7sec, upset pressure of 22bar and upset time of 5sec.
- ❖ The optimal level of hardness for the investigation is 18 bar of heating pressure, 5 sec of heating time, 22 bar of upset pressure and 3 sec.
- ❖ The effective optimal parameter for the experimental investigation of the temperature is 18 bar of heating pressure, heating time of 7 sec, 22 bar of upset pressure and 3 sec of upset time.
- ❖ The best combined optimal parameter for the experimental investigation based on Grey relational analysis is found using the Grey relational ranking as 18 bar of heating pressure, 7 sec of heating time, 22 bar of upset pressure and 3 sec.
- ❖ The welding industries identifies the correct process parameters for different combination of materials.
- ❖ Minimize the welding time and defects by selection of proper process parameters.
- ❖ This results may be helpful for the research and development department for the improvement of the welding process.

Axial shortening, hardness and temperature are taken into consideration for the performance response based on the experimental work. The efficiency and strength of the welded joint based on the input process parameters is enhanced during the friction welding process. For the researchers to improve the ability of friction welding on dissimilar materials, this experimental work is very precious Aluminium alloy 6351 and EN353 alloy steel specimens are important for modern growth in the engineering industry.

#### **PUBLICATION**

- ❖ Participated and presented a paper in National level technical symposium conducted by the department of mechanical engineering in TECXPLO'20 organized by Mookambigai College Engineering, Pudukkottai on 14th March 2020.

#### **Smart Brief**

Since the 1990s, new areas of tribology have emerged, including the nano tribology, bio tribology and green tribology. These areas study the friction, wear and lubrication properties at nano-scale, in bio medical applications (human joint prosthetics, dental implants) and ecological aspects involved in study of tribology of clean energy sources, green lubricants and biomimetic tribology.



## Development of Low Cost Solar Chimney Power Project (SCPP)

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SCPP



Students with setup

### OBJECTIVE

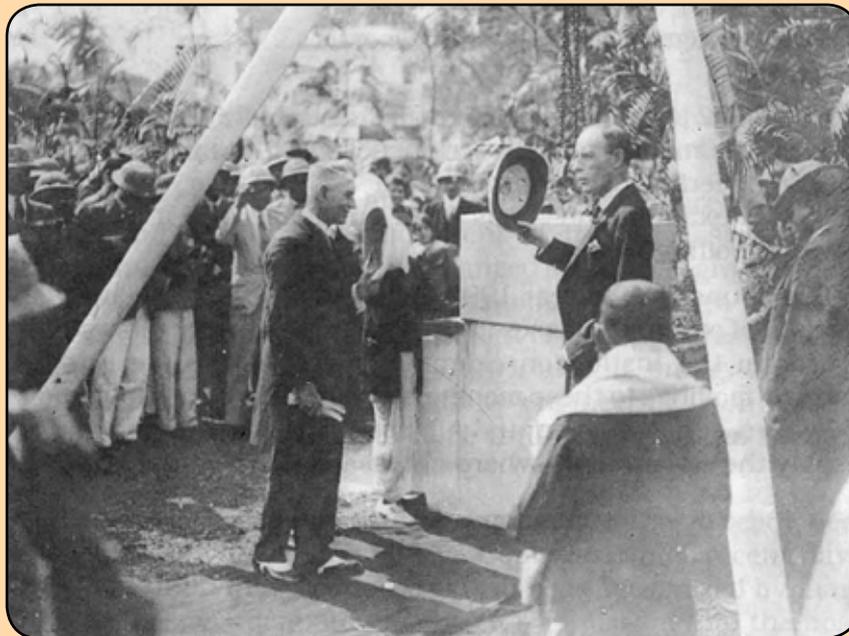
The use of fossil fuel is being discouraged globally because it is one of the major sources of environmental pollution and global warming. Fast depleting reserve of fossil fuel is causing price hike in its end use in power and electricity generation in developed and developing countries. For sustainable development, renewable energy popularly known as green energy is the most viable alternative. Amongst all types of renewable energy, solar energy is one of the most attractive green energy which is available in abundance and safe for our planet. The solar chimney power technology is the most reliable, promising and environment friendly approach to generate electricity using wind turbine where in flow of natural air is caused by solar energy. This type of solar chimney power plant (SCPP) would be promising unit in electricity production from renewable energy source in near future in India. SCPP uses solar energy directly to heat the ambient air in a control volume. The main

challenge of this technology is proper designing, reduction of the investment cost for fabrication, installation of tall tower and the land required for large solar collector. The performance of the plant depends upon solar radiation, collector area, size of chimney, type of wind turbine and generator etc. The present research project is planned to develop a low cost SCPP for electricity generation. Numerical study will be carried out to optimize the design of the plant using CFD software. Design and development of such kind of solar chimney power project with appropriate material, shape and size in the working setup will be a great application of knowledge for undergraduate students in the field of fluid thermal sciences.

#### ACHIEVEMENTS

Numerical study is focused to study the flow and heat transfer in solar chimney power plant (SCPP). Inlet height is varied from 10 cm to 5 cm. Comparison is made with mean velocity and mean temperature in each case. Lowering inlet height increases the outlet velocity thereby increases the power generation by SCPP. Further study is needed to identify the optimum height at inlet for achieving maximum power generation in a SCPP. Present setup produces theoretically 0.05 watt with chimney inlet velocity 1.5 m/s. Experimental study measures the inlet velocity to the chimney is around 0.6 /s corresponds power generation 0.08 watt.

### Legacy of IEI



Lord Irwin, Viceroy and Governor General of India, laying the Foundation Stone of the First Institution Building in 1930



## Solar Powered Unmanned Aerial Vehicles

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Solar Powered Unmanned Aerial Vehicles

### OBJECTIVE

Unmanned solar powered aircraft offer a unique set of advanced capabilities and have set general aviation records for longest continuous flight and greatest sustained altitude. However, the application of solar powered flight to small scale solar powered unmanned aerial vehicles (UAV's) has seen sparse research activity and is only partially explored. The use of solar power as an energy resource allows small scale UAV's to carry heavier, more powerful sensor payloads, and can extend flight times to over 24 hours, thereby achieving multi-day flight. This work focuses on recent developments of four meter wingspan solar UAV designed for low altitude aerial sensing applications.

### ACHIEVEMENTS

In this project we have proposed a solar powered unmanned aerial vehicle results of this study showed the impact of power system component performance and mission conditions on UAV aircraft size. The most significant reduction in aircraft size was found to occur by increasing the energy storage (fuel cells in this case)

specific energy, whereas the effects of PV module and power electronics efficiency and mass play a marginal role in comparison. Flight altitude, flight latitude, time of year, and payload mass also play significant roles in determining aircraft size.

### PROCEDURE

The energy received from the Sun light radiation is collected by the solar panel, which converts it into electricity and then there is the DC-DC converter, which helps to step up the voltage from its input to its output. Then it is connected to battery, which use to store the energy and supply the energy to the circuit. Then battery connect to receiver and electronic speed controller. An electronic speed control or ESC is an electronic circuit that controls and regulates the speed of an electric motor. Receiver is to pick up the radio signal broadcast by the transmitter and change it back into an audio signal and control the servomotor. Servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. Motors convert electrical energy into mechanical energy, motor is connected to propellers.

### RESULT

In this project, we using six panel in series. We getting output of 3v that is not sufficient to charge the battery so we are using DC-DC convertor to step up the voltage for 3v to 12v then it is connect to battery to charge. Main advantage is increase in flight time, less fuel costs, less pollution, less maintenance. Disadvantage is increase in length of wings reduces stability, less speed compared to conventional drones, initial cost is high.

Mr Tathagata Roy, Hon'ble Governor of Tripura delivering inaugural address during the 30<sup>th</sup> Indian Engineering Congress at Guwahati in December 2015





## Design and Development of Solar Powered E-Vehicle with Auto Intelligent Rotating Panel

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Solar Panel and the Auto Rotating Panel Boards



E Vehicle with Auto Rotating Solar Panel Mechanism

### OBJECTIVE

In this project, effective solar powered electric vehicle with reduced weight have been developed. This project also targets finding a better way of using solar panel in an electric vehicle. The weight reduction can be achieved by selecting appropriate materials for fabrication and effective design. The concept of solar tracking system which has been proven for improving the energy output of the solar panel on roof top can also improve the power output of solar panel even in a moving vehicle. Solar cells fixed on top of the vehicle unable to receive maximum sunlight because the position of sun changes with time, energy conversion is more efficient when the rays fall perpendicular on the solar panels so solar tracking system adjusts the solar panel position to achieve maximum power output. The electric vehicle requires tracking system as the sun direction varies with vehicle movement. So in this project, sensors and the auto rotating solar panel have been used. To obtain good performance the BLDC motor and lead acid battery combination is used. The electric rickshaw provides transportation with zero emission and will become an alternative for highly polluting traditional IC engine vehicles and also provides noiseless operation.



## ACHIEVEMENTS

The proposed intelligent vehicle can be used as commercial emission free automobiles. The power for the vehicle is obtained from the solar energy and can be used to drive the vehicles. So the vehicles will not emit the pollution gases. Further to enhance the effectiveness of the solar panel, sensors have been used to rotate the solar panel such that the panel is always perpendicular to the solar radiation. Thus the maximum outputs have been obtained all the time, there by the charging will be faster. For the rotation, the Arduino boards with the driver circuit along with relay units have been used in this work. Also the sensors have been triggered every 10 seconds to measure the solar radiations, because the vehicle is in the moving condition and the direction of the movement can be cried dynamically. These 10 secs have been set based on the trial and error method i.e. after rotation of the panel it takes 10 secs to settle down. Thus the panel is in the stable state only. The stepper motor have been used in this project and is having the self-locking mechanism, which helps to prevent the rotation of the panel during the movement of the vehicles.

The proposed tracking kit can be included as secondary power source in the cars, SUV, auto, vans, Jeep, mini bus, bus, lorry, trailers, on and off road vehicles. Because the panel have been tested and found that the auto rotation panels generates the satisfactory power for the battery. There is minimal maintenance for the setup and the only challenge is the initial cost of the panel.

The proposed tracking kit can be used for the domestic and commercial applications. As the kit is developed to rotate in the three different axis, the same panel can be used universally. The panel can be used on the domestic applications also.

The developed vehicle can be used as Toto and for load carrying purposes in the metro cities, where the pollution is the major problem. The developed vehicle have been tested and found that the vehicle charging can be full at the noon time. For the single charging, the vehicles can run for 28 kms at the speed of 40 kmph with the 6 persons. For the full charging it takes morning 9.00 am to 3.00 pm in the normal sunlight day. The best optimal usage is that the vehicle has to be charged though the electric power in the night and that power can be used to run the vehicle in the morning time. In the meantime the discharged power will be recharged with the solar power and can be used to run the vehicle till the sun sets. The charging of the battery during the day time can also be used to run the vehicle after the sunset time also. Thus the vehicle can be used continuously. The results obtained from the solar panel without auto rotating system and rotating system also been compared and found that the effectiveness of the auto rotating system is higher and can be best suitable for the automobile charging.

The initial cost is little higher and the maintenance cost is very low. As the lead acid batteries have been used, 48V 105 amps have been used for this project with the 3KwBLDC motor.

The ideal engineer is a composite ... He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems.

N. W. Dougherty

## IoT Based Smart Inhaler

### Student

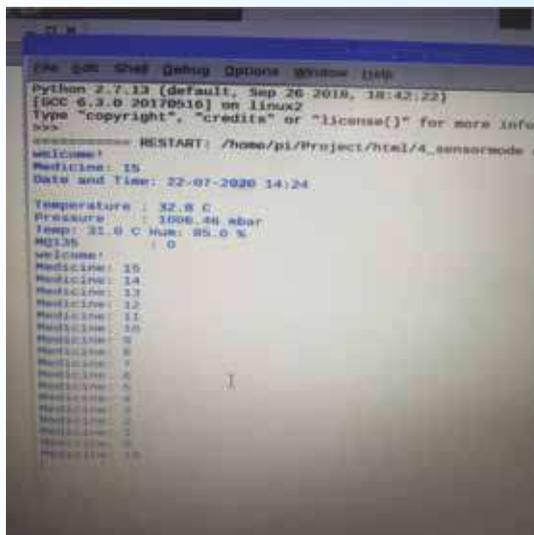
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Sensor Integration



LCD output display

### OBJECTIVE

Changing environmental condition has a huge impact in everyone's life. Asthma is one of the conditions heavily affected among people as a result of this environmental as well as several other reasons. Long years of asthma can lead to another more severe respiratory problem called COPD (Chronic Obstructive Pulmonary Disease). COPD can also be due to certain exposures in the working place. A recent survey conducted in 24 KSRTC stations in the state proved that the asthma patients are increasing at an alarming rate in Kerala. Out of 6,920 people surveyed 2,526 people were asthmatics. Those with no family history were 1,493 and with family history were 1,033. This is the case in Kerala which ranks high in pollution rate as compared to other states in India. It is hence important to bring new technologies in the inhalers used by the asthma and COPD patients.

For many patients, managing their asthma or COPD can be difficult – for some symptoms may be hard to control, and attacks may appear unpredictable. Globally, asthma is responsible for around 4, 00,000 deaths each year. Doctors also struggle to unpick what might be triggering attacks and have little idea if their patients are taking their medication properly.

Our project is to help asthma and COPD patients providing them with smart inhalers. It contains several sensor to detect the environmental factors such as humidity temperature, air pressure and gases in the environment. The inhaler is connected to a mobile application which can be accessed by the patient, the doctor and the care taker. It helps the doctor to have real time observation of the patient. It also contains a peak flow meter for spirometry to measure the breathing.

So, the core objectives of our project are

- Developing a smart inhaler system which monitors the environmental conditions of an asthma patient, thereby indicating the air quality, helping the diagnosis and control easier.
- Enables the physician to distinguish and diagnose the conditions of asthma and COPD and understand the severity of the condition.
- To develop an android mobile application that can be accessed by the patient, the doctor and the care taker
- Keeps and displays the record of the exact number of times, the date and time at which the inhaler has been used and the amount of medicine consumed from the inhaler. The mobile application can be checked to know the history of the patient whenever required.
- Gives timely notification and reminders to patients for taking medicine. The application also notifies if the patient forgets to take the inhaler along with them.
- Instructs the patient of the correct and appropriate usage of inhaler through a digital display on the device.



App developed login page



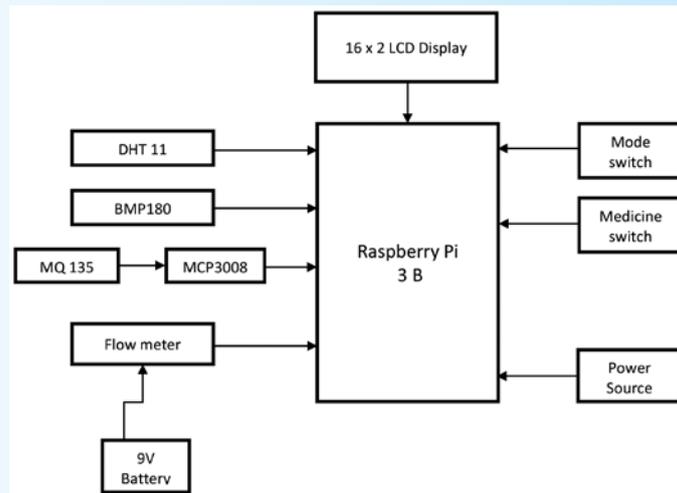
Second Interface

## ACHIEVEMENTS

### Procedure Followed

As shown in the block diagram the inhaler was integrated using Raspberry Pi 3B. All the sensors were connected to the Raspberry pi. The sensors like DHT11, MQ135 and BMP180 was used to measure the humidity,

temperature, air quality and air pressure respectively. The system makes it easy to track, understand and manage asthma in a controlled manner. The response and improvement in an asthma patient's condition during the treatment can be monitored accurately, enabling the doctor to prescribe changes in medication if needed, while patient is at home. The atmospheric condition details of several locations can be accessed by everyone using the application enabling to take precautions. This application can alert the patient to take medicine on time and notifies if the patient forgets to take the inhaler along with them. It helps to achieve measurable improvements in asthma and COPD management and better health outcomes for the people. It also contains a peak flow meter to measure the volume of air inhaled and exhaled by the lungs.



A peak flowmeter connected to the inhaler to find the respiratory level of lungs. This helps patient to understand the risk of asthma he has and hence makes him take self-prevention.. In the current scenario, respiratory diseases are increasing and it becomes important to take self-prevention from the air pollution and other factors leading to respiratory issues. Asthma triggers in surrounding atmosphere can be controlled by patient himself using the system by proper detection, also helping the doctor for better diagnosis. The system enables real time monitoring of atmospheric conditions or air quality (asthma triggers), distinguishing the levels of asthma and COPD, instant and remote connection with the doctor, better management of asthma and COPD. The LCD display shows the result of sensors, amount of medicine left in the inhaler and alerts the patient when the medicine is over. The instructions about the use of inhaler and the flow meter will be available in the application developed

In the application developed for the device a database is developed which stores the details of the device. The values of the sensors after displaying in the LCD is stored in the application which can be later accessed by the patient and doctor. It gives reminders to the patient for taking medicines. The application also stores the flow meter value. It is also used to find the result of the flow meter. A wifi modem is installed in the inhaler. The device collects the measured data from the sensors and sends it into the cloud through the modem. The user can access the details from the app through LAN. The doctor or the care taker can access the details from the app through IOT.

**Outcomes: The IoT based Smart Inhaler is able to**

- Sense the air quality
- Find the peak expiratory flow
- Help detect asthma attack

## Aeroacoustic Investigation of Airfoil with Tubercle

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project members with tubercled models



normal (swept back) and tubercled airfoils with  
pressure tappings



sweptback tubercled models with wind tunnel

### OBJECTIVE

Man has always tried to replicate the mother nature, of those efforts one such is the incorporation of leading edge tubercles in aircraft leading edges. It gives rise to several flow effects which could reduce or eliminate tonal noise. For example, the generation of streamwise vortices reduces the coherence of the wake and several other researches have shown evidence of this streamwise vortex formation. According to Nash et al. airfoil tonal noise is associated with the vortex shedding process. Tonal Noise of the aerodynamic surface is an important aspect of vehicle design in Aeronautical Engineering. Tonal Noise of the aircraft also indicates how convenient a vehicle is and how handy it can move. This leading edge geometry of the airfoil is inspired



from the morphology of the humpback whale's (*Megaptera novaeangliae*), which is a highly acrobatic species. capable of performing high speed manoeuvres and agile movements. This capability of the humpback whales is attributed to the presence of Pectoral Flippers with bumps called Tubercles. This biological feature of the humpback whales can be mimicked to improve the acoustic and aerodynamic performance of the aircraft. Study has to be made to identify the specific parameter that is to be varied to identify an optimum tubercle configuration in terms of mitigating Tonal noise disturbances. A new alternative modification has to be explored; where by sinusoidal surface waviness will be incorporated into the airfoil, giving a span wise variation in flow separation and by stream wise vorticities. The flow around the tubercled model was computed on suction side and pressure side at different angles of attack with ANSYS FLUENT package. The aerodynamic coefficients (CL, CD), coefficient of pressure (CP) have explored, modified airfoil compared with baseline airfoil. The stall delay phenomenon was cleared over the analytical results insists on peak, trough and medial region. Numerous graphs have accounted so that determined the performance enhancements by the flow control. The tubercles leads the post stall characteristics.

### ACHIEVEMENTS

To identify the effect of tubercles, swept back models were created with sinusoidal modification in the leading edge. The analytical work (by CFD and wind tunnel testing) was carried out at the angle of attack range from 0o to 20o. The effect of tubercles was identified based on coefficient of lift, coefficient of drag, coefficient of pressure, velocity vector, streamline pattern and noise generation aspects.

The implementation of tubercles at the leading edge of airfoil leads to the formation of counter rotating streamwise vortices between the tubercles peaks (i.e. trough region). The row of tubercles redirects the flow of air into the scalloped valley between each tubercle, causing swirling vortices that roll up and over the airfoil which actually enhances lift properties. The swirling vortices exchange momentum into the flow and this exchange of momentum keeps the flow attached to the suction side of the airfoil and delays stall to higher angles of attack. As the pressure tappings were positioned on the suction and pressure side for the baseline and tubercled airfoils, the pressure distribution is elucidated. Extreme concern was taken to measure the peak, trough and mid region pressure distribution. The surface pressure measurements taken varying chordwise positions for the picked airfoil. The chordwise pressure distribution shows the existence of spanwise variation in pressure by means of effective aerodynamic characteristics.

The effects of tubercles on the pre stall and post stall characteristics have been investigated by the surface pressure characteristics. The aerodynamic characteristics had been held by the comparison of baseline and modified airfoils. The important parameters considered when specifying the use of tubercles by amplitude and wavelength. It was found that performance changes, in terms of enhanced lift with minimal drag for modified airfoils, is limited to specific Reynolds number regimes. Analysis of the flow behaviour revealed that a pair of streamwise counter rotating vortices was generated in the troughs between tubercles and that counter rotating vorticity and circulation where highly dependent on streamwise location and airfoil angle of attack. CFD results shows the considerable amount of noise reduction through pressure fluctuations analysis.

The experimental validation shows the pressure distribution on suction and pressure side of the baseline and tubercled airfoils to determine the effective aerodynamic characteristics. There are various opportunities for future work on this proposition by large number of variables to consider when selecting an optimum tubercle configuration with varying Reynolds number, changing the shape of the tubercles, selecting airfoil with different profile shape.

### PUBLICATION

V T Gopinathan, J Bruce Raphin Rose, Surya M, Sooraj A, "Investigation On The Effect Of Leading Edge Tubercles Of Sweptback Wing At Low Reynolds Number". Published in Mechanics and Industry Journal

## Design of Low Cost Compact Mobile Crusher Robot for Clean Environment

### Student

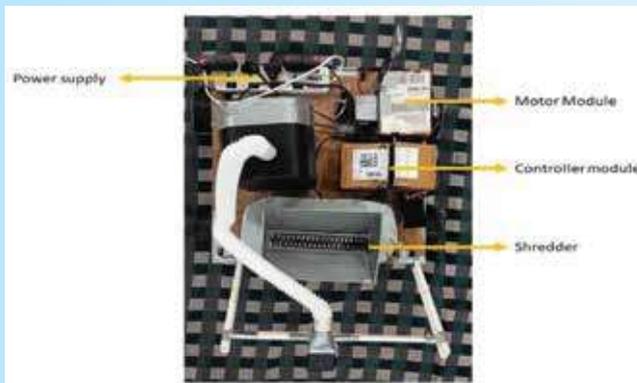
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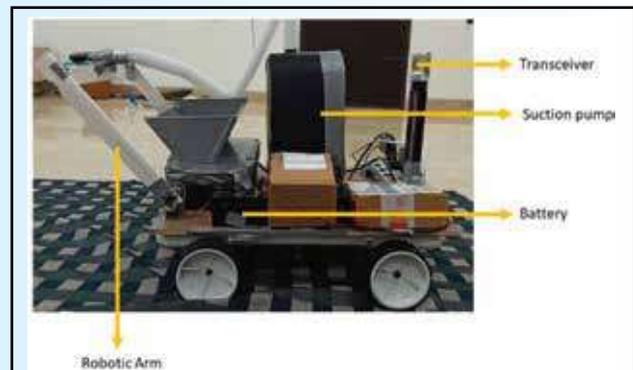


Smart crusher robo's side view with inner parts shown clearly. The shredder module will be used to cut and crush the plastic wastes. It is the main module in the project. It will cut the plastic wastes into small pieces, so that the recycling process will be made easy.

### OBJECTIVE

The aim of this project is to design a low cost, compact mobile crusher robot for plastic waste management to create an eco-friendly environment. Mobile robot crushers like the one we designed should be handy and should reduce the burden on environment as well as municipality workers to help them in keeping the environment clean. In addition to low cost, compactness, mobility it should also be maintenance friendly in plastic waste management. The above features will make it more appealing for efficient waste management in local/small/closed-areas.

If we switch on the machine, it should go to the interior place also to collect only the plastic waste. As a whole, the machine is like a robot to collect the waste. According to our requirement we can increase the capacity of the machine. For home crusher, any waste sucked and crushed, reduces lot of unwanted manual work and transportation difficulties.

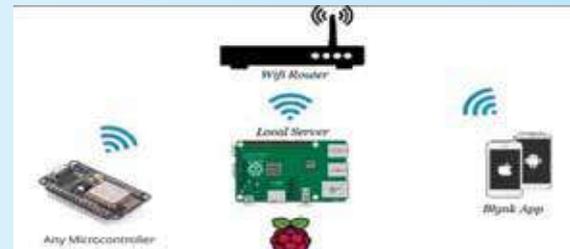


The snap shot of smart garbage collector which consists of many separate modules. Those modules helps in the working of the project in a good and optimistic manner. The modules are,

- Motor module
- Controller module
- Power supply
- Shredder module
- Waste storage section
- Transceiver module
- Suction module



The small plastic wastes from the shredder will be stored in the waste storage box under the shredder. It will store the plastic wastes until it is full. Once the plastic wastes in the box are full, the ultrasonic sensor will give signal to user mobile device. Then the user can empty the waste storage box by controlling the lid of the storage box wirelessly.



A microprocessor (Raspberry pi) module will be used as the server in order to make the transmission of control signals between the garbage collector and mobile controller safer. It ensures the transmissions of signals are protected.

At present our aim is to design a prototype for plastic waste management and later it will be scaled for other waste products.

By this project, our aim is to improve students “Engineering design skills and manufacturing skills” in integrated ECE & MECH domains. The students were encouraged to take it further as a start-up initiative.

### ACHIEVEMENTS

1. We have successfully designed a fully functional prototype mobile crusher robo using microcontroller and Raspbery pi. It can be used in small gardens, small institutions, small temples where the plastic waste collected is reasonable. To store the crushed waste, large size garbage dump is not needed; since they are converted into small pieces and powders.
2. Initially students tried with ordinary microcontroller only. Later on they utilized Raspberry pi due to its additional features. Raspberry pi module is used as the server in order to make the transmission of control signals between the garbage collector and mobile controller in a safe manner. It ensures the transmissions of signals are protected. For this, the mobile controller and the garbage collector must be connected in same network. It will create a local domain for accessing the project.
3. The same project can be used for large gardens and in other places by making large size waste collection box and shredder. The small plastic wastes from the shredder will be stored in the waste storage box under the shredder. It will store the plastic wastes until it is full. Once the plastic wastes in the box is full, the ultrasonic sensor will give signal to user mobile device. Then the user can empty the waste storage box by controlling the lid of the storage box wirelessly.
4. By being committed in this project, the students and college/institution alike are benefited as follows:
  1. Technical skills of students were highly developed from theory to practice in core domains.
  2. Students were guided and trained to follow best engineering practices that achieve robustness, efficiency, reliability and miniaturization in the developed system. In addition, they were also encouraged to introduce novel methods or techniques wherever applicable.
  3. The consultancy work will be improved in our department and in our college.
  4. This project will be definitely fulfil the need of our nation’s swachhbharath campaign.

## Performance Monitoring and Controlling Shell & Tube Heat Exchanger Using Internet of Things

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### OBJECTIVE

1. Designing a channel by drilling operation in a shell and tube heat exchanger is a primary objective of this work. Micro channel shell and tube heat exchanger is a device which consists of a shell with a bundle of tubes within a single unit.
2. Increasing heat transfer rate between hot and cold fluid is directly proportional increase in efficiency of any heat exchanger. Various methods are available to enhance heat transfer rate between hot and cold fluid. In this study micro channel tubes are used in order to have enhanced heat transfer.
3. Mass flow rate is an important parameter which influences performance of thermal system. In case of heat exchanger lower mass flow rate provides greater effectiveness and vice-versa. As a mean to obtain optimum mass flow rate for this hybrid system, multiple experiments were conducted for the various combinations of flow rates between 0.25 kg/min to 1.5kg/min. Such results are to be compared and plotted for validation.
4. In order to monitor, record and control performance of micro channel shell and tube heat exchanger. Arduino UNO based simple and reliable data logger system is to be developed. In addition its performance is being monitored and controlled using Raspberry-Pi board integrated with cloud computing.
5. Use of new efficient, minimum global warming potential and eco-friendly fluids increase the performance of shell and tube heat exchanger.



6. Adopting latest technique of automation using sensors and IoT interfacing to record the readings may lead to time consumption and also maintain the efficient operating condition of the experimental setup.

### ACHIEVEMENTS

From literature survey its observed that designing and fabrication of tube baffles is difficult which encounters following

- ❖ It is very tough to readily analyze the shell side of the tubes for scaling or tube damage and maintenance are Problematic for a tube cooler requires enough clearance at one end to remove the tube nest.
- ❖ It cannot be increased the capacity of tube cooler.
- ❖ Over tightening of the clamping bolts result in increased pressure drop across the cooler.
- ❖ Finding leakage is difficult since pressure test is not as ease as tube coolers.

To overcome such inconvenience a novel design has been proposed, designed, fabricated and its performance were studied.

- ❖ Tube part is completely replaced with drilled holes which serves as passage for working fluid to flow throw the holes.
- ❖ Cold fluid is allowed to circulate over the copper block surface such that convection heat transfer takes places at the walls of copper block.
- ❖ These arrangements lower the temperature of working fluid and vice versa with the shell side fluid.
- ❖ Since multiple tube parts are converted in to single block which reduces tube arrangements chaos and simplifies the fabrication portion.
- ❖ Leakage drawbacks are defeated by providing gaskets at the junctions of headers, shell and tubes portion.
- ❖ With the existing design the clamping and pressure loss are conquered.

As per literature review Shell and tube heat exchanger, there is continuously required for improving the performance and effectiveness. The effect of various parameters like mass flow rate, inlet temperature on the overall heat transfer rate is studied. Based on the results obtained from the model developed parameters are optimized for better performance following points were executed.

- ❖ Initially theoretical analysis were performed and flow rate has been optimized using non dimensional numbers.
- ❖ For better heat transfer, flow passage has been designed for turbulent flow, therefore efficient heat transfer have been achieved.
- ❖ Since the copper is the good conductor of heat it influences the conduction heat transfer transfers the heat to the wall of tube block this improves the heat transfer from core to the walls
- ❖ As the water has been circulated it enhances the convective heat transfer therefore heat transfer rate also improved. This will ultimately enhance the overall heat transfer rate and efficiency of the system.

For optimizing the result and validate the performance of newly developed heat exchanger, initially designed model has been simulated and heat transfer rate are calculated. Based on the cold water flow the inlet and outlet position of the valves are simulated, it enhances the heat transfer rate. Later experimentation were executed for various mass flow rate and temperatures of working fluid, compared with simulation results and validated. For further clarifications performed experiments were compared with literature prescribed values therefore new

model is justified with the existing performance. To read the data effectively and record the variations from transient conditions IoT have been interfaced with the experimental kit.

The following were the fewer advantages of conducting this experiments:

- ❖ The newly developed shell and tube heat exchanger is efficient to adopt on small scale industries and for laboratory purposes.
- ❖ This setup is much useful to analyze the flow pattern of various fluid since the glass is used as a shell material.
- ❖ The heat transfer rate between different fluids shall be conducted and determined.
- ❖ The impact of Reynolds number on heat transfer rate can be easily explained with this experimental set up.
- ❖ It is more convenient to execute the experiment by replacing the core part material.

## Legacy of IEI



**Mr Keshari Nath Tripathi, Hon'ble Governor of West Bengal delivering inaugural address during the 31st Indian Engineering Congress at Kolkata in December 2016**



## An IoT Based Smart Detection of Scenario of Driving in An Intoxicated State

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Testing of LCD and sensor



The proposed system module

### OBJECTIVE

India has earned a dubious distinction for accidents due to excessive alcohol consumption and wreck less driving. Drinking and driving is referred to as driving under the influence or driving while intoxicated (DUI). Safe driving requires the ability to concentrate, make good judgments and quickly react to situations. Due to this, the rate of accidents has reached to peak value and now needs to be saturated. The Objectives of this project are

- To develop a system with the help of sensor technology and IoT, that is convenient to detect the alcoholic driver in automobiles.
- To send a message “alcohol detected” along with the live location of the automobile to a specific police station.

The proposed system is designed to measure the alcohol level from the driver’s breath. If the driver is found in an intoxicated state, then an alert message will be sent to the police station along with the live location of the car. The car’s engine will not start due to this effect. Sharing the live location of the car will help police to track the car easily without any hindrance. In another scenario, if alcohol is detected from any other passenger’s breath then only a warning message will be given. Due to this action, the rate of accidents and reckless driving will minimize to some extent thereby saving lives of many innocent people. This will also increase the social awareness among people.

### ACHIEVEMENTS

1. Presented in Technical Paper Presentation “Papier” organized by Electrical Department, Jadavpur University Kolkata.

2. Presented in Innovative Model Presentation “Aavishkar” organized by National Institute of Technology, Durgapur.
3. Presented in Technical Paper Presentation “Celcius 2k19” organized by Calcutta Institute of Engineering and Management, Kolkata

#### PUBLICATION

1. Presented in Technical Paper Presentation “Papier” organized by Electrical Department, Jadavpur University Kolkata.
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3. Presented in Technical Paper Presentation “Celcius 2k19” organized by Calcutta Institute of Engineering and Management, Kolkata.

## *Legacy of IEI*



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

## Intelligent LPG Gas Stove based on Internet of Things (IoT)

### Student

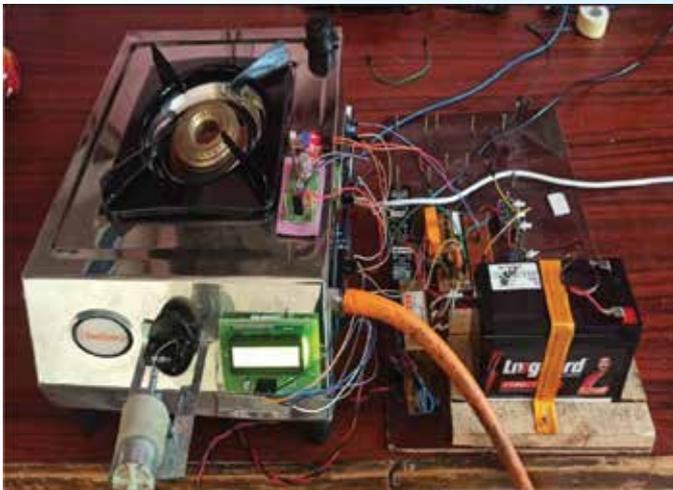
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Working Model



Flame Adjustment

### OBJECTIVE

There is a lot of energy wasted in the present LPG Gas Stove when the flame is greater than the vessel diameter. The diameter measurement is based on the conductivity of the vessel. On the top of the stove, there will be springs at different points so that it comes into contact with the vessel when the user keeps the vessel on the stove. Depending upon the spring which closes the circuit the diameter is measured. The automatic flame adjustment is achieved by fixing the servo motor to the valve of the gas burner. The overflow of food from the vessel is also a problem where the flame will turn off while gas is flowing. The overflow of food from the vessel will be detected using the conductivity nature of food. Two wires will be placed at a small distance in circular pattern when food falls on this these wires get shorted. So overflow of food from the vessel is detected. Gas leakage is also a big problem in the current LPG Gas Stove cooking system. The leakage of gas is detected through a gas leakage sensor. Then the information is sent to the user's mobile. The gas leakage is detected by using the gas sensor. If the sensor detected the gas leakage, an alarm will be raised and the same has been notified in the user mobile. The whistles are detected by using the sound sensor. When the number of whistles reached the pre-defined value, the gas stove knob will automatically turn off. The number of whistles is fixed by the user.



In this busy world, it is difficult to track the entire cooking process but it is unavoidable since we don't have an option to set the on period so that we can do other work during the cooking process. Hence a timer is introduced to fix the value of time for the cooking process. The user can fix the time for the flame is in on stage. Once the timer value is elapsed, the gas stove knob automatically turns off the stove. Also, we do not know about the remaining gas in the cylinder. The gas level in the cylinder is measured via the load sensor. The load sensor is placed below the LPG cylinder. Initially, the weight of the cylinder filled with LPG is calculated. Then subtract the weight of the empty cylinder from the initial calculated value. Now the weight of the gas is calculated. Thus the load sensor frequently measures the weight of the cylinder and it has been converted to the level of gas (in terms of percentage) in the cylinder. Finally, the value of the gas level is displayed on the user's mobile. This system can be used to check the weight of the cylinder at the time of delivery of the cylinder by gas agencies.

### ACHIEVEMENTS

A series of tests have been carried out to analyze the performance of the developed prototype. The designed prototype is user-friendly and efficient output by varying flame according to vessel diameter. The different adjustments of flames have been tested against the different diameters of the vessels. Also, the current status of the flame has been retrieved in the designed mobile application. Then the knob rotation has been tested by using different sizes of vessels. Also, the system will detect the overflow of food and prevent wastage of food. The food overflow detection is tested through the overflow of milk. When the milk is overflowed, the flame goes to the off condition. Then the gas sensor detects the leakage of gas which is informed to the user's mobile. Hence this project is very useful in our life. In this, we have saved a lot of money because in this system the leakage of gas has been detected which stops the stove where the gas has been saved from the normal one. When the leakage of the gas is detected, the processor will send the gas leakage information to the user's mobile, and also it will be displayed on the LCD as well as a buzzer will be on. The feature of automatic booking of gas cylinder is done when the gas level in the cylinder goes beyond the threshold level. The load sensor is used to measure the level of gas in the cylinder. The load sensor is placed below the LPG cylinder. Initially, the weight of the cylinder filled with LPG is calculated. Then subtract the weight of the empty cylinder from the initial calculated value. Now the weight of the gas is calculated. Thus the load sensor frequently measures the weight of the cylinder and it has been converted to the level of gas (in terms of percentage) in the cylinder. Finally, the value of the gas level is displayed in the user mobile. This system can be used to check the weight of the cylinder at the time of delivery of the cylinder by gas agencies. Also enables the user to set the period for which gas should be in ON state and gives the information about the amount of remaining gas in the cylinder. Thus it is more scalable and financially feasible. It will be widely used in houses and hotels. Also, the whistle counter option is tested by setting a value to the whistle count value.

### PUBLICATION

N V Anton Francis Jeejo, V M Ranjith Kumar, S Dheenathayalan & K Mohaideen Pitchai, 'Design of an Intelligent LP gas stove using Internet of Things' submitted in the International Virtual Conference on Advances in Communication, Machine Learning, Embedded with Internet of Things, Kongu Engineering College, Erode, 09-10 April 2021.

**With engineering, I view this year's failure as next year's opportunity to try it again. Failures are not something to be avoided. You want to have them happen as quickly as you can so you can make progress rapidly.**

*Gordon Earle Moore*



## Fully Automated Eco-Friendly Solar Grass Cutter

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### Guide

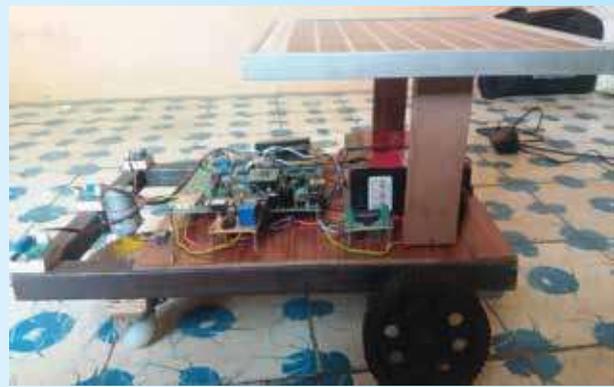
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Building of Grass Cutter Vehicle



Side view of Grass Cutter Vehicle

### OBJECTIVE

1. To design a fully automated grass cutter
2. To implement the automated grass cutter using Arm 7 Microcontroller
3. To design a solar based grass cutter
4. To reduce manpower
5. To design a grass cutter that works effectively

### ACHIEVEMENTS

- Solar powered grass cutter that helps in energy saving and reducing pollution
- Fully Automated grass cutting
- Vehicle movement adjustment based on obstacles and lawn edges detection
- User friendly operation
- Low cost design

This project proposes a conceptual design of an automated solar grass cutter. It is a fully automated robotic grass cutting vehicle powered by solar energy that also avoids obstacles and is capable of fully automated grass cutting, without any human intervention. When The solar battery is fully charged, it also disconnects the solar panels from the batteries and also connects to the panels when battery charge falls below a certain limit. The machine uses 12V batteries to drive both the motors for vehicle movement and the grass cutter engine. The grass cutter and vehicle motors are interfaced with a microcontroller of the ARM7 family which controls all the motors. The ARM7 microcontroller can supply 3V to 3.6V which is insufficient to drive a motor. So the motor is connected through the driver IC ULN2003 for driving the motor. The driver unit output is connected through the left and right dc motor and also to the grass cutting motor. The driver unit actuates the relay that controls the motor. Relay serves as a switch. The power is transmitted to the driving mechanism that makes it possible for the blade to rotate at high speed and to cut the grass evenly. The module is also interfaced with an object tracking IR-sensor to identify obstacles along its path. Four IR sensors are used in the system and are positioned at the front to detect the presence of obstacles long its path. When no obstacle is sensed by the sensors, the microcontroller guides the vehicle motors in forward direction. The IR sensor tracks the obstacle, and gives input to microcontroller which sends output control signal to stop the vehicle and turn either right or left side depending on the sensor data to avoid it. Cutting blade motor runs based on the commands issued by ARM controller to have smooth and neat grass cutting. This grass cutter is lightweight and occupies less space. The operating cost is zero as it is solar powered. The system's cost is small as compared with the existing grass cutter in the market.

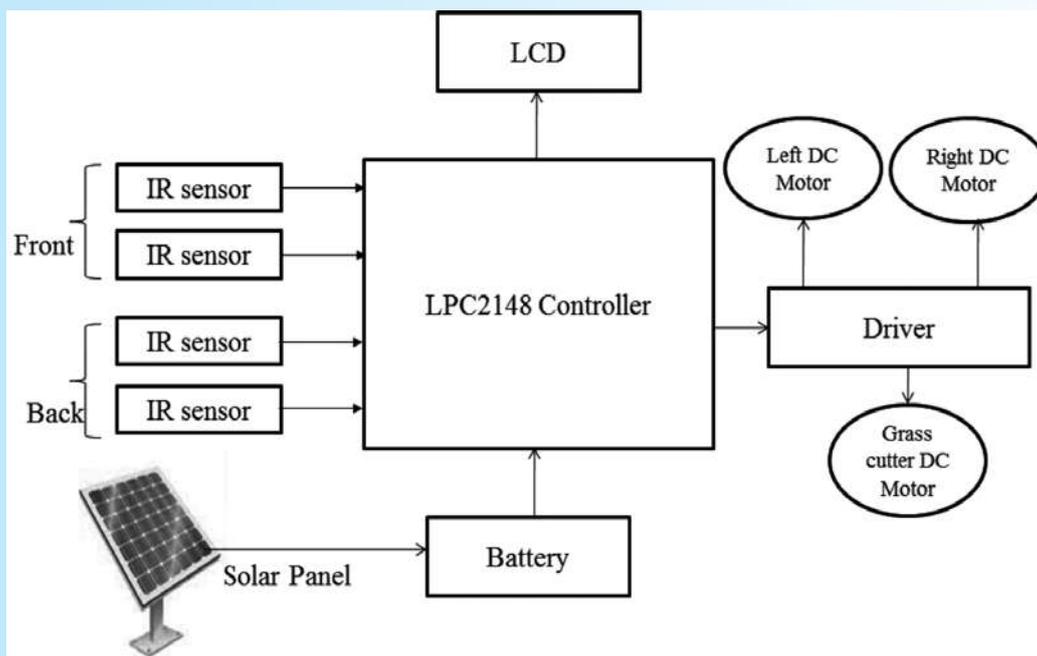


Figure A

Block diagram is shown in Figure A. The solar-powered Grass Cutting Machine is designed with IR sensors, ARM controller, solar panel, battery and Grass cutter. ARM LPC2148 controller controls the solar-powered Grass cutting device. Four IR sensors were used in the system. It is positioned at the front and the cutting machine at the end. It is used to detect direction and moves the grass cutting module left or right or move forward. The data is processed by the microcontroller and the output control signals taken from the designated pins of processor. The Driver unit output will be connected to the Left & Right DC motor and also to the grass cutting motor.



## Evaporative Cooler using Earthen Tubes with Passive Cooling

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Experimental Test Rig



(a) Plane tube (b) Dimple Tube  
(c) Protrusion Tube

### OBJECTIVE

1. The objective is to check the effect on heat transfer rate by incorporating patterned irregularities (dimples or protrusions) over the inner surface of the conical terracotta tubes (baked clay tubes) which are to be used in the Evaporative Cooler through experimental testing and computer simulation for given set of Reynolds number.
2. To develop experimental test rig which suits the experiment's requirements.
3. To perform experimental testing in controlled conditions, on plain tube, dimpled tube, and protrusion tube to obtain variation in flow characteristics (like Reynolds number, Nusselt number) and variation in rate of heat transfer at three different inlet air velocities.
4. To perform analytical study on two dimensional models in ANSYS Fluent software to determine the effect of inlet air temperature, inlet air velocity and wall surface temperature of terracotta tubes on percent temperature drop at outlet of the tubes due to use of dimples or protrusions and to obtain the contours of static temperature, static velocity, and static pressure for all three tubes.
5. To observe, tabulate and plot the results obtained through experimental testing and simulation studies.
6. To compare the results for three tubes at given set of Reynolds number and conclude about best suitable tube of the three, optimum inlet air velocity and optimum inlet air temperature for the Evaporative Cooler application.
7. To back the experimental results with computer simulation results.



8. To determine the scope and application of the findings of this project in various spheres of life.
9. To publish a research paper depicting the findings of this projects.

### ACHIEVEMENTS

1. The experimental testing and analytical study on Ansys Fluent are performed to fulfill the objectives of the project.
2. The suitable Experimental testing rig is developed through the process of computer design and modelling, selection and procurement of materials for various components, selection and procurement of various measuring devices, manufacturing of components as per design, and assembling all the components.
3. The experimentation is performed on three tubes viz. plain tube, dimpled tube, and protrusion tube under controlled conditions for given set of Reynolds number and the results in terms of rate of heat transfer are obtained. Variations in Reynolds number and Nusselt number are also determined for all three tubes at three different velocities.
4. Graphs for heat transfer rate against velocity for all three tubes are plotted. It is concluded that heat transfer rate increases with the use of protrusions on the inner surface of terracotta tubes used in the experiment. It is maximum for protrusion tube followed by plain tube and dimpled tube. Also, it is found that maximum cooling can be achieved by passing the hot air through protrusion tube.
5. The two-dimensional model of all three terracotta tubes is designed in Fusion 360 software for analytical study purpose. The simulation study on these models is performed on ANSYS Fluent software for given set of Reynolds number and the effect of inlet air temperature, inlet air velocity and wall surface temperature of terracotta tubes on percent temperature drop at outlet of the tubes due to use of dimples or protrusions is checked. Also, for all three tubes the contours of static temperature, static velocity and static pressure during the flow of air through them are obtained. It is found that tube with protrusion have maximum cooling efficiency. Also, it is concluded that to get maximum cooling the air should be admitted at lower velocities and more the inlet air temperature more it will get cooled. Also, the surface temperature of the medium at which heat transfer take place should be kept at lower constant temperature. Also, it is found that there is no significant drop in pressure when irregularities like dimples and protrusions are incorporated on the medium of heat transfer.
6. Computer simulation results backs the results obtained through experimental testing. Both studies shows that conical tubes with protrusions should be used in Evaporative coolers for given set of Reynolds number.
7. Details about the applications of the findings of the project are reviewed. Evaporative cooling along with passive cooling methods like incorporating irregularities can provide a cooling system alternative to current cooling devices. The findings of the project may prove useful in develop entirely new eco-friendly, economic and energy efficient cooling system, industrial cooling applications, in developing miniature heat exchanger, etc.
8. Research work regarding the same study is published in International Journal of Engineering Research and Technology by ESRAS Publications.

### PUBLICATION

Published research paper entitled as Potential Use of Passive Cooling Technique in Evaporative Cooler in International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181 Volume 10, Issue 2, February-2021.

## Design and Fabrication of Carbon Fibre Frame for Firearm

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Final assembly of Carbon fibre frame



Final assembly of Carbon fibre frame with jacket (armour) front view



Final perspective rendered view of soldier wearing carbon fibre frame with the help of armour



## OBJECTIVE

- The main objective of this project is to reduce weight of the firearm on the torso of the soldier.
- To increase the shooting accuracy of the firearm.
- The frame comprises a novel apparatus that improves accuracy for a wide variety of firearms, reduces arm fatigue, is adjustable for different user body sizes, and enables a wider range of motion with the firearm.
- To acquire single hand operation capable of providing a lightweight stable weapons platform
- To potentially redistribute recoil forces back equally to the body.

## ACHIEVEMENTS

- Carbon fibre frame for soldiers overcomes the disadvantage of using heavy firearms in land warfare.
- The soldier's fatigue is mainly reduced by improving the lethality through marksmanship and allowing them to use higher energy weapons.
- This frame provides stable platform which holds the weapon and potentially redistribute recoil forces back to the body.
- By this frame, the firearm accuracy for hunters, sport shooters and Soldiers is improved by stabilizing the weapon.
- Various tests were conducted by wearing the frame i.e., while running, walking and crouching. This interface provides all the necessary degrees of freedom for normal operation of a conventional weapon and also allows shooting even from the prone position.
- The frame does not lock or restrict weapon motion, so this frame need not to be steadied on the ground or another structure, allowing it to be used even while walking or running.
- This frame provides single hand operation capable of providing a lightweight stable weapons platform.

## PROCESS

The major disadvantage of traditional cutting processes on CFRPs was production of poor surface quality due to the heterogeneity of the composite material, the result of shear forces accompanying the cutting process, the phenomenon of fraying damage aroused in the case of cutting Carbon Fibre Reinforced Polymers (CFRP). So, carbon fibre reinforced polymer material was machined by laser beam cutting technology. Laser power, cutting speed, gas pressure and focal point position were the most important input parameters, in addition to laser wave frequency, type of laser and type of wave (pulsed or continuous wave). These input parameters determine the quality of the cutting process. Here the CFRP are disintegrated when it reaches melting point. While drilling a hole on the hook on a laser beam cutting machine it developed a crack on the hook which made us to change the width of the hook by increasing it to 1mm wider. And again, it was drilled and the required hole in the hook was as per our requirement

Verification of the frame was done by applying a load of 100 N at the hook using ANSYS FEA software, under the loading condition the tensile and compressive stress of the carbon fibre was within the limit.

## RESULT

Embodiments of the present provide a wearable apparatus for stabilization of a firearm. In one embodiment the wearable apparatus consists of a plate that slides into a tactical vest, a hinge assembly, a four-bar linkage with a spring to balance the weight of the firearm, and a firearm attachment assembly. Together, these assemblies comprise a novel apparatus that improves accuracy for a wide variety of firearms, reduces arm fatigue which is adjustable for different user body sizes and enables a wider range of motion with the firearm than existing firearm stabilizing devices.

## Comprehensive Analysis of New Composition Cast Single Point Cutting Tool in Machining Various Materials

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Mild Steel - after machining



Aluminium - after machining



Brass - after machining



Copper - after machining

### OBJECTIVE

The manufacturing sector focuses primarily on how the cost of goods can be minimised. The process planners must prepare the product process plan based on the availability of the remedies. All the data is available in the plan, including the product's inspection and delivery date. Components are manufactured at a reasonable cost on the basis of guidelines for production and inspection methods. Most of the researchers use optimization techniques to choose machining parameters and also show that the machining time / expense for the specific components / operations have been reduced. For the investigation of machining parameters, tool nomenclature should be considered in this work. From the instrument shank, the single cutting point tool is built and tool angles such as rake angle, end clearance angle, and nose radius affect the product's cutting efficiency. By varying rake angle, clearance angle and nose radius, three separate instruments must be planned, produced and checked, and the efficiency of the machining process must be evaluated. The best tool should be recommended to manufacturing industries on the basis of experimental investigations. The single point cutting tool is usually used in the lathe machine to perform different facing, turning, etc. operations. The tool is normally produced with the help of a tool and a cutter grinder. The following priorities are extracted from literature review and issue recognition.

- ❖ The single point cutting instrument is constructed based on the nose radius, the angle of the back rack and the angle of clearance.
- ❖ The nose radius of the instrument can differ with regard to the angle of the back rack and the angle of clearance.
- ❖ Machining efficiencies of new tools are to be measured by machining different materials for workpieces.
- ❖ To define the nose radius, rake angle and clearance angle results.



- ❖ The best parameters will be proposed to the machining industries from experimental investigations and validation.
- ❖ The proposed tool would improve the life and also withstand elevated machining parameters.
- ❖ The proposed technique should be suggested to other tool materials on the basis of the findings.

#### ACHIEVEMENTS

For the investigation of machining parameters, tool nomenclature has been considered in this work. From the instrument shank, the single point cutting tool is built and tool angles such as rake angle, end clearance angle, and nose radius affect the product's cutting efficiency. By varying rake angle, clearance angle and nose radius, three distinct tools have been developed, manufactured and checked and the efficiency of the machining process has been evaluated. The best tool should be recommended to manufacturing industries on the basis of experimental investigations. Most of the researchers used optimization techniques to choose machining parameters and also show that machining time and costs have been reduced for specific operations for the specific components. The work on optimizing the single point cutting tool for different machining parameters gives us the ability to use them to increase the better production in industries.

In order to increase profit, the job also allows companies to reduce machining time and production costs. It also allows the same tool to be used in different operating conditions for various work pieces. By improving the tool nomenclature, such as rake angle, nose radius and clearance angle, future researchers will refine the process and develop the machining parameters to create a standard tool for different types of operation. With regard to output responses such as metal removal rate, surface roughness, and machining time, the influence of input process parameters such as spindle speed, feed rate, and cut depth is analyzed. Factorial Experiment Design is used to verify the optimum degree of parameters of the input method for single objective functions to be addressed. The result of this experimental investigation was used to increase the consistency and accuracy of the product for a minimum period of time for the manufacturing industry.

- The experiments were conducted by the proper selection of turning process parameters to obtain good quality of machining by using Factorial Optimal Design.
- Following results were made for optimum MRR and Surface Roughness machining of Mild steel (AISI 1018), Aluminum (Al6063), Brass and Copper by using Hardened and Unhardened High Speed Steel (HSS) tool in conventional light duty lathe machine.
- The basic turning process parameters such as Spindle Speed, and Depth of Cut will be selected and examined at three different levels.
- Spindle Speed plays a vital role in finishing the workpiece.
- The effect of turning parameters on the Metal Removal Rate, Surface Roughness and Machining time are investigated.
- Continuous chips were obtained during the machining of mild steel and aluminum by Hardened HSS tool.
- Normal (unhardened) HSS tool failed during the machining of Mild Steel itself.
- For this optimization technique the feed rate was taken as constant value (0.123 mm/s).
- The maximization of Material Removal Rate were obtained by design of experiment approach, whereas surface roughness and machining time were minimized and such works were carried out and the predicated values were found out.
- The found values were then compared with the actual value and results were plotted according to them.
- The results infer that at a spindle speed of 815 rpm, at the feed of 0.123 m/min and a depth of cut of 1.5 mm the process is more desirable than the other combinations of speed and depth of cut for the feed taken.

## Cybernation of Home Appliances using Raspberry PI

### Student

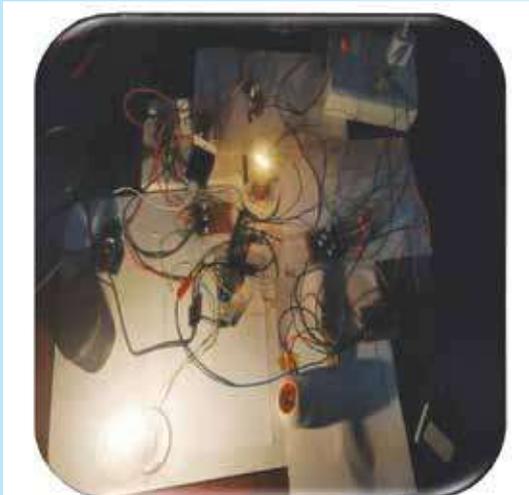
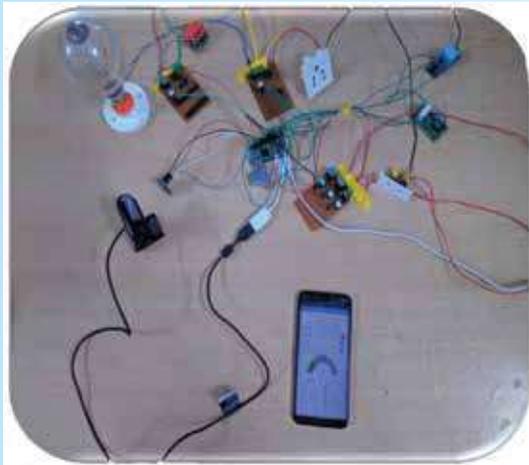
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Proto type to control fan, light and measure voltage, current and power using Raspberry PI and relay unit

Screen of the user mobile to control the brightness of light and speed of the fan and measures the electrical parameters



## OBJECTIVE

As the future depends on artificial intelligence based, the human work is replaced by the machine. Home automation: Homes are automated through the internet. This also comes under the category of artificial intelligence. The only problem arises in home automation is in protection and controlling because we can either control or protect the system but we didn't tried both at a time. But the proposed one monitors, controls and protects the home appliances with ease of control to the user at a time. The protecting devices such as MCB and fuses all are being replaced by the proposed module. In this Raspberry pi is a credit-card-sized single microcontroller computer. In this Python is used as the main programming language. It is easy to develop and suitable for real world applications.

The dash board of the user mobile consists of switch, gauge, led indicator, slider, graph plot etc. User can monitor the flow of current, voltage and power consumption in his/her mobile. User can also control the brightness of light and speed of the fan from his/her mobile screen. The user commands are processed and then the actions are controlled, when the user says the a particular device to be on/off, the mic converts the user commands and it is processed in the processing unit and then the GPIO pins are triggered, the power sensor are placed for each room and they sense the power consumed by the devices and it is fed to the processor, the current sensor senses the real time current and if in case the current exceeds then the current sensor sends the trip signal to raspberry pi and such that raspberry pi trigs GPIO to be opened. This process is analogous to MCB in home, when the current settles down then the appliances or devices are ready for controlling, the data of current and voltage are being updated to the User interface in which the user has the access of all appliances and the real time energy consumption at various instances is plotted.

The main objectives of the project are:-

1. To develop a low cost, reliable and scalable device that can replace fuses and circuit breakers in the home.
2. To save energy and control the equipment in home by adapting automation.
3. To monitoring, controlling of home appliances and their protection either by voice or through user mobile.

## ACHIEVEMENTS

1. Developed a low cost, reliable and scalable device that can replace fuses and circuit breakers in the home.
2. The developed device saves energy and control the equipment in home by adapting automation.
3. It creates a friendly interface to the users.
4. It provides Voice assistant control [speech recognition] Online/Offline modes
5. Smart light control with Study mode/ Movie or Sleep mode/General mode/scary mode
6. Fan speed control with Super Storm mode/ Storm mode/ Slow breeze/ Gentle air mode/
7. Socket and other appliances control [on/off]
8. It also works as Current magnitude-based auto reclosing fuse.
9. Successful in monitoring, controlling home appliances and their protection.
10. Able to indicate the each and every operation in user mobile.

## PUBLICATION

Yerramsetti Jaswanth, Bathina Venkateswara Rao, Kalagara V V R S Vishnu and Thejavathu Thirumalarao, "Cybernation Of Home Appliances Using Raspberry PI", 35th Indian Engineering Congress, Organized by The Institution of Engineers (India), during December 18th to 20th 2020 (Accepted) PAPER ID: ET/149/13.

## Renewable Energy based Atmospheric Water Harvesters for the Production of Potable Water

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Schematic setup of the project

### OBJECTIVE

India is the biggest user of groundwater – it extracts more groundwater than China and the US put together – the second and third on the list. Groundwater meets more than half of the total requirement of clean water in the country. On 26th August 2019 in Biarritz, Prime Minister Narendra Modi addressed the G7 summit in a session on ‘Biodiversity Ocean, Climate’. He spoke about how India and how his government is taking steps to deal with conserving water and harnessing solar energy for a sustainable future. If one looked at the numbers, India is still a water-surplus country and receives enough annual rainfall to meet the need of its 1.2 billion population. India received 4,000 billion cubic meters of rain against its requirement of 3,000 billion cubic meters, according to the Central Water Commission. The problem is only 8% of this is captured, which is among the lowest in the world.

The 2019 Chennai water crisis is an ongoing water crisis occurring in India, most notably in the city of Chennai



in Tamil Nadu. On 19 June 2019, Chennai city officials declared that “Day Zero”, or the day when almost no water is left, had been reached, as all the four main reservoirs supplying water to the city had run dry. Because tap water has stopped running, some families have been relying on alternative water sources such as distant, unreliable public water pumps, and costly private water tankers. This makes us to think “Is clean water a dream for many peoples living in the world”.

Being a great friend to the farmers by making them to produce water for agriculture on their own during summer season and to ensure the livelihood of farmers. There is a major important reason to implement our product for emergency situations. It doesn't matter where you are living either in a remote area, or your job is taking you to a place where living conditions are less than favorable, our device will get you covered when it comes to clean drinking water.

#### ACHIEVEMENTS

We are shortlisted in the quarter finals of completion entitled India Innovation Challenge Design – 2019 organized by DST and TEXAS Instruments. Out of 18,000 teams our team comprised of our students (Team Id-1051353) shortlisted.

### *Legacy of IEI*



Shri Pranab Mukhejee, President of India, in the inaugural programme of the 28<sup>th</sup> Indian Engineering Congress at Chennai in 2013



# Development of Ultra Low Power Medical Platform in Defining the Prediction Horizon and Real Time Prediction of Epileptic Seizures from Non-Invasive Scalp Electroencephalography Signals

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## INTRODUCTION

Epilepsy is the second most common neurological disorder occurring frequently, after stroke. Epilepsy is not a single disease; it results when there is any chemical imbalance or any non-linear dynamic fluctuations in the brain. Epilepsy is caused due to the injuries in the brain, which results in the imbalance of the chemicals in the brain. The patients affected with epilepsy are charged with a life-long burden of incapability for leading a common life. Even the day-to-day activities like driving a vehicle, swimming in a pool, climbing a tree, crossing a road, and so on becomes so difficult for the patients affected with epilepsy, that often results in serious injuries which are sometimes even fatal. Their quality of life is reduced and hence solely depending on their caretakers for the rest of their lifetime.

## MOTIVATION

Seizure forecasting is necessary for the epileptic patients to lead a normal life. Electroencephalogram (EEG) signals displays the activities of the brain, hence capturing the dynamics of the seizures too. From the studies, there exists four seizure states such as interictal (between two seizures), preictal (prior to seizure), ictal (seizure) and postictal (after seizure). Accurate prediction of seizures well before its commencement alarms the epileptic patients to take necessary actions to reduce the effect of these seizures and hence uplifts their lifestyle.

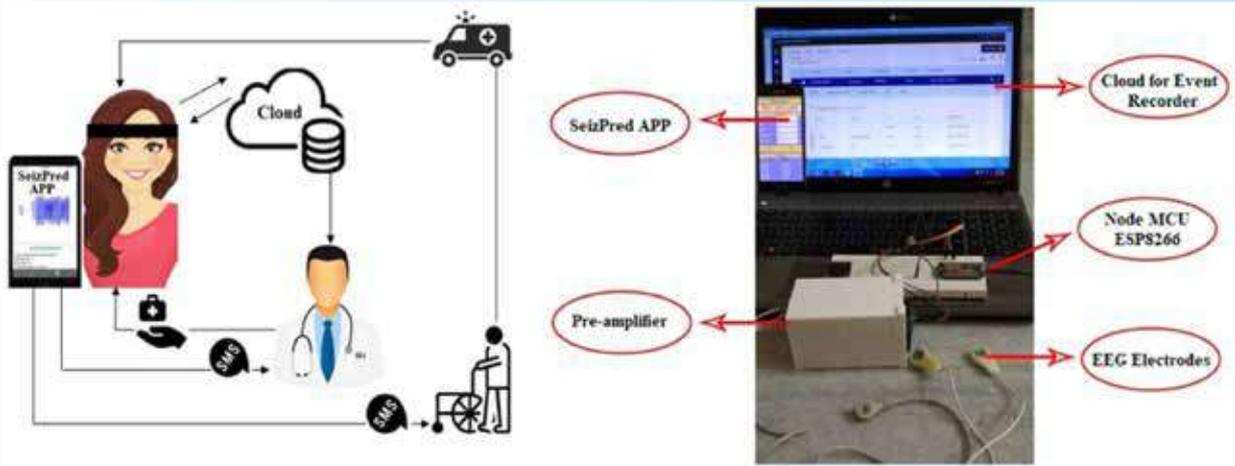
## OBJECTIVE

The major objective of this work is the real-time prediction of the epileptic seizures well before its onset. The seizure prediction is nothing but the early identification of the preictal state. Accurate prediction of seizures well before its onset aids in alarming the patients to take safety measures against injuries, eventually consenting for the early treatment or even for the anticipation of seizures.

## CONTRIBUTIONS

In this work, a smart IoMT based seizure predictor which fits into a headband weighing of 30 g, which is capable of working continuously up to 33 hours is proposed. Less complex scalp EEG electrodes, suitable for attaching to any fabric of the headband, along with a simple front-end circuitry is used. A Seizure Prediction Tag (SPT) consisting of less complex and less energy consuming Node MCU ESP8266 based hardware is implemented. IBM, Firebase and ThingSpeak IoT are utilized as the cloud for connecting the hardware set up to the remote emergency end, also the processing of the seizure prediction is done in the cloud to avoid data

overhead. An Enhanced Convolutional Neural Network (ECNN) classification model, optimized using Fletcher Reeves Algorithm (FRA) for accelerating the convergence and minimizing the model complexity is utilized. A Premium Seizure Prediction Horizon (PSPH) is gained by means of the Phase Transition Predictor (PTP) based on the Kullback-Leibler (KL) divergence.



Flow of Proposed Epileptic Seizure Predictor

Environmental set up of ForeSeiz

### ACHIEVEMENTS

Empirical results of the proposed model validated using transfer learning on 300 EEG recordings of CHB-MIT, NINC and SRM databases, ForeSeiz beats the existing algorithms with accuracy of 97%, FPR of 0.12 h<sup>-1</sup>, FNR of 0.15 h<sup>-1</sup> and with sensitivity of 94%. A compatible Seizure Prediction mobile application (SeizPred APP) is designed for the connection to the Firebase cloud, for computing the states of the epileptic patients for further reference for the doctors and if any onset of seizure is predicted, it is immediately informed to the caretakers for further intervention actions.



Snapshots of subjects with proposed seizure predictor headband



Snapshots of SeizPred pages of normal subject



Snapshots of SeizPred pages of abnormal subject

Project Demo Link:

<https://drive.google.com/file/d/1c3QY1cH1eSfRFEoy7wrQqTIVnJclRlui/view?usp=sharing>

## PUBLICATIONS

### List of Journals

1. Banu Priya Prathaban and Ramachandran Balasubramanian, "Prediction of epileptic seizures using Grey Wolf Optimized Model Driven mathematical approach", *Microprocessors and Microsystems*, 2020; 103370, <https://doi.org/10.1016/j.micpro.2020.103370>(SCI – 1.525)
2. Banu Priya Prathaban and Ramachandran Balasubramanian, "Dynamic learning framework for epileptic seizure prediction using sparsity-based EEG Reconstruction with Optimized CNN classifier", *Expert Systems with Applications*, 2020; 170:114533. <https://doi.org/10.1016/j.eswa.2020.114533>(SCIE – 6.954)
3. Banu Priya Prathaban and Ramachandran Balasubramanian, "Computational Analysis of W-MOBICA



- and SER Strategies in Automatic Electroencephalographic Source Separation for Seizure Prediction Application”, Journal of Computational Science (Accepted for Publication) (SCIE – 3.976)
4. Banu Priya Prathaban and Ramachandran Balasubramanian, “Proficient RO-RNN Learning Model for Seizure Prediction Systems”, Journal of Cardiovascular Disease Research (Accepted for Publication) (Scopus – 1.139)
  5. Banu Priya Prathaban and Ramachandran Balasubramanian, “Redefining the Prediction Horizon of Epileptic Seizures using Electroencephalogram Signals”, Proceedings of the iMeche, Part H: Journal of Engineering in Medicine, (Awaiting for final decision after minor revision) (SCI – 1.617)
  6. Banu Priya Prathaban, Ramachandran Balasubramanian and R. Kalpana, “A Wearable Headband for Forecasting Real-time Epileptic Seizures”, IEEE Sensors Journal, (Under Review after revision) (SCI – 3.076)
  7. Banu Priya Prathaban, Ramachandran Balasubramanian and R. Kalpana, “ForeSeiz: An IoMT based Headband for Real-time Epileptic Seizure Forecasting”, Expert Systems with Applications, (Under Review after revision) (SCIE – 6.954)

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1. Banu Priya Prathaban and Ramachandran Balasubramanian, “Automatic Artifact Removal from EEG Signals using W-MOBICA”, IEEE 4th Conference on Information & Communication Technology (CICT), IITDM, Kancheepuram, December 5, 2020, pp. 1-5, <https://doi.org/10.1109/CICT51604.2020.9312082>(Scopus Indexed)
2. Banu Priya Prathaban and Ramachandran Balasubramanian, “Proficient RO-RNN Learning Model for Seizure Prediction Systems”, International conference on Electronics, Photonics and smart technology at SRM Institute of Science and Technology, Kattankulathur, Chennai, November 2020.
3. Banu Priya Prathaban and Ramachandran Balasubramanian, “Computational Analysis of W-MOBICA and SER Strategies in Automatic Electroencephalographic Source Separation for Seizure Prediction Application” in National Conference on Innovations in Engineering & Management, FRENED, April 2, 2021.

### *Legacy of IEI*



Mohammad Hidayatullah, Vice President of India, Mother Teresa and Shri Jyoti Basu, Chief Minister of West Bengal during the Diamond Jubilee Celebration of The Institution of Engineers (India) in 1980

# Selectively Patterned Porous Evaporative Structure for Enhanced Solar Driven Interfacial Evaporation

## Student

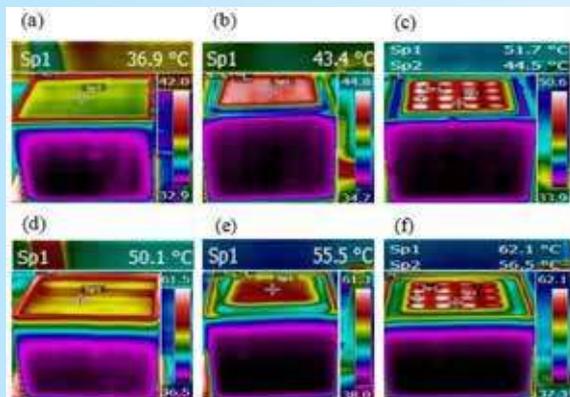
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## Guide

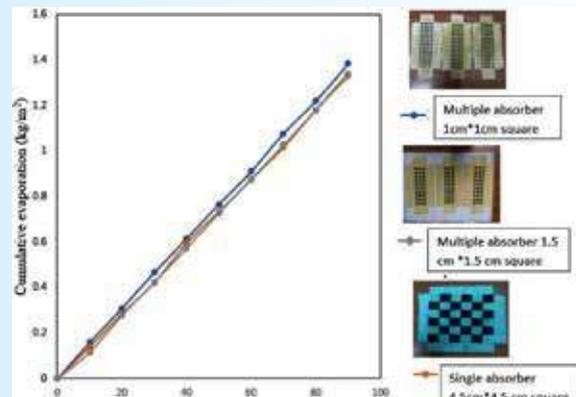
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a), b), and c) Thermal images after 2 minutes of bulk heating, interfacial heating without pattern and with pattern respectively. d), e), and f) Thermal images after 30 minutes of bulk heating, interfacial heating without pattern and with pattern



Cumulative evaporation rate

## OBJECTIVE

- Determined the suitable wicking material for interfacial evaporation by observing vertical wicking characteristics through static & dynamic absorption studies.
- Developed a novel reliable and efficient solar absorber system (CNT, Graphene, and NBP with different wicking materials) using a solar collector.
- Optimized the aspect ratio of absorber patterns for efficient conversion of light to heat.
- Determined the optimum pitch distance between adjacent patterns for effective transmission of heat.

## ACHIEVEMENTS

The proposed project was mainly focused on developing a novel, reliable, and efficient solar absorber system for evaporative study utilizing interfacial evaporation. The study includes selecting efficient wicking structure, the effect of absorber patterns on interfacial evaporation, optimizing aspect ratio and pitch for better performance, etc. Static and dynamic absorption along with vertical wicking experiments were conducted on three different



wick materials. Static and dynamic absorption experimental setup was arranged with the help of supporting stands, hinges, and CAS electronic weighing balance. For the vertical wicking experiments, a thermal imaging camera coupled to the personal computer was utilized for capturing the water movement and for determining temperature profile. The results show that the polyvinyl alcohol (PVA) has greater static and dynamic water absorption capacity, followed by ALP and cotton cloth. The increase in static absorption is due to high water absorption capacity, high-water capillary rates due to its porosity, and osmotic swelling capacity of PVA cloth. PVA has highly porous with interconnected fibers that promote water absorption. PVA also exhibited higher vertical wicking, which indicates its higher capillarity. From the experiments, PVA is found to be the efficient hydrophilic wicking structure.

For an evaporative study on PVA, the experimental setup was fabricated and consists of a solar simulator, an evaporative system with absorber, wicking and floating structure, baffles, water source, dimmer stat, and electronic weighing balance. A solar simulator with four halogen lamps, each of 500 watts, is used as the illuminating source for irradiating the test specimen. Light intensity is varied using a dimmer stat capable of providing light at different intensities by adjusting the voltage. Polystyrene foam with low thermal conductivity to reduce losses is used as the hydrophilic floating structure in the present study. The thickness was optimized by conducting an evaporative study using polystyrene foam of different thicknesses (10 mm, 20 mm, and 25 mm) and also compared with bulk heating. The optimized thickness was found to be 20 mm. Solar absorber (top surface of PVA wicking structure) with square patterns printed on it with NBP was used for the evaporative study to investigate the effects of patterned absorber on interfacial evaporation. It's evident from the results that the rate of interfacial evaporation for the patterned absorber is more than that of the bare absorber. The heating is confined at the water-air interface for interfacial evaporation, which leads to low heat losses and high conversion efficiency. The evaporative design promotes the localized heating of the evaporative surface at the air-water interface by controlling the water supply onto the porous evaporator by using an efficient wicking structure. The efficient evaporative design prevents overheating of the evaporator, conductive, convective, and radiative heat losses from the evaporator to the ambient system, and surroundings can be minimized. This enhances the vapor generation efficiency in interfacial evaporation. The solar-vapor conversion efficiency was obtained as 82.2% at an evaporation rate of  $1.91 \text{ kg m}^{-2}$ . This efficient solar interfacial evaporation system developed can be coupled into applications like a solar still for desalination, thus providing a promising solution to freshwater scarcity.

#### **PUBLICATION**

Experimental evaluation on the capillarity effect of different wicking structure incorporated in a patterned absorber facilitating solar interfacial evaporation. Journal of Thermal Analysis and Calorimetry.

## *Legacy of IEI*



## Development of Portable Multipurpose Computer Numerical Controlled Machine to Cater the Needs of SMEs and Tribal Community

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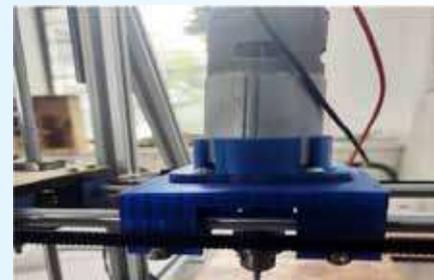
**Portable Multipurpose Computer  
Numerical Controlled Machine**



**3D Printing setup module**



**Laser Engraving setup module**



**PCB Milling setup module**

### OBJECTIVE

To cope up with the changes, in the current scenario, owing a PCB engraving machine by small and medium scale enterprises (SMEs) is not an encouraging investment. Therefore, there is a need to develop low cost, effective and efficient multi-purpose portable PCB engraving machine that could pave way to establish startup business ultimately. Even in this modern era, tribal people in our country are not able to procure spares required for home appliances like gas stove, table fan, mixer grinder, bulb holders and sanitary items due to location difficulty

Keeping the above requirements in mind, a low cost prototype PCB engraving machine(single purpose), was developed and tested according to industry standards, but is capable of fulfilling the needs partially. It is a 3-axes



computer numerical controlled machine, which can control the motions in three directions with better accuracy. Over years, engineers have proven the power of 3D printing to accelerate product development, elevate quality and lower costs. Hence, the developed prototype can further be enhanced with additional capabilities such as 3D printing and laser cutting operations. This could be achieved by developing a modular head which can be selected according to the operation needed, within no time. Increasing the functionality of the machine allows user to work smarter and innovate more freely.

So the major objective of this project work is to design and fabricate a portable multipurpose computer numerical control machine employed with multi operations like 3D printing, laser engraving and CNC milling machine.

This objective is achieved through the following:

1. Designing and CAD modelling.
2. Fabricating the machine.
3. Designing a modular head to accommodate 3D printer head, laser head and milling tool
4. Testing and fine tuning.
5. Training the representatives of the local tribal people.

### ACHIEVEMENTS

Fabrication of portable multi-purpose computer numerical controlled machine which is capable of carrying out three different operations namely printing of physical objects from the polymeric filaments, engraving the acrylic sheets, wooden boards and PVC using low power laser and making circuits on the printed circuit boards. The operations can be chosen by fixing the required tool head to the designed fixture.

An open source software is employed to control the entire processes which are also generating the G and M codes of computer numerical controlled operations. By utilizing the stepper motors for all the three axes the following accuracy is achieved:

x-axis:  $\pm 0.04$  mm

y-axis:  $\pm 0.04$  mm

z-axis:  $\pm 0.04$  mm

A fixture is designed in such a way to facilitate the change of tool heads used for three different units of operations. Using this design the tools like extruder head, laser head and milling tool can easily be fitted with minimum time.

The aluminum made channel sections are used to provide necessary rigidity to the structure and with proper selection of materials, the weight of the machine is limited to 15 kg which can be easily carried to any place.

Presented a conference paper entitled “Development of portable multipurpose computer numerical control machine” in the international conference on “New Age Systems and Automation Technologies (ICNAAT)” held during 09-10 July 2021. Further the extended version of the paper is submitted for the publication in the scopus indexed journal.

A design was made to have multiple operations in a single tool, especially for the 3D extruder. An Indian patent entitled ‘Multi-functional tool for the extruder unit of a 3d printer’ Was filed on 07th June 2021.

### PUBLICATION

A.B Jai Krishna Moorthi, K. L. Senthil Kumar, S. K. Dhinesh and A. Megalingam @ Murugan ‘Development of portable multipurpose computer numerical control machine’ was presented in the international conference on ‘New Age Systems and Automation Technologies (ICNAAT)’ during 09-10 July 2021.

## 3D Printing of Bone Scaffolds from Natural Materials for Effective Bone Regeneration

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### Institute

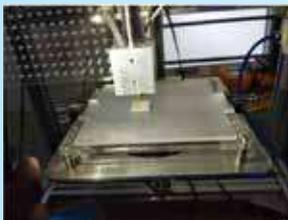
Annamacharya Institute of Technology  
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Cuddapah (Dist.), Andhra Pradesh  
IM 000215-3



Synthesis of composite material



Dissolving polymer into the solvent



3D printing of polymer composite sample



3D Printed cube shape polymer composite sample

### OBJECTIVE

Every day thousands of surgical procedures are performed to replace or repair tissue that has been damaged through disease or trauma. The developing field of tissue engineering (TE) aims to regenerate damaged tissues by combining cells from the body with highly porous scaffold biomaterials, which act as templates for tissue regeneration, to guide the growth of new tissue. The scaffold must satisfy two factors in the view of this application, one is mechanical strength and the other is biological activities (cell proliferation, differentiation etc.). Strength of the scaffold majorly effected by the type of the material, porosity, pore size, pore shape, scaffold external shape. External shape of the scaffold will be changed to its area of usage in the human body, pore size and pore shape can be decided by the maximum load acting on the scaffold, porosity and material will be varied with respective to age and bone strength of the patient. Nowadays scaffold used in the surgery is not a customized , with this patients are facing lot of problems which are not possible to cure in their entire life.

Finally we successfully developed pneumatic extrusion machine to meet this project requirements.



## ACHIEVEMENTS

In this step we developed patient specific CAD model from CT scan. In this process we used MIMICS software. This CAD model further used to meet different requirements.

### Mimics

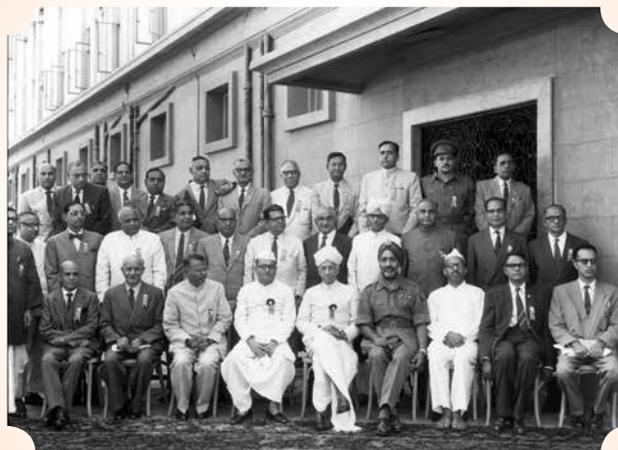
Materialise Mimics is an image processing software for 3D design and modeling, developed by Materialise NV, a Belgian company specialized in additive manufacturing software and technology for medical, dental and additive manufacturing industries. Materialise Mimics is used to create 3D surface models from stacks of 2D image data. These 3D models can then be used for a variety of engineering applications. Mimics is an acronym for Materialise Interactive Medical Image Control System. It is developed in an ISO environment with CE and FDA 510k premarket clearance. Materialise Mimics is commercially available as part of the Materialise Mimics Innovation Suite, which also contains 3-matic, a design and meshing software for anatomical data.

### Process

Materialise Mimics calculates surface 3D models from stacked image data such as Computed Tomography (CT), Micro CT, Magnetic Resonance Imaging (MRI), Confocal Microscopy, X-ray and Ultrasound, through image segmentation. The ROI, selected in the segmentation process is converted to a 3D surface model using an adapted marching cubes algorithm that takes the partial volume effect into account, leading to very accurate 3D models. The 3D files are represented in the STL format.

After selection of suitable values in the above parameters for the developed of prepared CAD model G and M codes based source code has to be developed. This G and M code depend on the type of controller and firmware used to run the pneumatic extrusion machine. The machine has developed with RAMPS1.4 (ATmega 2560 processor) with Marlin-1.1 version. Simplify 3D software has been used to develop the G and M code for the selected controller and firmware.

## *Legacy of IEI*



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



# The Institution of Engineers (India)

Recognized as Scientific & Industrial Research Organization by  
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

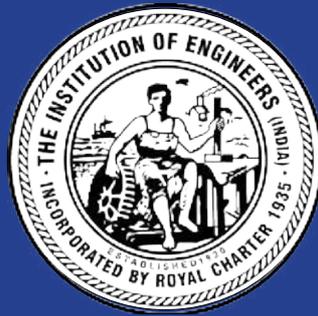
1. The project title should have clarity and must be relevant to the proposal.
2. Attach supporting documents for NBA / NAAC Accreditation or valid NIRF Rank for the Institutions.
3. Applications from Institutional Members [IMs] will be preferred.
4. Do not include names of more than two guides for a 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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