MS IITM AARDO SCHOLARSHIP PROGRAM

RESEARCH PROJECTS

Project: IA-000101

Renewable bioenergy production through waste valorisation for a sustainable circular economy

Project Nature: Experimental and literature survey

Department: Civil Engineering

Background Preferred: Mechanical, Chemical, Biomedical Engineering

Description and Objectives: This project aims to advance renewable bioenergy production through waste valorisation by integrating experimental studies with field surveys in Asian and African contexts. Laboratory-scale trials will optimize bioenergy yields from diverse organic wastes using anaerobic digestion and dark fermentation, while monitoring gas composition, energy output, and nutrient recovery. Parallel field/literature surveys will assess waste generation patterns, feedstock availability, socio-economic drivers, and stakeholder perspectives. By combining experimental data with field/literature insights, the study will model scalable energy outputs, greenhouse gas mitigation, and economic viability. The outcomes will build local research capacity and provide practical recommendations for decentralised bioenergy adoption and sustainable circular economy strategies in both regions.

Reading References and Materials: Investigating the performance of internet of things based anaerobic digestion of food waste-

www.sciencedirect.com/science/article/pii/S0957582019304239?via%3Dihub

Project:IA-000102

Development of microfluidic point-of-care diagnostic devices for rural health empowerment

Project Nature: Interdisciplinary and Experimental involving fieldwork

Department: Applied Mechanics & Biomedical Engineering

Background Preferred: Mechanical, Chemical, Biomedical Engineering

Description and Objectives: The project focuses on designing, fabricating, and evaluating affordable, portable microfluidic diagnostic chips tailored for diseases prevalent in rural communities (e.g., malaria, anaemia). The stakeholders will be enabled for deploying these technologies in resource-limited, rural health settings in both Africa and India.

Interdisciplinary Components:

- Microfluidics Engineering: Design and build centrifuge-driven or paper-based microfluidic chips that perform rapid, low-cost blood diagnostics suitable for field use.
- Rural Health Technology: Identify priority diseases (malaria, anemia, maternal health) and develop specific microfluidic assays for early detection in rural clinics, using mobile-connected or battery-powered readers.
- Cost & Impact Assessment: Develop and propose innovative models (e.g., microfinancing, subsidies, local manufacturing incentives) to lower adoption barriers and maximize social benefit, drawing comparisons between both regions.

Example Project Modules

- **Lab-on-a-Disc Experiments:** Prototype and field-test CD-based microfluidic systems for anemia and malaria diagnosis, focusing on stability under extreme rural conditions (heat, humidity, limited electricity).
- **Deployment Strategy Brief:** Create detailed public policy recommendations, including workforce upskilling plans, device certification pathways, and funding sources for scale-up in underserved communities.
- **Community Feedback Loop:** Pilot the diagnostic devices in select rural areas, gather feedback from local health workers, and employ this data to iterate both the technology and the policy frameworks.

Skills and Outcomes

The project combines microfluidics engineering, rural health analysis, and public policy drafting, producing functional diagnostic prototypes, data-driven policy briefs, and roadmaps for scalable introduction into African healthcare systems. This experience equips students to drive innovation and systemic change in resource-poor settings through advanced technology and policy integration.

Such a project directly addresses the intersection of microfluidics, rural development, and public policy, enabling collaborative learning and real-world impact across continents.

Reading References and Materials: Basic understanding of Fluid Mechanics

Project: IA-000103

Design, development and characterisation of agricultural pump

Project Nature: Computational and Experimental

Department: Mechanical Engineering

Background Preferred: Mechanical, Aerospace, Chemical engineering

Description and Objectives: Agricultural pumps typically have very low efficiencies, and increasing the efficiency of such pumps helps in the energy economics of the country. We will start with the meanline design, followed by detailed numerical simulations and finally experimentally demonstrate the performance.

Reading References and Materials: Books:

1. Centrifugal Pumps: Design and Application by Lobanoff & Ross
2. Centrifugal Pumps by Gulich

Project: IA-000104

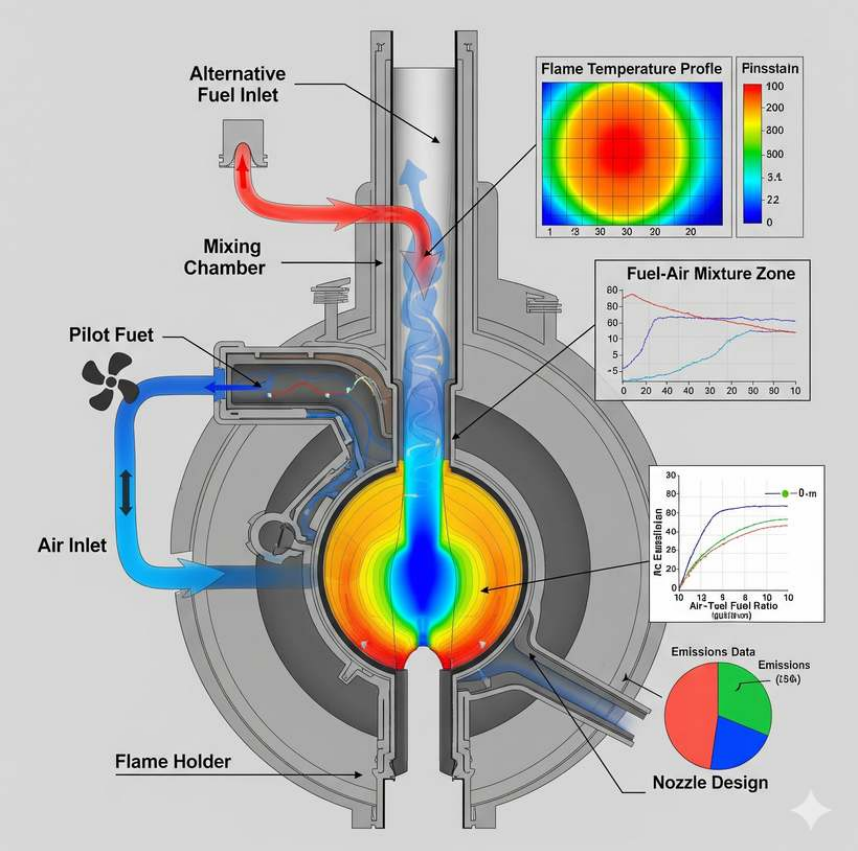
Analysis of burners using alternative fuels

Project Nature: Experimental and Numerical Analyses

Department: Mechanical Engineering

Background Preferred: Thermodynamics, heat transfer, and Fluid Mechanics courses

Description and Objectives: The aim of the project is to analyze burners using alternative fuels such as syngas, biogas, hydrogen and ammonia and fine tune its performance.



Project: IA-000105

Wearable Energy Harvesting from Human Locomotion for Rural and Remote Applications

Project Nature: Experimental

Department: Mechanical Engineering

Background Preferred: Mechanical, Materials, Mechanics, or Electrical Engineering

Description and Objectives: The world advances toward a smarter, more connected future, sustainable and localized energy generation is becoming increasingly vital—especially with the rise of wearable electronics. Many everyday electronic devices that require only low power currently rely on lithium-ion and other batteries, which have limited lifespans and pose significant environmental challenges at the end of their limited lifespan. In this context, the recent emergence of Triboelectric Nanogenerator (TENG) technology offers a promising alternative for clean, small-scale energy harvesting.

This project aims to harness ambient energy generated during human locomotion—such as walking or running—to produce electrical power. It brings together a multi-disciplinary approach involving additive manufacturing, advanced functional materials, flexible electronics, and TENGs. Key areas of focus include exploring innovative folding mechanisms, optimizing TENG integration within the shoe sole, and developing 3D-printed flexible electronics for effective power management. The ultimate goal is to create a working prototype of a Smart Shoe capable of generating electricity, with long-term durability, robustness, and reliable performance, offering a sustainable solution for autonomously powering low-energy wearable devices.

Reading References and Materials:

- www.sciencedirect.com/science/article/pii/S2211285519304690
- spj.sciencemag.org/journals/research/2020/7158953/

Project: IA-000106

Machine learning for photonic solutions for advanced and societal technologies

Project Nature: Computational and Experimental

Department: School of Interdisciplinary Studies

Background Preferred: Electrical, Computer, or Mechanical Engineering, Physics, or Chemistry

Description and Objectives: In this project we will apply machine learning techniques to solve problems in optical imaging and spectroscopy for solutions through photonics and optics, with particular relevance to advanced and societal technologies.

Project: IA-000107

Development of Coir-pith and Coir-fiber Hybrid composites for Industrial applications

Project Nature: Agricultural sustainability, waste management

Department: Mechanical Engineering

Background Preferred: Mechanical or Chemical Engineering.

Description and Objectives: Agricultural waste is a serious environmental problem in many countries. Moreover, fruit by-products represent a significant and increasing proportion of this waste. For ecological sustainability the importance of finding alternative uses for this waste is highly important. Two important waste products we look into are coir pith and coir short fiber.

The MS project is to make a hybrid composite making use of both coir pith and short coir fiber for industrial use such as thermal insulation material, vehicle interior panels. The properties we expect are good thermal insulation, thermal stability, sound absorption and satisfactory mechanical strength and durability. Typically fiber composites are made of a fiber (reinforcing material) and a matrix. In the hybrid composites we propose to use a mix of coir pith and short coir fiber along with a very small quantity of synthetic fiber such as glass, carbon or aramid. Or it can even be another natural fiber such as bamboo. The important advantage of using a hybrid composite is that, since it is made up of more than one fiber, if any one fiber lacks certain characteristics it can be complemented by the other fiber, and also a balance in cost and performance of this type of composite can be obtained by proper material design considerations. Better results could be obtained by hybrid composites depending upon various properties like fiber length, strength, orientation, fiber-to-matrix bonding and layout. The challenges in the project could involve giving the appropriate pre-treatment to the coir fibers and pith to improve the interfacial bonding, and also trying various other synthetic and natural fibers and matrix (polymer materials) which are preferably made of sustainable materials.

Reading References and Materials:

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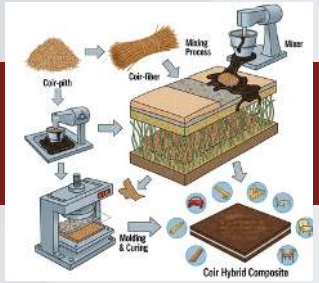

Project: IA-000108

Smart Rural Mobility Hubs: Electrified Transport, Farming, and Healthcare through Renewable Energy

Project Nature: Applied Research

Department: Engineering Design

Background Preferred: Mechanical , Electrical Engineering, Energy, Computer Science Engineering, Aerospace, Agricultural Engineering and Public Policy

Description and Objectives: Rural communities in India face critical challenges in mobility, farming efficiency, healthcare access, and energy reliability. Dependence on diesel vehicles makes rural transport expensive, unreliable, and environmentally unsustainable, while poor road and fuel access often delay farming operations and emergency healthcare. This project proposes to create a solar-powered, AI-optimized rural mobility ecosystem integrating e-rickshaws, e-autos, e-minibuses, EV tractors, and UAVs to provide sustainable solutions for commuting, agricultural logistics, and healthcare delivery. By combining powertrain electrification, renewable energy microgrids, and intelligent scheduling, the project aims to improve rural access to schools, hospitals, markets, and e-commerce opportunities, while promoting local entrepreneurship and resilience.

- Design and deploy rural-specific electrified vehicles (e-rickshaws, e-autos, e-minibuses, EV tractors) powered by locally generated solar energy.
- Develop AI-based scheduling and route-optimization models for passenger and cargo mobility, accounting for seasonal agricultural demand and daily community travel patterns.
- Establish hybrid EV–UAV frameworks for last-mile healthcare and e-commerce connectivity, particularly during natural calamities or in low-accessibility areas.
- Model energy flows within rural solar-powered microgrids, ensuring sufficiency for both household and mobility needs, while minimizing downtime due to energy shortages.
- Evaluate techno-economic and policy frameworks for rural adoption, focusing on subsidies, rural entrepreneurship, cooperative mobility models, and sustainable financing mechanisms.

The main research activities of the project will focus on developing and testing rural-appropriate electrified vehicles and their integration within a decentralized renewable energy ecosystem. First, prototypes of EV tractors will be designed and evaluated for high-torque, low-speed farming applications, alongside retrofitted e-rickshaws, e-autos, and e-minibuses tailored for rural commutes and cargo transport. These vehicles will be powered through village-scale solar microgrids, and experiments will be conducted to study the sufficiency, reliability, and load balancing of locally generated clean energy across both household and mobility demands. On the digital intelligence side, reinforcement learning-based scheduling and route optimization models will be developed and validated, capturing seasonal agricultural cargo peaks and daily commuter needs. To further extend accessibility, hybrid EV–UAV trials will be carried out, where ground-based EV cargo fleets transport goods to rural hubs, and UAVs enable last-mile delivery for healthcare, e-commerce, and disaster-relief applications. Together, these experiments will demonstrate the technical feasibility and operational efficiency of a sustainable rural mobility ecosystem.

Reading References and Materials:

1. Electric tractors: Survey of challenges and opportunities in India;
2. Standalone photovoltaic and battery microgrid design for rural areas
3. Drone-based medical delivery in the extreme conditions of Himalayan region: a feasibility study

Project: IA-000109

Enterprise Solution for Mango Pulp Industry

Project Nature: The project integrates waste valorization, process engineering, and rural entrepreneurship models to convert mango pulp industry by-products (seeds, peels, fibers) into value-added products such as mango butter, starch, pectin, charcoal briquettes, and biodegradable materials.

Department: Chemical Engineering

Preferred Background: Mechanical Engineering with rural entrepreneurship aspirations.

Description and Objectives: The project aims to develop an integrated processing system for mango seed and peel waste generated by the pulp industry.

The objectives are:

- To design and optimize small-scale, cost-effective machinery (dryer, decorticator, oil expeller, pectin extractor).
- To establish value chains for by-products (butter, starch, pectin, briquettes, biodegradable bags).
- To enable rural entrepreneurs and small farmers to generate income through mango waste utilization.
- To reduce environmental pollution and landfill pressure by upcycling agro-waste.
- To create scalable business models aligned with circular economy and green energy goals.

Reading References and Materials:

1. Mitra, S.K., Pathak, P.K., Lembisana Devi, H., & Chakraborty, I. (2013). *Utilization of seed and peel of mango.* https://doi.org/10.17660/ActaHortic.2013.992.74

2. Jahurul, M.H.A., Zaidul, I.S.M., Norulaini, N.N.A., Sahena, F., Jaffri, J.M., & Omar, A.K.M. (2014).
Supercritical carbon dioxide extraction and studies of mango seed kernel for cocoa butter analogy fats.
CyTA – Journal of Food, 12(1), 97–103.
https://doi.org/10.1080/19476337.2013.801038

3. Shinde, N.V. (2017).
Development of Pectin Extraction Unit for Mango Peel and Cost Economics of Extraction (Master's thesis).
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, India.

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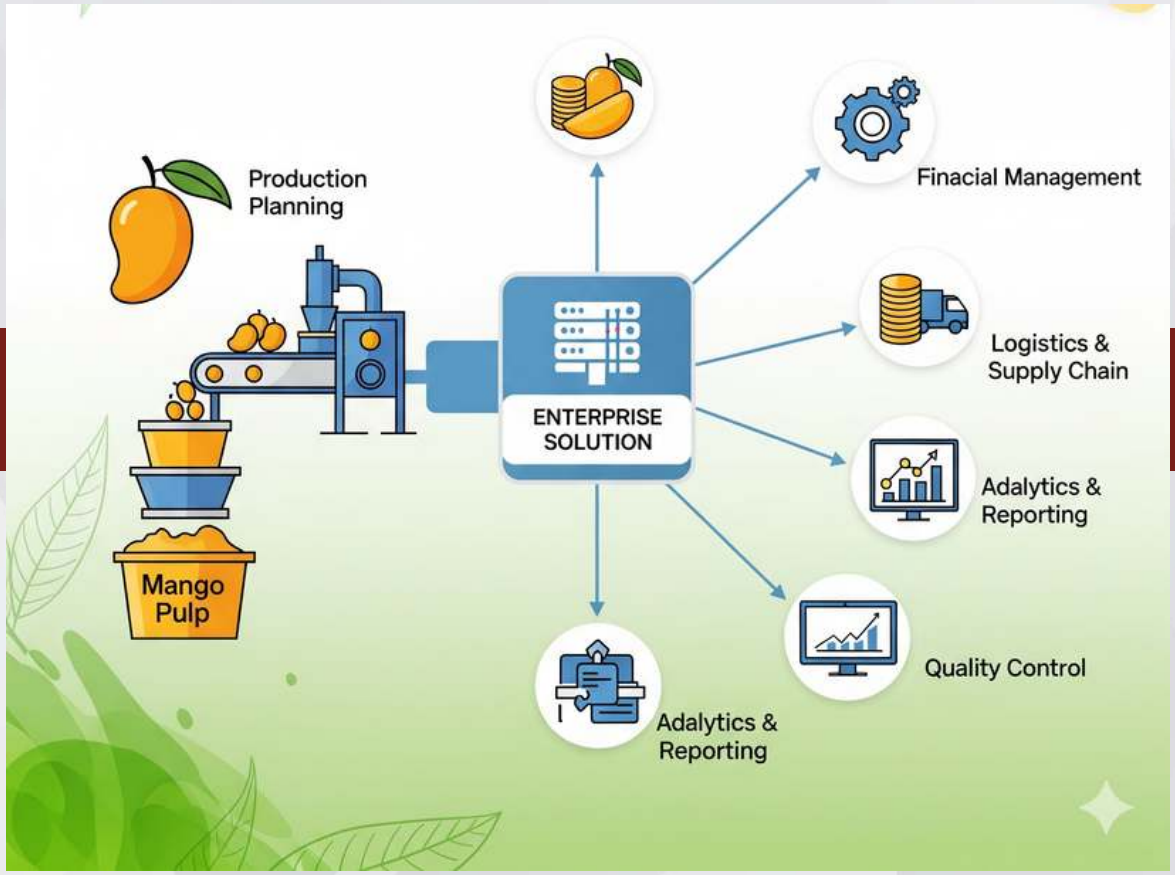

Project: IA-000110

Manufacturing of Lithium-ion Batteries Through Aqueous Processing for Tropical Countries

Project Nature: Experimental. Will involve material synthesis, characterization, processing and battery assembly inside glove boxes.

Department: Chemical Engineering

Preferred Background: Materials Science, Chemistry, Chemical Engineering, Electrochemistry, Physics

Description and Objectives: Tropical conditions prevalent in African countries as well as India poses a challenge for manufacturing Lithium-ion batteries (LIBs) requiring massive capital investments directed towards controlled environmental dry rooms. Our approach will be a paradigm shifting one geared towards assessing the manufacturability of LIBs in tropical conditions (humidity and temperatures) using aqueous processing approaches. Apart from the advantage of being cost effective, the aqueous processing strategy is also environmentally benign avoiding the use of toxic N-methyl-pyrrolidone (NMP) solvents otherwise used in conventional LIB manufacturing. If successful, this work would drastically transform the battery manufacturing landscape in these tropical environments achieving self-reliance in a strategically vital industry of the future.

Objective:

1. Assess the aqueous processibility of lithium battery cathodes and anodes in Tropical Humidity and Temperatures.
2. Perform rheological studies on electrode slurries to establish their processability criterion in Tropical Conditions
3. Develop protocols and methods for manufacturing viable Lithium-ion batteries (100 mAh Pouch Cells) using aqueous processing routes.
4. Evaluate the electrochemical performance metrics and benchmark against standard batteries procured from Commercial Sources.

Reading References and Materials:

http://sciencedirect.com/science/article/pii/S001346862100493X

Project: IA-000111

Design, Development, and Testing of a Spray Dryer Unit for Enhanced Jaggery Production in Rural Communities

Project Nature: Research and Development

Department: Chemical Engineering

Preferred Background: Mechanical, Aerospace, Chemical Engineering

Description and Objectives: The jaggery industry is mostly spread across rural areas in the country. Being an eco-friendly sweetener with additional nutritional value, jaggery has gained significant popularity in recent years. It also holds good export potential. To sustain the market and export potential of jaggery, it is imperative to maintain its quality and automate the production process. Nevertheless, the current jaggery production process faces several constraints, including poor storability (due to its hygroscopic nature) and a lack of skilled labor (since the process is manual in rural areas). The adaptation of spray-drying technology can greatly assist in overcoming such problems, as it also ensures the automatization of the production process. However, such technology, compatible with jaggery production in rural areas, is currently absent. The goal of the proposed project is to develop an efficient spray-drying unit to enhance the jaggery production process in rural areas. The main objective is to demonstrate the proof of concept of a rotary injector-based spray dryer unit that ensures the quality of jaggery powder and achieves a high production rate.

Reading References and Materials:

[1] Bhandari, B.R., Datta, N., Howes, T. (2007). Problems associated with spray drying of sugar-rich foods. Drying Technology, 15(2), 671–684. [2] Singh, A., et al. (2011). Spray drying of sugarcane juice: Quality and process optimization. CFTRI Technical Report, Mysuru, India.

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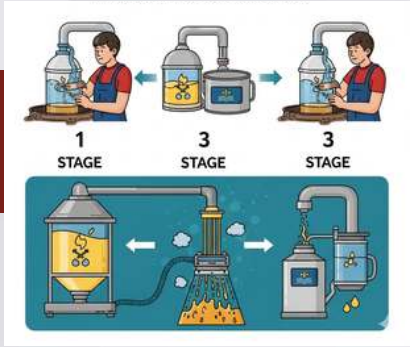

Project: IA-000112

Development of Region-Specific Climate Change Adaptation Strategies: A Special Focus on Rural Regions of Asia and Africa.

Project Nature: Downscaling of Climate model data (Simulation) and if required some field measurements.

Department: Civil Engineering

Preferred Background: Civil Engineering, Hydrology, Water resources, Climate Change Analysis

Description and Objectives: This project focuses on developing region-specific climate change adaptation strategies tailored to the unique needs of rural regions in Asia and Africa, which are particularly vulnerable to the effects of climate change. Recognizing the distinct environmental, economic, and social challenges these areas face, the project seeks to create localized solutions that enhance resilience and sustainability. The approach begins with comprehensive assessments to analyze the specific climate risks, vulnerabilities, and existing adaptation measures in selected rural communities across these continents. By engaging local stakeholders—including farmers, community leaders, and policymakers—the project ensures that the strategies developed are culturally and contextually relevant, integrating both innovative technologies and traditional knowledge.

The project will develop targeted adaptation strategies that address critical issues such as water management, agricultural practices, disaster preparedness, and ecosystem preservation. These strategies will then be piloted in select rural communities to assess their effectiveness and scalability. Additionally, the project aims to promote knowledge sharing by facilitating the exchange of best practices and lessons learned between communities, regions, and countries, thereby enhancing broader adaptation efforts across similar environments. Ultimately, the goal is to empower rural communities in Asia and Africa to better cope with the impacts of climate change, ensuring the protection of their livelihoods and ecosystems for future generations.

Reading References and Materials: Pichuka, S., & Maity, R. (2016). Spatio-temporal downscaling of projected precipitation to identify potential increases in monsoon rainfall over the Upper Mahanadi Basin, India. Hydrological Sciences Journal. Pichuka, S., & Maity, R. (2017). Method for identifying changes in extreme streamflow events under future climate scenarios with a focus on the Bhadra reservoir, India. Journal of Hydrology: Regional Studies. Pichuka, S., & Maity, R. (2018). Bayesian approach to time-varying downscaling model addressing non-stationarity in climate variables. International Journal of Climatology.

Project: IA-000113

Sustainable product development using 3D printing

Project Nature: Involves design and development of products

Department: Mechanical Engineering

Preferred Background: Mechanical, Materials Engineering, Polymers

Description and Objectives: Application of agrowaste based materials for engineering applications requires a thorough understanding of their characteristics. The project involves product development using 3D printing.

Project: IA-000114

Early detection and Prediction of sepsis using data science approaches

Department: Applied Mechanics and Biomedical Engineering

Preferred Background: Biomedical Engineering, Computer Science, Electronics, Electrical Engineering

Description and Objectives: Sepsis is a life-threatening condition that requires timely detection to improve patient outcomes. This research aims to develop a machine learning model to predict sepsis at an early stage by analyzing publicly available clinical datasets. The project will use advanced data analytics to identify biomarkers that signal the onset of sepsis. Particular emphasis will be given to adapting the model with missing and redundant data.

- To apply machine learning algorithms for developing an early sepsis prediction model.
- To communicate findings through academic publications and presentations.

Project: IA-000115

Emotion recognition using biomedical signal processing and data analysis

Department: Applied Mechanics and Biomedical Engineering

Preferred Background: Biomedical Engineering, Computer Science, Electronics, Electrical Engineering

Description and Objectives: Emotional well-being plays a vital role in both physical and mental health. Emotional dysregulation is strongly linked to psychological and physiological disorders. Emotion-related disorders, such as anxiety and depression, affect nearly 970 million people globally. For this reason, emotion recognition plays a significant role in modern digital healthcare. Although unimodal approaches have been explored for emotion classification, there is a lack of combined approaches incorporating both central and peripheral nervous system signals. This research aims to develop a multimodal emotion recognition system using electroencephalography (EEG) and electrocardiography (ECG) signals. By integrating neural and autonomic indicators of emotion, the study seeks to construct robust machine learning models capable of classifying human emotions across diverse populations. The outcomes are expected to contribute to mental health screening, stress monitoring, and human–machine interaction systems.

- To extract meaningful important features from EEG and ECG signals to differentiate between various kinds of emotion.
- To apply machine learning models for multimodal fusion-based emotion recognition.
- To communicate findings through academic publications and presentations.

Project: IA-000116

Classification of Motor Imagery Tasks using Electroencephalogram for Brain Computer Interface Applications

Department: Applied Mechanics and Biomedical Engineering

Preferred Background: Biomedical Engineering, Computer Science, Electronics, Electrical Engineering

Description and Objectives: Brain–Computer Interface (BCI) has emerged as a revolutionary technology for enabling communication and rehabilitation in people with motor disabilities caused by stroke, paralysis, or spinal cord injuries. Motor imagery refers to the mental simulation of movements in motor organs, which modulates EEG signals in the corresponding brain regions. Recording brain signals from these regions and identifying motor imagery patterns in EEG data can be used to control external devices. This project will analyze motor imagery brain signals to identify more discriminative features and effective classification models. Optimization in EEG recording and classification is expected to advance BCI technology, making it more practical and feasible for beneficiaries.

- To extract relevant and significant discriminant features for better classification of motor imagery tasks from EEG.
- To design a deep learning architecture with reduced complexity and physiological relevance.
- To communicate findings through academic publications and presentations.

Project: IA-000117

Digital Health Solution for Rural Development: A Policy Framework to Improving Healthcare Access and Outcomes

Project Nature: An application of policy-driven, and developmental research initiative aimed at leveraging digital technologies to improve healthcare access and outcomes in rural communities.

Department: Management Studies

Preferred Background: System Administration

Description and Objectives: The project "Digital Health Solution for Rural Development: A Policy Framework to Improve Healthcare Access and Outcomes" seeks to explore how digital technologies can be effectively integrated into rural healthcare systems to address issues of accessibility, affordability, and quality of care. Rural areas often face challenges such as inadequate medical infrastructure, a shortage of healthcare professionals, and limited access to timely services. By leveraging digital health solutions such as telemedicine, mobile health platforms, electronic medical records, and AI-driven diagnostic tools, this project aims to design a policy framework that strengthens rural healthcare delivery. The framework will provide strategies for policymakers, health institutions, and development partners to enhance healthcare outcomes and reduce disparities between rural and urban populations.