



భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

॥ नमोऽभ्येष्टे देशनिर्माणम् ॥

PhD in ENGINEERING SCIENCE

Interdisciplinary Research for
Engineering Solutions to
Real-World Challenges



Interdisciplinary
Research



State-of-the-Art
Facilities



Real-World
Impact

About Engineering Science at IIT Hyderabad

The Department of Engineering Science offers a holistic and interdisciplinary research environment that brings together expertise from across engineering and allied disciplines. The programme encourages fundamental and applied research to address complex real-world challenges through integrated engineering approaches, with a strong focus on innovation, technology development, and societal impact.

Research Areas

- Interdisciplinary engineering
- Data-driven technologies
- Human-centered systems
- Sustainability and resilience
- Societal impact and innovation

PhD Research Opportunities

1 Non-Invasive Peripheral Neuromodulation for Real-Time Regulation of Acute Stress: A Brain-Body Systems Approach

Investigators

Dr. Neeraj Kumar
Dr. Nagarajan Ganapathy



This project focuses on developing non-invasive neuromodulation approaches for real-time stress regulation using multimodal physiological measurements and wearable technologies. The research aims to develop a closed-loop neuromodulation system for continuous stress monitoring and targeted stimulation.



Relevant Backgrounds

- Biomedical Engineering
- Biomechanical Engineering
- Electrical / Electronics Engineering
- Computer Science & Engineering
- Related disciplines

2 Data-Driven Road Safety Auditing Using Multimodal Infrastructure and Vehicle Trajectory Data

Investigators

Dr. Abhinav Kumar
Dr. Digvijay S. Pawar



This project aims to develop an AI-driven framework for automated road safety auditing using computer vision, vehicle trajectory data, and infrastructure information. The research will integrate road infrastructure characteristics and road-user behaviour to identify safety deficiencies and provide evidence-based engineering recommendations.



Relevant Backgrounds

- Civil Engineering / Transportation Engineering
- Electrical / Electronics Engineering
- Computer Science & Engineering
- Artificial Intelligence / Data Science
- Related disciplines



Who Can Apply?

Candidates with a Master's degree in a relevant engineering or allied specialization are encouraged to apply. Relevant specializations include **Biomedical/Biomechanical Engineering, Civil/Transportation Engineering, Electrical/Electronics Engineering, Computer Science & Engineering, Artificial Intelligence, Data Science**, or closely related disciplines. Candidates from other specializations may also apply if their academic background and research experience are relevant to either of the projects.



Cutting-Edge
Research



Interdisciplinary
Collaborations



Access to
Advanced Facilities



Innovation with
Societal Impact



Non-Invasive Peripheral Neuromodulation for Real-Time Regulation of Acute Stress: A Brain-Body Systems Approach

Dr. Neeraj Kumar and Dr. Nagarajan Ganapathy

Stress is an important factor that determines mood, behavior, and overall health. Prolonged exposure increases the risk of cardiovascular disease, cognitive and behavioral disorders. In daily life, all individuals experience acute stress which induces measurable alterations across the brain-body dynamic's, including shifts in cortical electrophysiology, changes in hemodynamics, elevated heart rate, respiratory modulation, electrodermal activation, and peripheral vasoconstriction. Conventional stress management methods namely pharmacological approaches can reduce stress related symptoms but their applicability to acute stress is limited by side effects and lack of real-time adaptability. This limitation addresses the need for targeted, non-invasive neuromodulation technique capable of modulating autonomic tone during acute stress.

Transcutaneous Median Nerve Stimulation (tMNS) offers a peripheral, wrist-accessible neuromodulatory interface which mitigates acute stress by activating afferent sensory fibers that engage central autonomic control networks, resulting in suppression of sympathetic outflow and restoration of brain-body homeostasis. The overall block diagram for investigating stress induction and its modulation through tMNS is illustrated below in Figure 1.

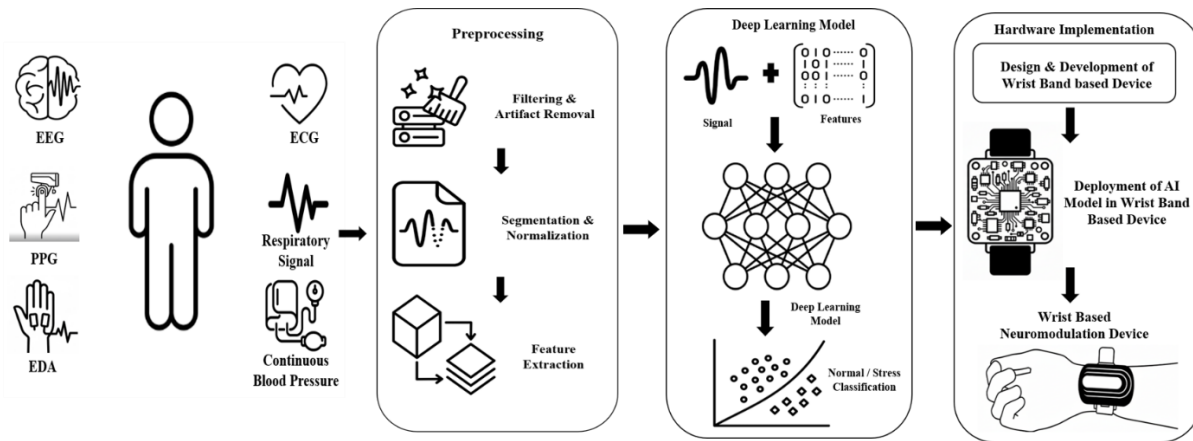


Figure 1: Overall block diagram for investigating stress induction and its modulation through tMNS

The proposed work aims to quantitatively characterize brain-body dynamics during acute stress and determine how peripheral neuromodulation regulates these interactions using synchronized multimodal physiological measurements, including electroencephalography (EEG), electrocardiography (ECG), photoplethysmography (PPG), respiration (RESP), electrodermal activity (EDA), and blood pressure (BP). The anticipated outcomes include to develop a wristband based peripheral neuromodulation wearable capable of continuous stress monitoring and targeted stimulation to enable real-time, closed-loop modulation of stress, thereby establishing a foundation for wearable, non-invasive neuromodulation systems for real-time stress regulation.

Data-Driven Road Safety Auditing Using Multimodal Infrastructure and Vehicle Trajectory Data

Dr. Abhinav Kumar and Dr. Digvijay S. Pawar

Conventional Road Safety Audits (RSA) rely heavily on manual inspections and expert judgement, limiting their scalability, reproducibility, and ability to continuously assess large road networks. This research aims to develop an AI-driven, automated RSA framework for Indian road environments by integrating computer vision, deep learning, image/video analytics, and vehicle trajectory data. A large-scale, georeferenced and expert-annotated road inventory will be developed covering expressways, national highways, state highways, and district roads. The database will include road signs, pavement markings, lane configurations, geometric characteristics, roadside hazards, intersections, pedestrian facilities, sight-distance constraints, and other safety-critical infrastructure attributes. Advanced object detection, semantic segmentation, visual localization, and multimodal data-fusion techniques will be investigated to automatically extract and classify road safety features. Vehicle trajectory data will be analysed to derive speed distributions, lane-changing behaviour, acceleration/deceleration profiles, and surrogate safety measures such as time-to-collision and post-encroachment time. The research will establish AI-based safety-risk models linking infrastructure characteristics and observed road-user behaviour, ultimately developing a continuously deployable RSA platform that automatically identifies deficiencies, quantifies safety risk, and generates evidence-based engineering recommendations for Indian roads.

