Grant Challenges
Centre of Excellence in Intelligent IoT Sensors, Kochi

Centre of Excellence in Intelligent IoT Sensors [CoE in IIoT Sensors] announces Grant Challenges for **Environmental/Air Quality Monitoring**

1. <u>Background</u>

CoE in IIoT Sensors, is a pioneering initiative of Ministry of Electronics and Information Technology, Government of India and Government of Kerala along with Centre for Materials for Electronics Technology, Thrissur (C-MET) and Indian Institute of Information Technology and Management – Kerala, Trivandrum (Digital University of Kerala) as the implementation agencies and Maker Village & Kerala Startup Mission as the supporting partners. The application domains of the CoE will be developed with the support of industry partners, including startups at Maker Village, as well as those in the Kerala Startup Mission ecosystem.

2. <u>Aim</u>

To conduct the IoT Grant Challenges which will produce accelerated output for the research topic "**Environmental/Air Quality Monitoring**". The winning participants will be incubated as startups in CoE in IIoT Sensors.

3. <u>Grant Challenge Statement</u>

Broad Area : Environmental/Air Quality Monitoring

<u>Problem Statement 1:</u>

Title: Development of a Low-Noise, High-SNR hardware for the C-MET developed Gas sensor

The primary goal is to design a system with an overall noise level of less than 1 mV and a Signal-to-Noise Ratio (SNR) of at least 50 dB, ensuring precise measurements under various environmental conditions without the need for individual calibration of each unit.

Challenge Objectives:

Development of Intelligent Hardware Solution for Gas Sensing:

- **System Noise and SNR:** Design a gas detection system with overall system noise less than 1 mV and an SNR not less than 50 dB. This requires careful selection and integration of components, to achieve the desired performance metrics.
- **Measurement Accuracy:** Utilize an Analog-to-Digital Converter (ADC) with an accuracy of 500 µV and two channels for precise voltage measurement, ensuring high accuracy in gas detection.
- **Power Consumption:** Ensure that the average power consumption of the system does not exceed 200 mA while on active mode, making it energy-efficient and suitable for battery-powered applications.
- **Calibration:** The system should be designed to eliminate the need for individual unit calibration, ensuring consistency and reliability across all produced units.
- **Manufacturing Cost and Portability:** The final design must be cost-effective and portable, making it suitable for widespread deployment in various applications. Considerations should include component selection, assembly processes, and materials to minimize costs without compromising quality.
- **Environmental Robustness:** The system should operate effectively in a wide range of environmental conditions, specifically with a working humidity of 0~90%RH (non-condensing) and a working temperature of 0℃ ~ 50℃.

Participants need to submit ideas, designs, product plans, or prototypes of their proposed solutions.

<u>Problem Statement 2:</u>

Title: Development of a High-Precision AFE for Advanced Sensor Applications

Introduction:

This challenge aims to design and develop an Analog Front-End (AFE) for a cutting-edge sensor system. The focus is on achieving high precision in current measurement and signal conversion, ensuring low noise levels, and integrating optical components effectively.

Challenge Objectives:

Development of Hardware Solutions for advanced sensor applications:

- **Current Measurement and Amplification:** Design a circuit capable of measuring current in the ranges of (10pA-10nA), (50pA-50nA), and (100pA-100nA). The current should be accurately converted to a voltage range of 1mV-3.3V preferably using a 2-stage amplification process.
- **Optical Components:** Integrate a photodiode with a peak wavelength of around 650nm and a laser diode with a wavelength of 650nm and pointed focus. These components must

be aligned and housed within an optical chamber designed for optimal performance and minimal interference.

- **Fan Control:** Incorporate a fan with a flow rate of less than 1 CFM, controlled by PWM (Pulse Width Modulation), to manage the airflow within the optical chamber. This ensures stable operating conditions and enhances sensor accuracy.
- **Noise Reduction:** Ensure the entire system design minimizes noise and interference, enabling the sensor to function effectively in various environments. This includes careful selection of components, shielding, and layout considerations.

Participants need to submit ideas, designs, product plans, or prototypes of their proposed solutions.

<u>Problem Statement 3:</u>

Title: Development of a High-Precision AFE for Multi-Channel Resistive and Capacitive Sensor Measurement System

Introduction:

This challenge focuses on developing an Analog Front-End (AFE) for a sophisticated measurement system encompassing up to 50 resistive sensor channels and one capacitive sensor channel. The goal is to achieve high accuracy and sensitivity across a broad range of measurements while incorporating energy-efficient modes for optimized performance.

Challenge Objectives:

Development of Hardware Solutions for Intelligent IoT Sensor Devices

- **Resistive Sensor Channels:** Design a system with up to 50 channels for resistive sensors with an input resistance range of 1 KΩ to 50 KΩ. The system should be capable of detecting a 1 Ω change across the entire range. Current sourcing for resistance measurement should be typically in the range of 10 µA to 100 µA, ensuring high accuracy and resolution.
- **Capacitive Sensor Channel:** Develop a single channel for capacitive sensor measurement with an input capacitance range of 50 pF to 500 pF. The capacitive sensor system must be designed to detect at least a 1 pF change, ensuring high sensitivity and precision.
- **Temperature Range:** Ensure the system operates effectively within a temperature range of 0°C to 60°C, maintaining accuracy and stability across all conditions.
- **Power Management:** Implement sleep and active modes to optimize power consumption, enhancing the system's energy efficiency without compromising performance. Ensure the transition between modes is seamless and does not affect measurement accuracy.

Participants need to submit ideas, designs, product plans, or prototypes of their proposed solutions.

Problem Statement 4:

Title: Optical cavity design with ray or beam path simulation and prototyping for optical based sensors for Environmental/Air Quality Monitoring

Introduction:

This challenge aims to design and develop optical cavity with ray or beam path simulation for optical sensors. The optical cavity shall be proposed for optical based sensors such as Particulate Matter sensor, NDIR Gas sensors, Smoke sensors, etc.

Challenge Objectives:

Development of an Optical cavity design and prototyping

- **Optical cavity design:** The optical cavity should be designed as per the requirement of the particular sensor application for which it is proposed. The design parameters such as high surface reflectivity, light damping, isolation from external light, etc. need to be defined corresponding to the property required for the particular indented sensor application.
- **Design parameters:** Since the optical cavity can be proposed for various optical based sensors, the detailed design plan with parameters that will be optimized for the particular sensor application proposed should be provided.
- **Ray or beam path simulation:** A detailed ray or beam path simulation to be provided to validate the optical cavity design for the particular indented sensor application
- **Prototyping of the optical cavity:** At least 25 Nos. of the optical cavity as per the finalized design needs to be provided. The material should be capable of withstanding -20 to +70ºC and RH of 10 to 95% (non-condensing). The prototype optical cavity has to be tested with C-MET developed sensors. The size and features should match with C-MET sensor requirements.

Participants need to submit ideas, designs, product plans, or prototypes of their proposed solutions.

Prize Money and funding

- For each problem statement maximum up to **Rs 5 lakhs** and free incubation for 2 years. **Companies can apply for multiple problems.** All the IP in this respect will rest with CoE.
- **Duration of grant Challenge: Maximum six months**

2. Eligibility Criteria

- The challenge is open for all Indian companies/citizens

3. Implementing Agency

- The implementing agency will be the CoE in IIoT Sensors, Kochi.

4. Evaluation Methodology

- Internal Review: An Expert Panel (EP) will evaluate the proposals and will finalize 5 top teams.
- Interview: The EP will conduct interviews for top 5 teams and finalize the winner for the Grant Challenge Award.

5. Important date to be noticed

- Submission last date: 15st September, 2024
- Internal Review result: 30th September, 2024
- Declaration of winner: 10th October, 2024.
- Registration Link: https://www.iiotsensors.org/

6. Rule and Guidelines

a. All participants and team have to be eligible (See Eligibility Criteria) to participate.
b. During the Challenge, the Team Leader shall be considered as the Single Point of Contact for all engagements & communication by the CoE in IIoT Sensors. Furthermore, the Team Leader cannot be changed during the course of the Challenge.
c. The Team Leader and Team Members will be required to provide working E-mail IDs and Mobile numbers for the purpose of Registration/ Communication.
d. Teams shall maintain detailed documentation of their Idea, Prototype and Solution at all stages of the Challenge for reference and record purposes.
e. The right to summarily reject any change in team composition is vested with CoE in IIoT Sensors.
f. Any IPR if generated in the Grand Challenge shall be jointly owned by the CoE in IIoT Sensors and the contributing team through a separate MoU as per Indian Laws/ Rules.
g. The solution should not violate/breach/copy any idea/concept/product already copyrighted, patented or existing in this segment of the market. Legal liability of such infringement will be the sole responsibility of the applicant team.
h. Anyone found to be non-compliant of rules and guidelines face the risk of their participation getting cancelled.
i. All documents/ papers etc submitted in relation to the Grand Challenge is non-returnable and shall remain as the property of CoE in IIoT.

j. The number of teams to be finally selected and incubated or not to be selected at all is at the sole discretion of CoE in IIoT Sensors and no suggestions and disputes will be entertained.
k. For any dispute redress, Secretary (MeitY)'s decision will be the final.
l. The selected teams receiving funding through this challenge have to give their written consent to must be willing to be incubated in the CoE in IIoT Sensors.
m. Previous Grand Challenge winners are not eligible for applying the 2^{nd} set of Grand Challenges till the project is over.

Appendix 1

Technology Readiness Levels (TRL)

Technology Readiness Levels (TRL) are a method used to measure and assess the maturity of a particular technology

TRL is based on a scale from 1 to 9 with 9 being the most mature technology.

Level	Definition	TRL Description
1	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2	Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3	Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4	Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include the integration of "ad hoc" hardware in the laboratory.

5	Component and/or breadboard validation in relevant environment.	The Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment.
6	System/subsystem model or prototype demonstration in a relevant environment.	A representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness.
7	System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space.
8	Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluations of the system in its intended weapon system to determine if it meets design specifications.
9	Actual system has proven through successful mission operations.	The actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Appendix 2

<u>Commercial Readiness Levels (TRL)</u>

Commercial Readiness Levels (CRL) is a framework for defining the spectrum of commercial maturity, from basic market research to full deployment.

CRL is based on a scale from 1 to 9 with 9 being the most commercial technology.

CRL	Description

1	Knowledge of applications, use-cases, & market constraints is limited and incidental, or has yet to be obtained at all.
2	A cursory familiarity with potential applications, markets, and existing competitive technologies/products exists. Market research is derived primarily from secondary sources. Product ideas based on the new technology may exist, but are speculative and unvalidated.
3	A more developed understanding of potential applications, technology use-cases, market requirements/constraints, and a familiarity with competitive technologies and products allows for initial consideration of the technology as product. One or more "strawman" product hypotheses are created, and may be iteratively refined based on data from further technology and market analysis. Commercialization analysis incorporates a stronger dependence on primary research and considers not only current market realities but also expected future requirements.
4	A primary product hypothesis is identified and refined through additional technology-product-market analysis and discussions with potential customers and/or users. Mapping technology/product attributes against market needs highlights a clear value proposition. A basic cost-performance model is created to support the value proposition and provide initial insight into design trade-offs. Basic competitive analysis is carried out to illustrate unique features and advantages of technology. Potential suppliers, partners, and customers are identified and mapped in an initial value-chain analysis. Any certification or regulatory requirements for product or process are identified.
5	A deep understanding of the target application and market is achieved, and the product is defined. A comprehensive cost-performance model is created to further validate the value proposition and provide a detailed understanding of product design trade-offs. Relationships are established with potential suppliers, partners, and customers, all of whom are now engaged in providing input on market requirements and product definition. A comprehensive competitive analysis is carried out. A basic financial model is built with initial projections for near- and long-term sales, costs, revenue, margins, etc.

6	Market/customer needs and how those translate to product needs are defined and documented (e.g. in market and product requirements documents). Product design optimization is carried out considering detailed market and product requirements, cost/performance trade-offs, manufacturing trade-offs, etc. Partnerships are formed with key stakeholders across the value chain (e.g. suppliers, partners, customers). All certification and regulatory requirements for the product are well understood and appropriate steps for compliance are underway. Financial models continue to be refined.
7	Product design is complete. Supply and customer agreements are in place, and all stakeholders are engaged in product/process qualifications. All necessary certifications and/or regulatory compliance for product and production operations are accommodated. Comprehensive financial models and projections have been built and validated for early stage and late stage production.
8	Customer qualifications are complete, and initial products are manufactured and sold. Commercialization readiness continues to mature to support larger scale production and sales. Assumptions are continually and iteratively validated to accommodate market dynamics.
9	Widespread deployment is achieved.