

IIT Ropar – Technology and Innovation Foundation

Powered by NM-ICPS

Exploring the World of Cyber Physical Systems



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Interest***



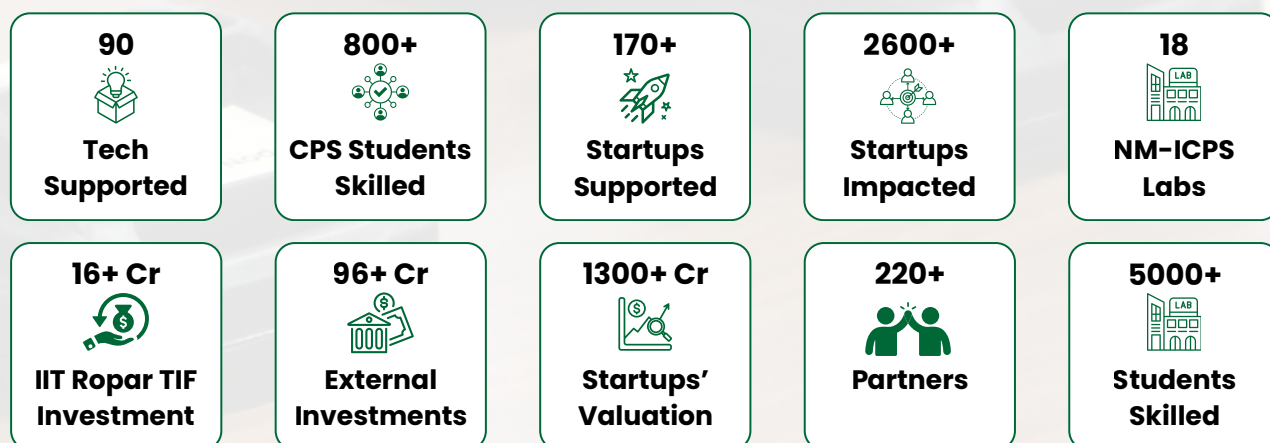
INTRODUCTION TO IIT Ropar TIF

IIT Ropar Technology and Innovation Foundation's Agriculture and Water Technology Development Hub stands at the forefront of India's innovation ecosystem, driving advanced Cyber-Physical Systems (CPS) technologies for smart and digital agriculture. Established under the **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** by the **Department of Science & Technology, Government of India**, IIT Ropar TIF focuses on transforming the water, food, fisheries, and animal husbandry sectors through cutting-edge technology and deep-tech entrepreneurship.

Our Impact in Numbers

Over the past four years, IIT Ropar TIF has created an extraordinary innovation ecosystem:

- 70+ Indigenous CPS Technologies developed, including globally recognized AI solutions like Digital Entomologist, MooSense livestock monitoring systems, Automatic Weather Stations, and nanobubble water treatment technologies
- 12 CPS Outreach Labs established nationwide, training 500+ students, 100+ faculty members, and 250+ entrepreneurs
- 137 Startups onboarded with ₹16.22 Cr invested in 90+ ventures
- ₹96+ Cr raised by our portfolio startups in external funding
- ₹1,300+ Cr combined valuation achieved by our startup portfolio
- ₹21 Cr commitment secured from MeitY, DST, and Startup India
- 9 Flagship national initiatives launched, impacting 2,600+ startups
- 5,000+ Students skilled in cutting-edge technologies
- 220+ Partners engaged across academia, industry, and government



Our Vision

NM-ICPS Labs serve as hubs for collaborative innovation, driving CPS advancements within partner institutes under the National Mission on Interdisciplinary Cyber-Physical Systems. Our network promotes research, development, and deployment of CPS technologies, enabling students, entrepreneurs, and researchers to gain hands-on experience in this transformative field—ultimately building indigenous capabilities in critical sectors that impact millions of lives.

IIT Ropar CPS Lab Powered by NM-ICPS

Cyber-Physical Systems (CPS) are revolutionizing industries and societies by seamlessly integrating digital computing with physical processes. At the core of this transformation lies the ability to bridge the gap between computational algorithms and the tangible world of machinery, sensors, and actuators.

Why CPS Matters

CPS serves as the backbone for Internet of Things (IoT) ecosystems, providing the critical infrastructure to connect, monitor, and control physical devices in real-time. These intelligent systems collect data through IoT sensors, process it using advanced algorithms, and execute precise actions—creating responsive environments that adapt to changing conditions without human intervention.

Our CPS & IoT Labs

The IIT Ropar's NM-ICPS Lab is a state-of-the-art facility designed to foster innovation in agriculture and water technologies. Equipped with cutting-edge hardware, software, and networking capabilities, our labs serve as innovation hubs where:

- Students gain practical skills in designing and implementing IoT solutions
- Researchers develop and test novel applications for critical sectors
- Entrepreneurs transform concepts into market-ready products
- Faculty members enhance their technical expertise and teaching methodologies

Each lab is strategically designed to support the complete innovation journey—from conceptualization to commercialization—creating an ecosystem where theoretical knowledge transforms into practical solutions addressing real-world challenges in agriculture, water management, and related domains.



Education & Training



Research & Development



Prototyping & Testing



Collaboration



Industry Alignment



Entrepreneurship Catalyst



Skills Enhancement



Economic Development

Benefits for Your Institution

- Integrate cutting-edge CPS/IoT modules into existing programs, elevating your academic offerings
- Differentiate your institution with specialized facilities that appeal to technology-focused students
- Establish your campus as a recognized center for emerging technology education and research
- Create seamless connections between theoretical learning and practical industry applications
- Access specialized infrastructure conducive to groundbreaking research in CPS and IoT domains
- Strengthen relationships with industry leaders seeking innovation partnerships and talent
- Facilitate internships and placement connections with leading technology companies
- Generate additional income through specialized short-term courses and training programs
- Provide students with IIT Ropar-recognized certifications that enhance their professional profiles
- Support student-led startups in emerging CPS and IoT markets with dedicated resources
- Increase potential for securing major research grants and industry-sponsored projects
- Position your institution at the forefront of international technology education trends
- Contribute meaningfully to regional economic growth through skilled workforce creation

Benefits to the Students

- Gain hands-on experience with industrial-grade IoT devices and CPS platforms
- Develop proficiency on technologies actively sought by employers and startups
- Master real-world challenges using sophisticated sensors, actuators, and analytics tools
- Experience emerging technologies including 5G, AI/ML, IoT, and edge computing applications
- Create end-to-end IoT solutions from concept to deployment under expert guidance
- Acquire in-demand skills that significantly enhance employability and compensation potential
- Build impressive projects for academic credit and professional showcasing
- Earn certifications jointly recognized by IIT Ropar and leading industry partners
- Develop innovations with opportunities for patent filing and commercialization
- Participate in specialized hackathons, challenges, and networking events

Key Knowledge Domains

- IoT software architecture, cloud integration, big data analytics, and security protocols
- Sensor integration, embedded systems development, wireless communications, and industrial IoT
- 3D design principles, additive manufacturing, and product prototyping methodologies
- Cloud computing infrastructure, machine learning applications for IoT, and predictive analytics
- Business model development, technology commercialization, and startup management fundamentals

Value Support with IIT Ropar CPS Lab Powered by NM-ICPS



Support for Faculty, Researchers, and Students

Technology Development Grants

- Funding support for groundbreaking research projects
- Support for technology development, upgradation, and enhancement
- Resources for validation and commercialization of innovations developed in IIT Ropar CPS Lab Powered by NM-ICPS
- Mentorship from industry experts and academic leaders



Support for Startups

Seed Funding & Growth Capital

- Initial seed support for promising startups emerging from CPS Labs
- Equity or debt funding for scaling validated ventures
- Comprehensive incubation support including workspace, mentoring, and market access
- Integration with IIT Ropar's extensive startup ecosystem and investor network



Model for Lab Setup

Collaborative Infrastructure Development

- Customizable lab configurations tailored to institutional requirements
- Technical expertise provided for lab design, setup, and implementation
- Ongoing technical guidance and periodic upgrades to ensure lab relevance and sustainability



Internship Support Program

Building Future Innovators

- Funding for dedicated interns to manage lab operations
- Stipend support provided under Chanakya Fellowship norms
- Six-month internship period facilitated by IIT Ropar
- Opportunity for exceptional interns to work on advanced projects at IIT Ropar

CPS Skilling Module of LAB

Module 1: Foundations of IoT (Internet of Things)

- Introduction to IoT architecture, components and industry applications.
- Hands-on component identification with sensors, development kits and modules.
- Review of protocols, security fundamentals, and communication frameworks

Module 2: Electronics & Hardware Integration

- Electronics principles and circuit design for IoT implementation.
- In-depth exploration of sensor technologies and selection methodologies.
- Microcontroller programming and interface development techniques.
- Practical exercises with BLE development kits and power management.

Module 3: Advanced Sensor Integration

- Multi-sensor system design and real-time data transmission development.
- Implementation of I2C, SPI, and UART communication protocols.
- Signal conditioning and noise reduction for improved data quality.
- Error handling and system optimization for field deployments

Module 4: Data Analytics & Visualization

- Gateway configuration for efficient data collection and transmission
- Cloud integration and analytics for IoT-generated datasets
- Visualization tools and interactive dashboard implementation
- Practical interpretation exercises for actionable insights

Module 5: Prototyping & Manufacturing

- Solidworks 3D modeling for component and enclosure design
- Slicing techniques and 3D printing with various materials
- Design for manufacturability and production scaling strategies
- Panel discussions with experts for design critique and improvement

Module 6: Capstone Project Development

- Project conceptualization, implementation, and technical troubleshooting
- Integration testing and performance optimization techniques
- Solution demonstration and peer evaluation sessions
- Certification and networking with industry partners and investors

Outcomes:

Participants will graduate with comprehensive practical skills in IoT system design, implementation, and optimization—ready to develop innovative CPS solutions for agriculture, water management, and related domains. All modules include extensive hands-on activities using industry-standard tools and technologies currently deployed in commercial applications.

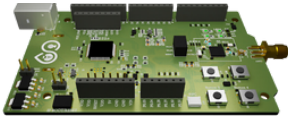
Hardware Components



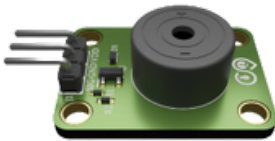
The **Bluetooth Gateway** serves as a framework enabling communication between a central device and numerous Bluetooth nodes, often applied in IoT networks, smart homes, and industrial monitoring.



Co2 monitoring device utilize NDIR technology for real-time monitoring, vital in various sectors like indoor air quality, HVAC, industry and agriculture environmental monitoring.



The **nRF52 DK** is a development kit for Bluetooth Low Energy and mesh applications, with ample memory and versatile features.



A **Buzzer** converts electrical signals into sound and is commonly used in timers, alarms, printers, and computers.



A **Weather Monitoring Sensor System** is a low cost device that collects data on atmospheric and environmental conditions using a network of sensors. This data is analyzed for weather forecasting, research, agricultural applications.



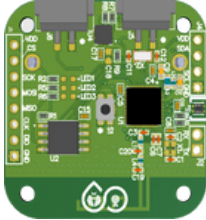
An **Activity Monitoring** using Bluetooth Low Energy is a wearable device equipped with sensor that tracks and monitors various aspects of a user's physical activity . These devices typically use BLE technology to communicate with BLE Gateway and upload sensor data to cloud



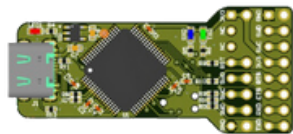
Grove Shield is a modular, simple-to-use system designed to easily connect a BLE development kit to a wide range of "modules" such as sensors, motors, and inputs.



A **relay** is an electrically operated switch that uses electromagnetic attraction to open or close its contacts.



BLE nodes feature **NRF52** Microcontrollers with sensors (**SHT40**, **LIS3DH**) and External Flash Memory (**W25Q16**), enabling data transmission.



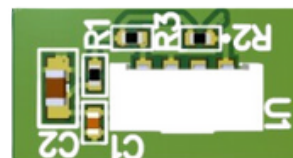
The **Flash Tool** designed to facilitate the development, programming, and debugging of applications on Nordic Semiconductor's nRF series chips.



The **Sensor Module** is equipped with a SHT40 **Humidity and Temperature** output via an I2C interface.



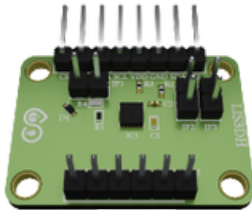
A **Hall Effect Sensor** is a transducer that varies its output voltage in response to changes in a magnetic field. The Hall effect occurs when a magnetic field is applied perpendicular to the flow of current in a conductor or semiconductor.



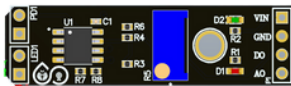
Lux Sensor is a high accuracy ambient light digital 16-bit resolution sensor. It includes a highly sensitive photo diode, a low noise amplifier, a 16-bit A/D converter and supports an easy to use I2C bus communication interface.



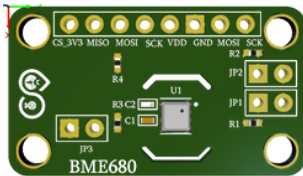
4G Kit is important to send data to the cloud for storage and further processing. The 4G Kit is developed to send the data to the Cloud. The 4G kit is equipped with a microcontroller.



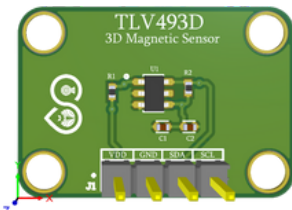
The **LIS3DH** is an ultra-low-power high performance **Three-Axis Linear Accelerometer** digital I2C/SPI serial interface standard output.



Infrared (IR) sensors detect infrared radiation emitted by objects. These sensors are versatile and are used in a variety of applications including motion detection, temperature measurement, and remote-control systems



The **BME680** is a sensor from Bosch that measures environmental parameters such as **temperature, humidity, air pressure, and gas (VOC) levels**.



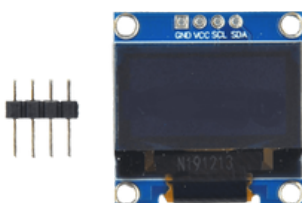
The **TLV493D** is a **3D magnetic sensor** that uses Hall-effect technology to measure the **magnetic field in three dimensions** (X, Y, and Z axes).



The **STTS751** is a digital temperature sensor with 9–12 bit resolution, communicating via SMBus 2.0. It features an EVENT pin for temperature alarms and supports ARA protocol for host response.



The Tipping Bucket **Rain Gauge** is a high-precision instrument designed to accurately measure and monitor rainfall. With an advanced design for continuous data collection.



The **SSD1306** is a popular controller IC used for driving monochrome OLED (Organic Light Emitting Diode) displays.



The **servo motor** is commonly used in robotics and model applications for precise position control.



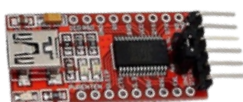
A **joystick** is an input device that allows users to control movements or actions by tilting a stick in different directions.



The **MD-02 with RS485** is a temperature and humidity sensor module that communicates via the RS485 (MODBUS RTU) protocol.



An **RS-485 to TTL converter** allows communication between RS-485 devices and TTL-compatible microcontrollers. It converts differential RS-485 signals to single-ended TTL signals.



An **UART to USB** converter is used to see the output at the serial output in the PC/Laptop.



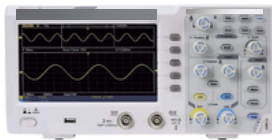
The **Power Profiler Kit (PPK)** is a standalone unit, which can measure and optionally supply currents all the way from sub-uA and as high as 1A.



This high-speed, precision **3D printer** is engineered for advanced materials such as carbon fiber-reinforced polymers, featuring AI-powered monitoring and intelligent sensors for enhanced performance and reliability.



A USB **Logic Analyzer** is a compact tool for capturing and analyzing digital signals, offering waveform visualization and protocol decoding via a computer.



A 2-channel **digital storage oscilloscope** (DSO) with 50MHz bandwidth is used to capture and analyze electrical signals. It has two input channels for simultaneous measurement of two signals.



MODView is a device for **Real-Time Data Display System** which is compact and efficient solution designed to provide real-time sensor data visualization on an **LCD screen**.



The **Wind Speed** sensor uses rotating cups to measure wind speed. The system differentiates between low and high ADC values to detect valid pulses.



A **Digital Power Supply** is an electronic device that provides a stable and adjustable voltage and current output, typically with a digital display for precise control and monitoring.



A **Digital Multimeter (DMM)** measures voltage, current, and resistance with high accuracy, displaying results digitally.



A **soldering station** is an essential tool for electronics work, offering precise temperature control for safe and efficient soldering of components onto circuit boards.

100+ Experiments Can Be Performed



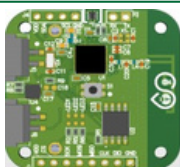
Air Sense



Weather Monitoring Sensor



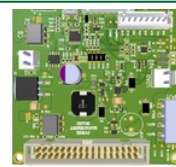
Activity Monitoring Device



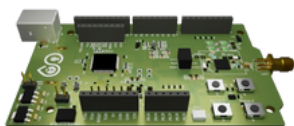
BLE NODE



4G with BLE



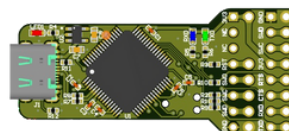
Solar Charging Module



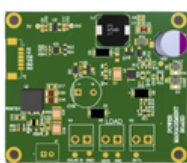
BLE Development Kit



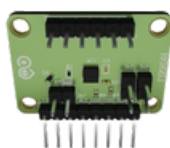
BLE Grove Shield



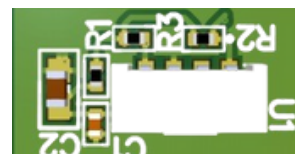
Flash Tool



Solar BMS



LIS3DH Sensor Module



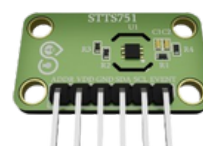
LUX Sensor



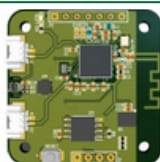
SHT40 Sensor Module



W25Q16 Memory



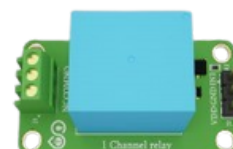
STTS751 Sensor Module



Acoustic Module Node



Buzzer



Relay Module



RS485 TO TTL



USB LOGIC ANALYZER



POWER PROFILER KIT

100+ Experiments Can Be Performed



BLE GATEWAY



WIND TUNNEL



MODVIEW



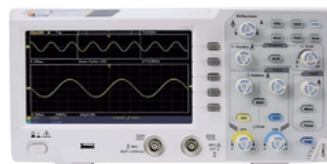
RAINGUAGE



3D-PRINTER



Weather Monitoring Sensor

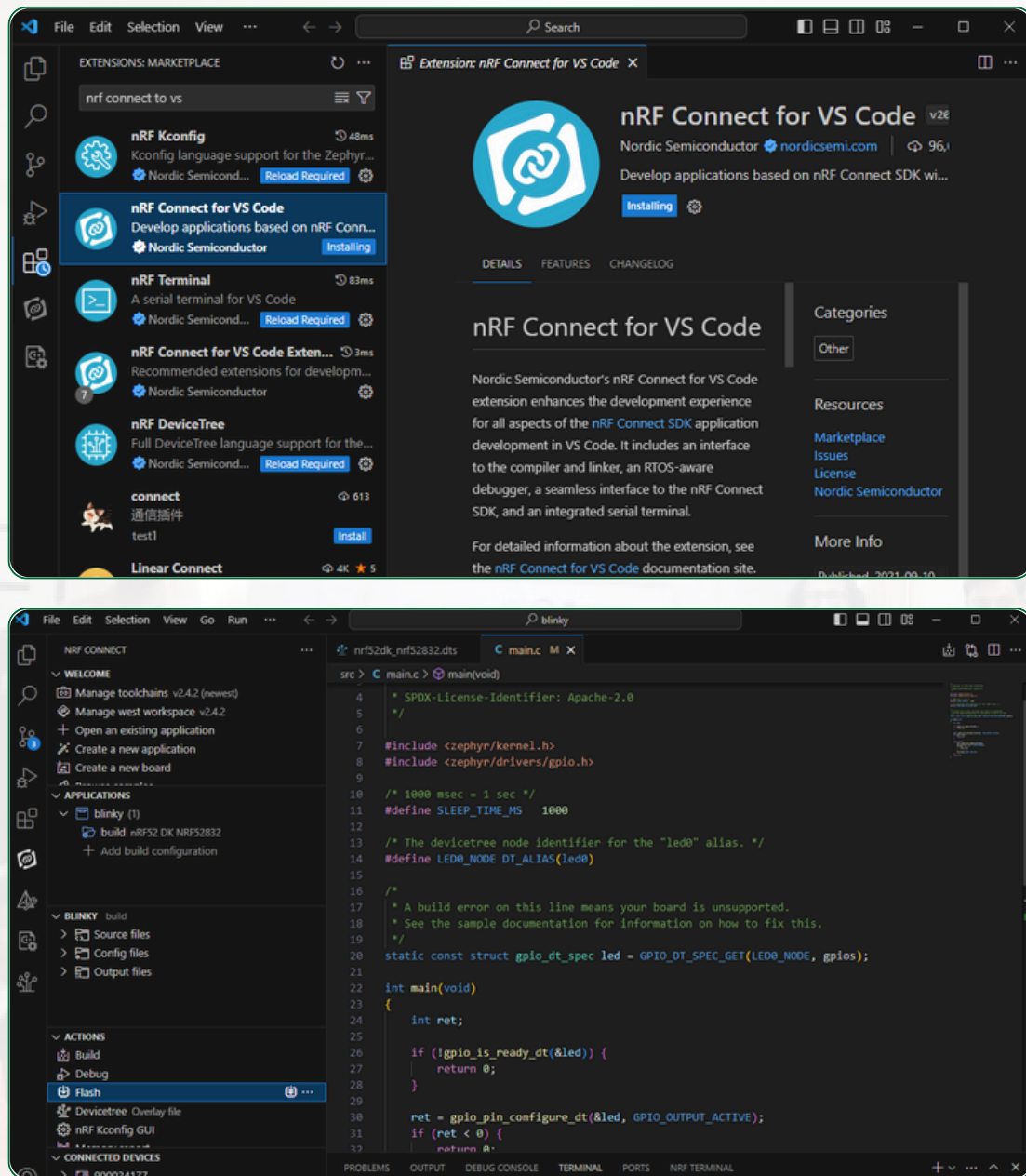


Digital storage
oscilloscope



Digital Power Supply

Software Components



Development Environment

- Visual Studio Code: Industry-standard IDE with comprehensive debugging tools and extension support
- nRF Connect for VS Code: Specialized tooling for Nordic Semiconductor device development

Embedded Development Tools

- nRF Connect Desktop: Complete platform for device configuration, testing, and firmware deployment
- nRF Command Line Tools: CLI utilities for automated workflows and production environments
- Nordic SDK: Complete software development kit with drivers, protocol stacks, and examples

Network of Established IIT Ropar CPS Lab Powered by NM-ICPS



NATIONAL INSTITUTE
OF TECHNOLOGY
DELHI

National Institute of Technology - Delhi



THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Thapar Institute of Engineering and
Technology - Punjab

CHITKARA
UNIVERSITY



Chitkara University - Punjab



CCCT

Centre for Computer & Communication Technology
Centre For Computers And
Communication Technology - Sikkim



Tula's Institute -

Dehradun, Uttarakhand



Khalsa College of Engineering &
Technology - Amritsar, Punjab



IILM
UNIVERSITY

IILM University -
Greater Noida, UP



University of Ladakh -
Leh



National Institute of Technology -
Jalandhar

**BABA FARID COLLEGE
OF ENGINEERING & TECHNOLOGY**

Baba Farid College of Engineering and
Technology - Punjab



Indian Institute of Information
Technology -
Una, Himachal Pradesh



Chamber of Industrial & Commercial
Undertakings - Ludhiana, Punjab



HRIT
UNIVERSITY

HRIT University -
Uttar Pradesh



Sardar Vallabhbhai Patel University of
Agriculture & Technology - Meerut, UP



ACROPOLIS

Acropolis Institute of Technology and
Research - Indore, Madhya Pradesh



Hindustan Institute of Technology and
Science - Chennai, Tamil Nadu



Model Institute of Engineering and
Technology - Jammu



Shoolini
University

Shoolini University -
Solan, Himachal Pradesh

IIT Ropar CPS Lab Powered by NM-ICPS in Pipeline



Chandigarh University



Government Industrial Training Institute,
Ropar



Shivalik College of Engineering -
Dehradun, Uttarakhand



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NATIONAL INSTITUTE OF TECHNOLOGY SIKKIM
National Institute of Technology - Sikkim



PI - RAHI
PU-IIT Ropar Regional Accelerator for
Holistic Innovations, Chandigarh



EPIC - Ambala College of Engineering

Glimpses from IIT Ropar CPS Lab Powered by NM-ICPS



Technologies Developed at IIT Ropar CPS Lab Powered by NM-ICPS:

Digital Entomologist



alliance for biodiversity knowledge



Fraunhofer
IME

**Funding
28 CR**

About The Digital Entomologist:

- It will help meet an urgent need to generate in-the-field time series biodiversity measurement data globally.
- The data from the autonomous, reliable, low-cost sensor network will be available publicly.
- Farmers will be able to track their on-farm biodiversity, learn how weather affects local ecosystems, where beneficial predators are present, and when to use pesticides.

Use Case:

The devices are providing a live feed of insects in fields from Pune and Ropar (India), Bazel (Switzerland), and Fraunhofer (Germany)



Technologies Developed at IIT Ropar CPS Lab Powered by NM-ICPS:

AmmoniQ Device



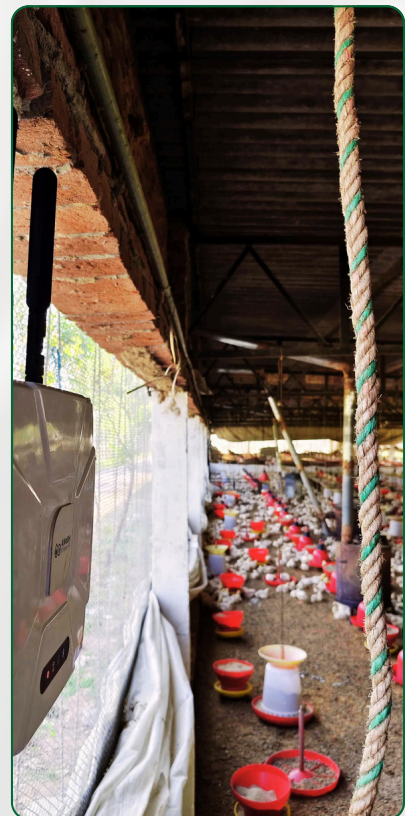
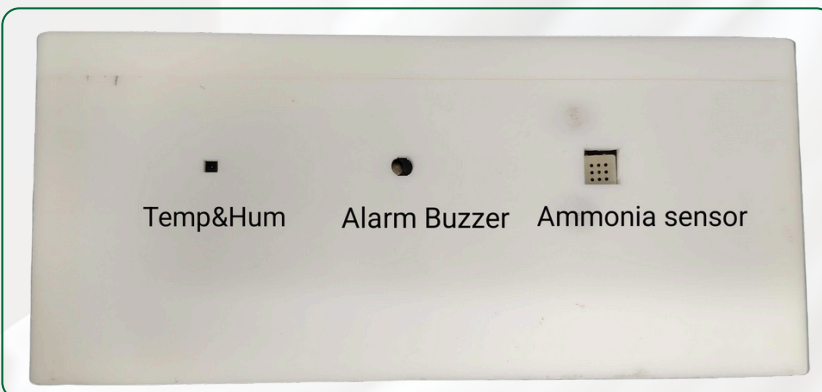
Funding
NA CR

About the AmmoniQ Device:

This device features a MEMS-based ammonia sensor that continuously monitors ammonia levels. We've used the nRF52 series microcontroller for efficient processing and connectivity. It includes a built-in alarm system that triggers when ammonia levels are high, helping to prevent accidents. The AmmoniQ device also supports real-time monitoring via the cloud and a mobile app, allowing users to track ammonia levels from any internet-enabled device.

Use Case:

The technology used in AmmoniQ is transferable to other gas monitoring or environmental sensing applications. Its modular design and AI features make it suitable for adaptation in industrial, agricultural, or urban safety systems. It also serves as a great learning tool for IoT, embedded systems, and smart sensor development.



Technologies Developed at IIT Ropar CPS Lab Powered by NM-ICPS:

Moohsense



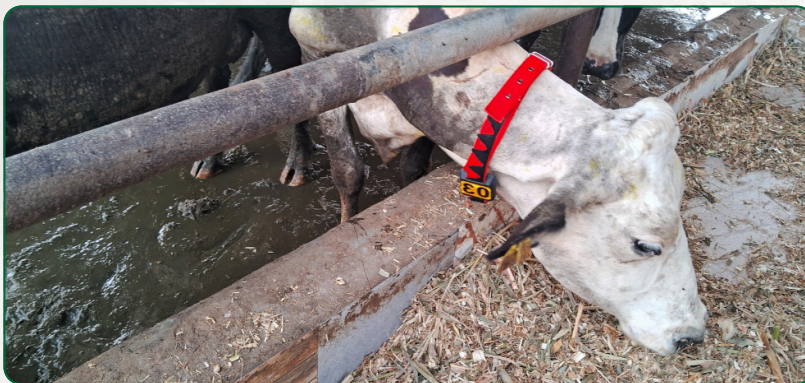
Funding
1 CR

About Moohsense:

- An AI – powered livestock management CPS to monitor the behavior (Standing/lying duration; Feed intake and feeding duration; Rumination duration, etc.) of the livestock.
- The device is in use with different farms in Punjab, including the R&D farms of Guru Angad Dev Veterinary And Animal Sciences University (GADVASU) in Ludhiana, through a project approved by NABARD.

Use Case:

This technology collect activity data and with the help of AI, it analyses whether the cow is in ha=eat or not and can also predict health parameters.



Technologies Developed at IIT Ropar CPS Lab Powered by NM-ICPS:

Automatic Weather Monitoring Station



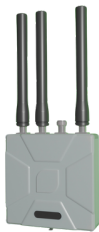
Funding
NA CR

About Automatic Weather Monitoring Station:

The smart, secure and future-proof Automatic Weather Station combines reliable measurements with data collection, processing and connectivity so you can optimize rainfall detection, temperature and humidity statistics, wind speed and wind direction throughout the day/week.

Use Case:

This Automatic Weather Station is ideal for agriculture, research, and infrastructure planning, providing real-time, accurate weather data to support decision-making and optimize operations. Its advanced connectivity and data processing capabilities ensure reliable monitoring of rainfall, temperature, humidity, and wind conditions.



Gateway

The BLE Gateway enables real-time sensor data transfer to the cloud for smart monitoring and analysis.



Rain Gauge

The BLE Gateway enables real-time sensor data transfer to the cloud for smart monitoring and analysis.



Radiation Shield

The BLE Gateway enables real-time sensor data transfer to the cloud for smart monitoring and analysis.





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