विज्ञान और प्रौद्योगिकी विभाग
Department of
SCIENCE & TECHNOLOGY

Azadi Ka Amrit Mahotsav

NM-ICPS

G20 भारत 2023 INDIA

# NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)

## QUARTERLY BULLETIN
## APRIL, 2023


**Department Of Science & Technology**
**Ministry of Science & Technology**
**www.dst.gov.in**


NM-ICPS

# NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)

## Department Of Science & Technology
## Ministry of Science & Technology

www.dst.gov.in

सत्यमेव जयते
डॉ. एस. चंद्रशेखर
Dr. S. Chandrasekhar

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**Secretary**
**Government Of India**
Ministry of Science and Technology
**Department of Science and Technology**

31st March, 2023

## MESSAGE

Technology innovations are interdisciplinary in nature and spans across various technology verticals including Artificial Intelligence & Machine Learning, Internet of Things & Internet of Everything, Data Banks & Data Services, Data Analysis, Robotics & Autonomous Systems, etc. Since the growth of these technologies is relatively recent, both Government and Private sectors are showing interests in advancements related to these technologies. Hon'ble Prime Minister had announced the need for development of a Cyber Physical System Mission at 104th Indian National Science Congress followed by the announcement of Hon'ble Finance Minister for launching the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) in the Union budget in February, 2018.

Department of Science & Technology (DST) is implementing NM-ICPS at an outlay of Rs. 3,660.00 crore. Under NM-ICPS, 25 Technology Innovation Hubs (TIHs) have been established in reputed institutes across the country. Through these hubs, an ecosystem has been created that fosters Technology Development, Human Resource Development, Entrepreneurship and Translational Research to aid key sectors of Indian Economy including, but not limited to (i) Healthcare (ii) Agriculture (iii) Industry 4.0 (iv) Transportation (v) Environment & Pollution (vi) Infrastructure & Energy (vii) Education (viii) Judiciary & Legal (ix) Security and (x) Communication.

I am optimistic that NM-ICPS would be able to make India a global leader in this niche area of Cyber Physical Systems and related technologies.

(S. Chandrasekhar)

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Dr. Akhilesh Gupta

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भारत सरकार
Senior Adviser & Head
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Ministry of Science and Technology
Government of India

## FOREWORD

The integration of the Physical and Cyber realms is inevitable in today's era, and it will undoubtedly cause disruption across all industries. India cannot afford to miss the race of this development. It is therefore critical to prioritize the acquisition of new knowledge, technological solutions, skilled workforce, and a conducive entrepreneurial environment to position India among countries leading Cyber-Physical Systems (CPS) field. The National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) is a step in that direction which provides a comprehensive technology platform for creating such an opportunity.

The Department of Science & Technology (DST), being the nodal department for the promotion of Science & Technology in the country, is implementing NM-ICPS. The 25 Technology Innovation Hubs (TIHs) set up as a part of the Mission in leading technology institutions across the country function at the core of implementation of the Mission. Each TIH follows a technology life-cycle approach, addressing all stages of Translational Research, namely, knowledge-development-translation-commercialization and are sufficiently equipped to function independently as a stand-alone entity.

Being the overall in-charge of the Mission, I am confident that through collective efforts involving the Government, Industry & Academia, India will be able to take a leadership position in the areas of Cyber-Physical Systems in the times to come.

(Akhilesh Gupta)

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## PREFACE

The National Mission on Interdisciplinary Cyber-Physical Systems (NMICPS) is being implemented by Department of Science & Technology (DST) through 25 Technology Innovation Hubs (TIHs) set up in academic institutions of repute (Host Institutes) across the country. Each TIH is a Section-8 Company, an independent entity within the Host Institute and has been assigned a Technology Vertical in the areas of advanced technologies. The Mission aims at the development of technology platforms to carry out R&D, translational research, product development, incubating & supporting start-ups as well as commercialization.

The Mission, with its scale and spread of activities, has brought about a paradigm shift in the requirements of skill sets in the field of CPS technologies. In addition to this, the job opportunities are also enhanced through the Mission by imparting advanced skills and generating skilled manpower as per the requirement of the industry and the society.

We, as part of the Mission Office at DST, are making sincere efforts to proactively implement the Mission by encouraging the TIHs to enhance their activities of technology development and to help achieving the commercialization of these technologies, leading to rapid economic growth and employment generation in the country.

Ekta Kapoor

(Ekta Kapoor)

## CONTENT

CONTENT

# About NM-ICPS

NM-ICPS

The Union Cabinet has approved the National Mission on Interdisciplinary Cyber Physical System (NM-ICPS) in December, 2018 at a total outlay of Rs.3660 Crores for a period of five years to be implemented by Department of Science and Technology (DST).

Under the NM-ICPS, 25 Technology Innovation Hubs (TIHs) have been established in reputed institutes across the country. Each hub is a Section-8 Company, an independent entity within the Host Institute and has been assigned a Technology Vertical in the areas of advanced technologies such as Artificial Intelligence and Machine Learning; Technologies for Internet of Things & Internet of Everything; Data Banks & Data Services, Data Analysis; Robotics & Autonomous Systems; Cyber Security and Cyber Security for Physical Infrastructure; Quantum technologies etc.

The Mission aims at development of technology platforms to carry out R&D, translational research, product development, incubating & supporting start-ups as well as commercialization. The Mission is being implemented with all the TIHs undertaking activities under the four major categories i.e., 1. Technology Development 2. Entrepreneurship Development 3. Human Resource Development 4. International Collaborations.

**Objectives of the Mission:**

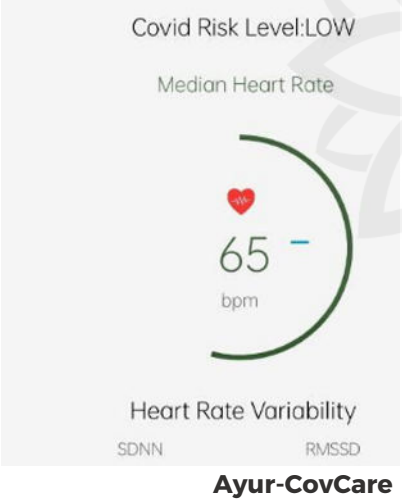
1. Technology Development, translational research and commercialization in Cyber Physical Systems (CPS) and associated technologies
2. Adoption of CPS technologies to address India specific National / Regional issues.
3. Produce Next Generation skilled manpower.
4. Catalyze Translational Research.
5. Accelerate entrepreneurship and start-up ecosystem development in CPS technologies.
6. Give impetus to advanced research in CPS technologies and higher education in Science, Technology and Engineering disciplines.
7. Bring India at par with other advanced countries and derive several direct and indirect benefits.

NM-ICPS is a comprehensive Mission that brings together academia, industry, government and international organizations. The mission has created an ecosystem that fosters entrepreneurship, develops next generation skilled manpower, catalyses translational research and promotes the commercialization of CPS technologies. NM-ICPS is an ambitious initiative that has the potential to transform key sectors of the Indian economy like healthcare, transportation, education, infrastructure etc. and make them more efficient, safe, and sustainable to place India at par with other advanced countries.

# TIH Foundation for IoT and IoE, Technology Innovation Hub (TIH) at IIT Bombay

The goal of the TIH is to create a self-sustaining IoT and IoE entrepreneurship ecosystem, increase technology readiness levels (TRLs) in IoT R&D to build and commercialize reliable IoT products. Technology developments are currently aligned with the needs of the industry and has also developed a unique structured four-level IoT course.

**EAgriS Station**




**Ayur-CovCare**

## Key Spotlights

I. EAgri station aka EAgriS (TRL8), a multi-parameter, remote-controlled energy-autonomous smart agri-station has been developed which is a fully automated multichannel indigenous energy-autonomous integrated station to record soil, weather and crop parameters. It can help in prediction of diseases, pest attack, weather, irrigation management in farms. The technology is deployed at Indian Council of Agriculture Research (ICAR) with further plans to deploy at two villages in Maharashtra.

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II. Ayur-CovCare (TRL9)- Smartphone-based comprehensive digital monitoring of ayurveda COVID care using deep pulse analytics and AI-based recommendation engine for therapeutics has been developed. The software stack consists of AI algorithms with accuracy of above 90% obtained from the symptoms-based network. The AI algorithm has been developed into a mobile app and is available on the Google Store.

III. An autonomous aerial Imaging of agricultural land using multi-rotor UAVs (TRL7) has been developed.

**Autonomous ariel imaging**

It is very useful for agriculture with ability to quickly detect diseases in crops using images from UAVs which can help farmers take timely action to prevent the spread of diseases and minimize crop damage. The technology is deployed along with EAgriS for testing and validation at ICAR fields.

# IIITB COMET Foundation, TIH at IIIT Bengaluru

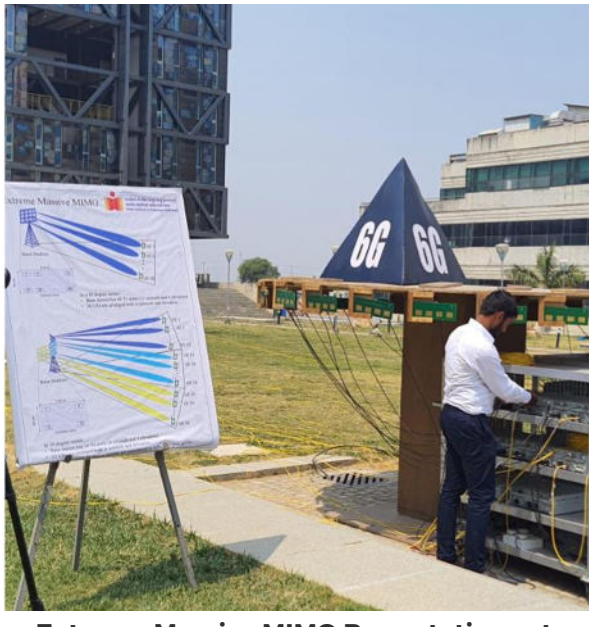
IIITB COMET Foundation is set up to spearhead innovations in the next generation of communication systems, indigenously develop technologies to power 5G communication address the critical demand of seamlessly connecting people, businesses & industries, and lay the foundations for 6G networks. IIITB COMET Foundation initially is focusing on the verticals of 5G infrastructure as well as 5G applications such as Industrial IoT, eHealth, education, automotive V2X, AI/ML and AR/VR.

**FPGA board used for Physical layer implementation**

**5G gNodeB and User Equipment Simulation setup**

## Key Spotlights

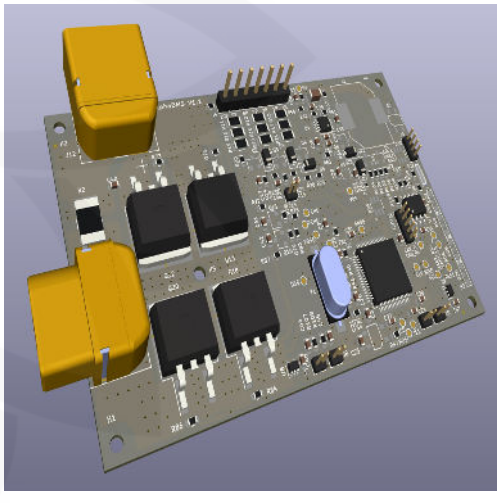
I. Development of ORAN massive MIMO 5G-advanced base station in collaboration with IIT Hyderabad: A massive MIMO Layer 1/2/3 stack to increase the capacity and coverage of cell towers.



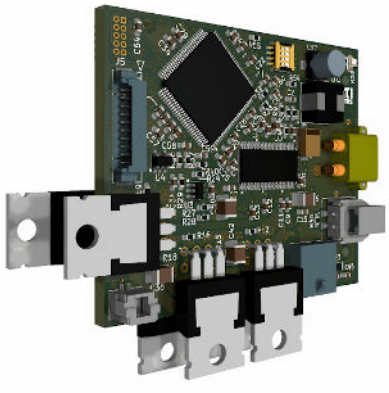

**Extreme Massive MIMO Base-station setup**

# IHUB for Robotics and Autonomous Innovation Systems Foundation, TIH at IISc Bengaluru

I-Hub for Robotics and Autonomous Systems Innovation Foundation fosters innovations in AI & Robotics by bringing together the best of the start-up, industry, research, and government ecosystem. It is trying to make advances in robotics, autonomous systems and AI through translational R&D in areas of Intelligent Healthcare, Automation for Logistics and Skilling for the AI age.



**Drone battery management system**



**Brushless Motor Driver**

**Krishak- DGCA-Mapping and Spraying Drone**

## Key Spotlights

I. A Brushless Motor Driver (TRL 4-5) has been developed which offers state-of-the-art Field-Oriented Control (FOC), supporting velocity, torque, position and impedance control modes. It is rated for 48V/15A, and offers communication through a 1Mbps CAN bus interface.

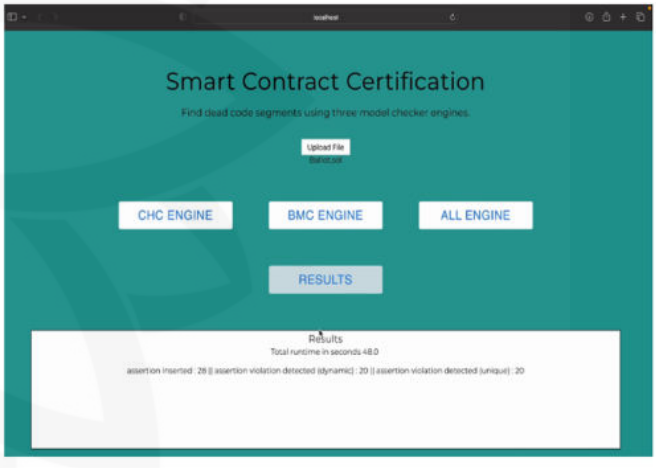
II. Drone Battery Management System (TRL 5) has been developed which can help to achieve completely autonomous Unmanned Aerial Vehicle (UAV) systems. These are designed to cater to micro to medium-sized drones.

III. The Hub's supported Startup General Aeronautics aims to make agriculture more sustainable for farmers through drone technology by increasing their yield, reducing cost and saving time and water. It has developed Krishak-DGCA-approved Mapping and Spraying Drone which possesses Variable Rate Technology, advanced AI/ML capabilities and other best in class features which enables it to spray upto 60 acres in a day.

## Vertical: Technologies for the financial sector (Fintech)

# IIT Bhilai Innovation & Technology Foundation (IBITF), TIH at IIT Bhilai

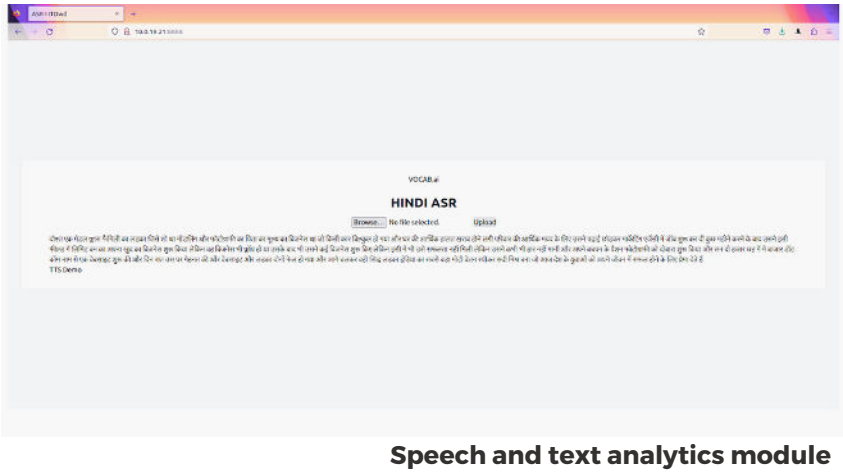
IBITF at IIT Bhilai is focused on translational research, entrepreneurship development, and commercialization of technologies in fintech, including e-payment systems, the Internet of Things, Artificial Intelligence, and Blockchain Technology.




**Smart Cleaner**

## Key Spotlights

I. Nitminer Technologies Pvt. Ltd, a Startup incubated under the TIH, has developed a Smart Cleaner (TRL7), which ensures the identification and removal of bugs (with 100% code coverage) and dead conditions while automatically repairing the smart contract before deployment. It is a tool to generate coverage reports for smart contracts.




**Speech and text analytics module**

II. Vocab AI Pvt. Ltd., an incubatee of the TIH has developed the speech and text analytics module for limited vocabulary (TRL7) by creating an Indian English and Hindi speech/text database for automatic speech recognition for a specific business use case in Fintech applications such as speech recognition for validation purposes during financial transactions.

One such applicability being explored is the voice authentication for ATM transactions for blind and visually impaired.

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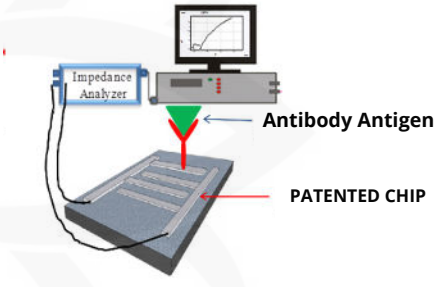
## Vertical: Bio-CPS

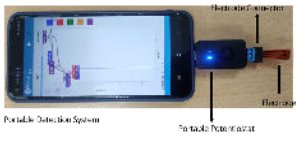
# BITS BioCYTiH Foundation, TIH at BITS Pilani

BITS BioCyTiH Foundation fosters research, innovation and skill development in the interdisciplinary area of "Bio Cyber Physical Systems (Bio-CPS)" to undertake cutting edge research and provide affordable solutions in the priority areas of healthcare, agriculture, water and environment.




**Novel electrochemical immunosensor for the detection of AFM1 in milk & milk products**

**Remote cell culture monitoring system**



**Illuminate pro**

**Electrochemical sensing platform**

## Key Spotlights

I. A deployable biosensor chip for detection and analysis of Aflatoxin M1 in milk and milk powder (TRL5) has been developed, which meets stringent regulatory standards (FSSAI 500 ng/L and EU 50ng/L).

II. A portable Bio-Cyber Physical System based microfluidic cell culture platform (TRL5) has been developed which is standalone and integrated Lab-On-Chip (LoC) microfluidics-based system having culture environment regulation, and detection subsystems. It is ultra-portable and has low-cost regulated chambers for cell culture applications with IoT-based real-time monitoring.

III. Microfluidic / Miniaturized Electrochemical Sensing Platform for multiple bio-analytes (TRL 5) associated with renal health, aims to bring down the complexity and improve affordability in renal health assessment by developing a portable system. Along with assessment, it also aims to incorporate IoT-based architecture for secure data availability to all involved stakeholders for enhanced diagnosis or timely preventive measures.

IV. The TIH has incubated Adiuvo Diagnostics Private Limited which is a Start-up focusing on developing platform technologies in Opto-Electronics to effectively aid in early disease detection, specifically customized for low-resource settings. Illuminate® (TRL 8), a product developed by the startup is a novel (Patented granted- India and US) imaging device, that combines multispectral imaging with Artificial Intelligence to detect wound bioburden along with bacterial classification by leveraging the inherent autofluorescence property exhibited by pathogens (bacteria and fungus).

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Technology Innovation Hub of IIT Delhi

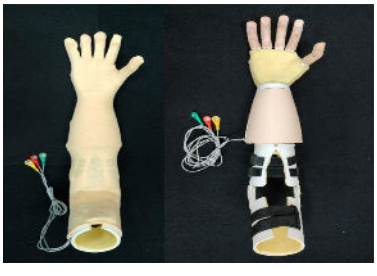
# I-Hub Foundation for Cobotics (IHFC) Foundation, TIH at IIT Delhi

The vision of the IHFC is to focus on the research and development of novel technology in the areas of robot analysis, design and control, communication, computer architectures, machine learning, artificial intelligence & the design of embedded systems and power topologies. The IHFC aims at serving various sectors like medical robotics, agriculture, disaster management, defence, industry.

**Drone show by BotLab Dynamics**

## Key Spotlights

I. IHFC has developed ENRICH (currently at TRL 6), a cost-effective, EMG (Electromyography) controlled prosthetic hand, useful for upper limb amputees in daily activities, specifically for multiple grasp patterns. The product is under clinical trials and has significant demand in the armed forces



**ENRICH**

**Autonomous drone**

II. Under the Hub, autonomous drone (TRL5) for aerial and close up survey of agriculture and farmland has been developed. For this technology, ground control station set-up and flight testing and autonomous mission planner testing have been completed.

III. Hub has developed a drone for disease identification in farms /plants for precision agriculture (TRL5).

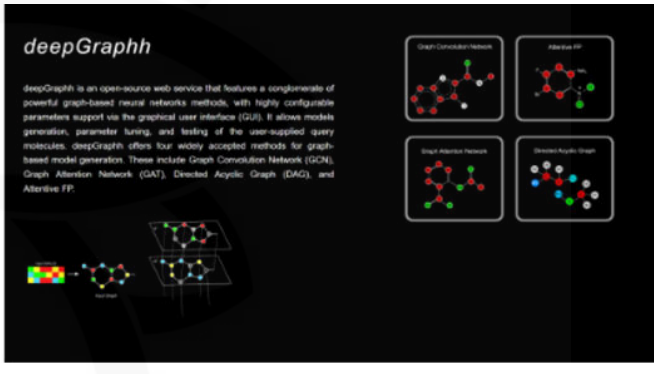

**Drone for disease identification**

IV. IHFC has accelerated Botlab Dynamics, a start-up involved in drone swarming using a combination of programmed drones to fly in 3D space to make an eco-friendly substitute for fireworks. This technology is of significant importance for Defence in search and rescue operations, and various counter attack operations.

## Vertical: Cognitive Computing and Social sensing

# IHUB Anubhuti - IIITD Foundation, TIH at Indraprastha Institute of Information Technology Delhi

iHub Anubhuti-IIITD Foundation aims at building a tripartite collaboration between industries, academia and government agencies by developing data-driven Cognitive Computing and Social Sensing solutions, mainly in the verticals - Healthcare, Education and Law Enforcement & Security.




**Computational-assisted and data-driven olfactory cognitive abilities**

**Re-identifying the vehicles between the pair of given cameras**

## Key Spotlights

I. The Hub is working on computational-assisted and data-driven olfactory cognitive abilities: which encompasses diagnostic and prognostic techniques using genomic, radiological, molecular, biochemical, and histopathological patterns and the associated computational challenges of processing corresponding datasets for better results. AI and deep learning approaches for detecting anomalies in the lungs and olfactory systems have been developed.

II. The Hub is working on object tracking, re-identification, and counting: Multi-camera target tracking (MCTT) used for tracking objects across multiple cameras along with re- identification.

III. The Hub has supported Neuranics Lab Pvt. Ltd., a Start-up which envisions to bring multitude of disease diagnosis in less than ten minutes. Recently, Neuranics Lab won the 3rd ISHIC challenge hosted by joined India Sweden Healthcare Innovation Centre in Delhi.

# TExMIN Foundation, TIH at IIT (ISM) Dhanbad

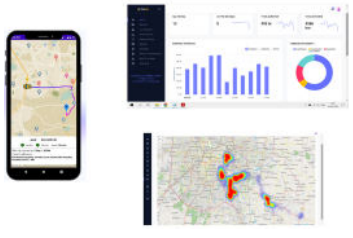
Technology Innovation in Exploration & Mining (TEXMiN) Foundation has been set up to address the issues and challenges of mining and exploration industry through intervention of CPS based technologies. The objective is to develop commercially feasible solutions using IoT, AI/ML, blockchain, drones, robotics, and satellite imagery for achieving 3S Mining (Safe, Smart, and Sustainable Mining) leading to Mining 4.0; and Mineral Exploration 4.0.

**Graphene manufacturing facility**

**Unsafe activity detection system**

**WISE**


**Graphene powder**



**Telematics platform**

## Key Spotlights

I. M/s Graphenera Carbon Private Limited, an incubatee of the TIH has developed a proprietary and modular fully automated setup for high quality Graphene manufacturing in bulk quantity. This setup is capable of converting any carbon containing source viz coal into high quality graphene. The technology developed is at TRL 9 and is at commercial stage along with its products like graphene powder, coating, filaments, etc.

II. M/s Bidaal Technologies, a start-up incubated under the TIH has developed WISE (TRL 9), an IoT based system for Illumination mapping and planning of industrial complexes which allows industries to follow compliance and reduce risk thereby offering enhanced safety and efficiency to workers. The Start-up has also developed and commercialized Bidaal-Lens (TRL 8), an AI-powered e-surveillance system, for monitoring unsafe activities and security breaches in real-time.

III. TEXMiN in collaboration with its incubatee start-up "Ecross Technologies Pvt Ltd" has developed a cutting-edge telematics platform that enables real-time monitoring and optimization of vehicle and asset movements. The platform includes specialized features such as fuel monitoring and pilferage detection through the use of advanced fuel and load sensors. This solution is currently being used by 5000+ retail customers across India for tracking their assets.

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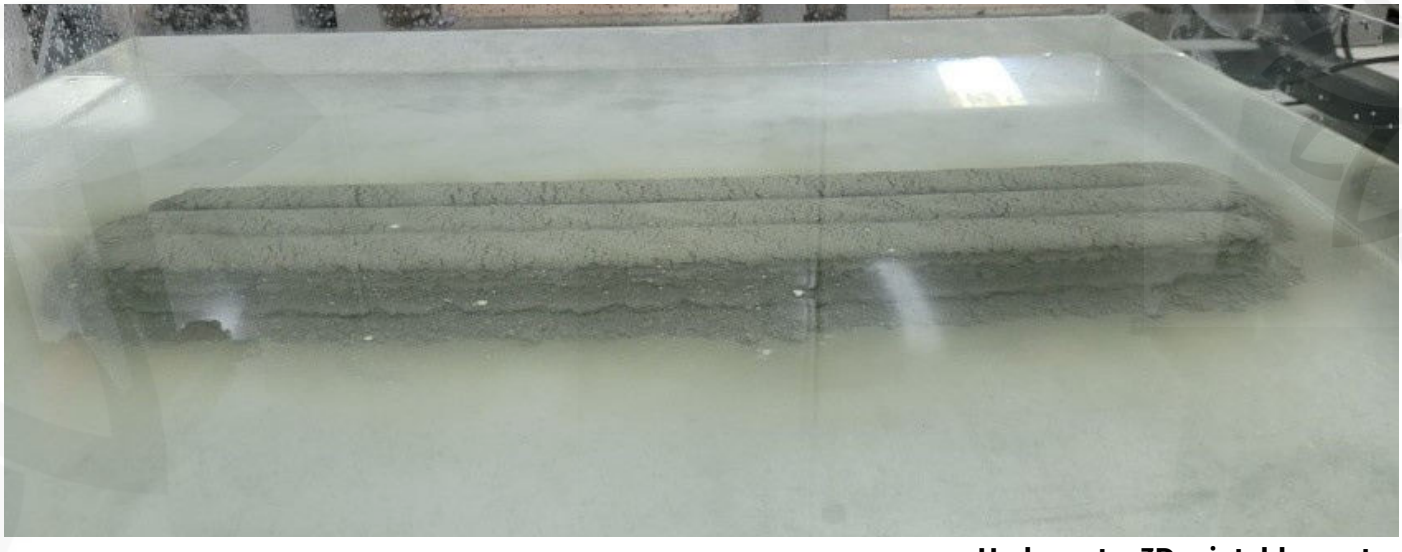
# IIT Guwahati Technology Innovation and Development Foundation, TIH at IIT Guwahati

Technology Innovation & Development Foundation, IIT Guwahati focusses projects on the development of underwater robots, which may be used for underwater tracking, surveillance and monitoring purposes. Monitoring of cracks in ship hulls, industrial pipes and development of an apparatus for underwater operations like cleaning, cutting, etc. at lower cost are other areas of focus.



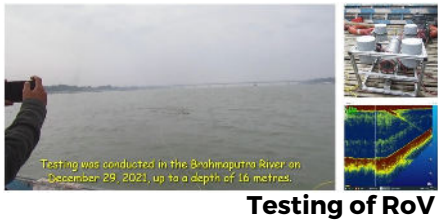
**Underwater 3D printable mortar**

## Key Spotlights

I. Underwater 3D printable mortar with high washout resistance using natural anti-washout admixtures ( TRL7) has been developed. The developed material will be used for printing of coral reefs, as global warming has severely affected coral bleaching and reef degradation. Using the developed mix, underwater structures can be printed on-site, thus avoiding labour and tramportation costs.

II. Underwater Remotely Operated Vehicle (ROVs) have been developed (TRL8) and tested in nearby lakes and water bodies.

**Deep Wave Net**




**Testing of RoV**

These ROVs are equipped with temperature, pressure, depth, IMU and Sonar sensors and can be used for underwater survey and explorations, bathymetry study, fisheries, water quality and aquatic life monitoring, search and object detection up to a depth of 100 meters.

III. Deep WaveNet (TRL7), a wavelength-based attributed deep neural network for underwater image restoration has been developed and optimized. An extensive set of experiments have been carried out to show its efficacy apart from comprehensive validation of enhanced images across various high-level vision tasks, e.g., underwater image semantic segmentation, and diver's 2D pose estimation.

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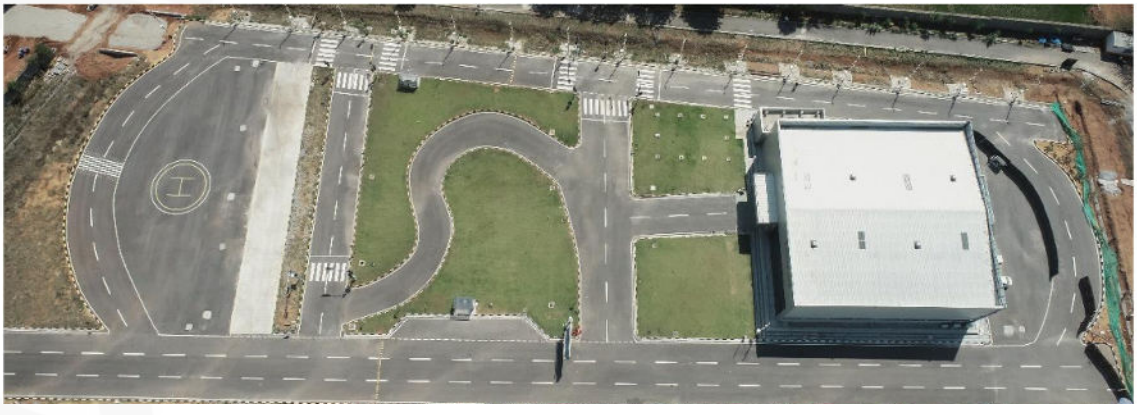
## Vertical: Autonomous Navigation & Data Acquisition Systems

# NMICPS Technology Innovation Hub on Autonomous Navigation Foundation, TIH at IIT Hyderabad

Technology Innovation Hub on Autonomous Navigation (TiHAN) has the vision to become the global destination for next generation smart mobility technologies that utilize reliable and efficient autonomous navigation & data acquisition systems.



**TiHAN Testbed on autonomous navigation (Aerial & Terrestrial)**

**Autonomous navigating humanoid**

## Key Spotlights

I. TiHAN Testbed on Autonomous Navigation (Aerial & Terrestrial), TRL 9, deployed at IITH Campus, is a first of it's kind state-of-the-art testbed which has facilities such as proving grounds, test tracks, mechanical integration facilities like hangars, command control stations, state of the art simulation tools, smart poles, environment emulators like rainfall emulator, V2X communications, drone runways & landing area, control test centres etc. This testbed provides a platform for collaborative research on next generation mobility, services for autonomous navigation and safety related R&D, homologation, regulatory framework etc.

II. An autonomous navigation humanoid robot (TRL 6) has been developed in collaboration with IIIT Dharwad, with AI-based conversational neural engine that can be customized to any language as per the requirement. As a prototype, hindi language has been used to test and validate the AI engine. The robot can be applied at self-service kiosk at various avenues to assist and serve as per the requirements.

III. Dedicated short-range communications (DSRC), a wireless standard and a promising protocol stack to be used for vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communications has been developed (TRL9), and deployed. The technology consists of two components – road-side unit (RSU) & on-board unit (OBU), developed by the TIHAN in collaboration with CDAC – Hyderabad and Trivandrum. The DSRC standard is specifically designed for automotive use, focused on building vehicular safety applications.

**Roadside unit at test bed**

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## Vertical: Data Banks & Data Services, Data Analytics

# IIIT-H Data I-Hub Foundation, TIH at IIIT Hyderabad

IIIT-H Data I-Hub Foundation (i-Hub Data) was established to help coordinate and enhance national research and know-how in data banks, data services and data analytics. iHub-data is expected to play a central role in design, development, and diffusion of data-driven technologies by taking a proactive strategy in curating and creating data banks and data services and also to catalyse, nurture, and enable the growth of an ecosystem.


**Artificial Intelligence (AI) driven predictive model**

## Key Spotlights

I. Development of a website (http://datafoundation.iiit.ac.in) [TRL-8] which enables researchers to publish and use Indian datasets in healthcare, Mobility, Infrastructure and other domains (with Indian context). A hardware ecosystem is also set up with multiple web/application servers, 1.6+ petabyte shared object storage and a shared GPU compute ecosystem with 20 GPU nodes.

II. Artificial Intelligence (AI) driven predictive models for assessing cancer probability in oral, breast, and lung regions (TRL-8). The technology is focused on developing a model to identify precancerous lesions from smart phone based on oral cavity images. The app records photographic images of oral cavity and demographic details and the follow up reports of the patients that comes with the oral cavity images.

III. Arka Aerospace, a startup supported by the hub is involved in developing a drone which can alter its shape- Elastocopter.

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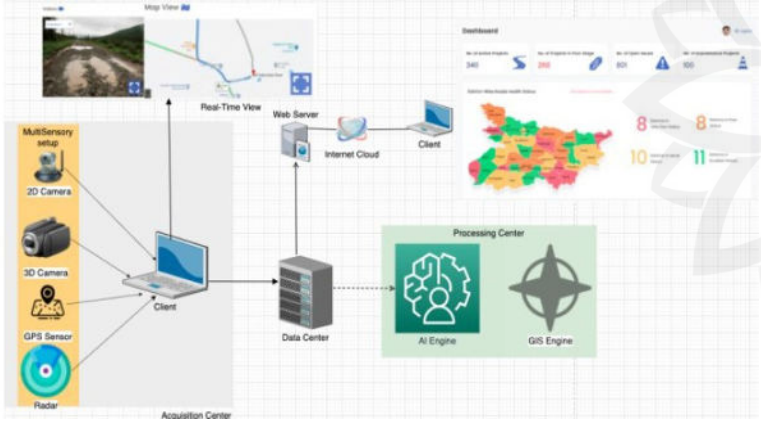
## Vertical: System simulation, Modelling & Visualization

# IITI Drishti CPS Foundation, TIH at IIT Indore

IITI DRISHTI CPS Foundation, created as a one-stop shop for CPS solutions with a specific focus on system simulation, modelling and visualisation. The hub has created an ecosystem which works as a focal point for the convergence of the efforts of academia, industry and government agencies for technology development and commercialization.


**Intelligent Road Maintenance and Monitoring System**

## Key Spotlights

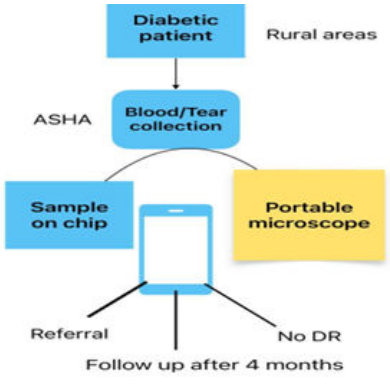
I. A Multistrategy Shop Floor Job Scheduling software tool (TRL5), based on Modelling and Simulation for automated production scheduling in a job shop environment has been developed. The tool offers a thorough, adaptable, and practical answer for a variety of Job Shop circumstances and provides simple task scheduling through web.

II. An Intelligent Road Maintenance and Monitoring System (TRL6) has been developed under the Hub. The system includes specialized sensors and networking modules along with Cloud based Dashboard.


**Multidisciplinary strategy web application**

The prototype has been piloted for rural roads in Bihar. Improvements are underway for urban usage and better reliability and repeatability.

III. A portable tool for diabetic retinopathy detection (TRL6) has been developed as a point-of-care

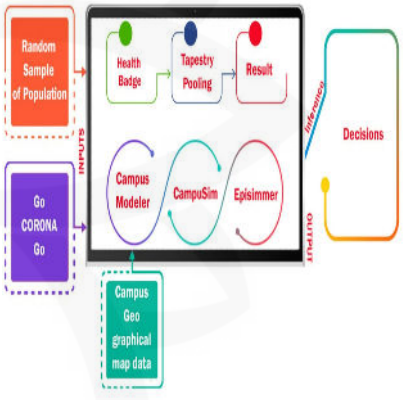



**Schematic Representation of point of care diagnostic for improved diabetic retinopathy management**

diagnostics for ocular problems in diabetes, for effective management and prevention of diabetes and its complications. Improvements in the automation, specificity, sensitivity of the tool is in process.

# IHUB Drishti Foundation, TIH at IIT Jodhpur

The TIH focuses on the core research areas of seeing and sensing, dependable and responsible CV/ARVR, Real-time computer vision systems, and data collection, curation and annotation. It has identified the following application areas for developing technologies: computer vision for autonomous systems; computer vision for better living: healthcare and biosphere; imaging for document analysis; CV and VR for industry 4.0; dependable AR-VR for X (including games).




**Campus Rakshak**


**Gamification of Vadnagar Site**

## Key Spotlights

I. The Hub has developed "Campus Rakshak" - a safety assurance solution for academic institutes to manage their campuses during the pandemic. Campus Rakshak as a Service (C-RaaS) can act as a decision support framework and assist the campus administrators in making an informed decision during the critical transition period in the time of a pandemic. It consists of tools such as Tapestry pooling, information management system, badging system, contact tracing app, and three agent-based epidemic simulators, namely Campus Modeler, Episimmer and CampusSim. The product is at TRL 9 and has been successfully piloted and commercially deployed at IIT Jodhpur and IIIT Hyderabad campuses.

II. Under Gamification of ASI Vadnagar Site, the TIH has created a 2D side-scrolling single player platformer game for the Archaeological Survey of India (ASI) in collaboration with its industry partner Vizara Technologies Private Limited. The concept of the game is the story about the rich heritage of the Vadnagar site. In the game, The game's mechanics and level design have been carefully crafted to provide an immersive and engaging experience for the player while also delivering educational content about the site's history. Currently the game is at TRL7 and three levels are available at Google play store.

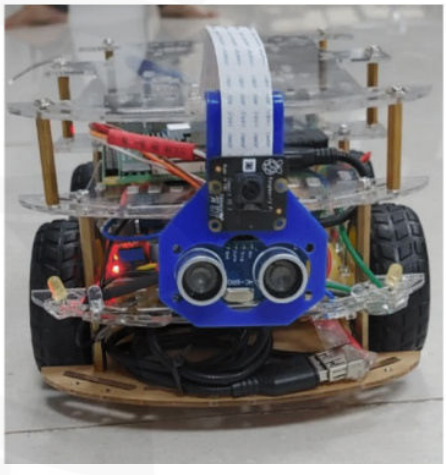
III. The Hub has developed Smart Health Solution for rapid mass screening using integrated telemedicine for homecare. The key features involve monitoring of SpO$_2$ heart rate, and temperature of the human body. The application uses web and android application for video conference and chat support. The telemedicine solution at TRL7 supports Hindi, Bangla, and English. The solution has been deployed at IIT Jodhpur Primary Health Centre and a village in Sundarbans, West Bengal.

## Vertical: Artificial intelligence and Machine Learning

# AI4ICPS I-Hub Foundation, TIH at IIT Kharagpur

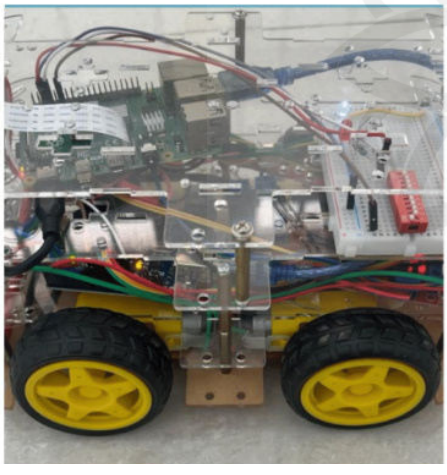
AI4ICPS

AI4ICPS@IITKGP aims to create a national ecosystem to foster innovations of AI and ML interventions to ICPS by solving societal challenges spanning across three core sectors of healthcare, precision agriculture & nutritional security, manufacturing and three dynamic sectors of energy & infrastructure, transportation and communications.



AI based Autonomous Driving Agent (Built indigenously in-house)


Defense to Adversarial Attacks: What if AI is made to see a STOP as Go Sign?



AI Model that are robust to Adversarial Attacks

## Key Spotlights

I. In autonomous systems, incorrect classification could lead to serious accidents. The findings demonstrate the attackers' capacity to trick the network into misclassifying symbols. As a result, handling such circumstances needs a network defence system. The hub has therefore developed an adversarial attack and defence for autonomous driving agents. This ensures that the network is trained to identify the base structure for various environmental settings, thereby nullifying the effect of different adversarial attacks. The technology is at validation stage.


**Monitra healthcare**

II. AI4ICPS has mentored Monitra Healthcare which already has a product upbeat in the market which helps in clinical reporting workflow to improve diagnostic yield. The data is sanitized for artifacts and noise, false positives and incorrectly classified annotations are corrected and templates are then generated so that they contain correct information. Data is reviewed for clinically relevant events.

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## Vertical: C3i Hub, Technology Innovation Hub (TIH) at IIT Kanpur

# Cyber Security for Cyber Physical Infrastructure Foundation, TIH at IIT Kanpur

Cybersecurity and Cybersecurity for Cyber-Physical Systems Innovation Hub (C3iHub) aims to address cyber security issues of the cyber-physical systems and devise technologies for protecting these systems. C3iHub is focused on application verticals of critical infrastructure, automotives, unmanned aerial vehicles (UAVs), cyber-crime prevention and tamper-proof data-storage and all horizontal layers of security associated with these verticals, including hardware security, network security, firmware security etc.

**SoC installed at NHAI (2021)**

## Key Spotlights

I. Developed Security Operations Centre (SoC) based on open-source components and integration. The technology developed is at TRL 9 and has been already deployed at National Highways Authority of India (NHAI) headquarters in 2021, Indian Port Association in 2022. Major benefits of these SoCs are minimal potential security threats, minimal impact of security breaches, and highly efficient reporting.

II. A Self-Sovereign Identity (SSI) system based on blockchain technology has been developed (TRL 9) for securely storing wide range of personal information e.g. degrees, certificates, identity proofs, land records etc. CRUBN/Trential, one of the incubated Startup under the hub has developed SSI-based digital degrees and certificates that are tamper-proof, shareable, and globally verifiable, and have been used to award degrees at IIT Kanpur, IIT Indore, NIT Rourkela, IGNOU, and AKTU.


**Vulnerability LifeCycle and Compliance Management from eGyanamTech**

III. eGyanam Technologies, an incubated Startup under the TIH has developed a product Vulnerability Life Cycle and Compliance Management (VLCM) for traditional IT landscape, which is at TRL 9 and offers cyber security assessment and compliance solutions related to critical infrastructures.

## Vertical: Data Science, Big Data Analytics & Data curation

# IDEAS-Institute of Data Engineering, Analytics and Science Foundation, TIH at ISI Kolkata

The Technology Innovation Hub, IDEAS (Institute of Data Engineering, Analytics and Science Foundation), is working towards Data Science, Big Data Analytics, and Data Curation


**Vehicle detection**

## Key Spotlights

I. Video surveillance. The technology developed would assist in vehicle detection, speed detection, number plate recognition etc.

II. Start-up- Whitelint-IDEAS array LLP: It is working in the domain of application of bulk analysis of data for network security & surveillance and data security.


**Vehicle detection**

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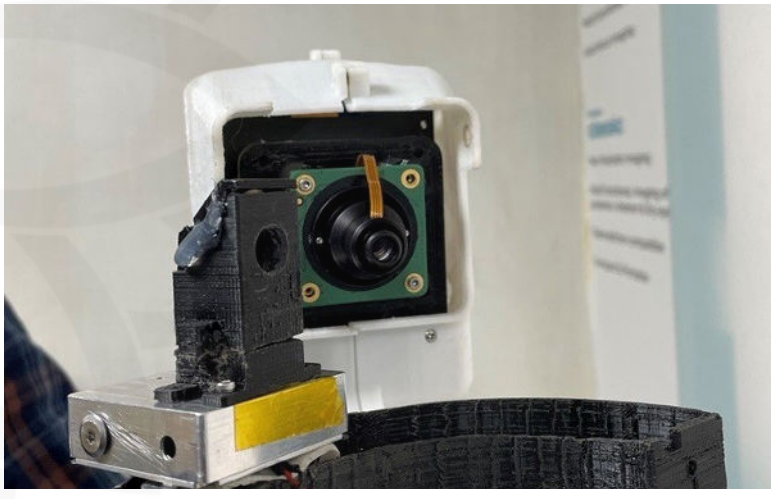
## Vertical: Sensors, Networking Actuators & Control Systems ( SNACS)

# IITM Pravartak Technologies Foundation, TIH at IIT Madras

IITM Pravartak focuses on new knowledge in SNACS through extensive and application-oriented research and gladly prepares young India for the next generation of world-class technologies. IITM Pravartak contributes to areas of national priority such as health care, agriculture, education and upskilling, including targeted training for economically weaker sections.



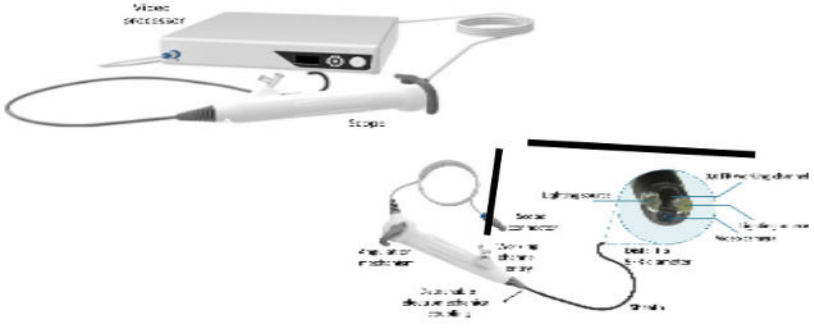
**Device for large scale eye screening**


**Mobile operation system**

## Key Spotlights

I. Comprehensive Anterior Segment Screening Device (TRL7) for large scale eye screening developed under the Hub helps to investigate anomalies in the anterior segment of the eye. The important features of the device are small size and lightweight, easy to operate and cost-effective.

II. Portable and disposable ureteroscopy system (TRL7), a low-cost device developed for examination of the interior of the urethra, bladder, and uterus using a ureteroscope, which will help in treating kidney stones without surgery.



**Portable and disposable ureteroscopy system**

III. Jandkops Operations Private Limited, a Start-up incubated at IITM Prvartak has developed BharOS, an indigenously developed Atmanirbhar trustworthy mobile operating system. This operating system will have features such as PASS (Private App Store), NOTA (Native Over The Air) updates, NDA (No Default Apps), COTE (Chain of Trust Environment). The developed product is at TRL8 and has been tested and deployed at IIT Madras.

# IIT Mandi IHUB and HCI Foundation, TIH at IIT Mandi

IIT Mandi iHub and Human-Computer Interaction (HCI) Foundation is a Technology Innovation Hub that focuses on Human-Computer Interaction with a vision to nurture research in the area, enable technology translation for industry, and build scale in skill development.

**HCI-based head-mounted display for Underwater Simulation**


**GRAHAs VR**

**NES games**

## Key Spotlights

**I.** HCI-based head-mounted display for underwater simulation has been developed at the Hub for assessing and enhancing cognitive performance and decision-making in Unmanned Underwater Vehicle (UUV) operators. The technology developed is currently at TRL 8 and is deployed for testing & validation in an operational environment (with the civilian population).

II. Biofeedback Nintendo Entertainment System, (TRL 8) (BioNES) is an Open-source plug-and-play MATLAB-based tool. It is used in NES games and multimodal biofeedback has been developed. With this, it can receive real-time heartbeat intervals (RR), and compute real-time heart rate and Heart Rate Variability (HRV). This tool can benefit researchers or hobbyists, who want to quickly deploy a biofeedback system to explore the NES games for biofeedback, or just want to record the physiological signals for subsequent use.

III. Square Comp Solutions Pvt. Ltd. is a start-up supported by the Hub, which offers Virtual Reality (VR) based training solutions to manufacturing & industrial organizations for the upskilling and reskilling of their workforce. The product GRAHAsVR Headset developed by the company is the smallest in terms of size and weighs just above 250 grams, having a superior field of view of 101 degrees. The developed product is at TRL 9 and is deployed at 3 sites in the manufacturing industry across India that are paying customers.

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# IIT Palakkad Technology IHUB Foundation (IPTIF), TIH at IIT Palakkad

IIIT Palakkad Technology IHUB Foundation (IPTIF) on Intelligent Collaborative System (TIH-ICS) aims to create a strong foundation and a seamless ecosystem for Cyber Physical Systems. One of the primary goals of this company is to work in close collaboration with the industry to deliver commercial technology and products and build a vibrant innovation ecosystem by providing a reliable platform for technology-based start-ups and entrepreneurs.



**Underwater Robotic Vehicle**

**Smart Agriculture System**

## Key Spotlights

I. Design and development of an intervention-class underwater robotic vehicle with tilting thrusters for marine applications (TRL 6). A fully functional prototype is developed and pool-based trials for basic tasks based on open-loop and closed-loop control have been performed. The technology will find use in defence applications, ensure safe working in hazardous environments and offshore energy sectors in terms of deep-sea intervention tasks.

II. Cyber-Physical Systems in Collaboration with Artificial Intelligence for Smart Agriculture Improving Energy Efficiency and

**Convei health**

Environment Safety (TRL5)- A low-cost energy-efficient CPS-based surveillance framework has been developed with multitude of feature such as keeping an eye on the weather and plant health, gathering information about crops and analysing it etc.

III. Convai Health an incubated start-up under TIH is a virtual reality platform for medical consultation, with a focus on physiotherapy and mental health. The platform allows users to connect with healthcare professionals in an immersive, 3D environment, enabling them to receive treatment and support from their homes. Users can access Convai Health through a VR headset or a web browser and can choose from various medical professionals, including physiotherapists and mental health therapists. The product with Convai is at TRL7 and is tested in 43 clinics and hospitals.

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## Vertical: Speech, Video and Text Analytics

# IIT Patna Vishleshan
# I-Hub Foundation, TIH at IIT Patna

Vishlesan I-Hub foundation is established to build an ecosystem for the domain of "Speech, Text and Video analytics". TIH IIT Patna focusses on Industry's real requirements and all projects are working towards meeting the industrial ends.

## Datasets

Dataset:

- We have created image person re-identification dataset.
- Overall, our dataset contains 20,634 images of 209 identities (people) captured by four cameras.
- Table shows the description of our dataset and Fig depicts the instances of our created dataset.

Table: Statistics of Our Dataset

| Data | Number of Identities | Number of Images | Number of cameras |
|---|---|---|---|
| Training Set | 105 | 12820 | 4 |
| Gallery Set | 104 | 2790 | 4 |
| Query Set | 104 | 5024 | 4 |

Samples of the datasets

**Automated person re-identification and monitoring**

## Key Spotlights

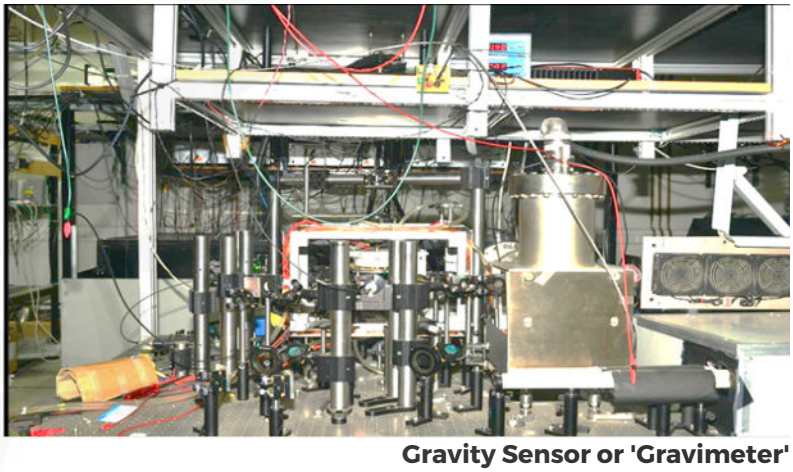
I. Automated person reidentification and monitoring in public spaces by leveraging Deep Learning Using CNN and transformers (TRL 4-5). Various applications of this technology are: video surveillance (monitoring public places), crowd movement analysis ,pedestrian tracking, automatic gate opening on identity authentication. This technology will bring in high end forensic, monitoring and security.

II. Extractive Text summarization using Meta heuristic approach using NLP based Deep learning using ML algorithms (TRL-5). This system works by picking up sentences directly from the text using a ranking function to form the corresponding summary. Currently, it is operational in English and Telugu, with ongoing efforts to expand to other languages.

III. The Hub has incubated Portable Power Technology Pvt Ltd., a Start-up that has developed a series of Battery Management System [BMS] that has reproducibly established its functioning for protection, energy balance and a state of charged detection features essentially required fore-mobility and operational safety. The developed technology is indigenous, developed from concept to product readiness with reproducible test and performance reliability. Products developed from cell to battery pack level applications with rating 3.4V,1A cell to 60V, 100A pack. The BMS circuit self-current consumption is far less than the imported commercial counterpart.

# I-Hub Quantum Technology Foundation (I-Hub QTF), TIH at IISER Pune

I-HUB Quantum Technology Foundation is focusing on translating research in quantum Information and computing, quantum communications, quantum sensing and metrology, and quantum materials devices and is currently working on developing ion-trap based quantum computer, gravity sensor, quantum clock, advance materials and devices that can be commercialised in future.



**Gravity Sensor or 'Gravimeter'**

**Portable Cold atoms setup**

## Key Spotlights

I. IISER Pune together with I-HUB quantum technology foundation (I-HUB QTF) has demonstrated the technology of quantum gravity sensor or gravimeter that measures the local gravitational acceleration 'g' using ultracold atoms at temperature ~100 nK which can measure local 'g' upto 200 micro-Gal (1 Gal=10-2 m/s2) precision which is being further scaled up to 1 micro-Gal and the prototype is being translated into a transportable device. This device will be useful in creating gravity maps of earth, local mineral prospecting, underground hydrological surveys, to detect underground structures such as tunnels, cavities for civil engineering and strategic applications.

II. The I-HUB QTF, IISER-Pune and GDQLabs successfully demonstrated the nation's first portable cold atoms at the DST hosted centre-state science conclave held at Ahmedabad in september 2022. GDQLabs is developing cold atoms-based quantum computer.

III. The Hub hosted Indo-Russia workshop on quantum technologies in 2022 that facilitated exchange of state-of-the-art research and technological developments in quantum areas. A MoU between I-HUB QTF and Russian Quantum Centre (RQC) is underway to facilitate exchange of students, researchers, technologists and start-ups and joint programs in quantum technologies

## Vertical: Device Technology and materials

# Divyasampark IHUB Roorkee for Devices Materials and Technology Foundation, TIH at IIT Roorkee

DivyasamparkiHUB Roorkee for Devices, Materials, and Technology Foundation aims to enable an innovative ecosystem in CPS and become the source for the next generation of digital technologies, products, and services by promoting translational research, enhancing core competencies, capacity building, training.


**IoT-enabled Smart Purification**


**IoT based Solar Cooker**


**Rhino UGV- All-terrian Unmanned Robotic Platform**


**Camboss**

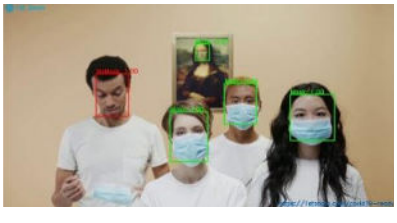
## Key Spotlights

I. Ballice Smart Devices Pvt. Ltd., a start-up incubated under the Hub has developed IoT enabled smart solar cooker (TRL9) which can provide solution to some remote/ resource prone areas where cooking is not possible. It has also developed an IoT enabled smart air purification (TRL9) where in data is recorded in dashboard on which decisions are driven, information is projected via graph and stats.

II. TIH is supporting Dtown Robotics which has developed an UGV Rhino- All-terrain Unmanned Robotic Platform (TRL9), the key features of which are Hybrid autonomous system with GPS accuracy <1m, Range upto 5km, Multiple payload Integration, 8Hr endurance and 24Hr standby.

**Optimus**

III. The TIH supported Adeo Distinctions & Dimensions Pvt Ltd, has primarily 3 lines of products: Poise is state of the art facial recognition system designed to handle 5G mobile networks - with stationary and mobile footprints. Optimus is a powerful AI-based integrated, digital surveillance system for ensuring the safety of citizens and deterring crime. CamBoss is enterprise-grade AI-powered CCTV health monitoring system that can monitor thousands of commercial CCTV cameras from any manufacturer across hundreds of locations. All the products are are at TRL9.



**Poise**

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# I-Hub AWaDH (Agriculture & Water Technology Development Hub) Foundation, TIH at IIT Ropar

The goal of iHub - AWaDH is development of technologies to support environmentally sustainable and profitable agriculture, quality food for all, and the preservation of biodiversity. It aims at providing technological solutions to the agricultural & water related issues through deployment CPS in food processing, rural development, fisheries, textiles, electronics, fertilizer, atomic energy etc.


**Ambi Tag**


**Digital Entomologist**

**Mooh Sense 1.0**

## Key Spotlights

I. Ambi Tag (TRL9), a USB-shaped CPS device that continuously records the temperature during the transportation of perishable products (Agri commodities), vaccines, and even body organs and blood from -40 ℃ to 80 ℃ in any time zone for 90 days on a single charge has been developed. It is India's first indigenous temperature data logger for the cold chain management.

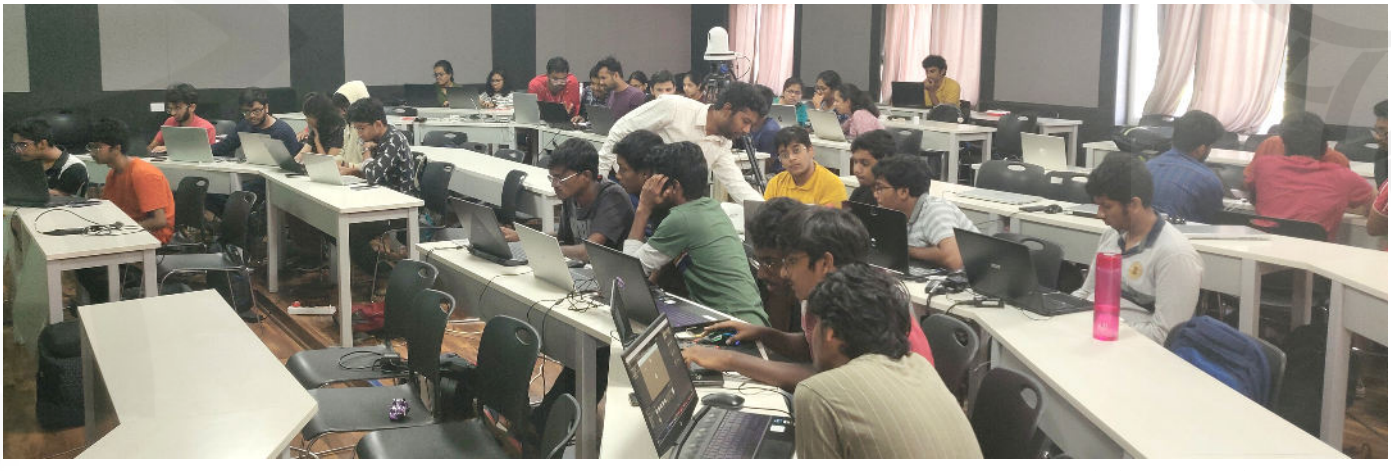
II. Digital Entomologist (TRL9), a CPS device to understand insect biodiversity in farms and to understand their behaviour has been developed which is capable of detecting flying insects - automatically, autonomously, and reliably. Presently, four devices are providing a live feed of insects in fields from Pune and Ropar (India), Bazel (Switzerland), and Fraunhofer (Germany).

III. Mooh Sense 1.0 (TRL9), is a livestock monitoring CPS device developed under the TIH that monitors livestock/cow movements to detect heat-related activity, rumination accurately, resting, and feeding behaviour. It uses animal movement and temperature data to provide actionable insights through inbuilt AI models to the farmers on their mobile phones.

IV. Urban Air Labs Pvt Ltd/ Ubreathe, a Start-up incubated under the TIH, develops smart natural air purifier solution to solve air quality challenges in cities and buildings. With the help of a centrifugal fan, Ubreathe's technology accelerates plant phytoremediation by 500%.

# IIT Tirupati Navavishkar I-Hub Foundation, TIH at IIT Tirupati

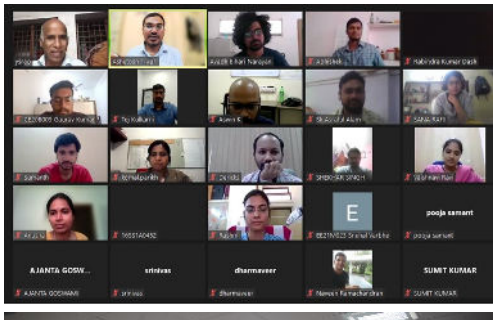
The Navavishkar I-Hub Foundation primarily focuses on Public Private Partnership (PPP) model to generate revenue. For technology development, the Hub is focusing on developing atomic clocks for GPS and navigation systems and their applications; developing solar-blind UV photodetectors for LIDAR; indoor positioning systems; data analysis and image processing techniques and visualization tools; decision making systems. The activities of the hub are primarily aligned to the National Geospatial Policy.



**Training organized at Hub**

## Key Spotlights

I. The hub is focusing on quantum positioning, smart cities, data science, geospatial tools, data science, radio frequency, disaster management, defence, precision agriculture, SMART villages, augmented navigation for technology development.

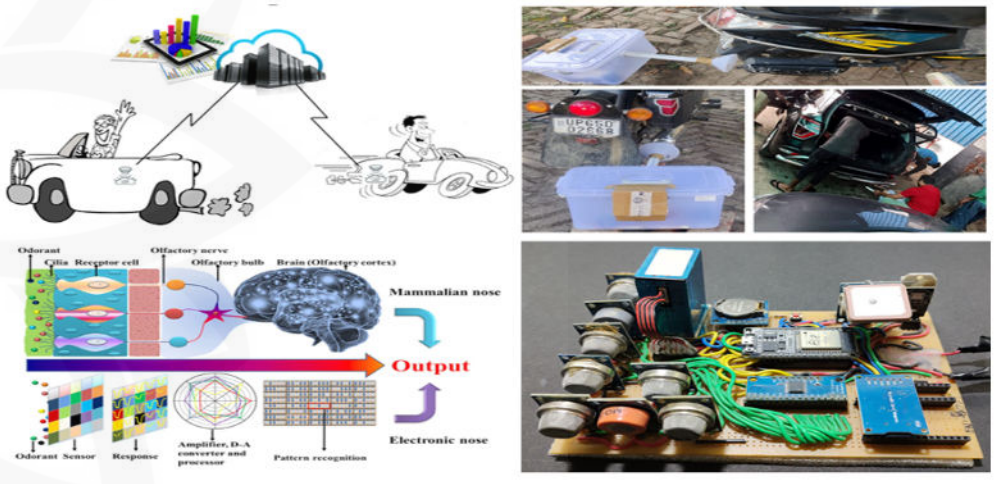


***Workshop sessions organized at Hub***

## Vertical: Data Analytics and Predictive Technologies

# I-DAPT-HUB Foundation, TIH at IIT (BHU) Varanasi

I-DAPT Hub Foundation aims to use the interdisciplinary nature of data analytics and predictive technology to fulfil the modernization of socio-technical systems and services with disruptive innovations in telecommunications, power, road transport and highways, defence research and development, and health and Family Welfare.




**Demonstrable prototype of a real-time onboard vehicular exhaust gas monitoring**

## Key Spotlights

I.An IoT Based Smart Grid (TRL7) has been developed which is empowered with IoT-enabled technologies which enable the devices to be controlled remotely. A new type of converter topology has been developed that can take power from solar PV and give three simultaneous outputs i.e. 1) 230V, 50 Hz AC, 2) 90 V dc, and 3) 5V DC. With this smart grid laptop, mobile phone battery can be charged directly without local adopters.


**LoRaWAN: Outdoor Gateway (2022)**

**IoT Based Smart Grid**

II. Demonstrable Prototype of Vehicular Pollution Monitoring System (TRL5) has been developed which is a real-time onboard vehicular exhaust gas monitoring system and uses the signature pattern analysis of the volatile organic compounds (VOCs) using Artificial Intelligence (AI) based algorithms.

III. LoRaWAN devices, mobile software, and protocols ( TRL5), that securely transmit data between locations with minimal power consumption, eliminating the need for frequent battery replacements and reducing monetary costs has been developed. This will help in critical information transmission over long distances using low-powered devices.

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**2023**