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
JULY, 2023

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

NM-ICPS

National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)

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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:

i) Technology Development, translational research and commercialization in Cyber Physical Systems (CPS) and associated technologies
ii) Adoption of CPS technologies to address India specific National / Regional issues.
iii) Produce Next Generation skilled manpower.
iv) Catalyze Translational Research.
v) Accelerate entrepreneurship and start-up ecosystem development in CPS technologies.
vi) Give impetus to advanced research in CPS technologies and higher education in Science, Technology and Engineering disciplines.
vii) 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.

IIITB COMET Foundation, TIH at IIIT Bangalore

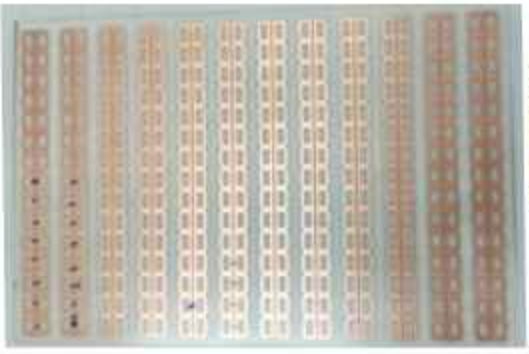
IIITB COMET FOUNDATION

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

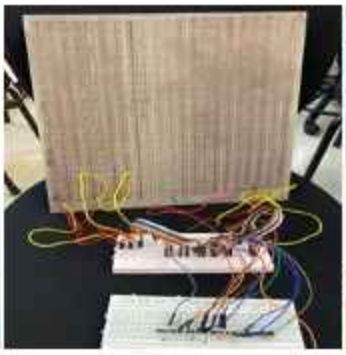
Key Spotlights

I. **Smart Radio Environments: Reconfigurable Intelligent Surfaces (RIS)** is a new paradigm that can potentially extend the communication range and quality of 5G-Advanced and 6G base stations. Moreover, they also allow to control and dimension the unpredictable wireless environment, which will allow to create Smart Radio Environments (SRE) and can be tailored to fit specific use-cases like Industrial IoT (IIoT) to improve overall system performance. For implementation and deployment for target use cases, a **prototype of RIS (TRL 3), a key feature of the evolving standard for 5G-Advanced/6G networks, is being developed** and is in line with the Bharat 6G Vision.

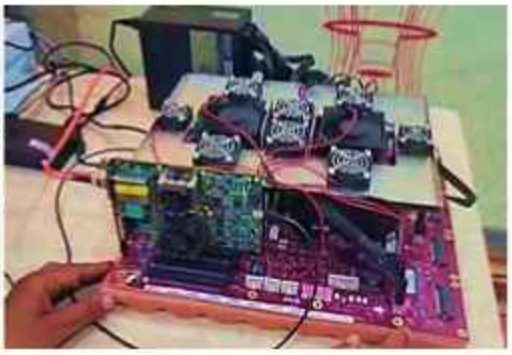
II. **5G-Advanced Massive MIMO O-RAN Base Station: Development of a Massive MIMO stack and integration with other network elements like Radio Unit (RU), Distributed Unit (DU), and Centralized Unit (CU) (TRL 4)** is underway. These three units put together constitute a 5G base station. To build this massive MIMO base station, the Hub is employing the Open Radio Access Network (O-RAN) technology which enables systems integration using open interfaces.



I. Passive RIS Fabricated



I. RIS with Parallel Capacitive Setup



II. ORAN complaint CU & DU Software Operating on an x86 Server

II. Open Space Testing of the Massive MIMO Stack

ARTPARK
AI & Robotics Technology Park

I-Hub for Robotics and Autonomous Systems Innovation Foundation, TIH at IISc Bangalore

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.

Key Spotlights

I. **Omnipilot AI Driven Autopilot (TRL 5)**, low power autopilot system for Unmanned Aerial Vehicles has been developed with advanced features such as advanced computer vision, autonomy, flight control, hardware accelerated on-board AI, 4G/5G enabled etc. The technology has been field tested for GPS based navigation, and safety features like geofence, return to home position, low battery sensing, etc. on a generic quadcopter system.

I. Omnipilot AI Driven Autopilot

II. **Comrado Dhara XTOL 100 (TRL 5) Unmanned Aerial Vehicle (UAV)** is being developed with features such as Maximum Launch Altitude: 2500 m, Ceiling: 3500 m, Cruise speed: 28 m/s, Range: 200 km, Payload Capacity: 25 kg, Max. Take off Weight: 125 kg.

II. Comrado Dhara XTOL 100

III. The Hub's supported start-up Acceleration Robotics focuses on designing customized brains for robots to hasten their response time. **ROBOTCORE, a product developed by the start-up helps map Robot Operating System (ROS) computational graphs to its CPUs, GPU and FPGA** efficiently to obtain best performance.

III. ROBOTCORE

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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.

Key Spotlights

I. **Accessible Banking Functionalities for DIVYANG (visually impaired) using Smart ATM (TRL 5)** has been developed to provide ATM functionalities, incorporating smooth access and advanced security features in the ATM, namely, multi-factor authentication using ATM cards, Aadhaar-based face recognition and voice recognition using mobile phones.

II. **Secure Application Framework based on indigenously developed PKI hardware token (TRL 6)** has been developed which provides secure dongle with mechanism to enforce authentication, access to an electronically restricted resource, 2-factor authentication to applications where security is critical etc. It is based on home-grown SCOSTA OS that has been adopted by the Bureau of Indian Standards (BIS).

III. **BhoomiCam Pvt. Ltd.** a start-up supported under the Hub is developing a **first-of-its-kind solution based on remote sensing technology (i.e., satellite imageries) to assist farmers** in evaluating their credit worthiness. This technology aims to provide hassle-free loans to farmers, enabling cultivating crops in challenging environment. The solution expedites decision-making process for loans by leveraging land and atmospheric data.

I. Divyang ATM

II. PKI Hardware Token

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TIH Foundation for IoT and IoE, 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 have also developed a unique structured four-level IoT course.

Key Spotlights

I. **SAgriS, an IoT-based Smart Agri Storage System (TRL 6)**, a promising technology with potential to improve the quality and safety of agricultural products has been developed. It can help prevent crop spoilage, rotting, sprouting contamination and avoid wastage that occurs in the traditional storage systems. Real-time data from the storage system will be accessible to farmers through a dedicated app. The solution will increase income for farmers.

I. SAgriS

II. **Mozek Band - a wrist worn seizure detection device (TRL 7)** that can detect epilepsy seizures and send an instant alert to the caregiver has been developed. It also logs all the information for the doctor by creating an automated seizure diary which comprises the specific location of the episode, total duration of the episode and the exact time of the event. Mozek has tied up with Zydus hospital in Ahmedabad to continue conducting testing in the actual hospital environment.

II. MOZEK Band

III. **ONHAR, a specialized machine designed to automate the harvesting process for onions (TRL 5)** is being developed. The design of the onion harvester has been completed and the first prototype manufacturing is in process. The product is under fabrication and will be tested at the ICAR-DOGR.

III. ONHAR

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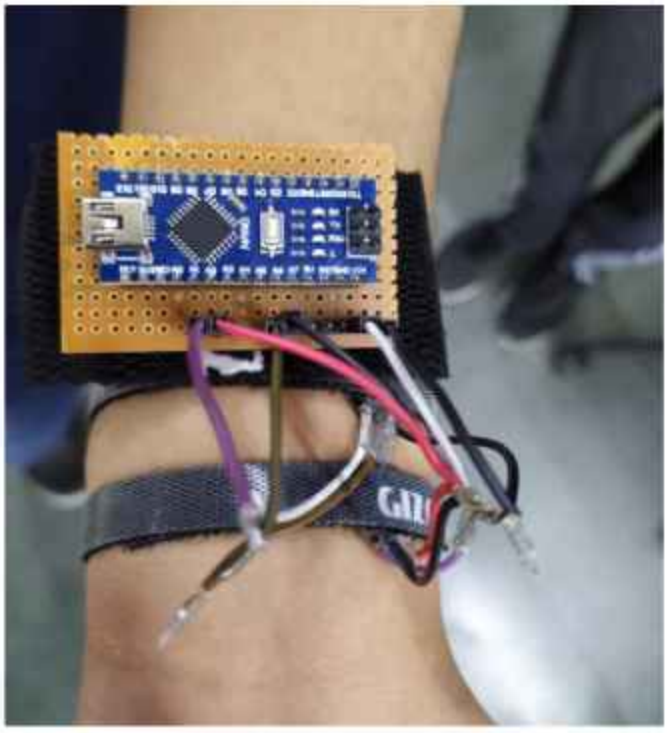
iHub Anubhuti-IIITD Foundation

IHUB Anubhuti -IIITD Foundation, TIH at IIIT Delhi

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

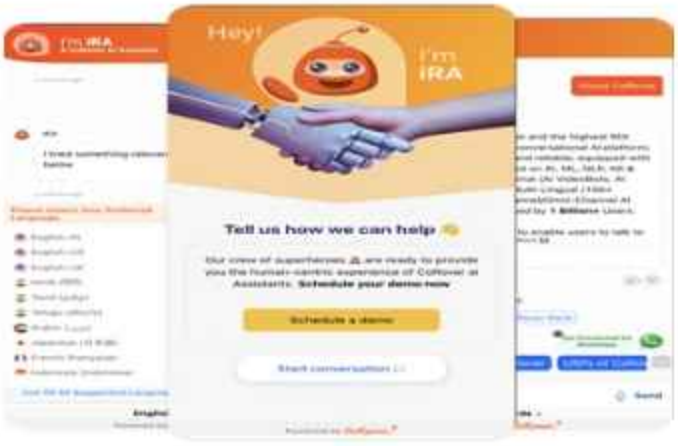
Key Spotlights

I. **The TIH is in process to develop an integrated, and synchronized, dataset of health-data from wearable sensors** to facilitate research and development in the e-health and m-health domains. Such wearable sensors can be viable diagnostic tools to healthcare personnel for monitoring important physiological signs and activities of the patients in real-time, apart from other applications.

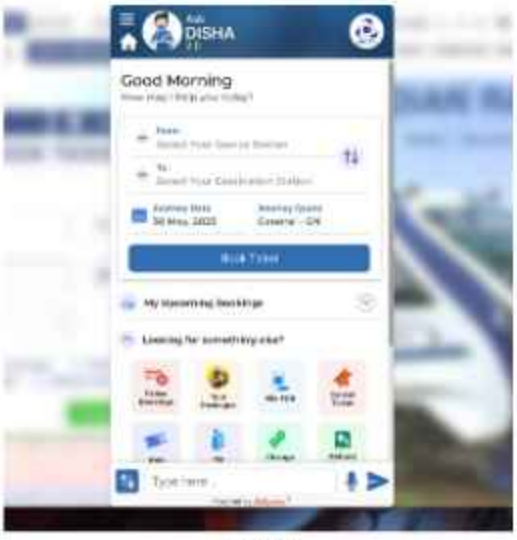


I. Lab Prototype of NadiPariksha

II. **CoRover Private Limited**, a start-up supported by the Hub has developed a **human-centric conversational AI platform with proprietary cognitive AI technology**. The start-up has products such as DISHA, iRA which are already in the market.



II. iRA



II. DISHA

Vertical: Cobotics

I-Hub Foundation for Cobotics (IHFC), 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 and the design of embedded systems and power topologies. The IHFC aims at serving various sectors like Medical Robotics, Agriculture, Disaster Management, Defence, Industry.

Key Spotlights

I. **The Innovation Story is an incubated Ed-tech start-up of IHFC** which has developed courses in coding and robotics. It strives to inspire and transform children through experiential learning; seeing them change and grow as they create things with their own hands thereby equipping children with cutting edge skills for their future careers.

II. **Hub SeiAnmai Tech an incubated start-up under the Hub has developed a Tele Observance Tele Operation (TOTO) Robot (TRL 7).** The features of the product include autonomous navigation, obstacle avoidance and self-docking capabilities. It can be controlled over the internet from anywhere in the world. Key applications of the product would be assistance of senior citizens at homes, patients at hospitals, doctors in simulation labs and engineers in research projects etc.

III. **IP for design of EMG Controlled Prosthetic Hand (ENRICH) has been granted to IHFC** along with other institutions by the Controller General of Patents, Designs and Trademarks, India. ENRICH is a real time Electromyography (EMG) controlled prosthetic hand designed mimicking its natural counterpart.

IV. **A mobile robot, Robomuse 5.0** developed that can have multiple applications, including the transportation of heavy items on a factory shop floor. If a manipulator is fitted on its top, the mobile manipulator can perform pick-and-place operations, e.g., to dispose of a faulty item in a bin. A licencing agreement has been signed between IHFC, and a Pune-based company, SVR InfoTech, for the technology transfer of Robomuse 5.0.

I. The Innovation Story - Ed tech Start-up Initiative

II. Tele Observance and Tele Operation (TOTO) Mobile Robot

IV. Robomuse 5.0

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Vertical: Technologies for Mining

TEXMiN Foundation, TIH at IIT (ISM) Dhanbad

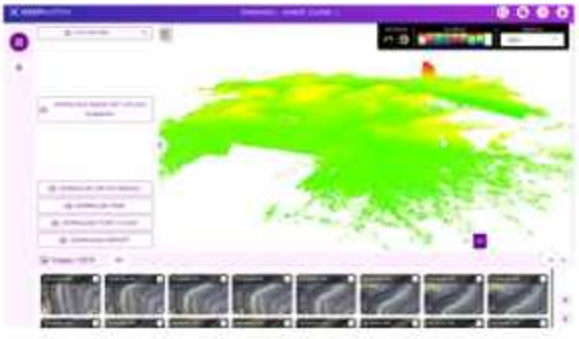
Technology Innovation in Exploration & Mining (TEXMiN) Foundation has been set up to address the issues and challenges of mining and exploration industry through intervention of CPS based technologies. The objective is to develop commercially feasible solutions using IoT, AI/ML, blockchain, drones, robotics,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

Key Spotlights

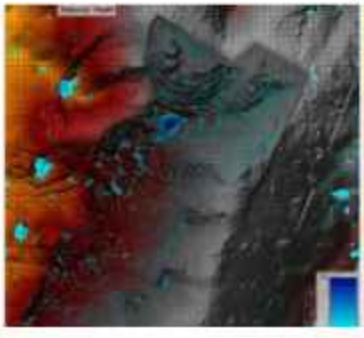
I. **Deepmatrix Private Limited, an incubatee of the TIH has developed FLY (TRL 7)**, a platform-based solution provider for geospatial data-related solutions. The platform enables the user to process the raw drone data to generate photogrammetric outputs. The platform is user-friendly and streamlined, allowing for intuitive photogrammetry processing.

II. **Climate-B Ventures Private Limited**, a start-up incubated under the TIH leverages the power of open-source, geospatial, cloud and big data analytics to provide robust enterprise-level physical climate risk assessment, adaptation scenario planning and streamlined integration of results into regulatory reporting, standards and disclosure frameworks.

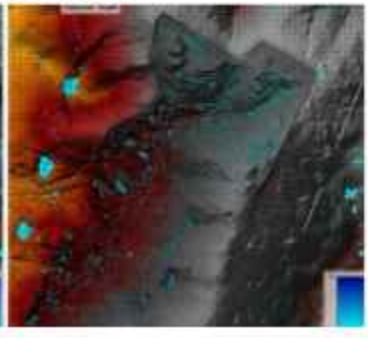
III. **Incubig Innovations Private Limited**, a start-up incubated under the TIH is enabling **research intelligence for augmenting mining**, REE and exploration research. Research Intelligence platform determines the success or failure of idea, or in turn provides comparative and predictive analysis derived from a trustworthy data source. It utilizes patent and research insights to make better business and strategic decisions and drive the innovation.



I. Deepmatrix Fly



II. Flood Map-Baseline



II. Flood Map-Adaptation

III. Research Intelligence for Augmenting Mining

Vertical: Technology for Underwater Exploration

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

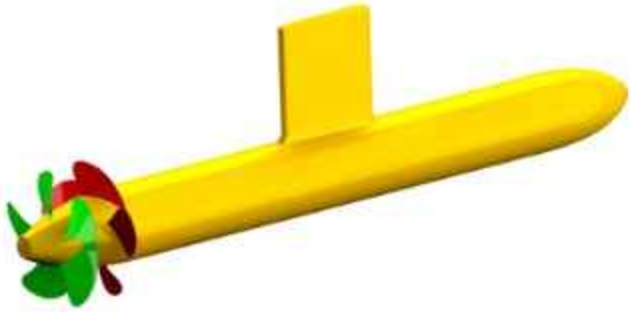
Technology Innovation & Development Foundation, IIT Guwahati focusses projects on the development of underwater robots, which may be used for underwater tracking, surveillance and monitoring purposes. Monitoring of cracks in ship hulls, industrial pipes and development of an apparatus for underwater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

Key Spotlights

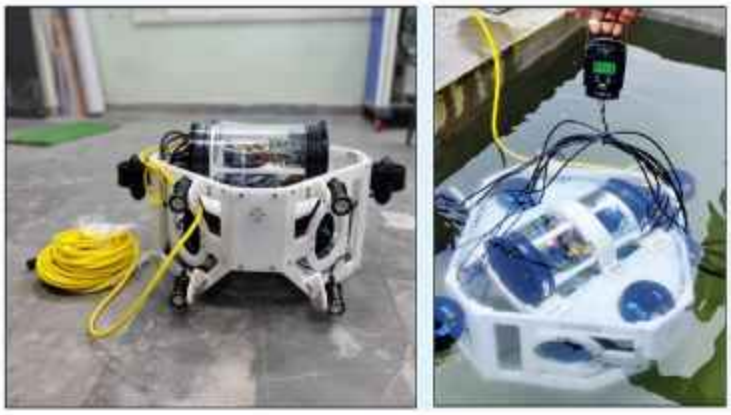
I. **Maribus Solar Pvt. Ltd, a Start-up incubated under the Hub is developing 6 PAX + 1 Solar Powered Electric Catamaran** with following salient features: smokeless and silent ride, covering distance of 42 nautical miles in one go, operate at a maximum speed of 6-8 knots. The hull form has been designed and tested for efficiency and stability at Centre for Inland and Coastal Maritime Technology (CICMT), IIT Kharagpur.

II. **An ROV along with a software for computational intelligence based navigational strategies** has been developed **(TRL 5)**. The ROV was successfully tested in the water body.

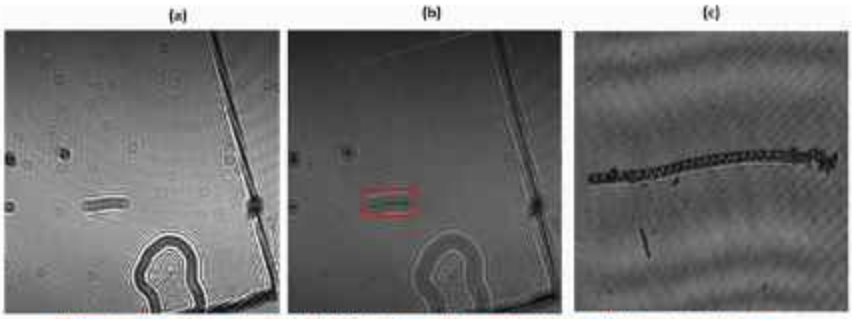
III. **An economical digital holographic microscopic imaging system (TRL 5) for detection and recognition of underwater microorganisms** and particles has been developed.



I. Solar Powered Electric Catamaran



II. Underwater ROV



Filamentous algae (micro-plankton) (a) Digital hologram (b) Reconstructed image (c) Reconstructed image (zoomed and cropped from (b))

III. Digital Holographic Microscopic Images

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. I-Hub 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.

Key Spotlights

I. **Bodhayan-Multi sensor mobile car platform (TRL 9)** developed by Hub serves as an easily accessible platform for start-ups, organizations, government, and students interested in road safety or road infrastructure inspection. It is an autonomous data capturing platform equipped with multiple sensors to enable research from academia start-up, industry in India to work on the problems specific to Indian roads. This platform enables to experiment technologies such as AI, ML, computer vision, image processing, pattern recognition etc.

II. **Flo Mobility** an incubated start-up under the Hub has built a computer vision based autonomous navigation solution that can be retrofitted on various farm equipment like sprayer, harvester, weeder, etc. It's a real time, computer optimized affordable stack, that helps farmers to adopt mechanization, reduce input costs &improve crop yield which in turn, increases their income. **It has developed Flo Universal Chassis with boom sprayer attachment (TRL 5).**

II. Electric Remote Controlled Boom Sprayer

III. Smartphone Based Fluorescence Spectroscopy Device for Cervical Pre-cancer Detection

III. **PhotoSpIMeDx, a start-up incubated under the Hub has developed smartphone based fluorescence spectroscopy device for cervical precancer detection (TRL 5)** which is compact, portable, cost-effective, accessible, minimally invasive and user-friendly. A cloud-based AI/ML algorithm being developed which will provide real time prognosis with smartphone app and could be used as a regular biopsy guidance tool.

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Vertical: Autonomous Navigation & Data Acquisition Systems

Technology Innovation Hub on Autonomous Navigation, 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.

Key Spotlights

I. **Data Collection Vehicles for Autonomous and Connected Vehicle (CAV) Development (TRL 9).** TIH has developed a NDS vehicle, which is equipped with sensors such as long-range radar, short-range radar, Lidar, high-end GNSS, cameras, etc. for collection of data about road conditions, traffic patterns, and driver behaviour. By analysing naturalistic driving data, autonomous driving systems can learn about real-world driving scenarios and improve their performance in various conditions.

I. Data Collection Vehicles for Autonomous and Connected Vehicle (CAV)

II. **GNSS Based Navigation of Autonomous Campus Shuttle Vehicle (TRL 9)** has been deployed at IITH campus. The vehicle performs GNSS-based path planning, localization, and navigation. It includes camera-based obstacle detection, autonomous emergency braking, LiDAR and camera-based autonomous parking.

III. **Swarm of Network Connected Unmanned Aerial Vehicles (UAVs) (TRL 7)** is being piloted at TIH. The framework primarily comprises a swarm of UAVs; a centralized ground control station; a marker layout for precision landing; and a communication network.

II. Autonomous Campus Shuttle

III. Demonstration of Swarm of Network-Connected Drones at TiHAN Testbed

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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 solution provider 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.

Key Spotlights

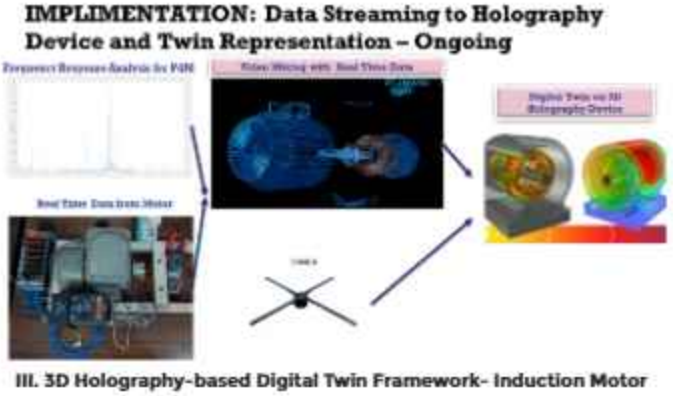
I. **Egg quality prediction and anomaly detection (TRL 5)** for hatcheries has been developed and is under validation. It is a low-cost mini egg grading machine that can be used to select eggs suitable for hatching at home or small poultry farms.

I. Final Product for Egg Quality Prediction and Anomaly Detection

II. **Technology for microscopic image based vegetable/fruit quality assessment (TRL 5)** has been developed having image capturing system on a mobile App to analyze the quality of vegetable using deep learning. This provides quantitative assessment in real time and prediction of vegetable quality in terms of nutrients, freshness index and shelf life. Useful primarily for export crops to reduce rejection and quality related issues.

III. **3D holography based digital twin technology for an induction motor for predictive maintenance (TRL 5)** has been developed. This technology assesses and offers real-time inputs and suggestions for improvement, monitor experiments, analyze health, and predict repair and maintenance of the electrical/mechanical systems. The key data/content from the system under consideration is updated dynamically with the support of artificial intelligence (AI), big data and other technologies.

II. A Prototype of Microscopic Image -based Vegetable Quality Assessment System



III. 3D Holography-based Digital Twin Framework- Induction Motor

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Vertical: Computer Vision, Augmented Reality and Virtual Reality

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).

Key Spotlights

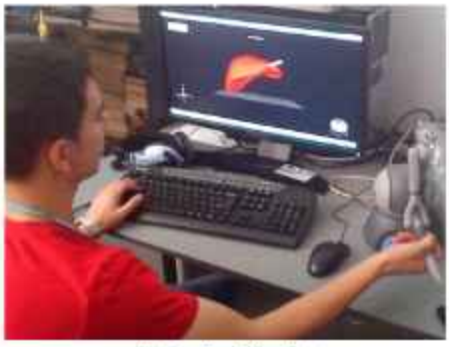
I. **Digitization of five museums of Rajasthan (TRL 9)** in Alwar, Chittorgarh, Baran, Bundi, and Bharatpur in Rajasthan. A web-based virtual museum space with interactive and immersive infographic content has been developed with features such as 360 degrees Interaction, 3D models of artefacts, Pre-defined tours to take through a guided experience with enhanced imagery and descriptions, easy-to-navigate controls.

I. Digital Alwar Museum

II. **Vision system for integrating mass manufacturing line of bearing rollers (TRL 7)** developed. The vision-based inspection system can accurately measure and sort parts at higher speeds to improve productivity. In addition, the vision-based system can facilitate 100% inspection requirements of manufactured components, ensuring conformance to specifications and customer satisfaction.

II. Vision System Assembly

III. TIH is supporting Markel Haptics System Pvt. Ltd. for developing **haptics based medical simulators for palpation and tele-diagnosis.** The palpation training simulator has two main components: a-custom haptic device having six-degree-of-freedom for interfacing with simulated organs, 3D location and rotation sensing, force rendering capability. B-Immersive Environment where various organs simulated and different properties rendered.



III. Medical Simulator

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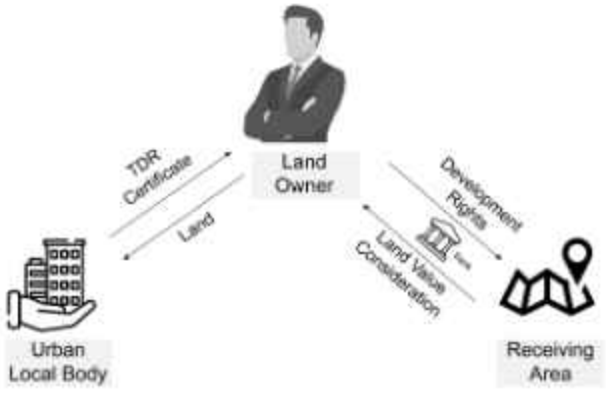
Vertical: Cyber Security and Cyber Security for Cyber Physical Infrastructure

Cybersecurity & Cybersecurity for Cyber-Physical Systems Innovation Hub, 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 focuses on verticals critical infrastructure-security, automotive-security, UAV-security, tamper-proof data storage and cybercrime prevention, and all horizontal layers of security associated with these verticals, including hardware security, network security, firmware security etc.

Key Spotlights

I. **Blockchain-based transferable development rights (TDR) system, TRL 8,** is under deployment with Kanpur Development Authority (KDA). The TDR system allows transparent, tamper-proof storage and management of the Development Rights Certificates (DRCs), thus enables transparent trading of land holdings in cities and reduces litigations, frauds, while contributing to ease of doing business.



I. Schematic Platform for Trading DRCs

II. **Exam Anti-cheat Solution (TRL 7),** a tool to detect interferences in the Windows machines of examinees in competitive exams has been developed which enables preventing cheating in computer-based examinations. The technology has been demonstrated with National Testing Agency (NTA) and ENY.

III. **Treacle Technologies Private Limited, an incubated start-up under the TIH has developed Treacle MUTACON Blackbox (TRL 9),** an AI-driven autonomous honeypot and deception technology platform that diverts attackers from targeting real systems in real-time while analyzing their hacking attempts.

II. Malicious Activities in Examination Center Machines Detected by the Anti-Cheat Solution

III. MUTACON Dashboard

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Vertical: Artificial Intelligence and Machine Learning

AI4ICPS I-Hub Foundation, TIH at IIT Kharagpur

AI4ICPS IIT Kharagpur

AI4ICPS at IIT Kharagpur 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, three dynamic sectors of Energy and Infrastructure, Transportation, & Communications.

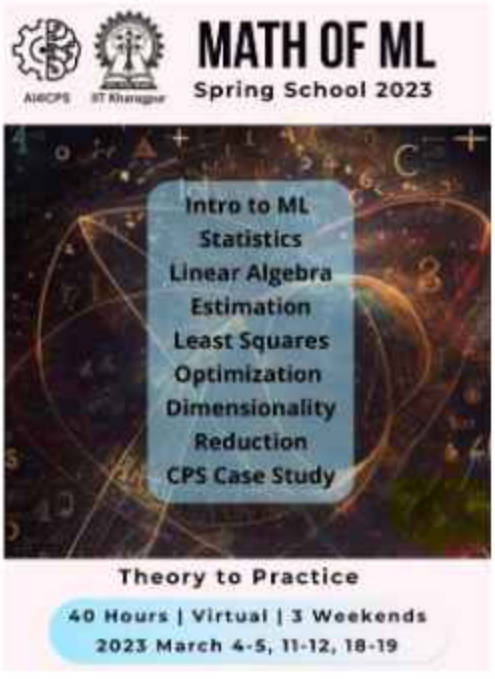
Key Spotlights

I. **Distributed Air Quality Monitor or DALTON developed (TRL 4)** is a compact, lunch-box-sized sensor fusion box that monitors 12 indoor pollutants, including VOC (Volatile Organic Compounds), CO_2, and formaldehyde, which can arise from routine household and industrial activities. The Device, powered by AI algorithms, analyses its environment and identify any dangerous gas emissions.

II. **AI4ICPS at IIT Kharagpur conducted AI Nano Accelerator (ANA) Program at its AI4ICPS incubator.** Early-stage start-ups from healthcare, agriculture, manufacturing, energy, transportation and education sectors participated and have been shortlisted for AI translational research funding.

III. **AI4ICPS at IIT Kharagpur organized Mathematics of Machine Learning Spring School 2023** for undergraduates from 6 different colleges across India. Every theoretical AI and ML session was followed by hands-on lab sessions for practice. The Spring School also had AI experts from industry demonstrate some real-world use cases.

I. Distributed Air Quality Monitor (DALTON)



III. Math of ML Spring School

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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.

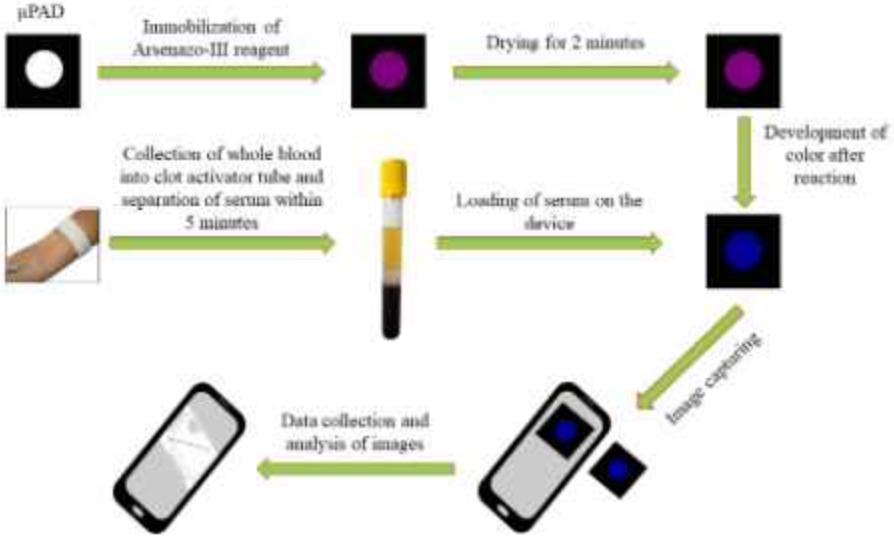
Key Spotlights

I. **Technology for detecting behavioural health disorders in older adults using self-supervised learning and causal reasoning (TRL 5)** is being developed and significant progress has been made on time-varying dynamical model of epidemic evolution in largescale complex networks that capture the response of individuals to the spreading process. Observability and identifiability of the model is currently being examined.

I. Sensing Device Image

II. A portable **low cost point of care device on a simple paper strip for estimation of Calcium** is being developed. The product developed is currently at **TRL 5**.

III. **Development of data science methods for cyber physical system design of IoT enabled wireless sensor network (WSN) for monitoring environmental variables** such as soil moisture, air humidity, temperature etc. is in process.



II. Calcium Estimation Process

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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.

Key Spotlights

I. **LIBERA – Menstrual pain relief device using pulsed electro-magnetic field therapy (TRL 8)** has been developed. It is a wearable, non-invasive, wireless device which improves women's performance and quality of life without causing any side effects or risk of drug interactions.

I. LIBERA

II. **Conqur an advanced human performance monitoring system (TRL 8)**, a solution for a team's physiological and motion monitoring needs has been developed. With focus on individualized reports and comprehensive team analytics, Conqur helps align all athletes towards peak performance while reducing the risk of injury. With key performance metrics like heart rate, training load, and movement load, Conqur enables coaches to get the best out of their athletes and train them the right way.

III. **SecurWeave Research Labs Private Limited, an incubated start-up under TIH has developed Configurable Hardware Enforced Safety & Security (CHESS), TRL 9**, a platform that leverages hardware-provided security-related extensions to isolate critical software modules from untrusted entities to provide-componentization security and flexible policy. It is capable of detecting and preventing advanced malware attacks that try to compromise the kernel of the Operating System.

II. Conqur

III. CHESS Architecture

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Vertical: Human-Computer Interaction (HCI)

IIT Mandi IHUB and HCI Foundation, TIH at IIT Mandi

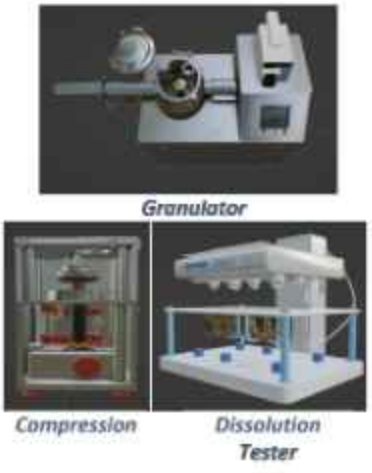
IIT Mandi iHub and Human-Computer Interaction (HCI) Foundation is a Technology Innovation Hub that focuses on Human-Computer Interaction with a vision to nurture research in the area, enable technology translation for industry, and build scale in skill development.

Key Spotlights

I. **HCI-based Driver's Attention Management System (DAMS) (TRL 8)**, a proven technology which assesses cognitive loading through computer-vision based device-led technology and enables prevention of fatal accidents by providing the timely alerts to the driver, has been developed. PoC is getting deployed with Chandigarh Transport Undertaking (CTU) Chandigarh.

I. Driver's Attention Management System (DAMS)

II. **AR based low-cost training module for pharmaceutical industry (TRL 9)**, developed and has been proven in operational environment. IHub is developing a training module for Aizen Algo (Hyderabad based pharmaceutical company). This technology is affordable and can be used to train employees in any industry using mobile phones, without any expensive gadget. AR training module involves three processes in the manufacturing of medicinal tablets: granulation, compression, and dissolution.



II. AR-based Training Module for Pharmaceutical Industry

III. SMARTON

III. **Sunbots innovations LLP, a start-up supported by the Hub has developed SMARTON (TRL 8)**, a dependable, convenient, and user-friendly device which translates visual world into audio form using camera vision to provide actionable intelligence for blind and visually impaired persons using ML and computer vision algorithms. When integrated into daily routines it allows user to navigate their environment and access information with confidence.

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Vertical: Intelligent Collaborative Systems

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

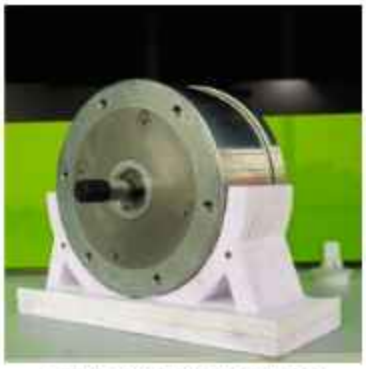
IIT Palakkad Technology IHUB Foundation (IPTIF) on Intelligent Collaborative System (ICS) aims to create a strong foundation and a seamless ecosystem for Cyber Physical Systems. One of the primary goals of this company is to work in close collaboration with the industry to deliver commercial technology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

Key Spotlights

I. **High power density switched reluctance motor & drives (TRL 4)** in the power levels of 2-20 kW is being developed for powering two/three wheelers and smaller trucks, micro wind turbines etc. SRMs utilize ferromagnetic rotors aligned to magnetic fields applied to the stators, resulting in a simple rotor construction, greater mechanical stability, and the ability to operate at higher temperatures without significant cooling requirements.

II. **Long endurance small solar glider as low-altitude microsatellites for communication and surveillance (TRL 3)** is being developed. It can operate at lower altitude outside the commercial airspace. Additionally, the development of a solar power converter, bidirectional battery converter, BLDC motor drivers, flight controller boards, and software is integral to this endeavor.

III. **INALUX an incubated start-up under the Hub has created an ML-driven and IoT-connected autonomous system** that revolutionizes the cleaning and maintenance of large-scale solar power plants by leveraging machine learning algorithms and IoT technology. This innovative solution enables remote command and supervision, allowing operators to remotely initiate and monitor cleaning operations with minimal human intervention. Thereby, the technology increases energy production and ensuring long-term efficiency and sustainability.



I. Switched Reluctance Motor

II. Solar Glider

III. Solar Panel Cleaning Robots

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Vertical: Speech, Video and Text Analytics

Vishleshan I-Hub Foundation, TIH at IIT Patna

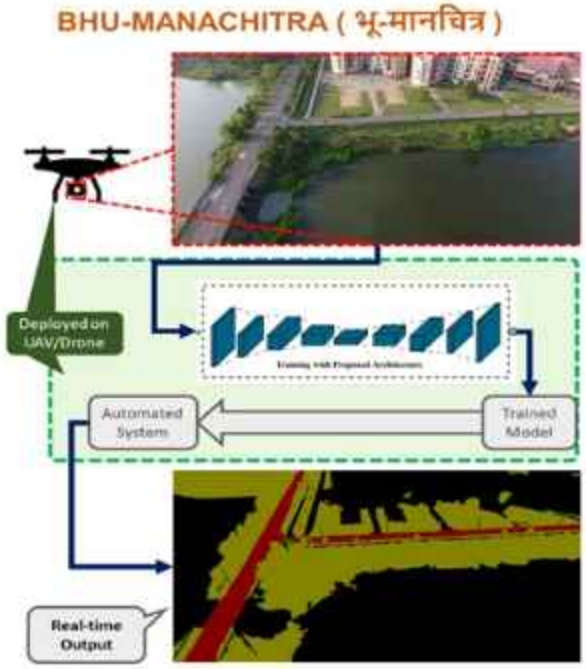
IIT Patna Vishlesan I-Hub Foundation is established to build an ecosystem for the domain of "Speech, Text and Video analytics". TIH IIT Patna focusses on Industry's real requirements and all projects are working towards meeting the industrial ends.

Key Spotlights

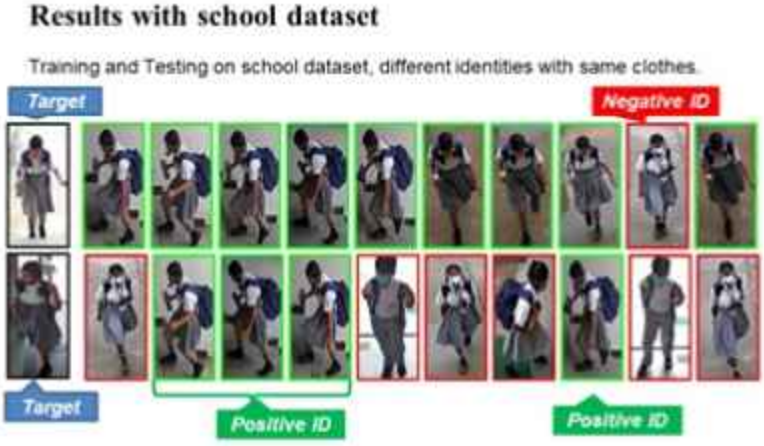
I. **BHU-MANACHITRA (TRL 5), UAV/Drone video based remote sensing technologies** has been developed. Bhu-Manchitra is a CNN architecture-based system that enables drones to capture images of landscapes and use advanced computer algorithms to map out terrain, vegetation, and buildings. This technology has numerous applications in fields such as agriculture, forestry, and urban planning.

II. **Subjects Re-identification (TRL 5) Technology is being developed which aims to use AI/ML based to identify the subjects re-appearing in the gambit of the deployed CCTV's visual zone.** Applications of technology include security and safety, police and vigilance.

III. **The Hub supported start-up Travvir has developed digital meta twin for real-estate (TRL 9)** with features such as video analytics for mapping real-estate in 3D metaverse, conversational AI speech bot that assists the users, smartphone based virtual tour creation etc.



I. BHU-MANACHITRA



II. Green Enclosures as Positive ID and Red as Negative ID

Vertical: Bio-CPS

BITS BioCYTiH Foundation, TIH at BITS Pilani

The mission BITS BioCyTiH Foundation is to foster research, innovation, skill development and training in the interdisciplinary area of Bio-CPS through mentoring and nurturing start-ups & entrepreneurs, and industry-academia collaborations. The foundation envisions to undertake cutting edge research to provide affordable solutions in the areas of healthcare, agriculture, water and environment.

Key Spotlights

I. **Billioncarbon Solutions Private Limited**, incubated by the TIH is involved in nutrient mining from biodegradable waste and convert it to bio-fertiliser. It is one of the fastest, nature optimised, IoT enabled and low-cost biodegradable waste treatment solution. It has developed **Billioncarbon bioreactors (TRL 7) which processes and makes the waste disappear within 3 days - without any waste products, and with no external energy usage.**

II. **Sensivision Health Technologies Private Limited, a Start-up supported under the TIH has developed REVIVE Brain Function Monitor (REVIVE BFM) (TRL 7) to diagnose Hypoxic Ischemic Encephalopathy (HIE).** The device diagnoses and monitors baby's brain condition either during treatment or independent of the treatment by communicating wirelessly with the treatment device through proprietary communication protocols to assess the brain electrical activity as well as levels of brain tissue oxygenation.

III. **Bagmo Private Limited, a Startup supported under the TIH has developed Bagmo Blood Tracker, which monitors the storage conditions of blood bags during transportation and storage (TRL 7).** Each blood bag comes with a unique radiofrequency identity (RFID). When a blood bag is transferred to a storage unit from the blood bank, its entry is noted by the RFID scanner fitted to that storage unit. This, in turn, is connected via the internet to a central monitoring system which starts recording the temperature, position and expiry date of the blood bags. The solution will avoid blood wastage and increase the inventory of blood units in rural India.

I. Low-cost Biodegradable Waste Treatment Solution

II. REVIVE Brain Function Monitor in ICU

III. Bagmo Blood Tracker

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Vertical: Quantum Technologies

I-HUB Quantum Technology Foundation, TIH at IISER Pune

I-HUB QUANTUM TECHNOLOGY FOUNDATION

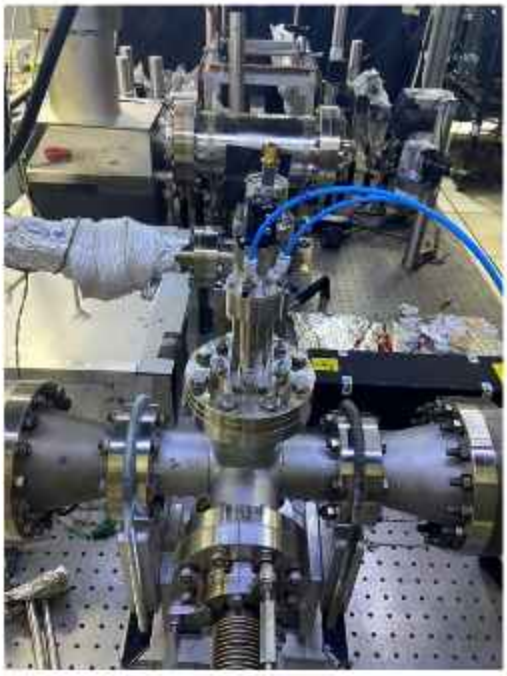
I-HUB Quantum Technology Foundation is focussing on translating research in Quantum Information and Computing, Quantum Communications, Quantum Sensing and Metrology, and Quantum Materials and Devices and is currently working on developing ion-trap based quantum computer, gravity sensor, quantum clock, advance materials and devices that can be commercialised in future. The I-HUB QTF runs nation's quantum incubator that supports start-ups working in Quantum Technologies.

Key Spotlights

I. **GDQLabs, a start-up incubated under the Hub has developed Nano Burst: a nanosecond resolution Pulse Generator (TRL 7)** which is an important sub-system of a quantum computing control and measurement system to generate pulses with variable duration to drive the qubits for applications in quantum computation, quantum information, and many more. It is an indigenously developed pulse generator with specifications superior to those offered by other market players, and is available at a more affordable price.

II. **Gravity Sensor or 'Gravimeter' technology developed under the Hub is being translated into a Transportable Gravimeter that can be deployed in the field.** The Gravimeter will be field-deployable and will have the following applications: creating gravity maps of earth, local mineral prospecting, underground hydrological surveys, detecting underground structures such as tunnels, cavities for civil engineering and strategic applications.

I. Nano Burst



II. Gravity Sensor or 'Gravimeter'

Vertical: Devices Materials and Technology

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

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

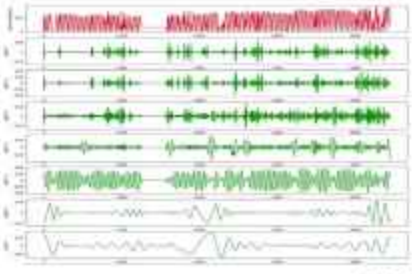
Key Spotlights

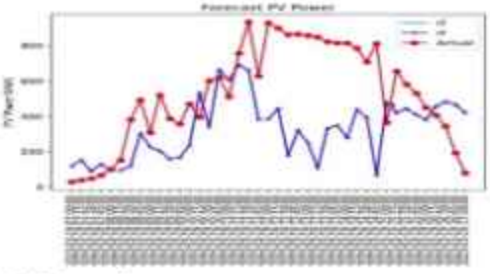
I. **Proof of concept for detecting cyber-attack on Automatic Generation Control (AGC) signal (TRL 6)** has been developed with industry partner THDC India Ltd.

II. **Solar PV forecasting (TRL 7)** has been developed with industry partner Inspire Clean Energy Pvt. Ltd. The target is to setup a reliable and autonomous hardware system for collecting data necessary for generation forecasting, development of PV power forecasting methodology which can account for variations in local or climatological parameters.

III. **Nexactly AI Solutions a Start-up supported by the Hub has developed Brain Ed (Brain-Computer Interface) (TRL 9)**, a SaaS-based platform for neuromarketing, incorporating advanced AI algorithms for eye-tracking heatmaps and brain activity prediction. The platform has undergone rigorous testing and iterations to ensure its accuracy and effectiveness.

I. Detecting Cyber-attack on Automatic Generation Control (AGC) Signal





II. Solar PV Forecasting

III. Brain Ed (Brain-Computer Interface)

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iHub - AWaDH
IIT Ropar - Technology and Innovation Foundation
Quality Food • Sustainable Agriculture • Biodiversity

IHUB - AWaDH (Agriculture & Water Technology Development Hub), 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 of CPS in Food Processing, Rural Development, Fisheries, Textiles, Electronics, Fertilizer, Atomic Energy etc.

Key Spotlights

I. **Industrial IoT Lab (TRL 9), an industry-grade "automation lab in a box"** enabled with chip-based wireless communication protocol, 24 plug-play e-modules controller and multiple sensor systems, high-end resources, has been developed which has the capability to sense, log and transmit data. The equipment in the lab will be used mainly by M. Tech and B. Tech students as part of the academic curriculum and to develop projects to create new smart solutions.

I. Industrial IoT Kits

II. **Yoboshu Private Limited, a Start-up incubated under the TIH has developed Yoboshu care (TRL 9)** an AI based application to understand food consumption behaviour. This app helps in taking assessments to creating a perfect weight management plan by understanding underlying mechanisms of human behaviour.

II. Yobushu Care Mobile App

III. **Nanokrti Private Ltd., a start-up incubated under the TIH has developed NanoOxy - Nanobubble generator in aquaculture**, which is efficient, compact, plug and play device with in-built oxygen concentrator for the nanobubble generation. It helps to treat and prevent algae and biofilms in water bodies, improve overall water quality, sustain aquatic life and maintain ecosystem health and removes odour compounds.

III. Nanokriti NanoBubble Generator

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IIT Tirupati Navavishkar I-Hub Foundation

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

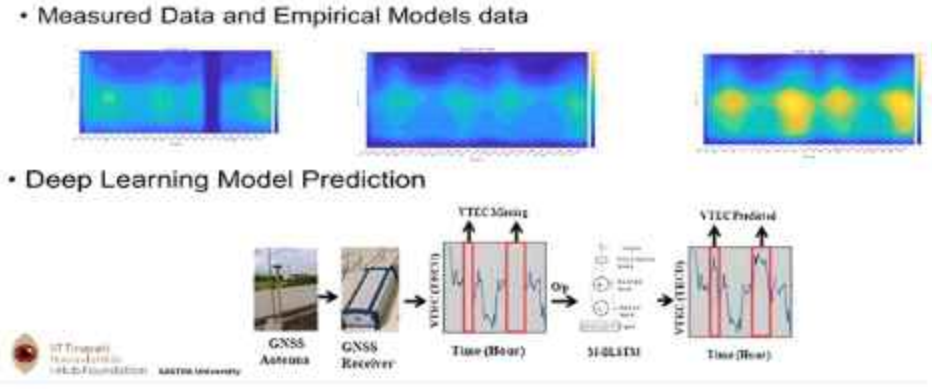
The IIT Tirupati Navavishkar I-Hub Foundation primarily focuses on Public Private Partnership (PPP) model to generate revenue. For technology development, the Hub is focusing on Developing atomic clocks for GPS and navigation systems and their applications; Developing solar-blind UV photodetectors for 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.

Key Spotlights

I. **GNSS antenna system with anti-spoofing and anti-jamming (TRL 3)** is under development which will be an independent module that can be connected to an existing GNSS receiver to mitigate anti-spoofing specifically for IRNSS. This product can be adapted for other constellations like the GPS, Galileo, etc.

II. **Ionospheric model of the Indian sub-continent for use in IRNSS** to predict and forecast ionospheric TEC for the Indian subcontinent is being developed supported by a multi-station dataset. The model will have the capability to be adaptive with continuous learning ability. The model could be further adapted to improve the ionospheric delay estimation by navigation receivers in real-time scenarios.

I. GNSS Antenna System with Anti-spoofing



II. Ionospheric Studies at Thanjavur

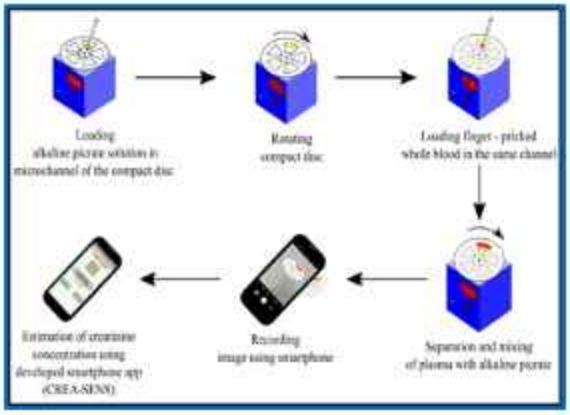
Vertical: Data Analytics and Predictive Technologies

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.

Key Spotlights

I. **Multiplex diagnostics on a spinning disc (TRL 6),** a portable multiplexed diagnostic platform integrated with a smartphone app for providing rapid diagnostics of different analytes has been developed. The platform is being facilitated by machine learning tools such as random forests, decision trees, etc. to determine the concentration of different analytes with uncompromised accuracy. The technology can easily be deployed to resource-constrained settings.



I. Working of Spinning Disc Technology

II. **Baby Care Robot (TRL 5), a fully ROS-integrated mobile robot** designed and fabricated to assist with day-to-day activities in an average household has been developed. The robot utilizes advanced technologies, including autonomous navigation, computer vision, and deep learning algorithms, to achieve a wide range of functionalities such as human following, face recognition, and threat detection capabilities etc.

III. **Low-cost, privacy-secured, and vision-based divergent behaviour prediction system (TRL 5)** has been developed for both individual and group, recognizing divergent behaviours of people present in crowds or individually and abnormalities that impact road traffic. This technology is designed as a privacy-secured robust model.

II. Baby Care Robot

III. Vision-based Divergent Behaviour Prediction System

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