CSIR-CSIO

वार्षिक प्रतिवेदन
Annual Report
2021-22

सीएसआईआर - केंद्रीय वैज्ञानिक उपकरण संगठन
सेक्टर 30 C, चंडीगढ़, 160 030

CSIR- Central Scientific Instruments Organisation
Sector 30 C, Chandigarh, 160 030

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From the Director's Desk...

It is with great pleasure that I present to you the annual report of the CSIR-Central Scientific Instruments Organisation for the year 2021-22. This report outlines our recent progress and provides an overview of our R&D, Industry oriented initiatives, and HRD activities over the past year. As the world gradually recovers from the adverse effects of the pandemic and the associated socio-economic challenges, this has reinforced the responsibility of the scientific community to augment the knowledge production systems for sustainable technological solutions for various fronts.

At the national level, the focus has been on the development of niche technologies in the strategic sector, for public safety and in the societal sector for inclusive development, in addition to the health sector. This year, our scientific teams at CSIR-CSIO worked extensively to develop technologies for the aviation sector, agricultural instruments, energy management tools, systems to contain COVID-19 and other important socially relevant technologies. I hope readers will find this edition of the annual report informative and will continue to support us with constructive comments and suggestions.

Even as we celebrate 75 years of independence this year, we realize that our nation has come a long way from a newly independent country with complex economic and geopolitical crises to an intellectual powerhouse that is now shaping the future of humanity. In our country's glorious journey, CSIR has made significant contributions through indigenous technologies in aerospace, agriculture, food safety, industrial automation, instrumentation, sensors, nanotechnology, and healthcare. As we continue to evolve and realign our focus with national priorities, it has become critically important to identify and engage at the frontiers of S&T and to use research findings to develop products of point. In the rapidly evolving areas of science and technology, where obsolescence is hitting harder and at a much faster rate than a decade ago, it is time to refocus on embracing innovative, cutting-edge research with a focus on delivering products and technologies to improve the quality of the lives of our citizens and humanity in general. To encourage and foster such research practices, a major reorganization of CSIO S&T staff was undertaken this year, with particular emphasis on emerging areas such as intelligent sensors and systems, optics and photonics, imaging and display systems, and intelligent communication systems. To support research activities and ensure seamless access to laboratory facilities, a centralized analytical facility, a mechanical and electronic design, and manufacturing facility, and a thin film coating facility with dedicated scientists and support staff were created this year. These facilities have also been able to generate external cash flow through routine and custom testing, design, and manufacturing services. A facility dedicated to instrumentation based on micro-nano-optics will also be set up in the laboratory to continue research in emerging fields of optics and display technology.

During this year, the laboratory transferred 6 technologies to different industries in the fields of COVID-19 mitigation, avionics, energy management, and agro-instrumentation. The technologies of 'UV Disinfectant retro-fit systems for HVAC Ducts', 'Standalone UV Air Disinfection System for Rooms', and 'UVC Disinfectant Circulating Air-Flow Systems for Elevators and Toilets' were developed and transferred to a record 46 industries to maximize

its reach and to ensure faster technology deployment. Extensive trials of these products were carried out in public transport systems, buildings, lecture halls, and elevators. The readers would be happy to note that the UVC disinfection system, developed by CSIR-CSIO, was installed in Parliament House to minimize the risks of airborne transmission of COVID-19 during house proceedings. Our systems are also being implemented by Indian Railways in the train coaches to provide passengers with a safer travel experience.

In the areas of avionics, the laboratory transferred the technologies of 'LED-based NVG compatible Wing and Fin Navigation Lights, Taxi & Landing Lights (TLL) and Drogue Lights along with associated Test Rigs for LCA Tejas' to BEL, Panchkula. Avionics and Cockpit Instrumentation has always remained a key focus area of the laboratory and such technologies demonstrate our commitment to fulfilling our aspirations under 'Atmanirbhar Bharat'. On the agri-instrumentation front, the laboratory developed and transferred the technology of 'Digital Grain Moisture Analyser' which can be used during harvesting, procurement, storage, and processing to ensure the right quality and shelf-life of grains. The laboratory also transferred the technology of a 'Non-Intrusive Load Monitoring System' for energy management in residential/commercial buildings. It uses a machine learning approach to disaggregate the individual appliance's status and energy consumption from the aggregated energy data. I am confident that all these technologies will have a significant contribution in achieving self-reliance in the strategic sector as well as improving the quality of life for sustainable development.

Looking back on our journey over the years, we have achieved many successes and delivered niche technologies in line with our national priorities, but none of these would have been possible without the active support of our collaborators. The lab has always been keen to forge new partnerships with industry, academia, and other R&D labs to share resources, ideas, and expertise. During this year, the laboratory signed 13 MoUs and 22 project agreements with various industries, universities, and PSUs including IIT Ropar, IIT Kanpur, NIPER Mohali, PGIMER Chandigarh, ICMR, Honeywell Technology Solutions, Voltas, etc. I am sure that these associations would lead to the development of advanced products and technologies in various research fields of considerable importance. Regarding IP generation, CSIR-CSIO filed 13 patent applications (India & Abroad), 18 design applications, and 6 copyrights in 2021-22.

As far as HRD is concerned, the laboratory has been offering diploma, and postgraduate diploma programs through its Indo-Swiss Training Centre (ISTC) and master, integrated dual degree, Ph.D. programs as part of the Academy of Scientific & Innovative Research (AcSIR). All these academic programs are supported by experienced teams of qualified scientific and technical staff with multidisciplinary expertise. Also, several skill development programs, workshops, and mentoring programs were regularly carried out under DSIR-PRISM, Skill India, CSIR-JIGYASA, and CSIO student chapters of different professional societies. Such activities and interactions help instill scientific curiosity, critical thinking, and team spirit in young minds and prepare them to face the scientific challenges of the future with out-of-the-box thinking and innovative solutions.

On this auspicious occasion of CSIR-CSIO Foundation Day, I would like to congratulate all employees for their unwavering commitment to our shared vision and their quest to reach new heights of scientific excellence. I would like to thank DG CSIR, the members of the Research Council, and the Management Council for their continuous advice and support in managing the activities of the laboratory. I would also like to express our sincere thanks to all our funding agencies and end users for their trust and support for our staff. Their feedback has always

helped us diversify and increase our professionalism in managing demanding, time-limited projects.

In this Amrit Kaal, we fondly remember the Father of our Nation, Mahatma Gandhi, who once famously said, "If I have the belief that I can do it, I shall surely acquire the capacity to do it even if I may not have at the beginning". The magnanimity of this quote has all the momentum to propel us on a path of excellence, both personally and professionally. On this occasion, we must strive to increase our skills, competencies, and intellectual acumen at every stage of our professional career to remain relevant and continue to serve this great country.

Let's write a new beginning for a better future!

Jai Hind !

October 30, 2022
Chandigarh

(S Anantha Ramakrishna)

R&D Achievements

Imaging, Avionics & Display System

Dr. Shravan Kumar R R
srr@csio.res.in

The Imaging, Avionics & Display System division at CSIR-CSIO is carrying R&D activities on design & development of systems based on Avionics, Imaging & Display Systems. The developments in this area include technologies for societal, industrial as well as strategic sectors of the nation. The group provides technological solutions for import substitution in strategic sector with globally competitive specifications and also customizes its innovative technologies for end user requirements. In addition to it the group also works on fabrication & metrology of precision aspheric, off-axis mirrors required for space applications with stringent specifications. Our group is having capabilities of design of Opto-Mechanical, Optics, Electronics and software developments.

Completed projects:

- **Design and Development of PDU for Hawk-*i* aircraft**
- **Vein-Viz: Image-guided vascular vein visualizer**
- **Robotic wireless Cart**

Ongoing Projects:

- **Marine Bearing Sight for Indian Navy Ships and Submarines**
- **Visual Landing Aids for Naval Operations**
- **Design, Development and Functional Proving of Attack Periscope: Repair/Refurbishment of Periscopes**
- **Design, development and supply of LED luminaries for civil aircraft**
- **Design and development of Augmented Reality Display for Use in Aviation Maintenance**
- **Design, development and supply of head up display HUD MK 2 units for LCA AF Mk2 & LCA Navy Mk2**
- **Design and development of Digital HUD & UFCP for Su-30MKI aircraft**
- **Design & Development of Dristiscope**
- **Development of aspheric Mirrors by Aspherical Grinding and polishing of Zerodur mirror blanks for space application**
- **Ges-Chair: Finger gesture control based alternate drive controller for motorised Wheelchair**
- **Vascu-Guide: Vascular sclerotherapy guidance and assistance tools for clinical diagnostics and treatment of venous malformations**
- **Design and Development of Image Colorimeter**
- **CSIR Jigyasa 2.0 Programme: Virtual Lab Integration**
- **To develop a CAD system for diagnosing compartment syndrome by using thermal imaging**
- **Artificial Intelligence based vision for grasp classification in prosthetic hands.**

Design and development of Pilot Display Unit (PDU) for Hawk-*i* aircraft

Type of Project : *HAL funded sponsored project*
Project No. : GAP385
Project Leader : *Dr.Vipan Kumar*

The progress made in the project during this year are as below:

- Development of Form-fit-functional PDU completed
- Safety of flight testing (SOFT) completed
- Ground integration check of PDU with Hawk-*i* test Rig at MCSRDC-HAL Bangalore completed and same is shown in below figure.
- Flight evaluation completed successfully
- Hawk-*i* aircraft demonstrated at international air show 2021 with CSIR-CSIO as a partnering agency.

Rig & Aircraft Integration Testing of PDU

Vein-Viz: Image-guided vascular vein visualizer

Type of Project : *CSIR funded (FTT Project)*
Project No. : *MLP-0050*
Project Leader : *Dr. Amit Laddi*

Real-time vein detection, localization and visualization device is based upon near infrared light and digital imaging. It is useful towards finding and visualizing clinically relevant and difficult-to-access veins. This device is developed to assist Phlebotomists and healthcare workers improve patient experience by reducing number of sticks, lower catheter dwell time, and precise venipuncture avoiding associated complications. During this year, the major millstones of the project include redesign of portable variant of Vein-Viz as per the industrial feedback, clinical data collections and registration of software copyright (Vein-Viz).

Redesigned vein visualizer demonstrated in Medical Fair, Mumbai, 2022

Robotic Hospital Logistic Cart

Type of Project   *: CSIR (In-House)*
Project No.   *: XXXX*
Project Leader   *: Dr. Amit Laddi*

The prototype of wireless cart renamed as Robotic Hospital Logistic Cart is a remotely controlled robotic cart that works on an easy to use sliding finger gesture interface based on Android mobile device for wireless maneuvering. The wireless robotic cart prototype and the Android Application with intuitive commands for maneuvering has been designed and developed in-house. Research tasks performed involved testing and optimization of motion control algorithm on mobile device.

Wireless cart prototype

Marine Bearing Sight for Indian Navy Ships and Submarines

Type of Project   *: CSIR funded*
Project No.   *: MLP 2005*
Project Leader   *: Dr. Vinod Karar*

Marine Bearing Sight provides True North/corresponding directions with ship's heading/azimuth of surface/aerial targets in sailor's line of sight. The compass virtual image is superimposed with target image and presented in the sailor's line of sight. The progress made during 2021-22 is as follows:

- Design of marine bearing sights for naval ships and submarines completed.
- Mock-up units fabricated and installation verified.
- Documentation including Bill of Material, Master Drawing Index, Technical Specifications, User Manual submitted.
- Form, fit and functional unit fabricated and demonstrated for user's feedback.
- One unit of marine bearing sight for submarine delivered based on user feedback. Unit received back after user feedback regarding stray light minimization, ergonomics, image clarity and FOV.

Marine Bearing Sight for Submarine integrated with the Bridge Bearing Repeater System

Visual Landing Aids for Naval Operations

Type of Project   *: CSIR funded*
Project No.   *: MLP 2004*
Project Leader   *: Dr. Raj Kumar Pal*

Visual landing aids provide optical references for helicopter landing on Ship Deck with Normal and NVG modes imparting strength to naval operations for routine & critical missions during poor visibility. The progress made during 2021-22 is as follows:

- Final design report involving each type of light unit as LRU completed.
- Mock-up units and Field units of Line Replacement Units (LRUs) as part of visual landing aids made.

- Hardware & software design as per the revised interface protocols.
- Two configurations of driver sections used to maintain commonality of design & consumables, LEDs of five wavelengths uses across 09 types of display board configurations.
- Optical reflector, diffuser, customized light profile through lens, protective cover, etc. used with sealing gaskets & mechanical housing to provide required light profile in terms of light spread & light output & ruggedness for mechanical strength & prevention of moisture.
- Lab functional testing for electrical & optical performance, electrical interface with ship's control panel.
- Final Binding Data & Drawings (BDD) approved by Navy.

Functional Prototypes of two of the LRUs Visual Landing Aids

Design, Development and Functional Proving of Attack Periscope: Refurbishment of Periscope

Type of Project   : *Grant-in-aid*
Project No.   : *GAP 443*
Project Leader   : *Dr. Vinod Karar*

The periscope system for submarine enables to see a view of the surrounding horizon and detect foreign objects in day as well as low light conditions using Visible/LLTV modalities, while the vessel remains submerged. The broad objectives of project include repair/refurbishment of complete set of periscope internal modules and subsystems and carryout new design and development wherever required to ensure restoration of complete functionality of the periscope in terms of operational capabilities as indicated in technical manual.

The progress made in the year 2021-22 is as follows:

- Understanding and conceptualization of Periscope system design to achieve above objectives.
- Submission of preliminary and critical design documents; Completion of preliminary and critical design reviews.
- Test bench demo of periscope functionality.
- Setting up of new lab area for periscope upgradation which included design and procurement of specialised tools and fixtures for mounting of periscope mast inner tube and outer tube. The periscope system was setup in the new lab.
- Module-level specifications were deduced from analysis, available literature and optical metrology.
- Design and fabrication of new optical components and refurbishment of few optical components for periscope upgradation.

- Design of protective glass window (sighting window) assembly along with hydrophobic coating; First level of prototype made and demonstrated.
- Initial demonstration of functionality of prism and zoom lens assembly.
- Limited functional demonstration of Low Light TV Camera and Recording Camera.

Design, development and supply of LED luminaries for civil aircraft

Type of Project   *: CSIR funded*
Project No.   *: MLP2016*
Project Leader   *: Dr. Vinod Karar*

The project envisages design & development of LED based Lights for HANSA-NG and SARAS Mk-II Aircraft as per the required technical performance requirements of aircrafts. These lights are proposed to be developed using LEDs as light source owing to numerous advantages of LED as source of illumination. LEDs require lower power than traditional lighting sources to emit light. The following are a brief description of different light types used in the aircraft:

- Three types of Navigation Lights (LH, RH and Tail): Navigation Light is a coloured source of illumination on an aircraft, used to signal aircraft's position, heading and status.
- Anti-collision lights: Strobe lights mounted on the top and bottom of the fuselage, intended to aid in collision avoidance while on the ground and in the air.
- Taxi & Landing Lights: Bright white light source located on the Nose Landing Gear Strut of aircraft, which is turned on whenever the aircraft is in motion on the ground for greater visibility.
- Dome Light: To provide high-intensity illumination to passengers with adjustable dimming and light spread options.
- Panel Light: To provide focused light toward the instrument, rather than toward the pilots eye.

Progress made during 2021-22 is as under:

- Design, fabrication, testing and first fitment trials of functional prototypes for 8 types of Light Units for HANSA-NG aircraft
- Preparation of Technical Description Document, Safety of Flight Test Procedure, Qualification Test Procedure, Design Document, Bill of Material, Thermal Analysis, Structural Analysis, Reliability Analysis and De-rating Analysis documents:

Design (system, electronics, optical and mechanical design) of 7 types of Light Units for SARAS MKII aircraft in progress:

- Three types of Navigation Lights (LH, RH and Tail)
- Anti-collision lights
- Taxi & Landing Lights
- Dome Light

Form-Fit-Functional Units of LED Lights for HANSA-NG aircraft under testing at NAL Bengaluru

Design and development of Augmented Reality Display for Use in Aviation Maintenance

Type of Project   *: CSIR funded*
Project No.   *: MLP2023*
Project Leader   *: Dr. Divya Agrawal*

Maintenance is an important activity in aviation industry. Maintenance is tricky in this environment because of the space constraint in various zones of the aircraft, where maintenance needs to be carried out. To ease out the ground personnel maintenance task use of wearable maintenance augmented reality display (ARD) is proposed in this project.

An Augmented Reality Display (ARD) is a system in which the real world as one usually perceives visually, is augmented by virtual components like animations, displays, pictures, etc., which are superimposed on top of the real world. This facilitates the seamless perception of the real world and the virtual components together in the field of vision of the observer. As immersive technology, augmented reality will have a huge impact on the future of aircraft maintenance and training. The repair and maintenance work in aviation industry is a humongous task. The objectives in the area can range from: assembly/disassembly, diagnosis of defective part and repair. Use of ARD makes repair & maintenance work faster, productive and handier by providing direct spatial context of the information as well as making access to reading of measuring instrument or instruction manual easier and handy for maintenance personnel. The selection of display device is the first critical selection in the design of ARD. For selection of display device, study of different miniature display devices was carried out to compare the pros & cons vis-à-vis cost, weight and design requirements.

Design, development and supply of head up display HUD MK 2 units for LCA AF Mk2 & LCA Navy Mk2

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP 356*
Project Leader   *: Dr Vinod Karar*

Conceptual design of HUD envelope for various configurations based on newly proposed LCA-Navy Mk2 Cockpit with Instantaneous FOV of 20 deg x 22 deg, and IFOV of 24 deg x 24 deg for varying placement locations of display device, waveguide size and orientation, single and dual beam combiner configuration and tilt, distance from design eye positions, etc.

Conceptual design of HUD for LCA-AF Mk2 for IFOV of 21.2 deg x 18 deg to IFOV 21.2 deg x 20 deg for different placement locations of display device, waveguide size and orientation, single and dual beam combiner configuration and tilt, distance from design eye positions.

Basic hardware around digital display source DMD is designed while initial level of software development for user defined symbology as well as raster form of display with real time brightness manipulation, etc. has been done. Preliminary electronics and electrical interface design made based on new electrical specifications of HUD Mk2.

Design and Development of Digital HUD & UFCP for SU-30 MKI

Type of Project : Grant-in-Aid
Project No. : GAP 0440
Project Leader : Dr. VIPAN KUMAR

The major progress made in this project are as below:

- An analog signal conditioning unit has been designed to take stroke signals as inputs and to convert them to digital signals to be given as input to any FPGA based processing unit.
- Processing of raster video from STANAG-B (PAL) to HDMI to feed it to the FPGA based processing unit, scaling and time synchronisation and giving the desired HDMI output feed of Raster/Raster + Stroke/SBS/Autonomous signals.
- Generated Stand by Sight (SBS) and Autonomous Symbology in both analog signal output and HDMI output form. The generated symbology are refreshed at a rate of 20mS.
- Designed the lab prototype of Up Front Control Panel (UFCP) by implementing the transmission and reception protocols as per the ICD of Su-30 using the RS422 communication protocol.
- Design and implement the algorithm for Alpha blending that can be used to overlaying a Stroke Signal with transparency over a Raster signal as per the Su-30 Technical specifications and requirement.
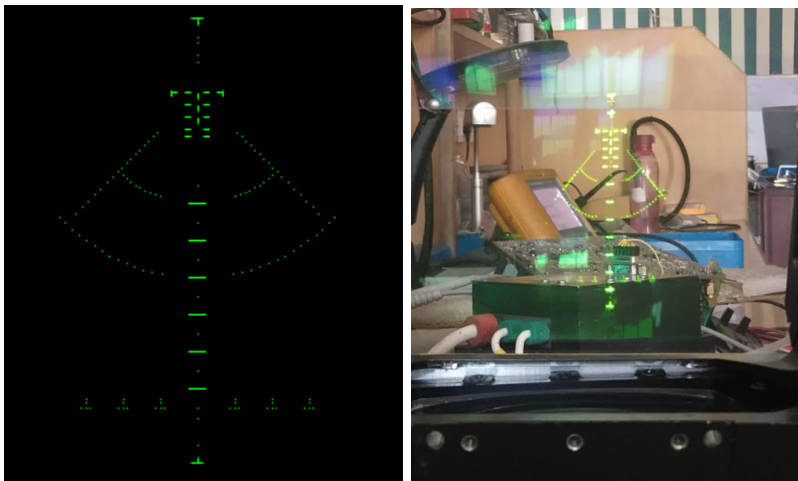
Stand by Sight (SBS)

Lab Prototype of UFCP

Alpha blending of Stroke and Raster signals

Design & Development of Dristiscope- An operating Microscope

Type of Project   : CSIR funded
Project No.   : HCP0026 TASK 3.3
Project Leader   : Dr.Shravan Kumar R R

Dristiscope is primarily a medical instrument to assist the doctor for cataract surgeries and many other eye related decease/ problems. It is used for precision surgical applications like keratoplasty, keratoprothitics and cataract operations. The design is on the principle of telescopic magnifier and five steps magnification. One prototype has been fabricated. The CAD model of the Binocular head and complete picture of the prototype is shown in below figure. Some of the key salient features of the Dristiscope are given below:

•   Sufficient large working distance between operation field and Microscope.
•   A true stereoscopic observation for reliable acquisition of three dimensional structure of the object field.
•   Five step Magnification: 3.6X to 22.5X
•   Good resolution with adequate contrast.
•   Brilliant and uniform illumination of the field of operation
•   Provision of dual light sources i.e. Halogen light bulb and LED.
•   Provision of Blue, Yellow filters
•   Coaxial illumination which overcomes the shadow and dimness of the FOV.
•   Fine adjustable inter binocular distance (56mm to 75mm)
•   Motorized Foot operated focus control (30mm in Z- Direction)
•   Sturdy base with Four Caster's supported Wheels
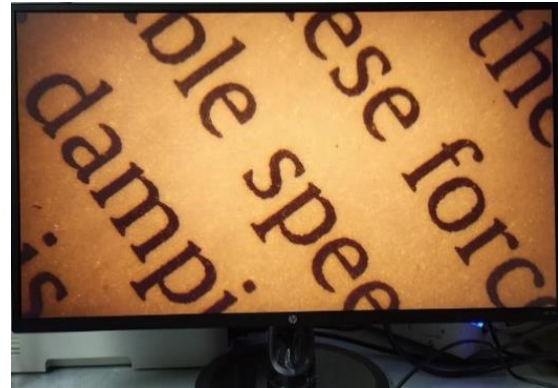
Prototype of Dristiscope

Image through camera module

Development of aspheric Mirrors by Asperical Grinding and polishing of Zerodur mirror blanks for space application

Type of Project   : *Sponsored Project (by ISRO-LEOS, Bengaluru)*
Project No.   : *SSP0046*
Project Leader   : *Dr. Shravan Kumar R R*

Till date eight nos. of mirrors have been supplied for High Resolution Satellite Imaging Module. The typical specifications of the mirrors which were developed are of surface figure 1λ(PtV), Surface roughness ≤ 4nm, Surface quality 60:40 and Wedge angle ≤ 20 arc sec. The mirrors developed will be used in payloads of various satellites like High Resolution Satellite(HRS), Carto Satellite 3A (C3A), Advanced Linear 3C Satellite & Micro satellites.

Mirrors have been fabricated by a novel technique which is combination of Membrane polishing & Pitch polishing enabling uniformity in surface quality. The mirrors fabricated were tested at ISRO-LEOS by Hindle sphere test setup and results of mirrors found to be very encouraging & satisfactory.

Ges-Chair: Finger gesture control based alternate drive controller for motorised Wheelchair

Type of Project   : *DST (SSTP)*
Project No.   : *GAP-415*
*Project Leader*   : *Dr. Amit Laddi*

Ges-Chair technology consist of two parts, first part is thefinger gesture control module for mobility assistance comprised of sliding finger based interactive interface on touch screen suitable forpersons with weak upper limbs, who want to manuever motorised wheelchair without need of caregivers. Other part of the technolgy is indegenously developed alternative drive for controlling direction and speed of the motorized wheelchair. Progress was made towards testing and optimisation of gesture control based upon feedback of rehabilitaion centers.

Vascu-Guide: Vascular sclerotherapy guidance and assistance tools for clinical diagnostics and treatment of venous malformations

Type of Project   *: CSIR (HQ)*
Project No.   *: HCP26-3.1*
Project Leader   *: Dr. Amit Laddi*

Vascuguide technology is a hands-free and non-contact visualization and guidance functionality for the vascular surgeons during the treatment of venous malformations. It is an alternate approach to conventionally usedlow-resolution ultrasound imaging that limits the vascular surgeon during diagnosis and treatment of minute veins, bifurcations or clots. It is useful for vascular surgeon towards treatment planning with recording facility to know its status after treatment.

Research tasks performed towards optical setup design based upon high resolution near infrared imaging, illumination control and suitable optics sensitive towards detection and visualization of malformed vasculature as per the requirements of the vascular surgeon. Algorithms were developed to acquire venous images and its visualization in real time on large screen. Clinical image data collection is initiated towards algorithm development for the detection of malformed veins and its morphology as per the requirements of the vascular surgeons.
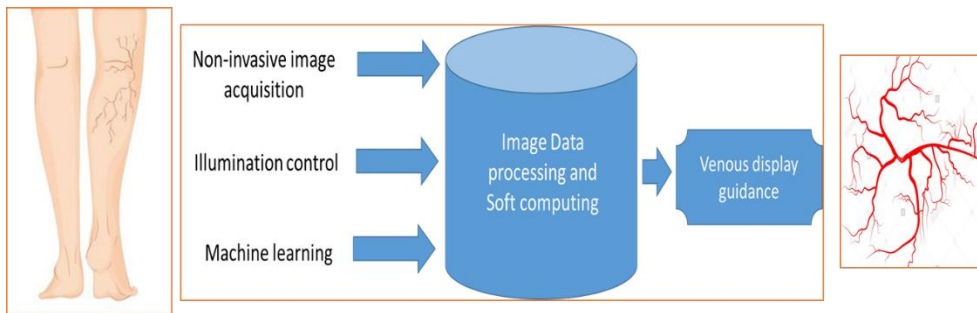
Vascuguide data collection interface

Design and Development of Image Colorimeter

Type of Project : *CSIR IDEAL Mission*
Project No. : *HCP0034 WP4.4*
Project Leader : *Dr. Neerja Garg*

This work aims the development of an image colorimeter with automated image processing software for providing the analysis of homogeneity, contrast, luminosity and chromaticity features of samples. Color measurement and spectral reconstruction are two recent applications of the imaging-based systems which depends on recording the colorimetric quantities. The proposed system comprises a color camera with objective lens of variable focal length, light source, filters and some electronics components. A customized acquisition box is designed for setting up the mentioned system components and to maintain the distance between sensing unit & sample. Color measurement and spectral reconstruction methods will be developed with image characterizations and reference color checker recording for the training and validation combinations. This work will provide a hardware/software solution for color-based applications such as water quality, textile industry, food industry, pharma industry, dental applications, etc. In view of the need towards virtual experimentation, it is imperative to come up with solutions based upon imaging technologies with the help of high speed/resolution cameras and ML/AI.

Brief description of the progress of the project during FY 2021-22 is as below:

1. Image and color spectra acquisition system for spatial-spectral training, model development, validation and testing of the proposed image colorimeter.

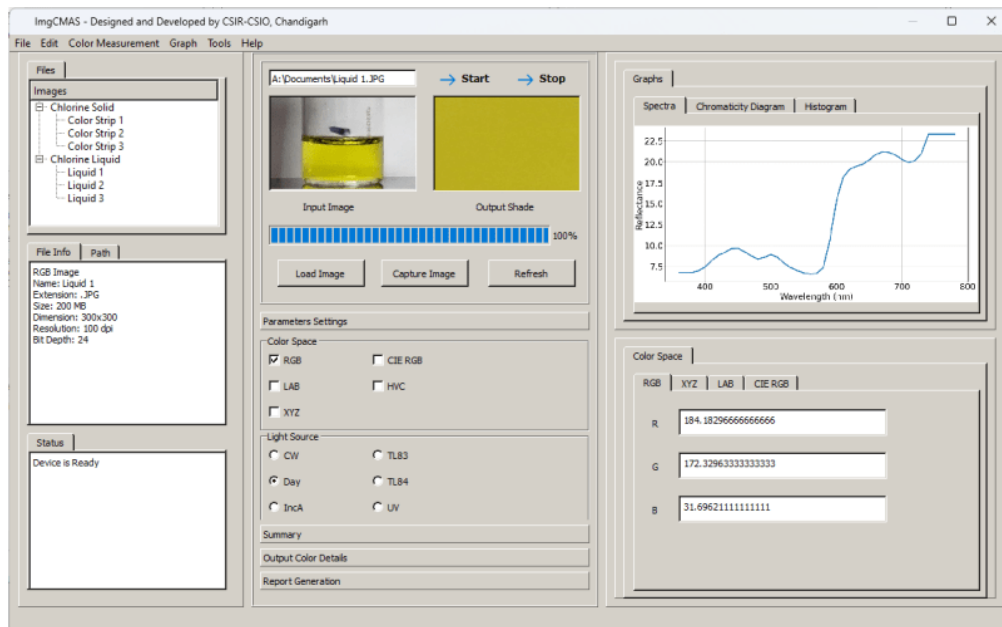**Image acquisition setup under varied light sources, Color Spectrophotometer and the Color Characterization System for developing ML/DL models**

2. Design and implementation of Image Colorimeter software GUI for visualization and analysis of colors

**ImgCMAS – Image Color Measurement and Analysis Software login page**

ImgCMAS–Image Color Measurement and Analysis Software processing framework

CSIR Jigyasa 2.0 Programme: Virtual Lab Integration

Type of Project   *: CSIR funded*
Project No.   *: HCP0101*
Project Leader   *: Dr.Neerja Garg*

This work is designed to bridge the gaps among the students, teachers and the scientists, not just physically but virtually as well. Experiments and visuals are an important source of learning for better understanding of both concepts and theories.

a) Jigyasa 2.0 Virtual Laboratory Implementation Programme –
   - Connected with ~9000 school students and teachers of more than 35 KVs and 2 ATL schools
   - Conducted ~12 lectures under Let's Talk Science Series 2.0 (online) and collaborated with local science academies (NASI, INSA and INYAS) and NGOs (SPSTI) for it (CSIR JIGYASA YouTube channel) https://www.youtube.com/c/JIGYASACSIR/videos)
   - Direct interaction of students with the scientists and also inculcated a culture of curiosity by asking questions. Activities under Jigyasa Virtual Lab portal allows the young minds of society to "tinker" with virtual laboratory that behaves in almost the same way as it would in a real environment (~500 clicks daily).

b) Digital content development under Jigyasa 2.0 Programme for uploading on CSIR Jigyasa Portal (https://jigyasa-csir.in/)
   - Science Game on Optics V1.0 (for grade VII-XII)
   - Learning on different applications of spherical mirrors and lenses and to understand the application of different types of lenses in correcting eye defects
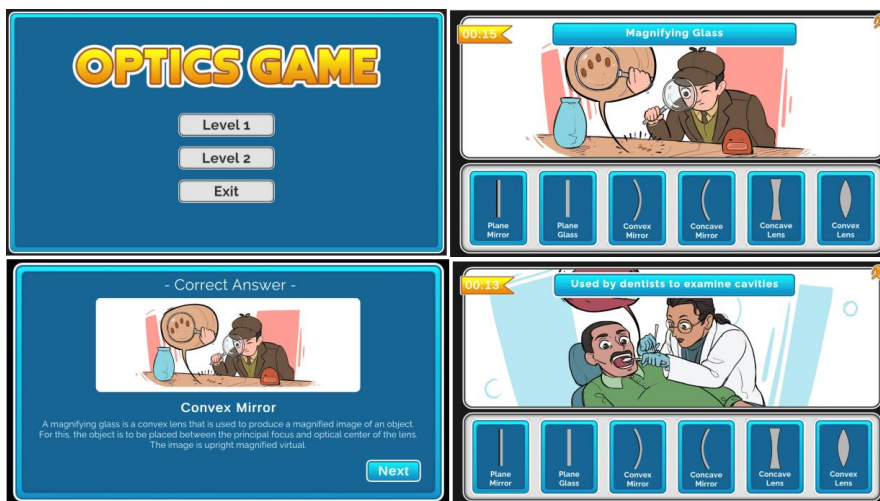
c) Simulation:
   1) Working with Logic Gate (Physics, for grade IX-XII)
      Introduction to different logic gates, Verification of the truth table using interactive simulation, Combinations of different logic gates
   2) Heating effect of Electric Current using Infrared Imaging (Physics, for grade VIII-XII)
      Introduction to the concept of Joule's heating effect, Application of Ohm's Law, Differences between series and parallel circuit, Introduction to IR imaging Camera

3) Heart Rate Calculator (Bio/Phy, for grade VI-X)
   Interactive calculator, Concept targeted heart rate calculation
4) Testing Residual Chlorine in Water (Chemistry, grade VI-X)
   Different methods to test chlorine at industrial level
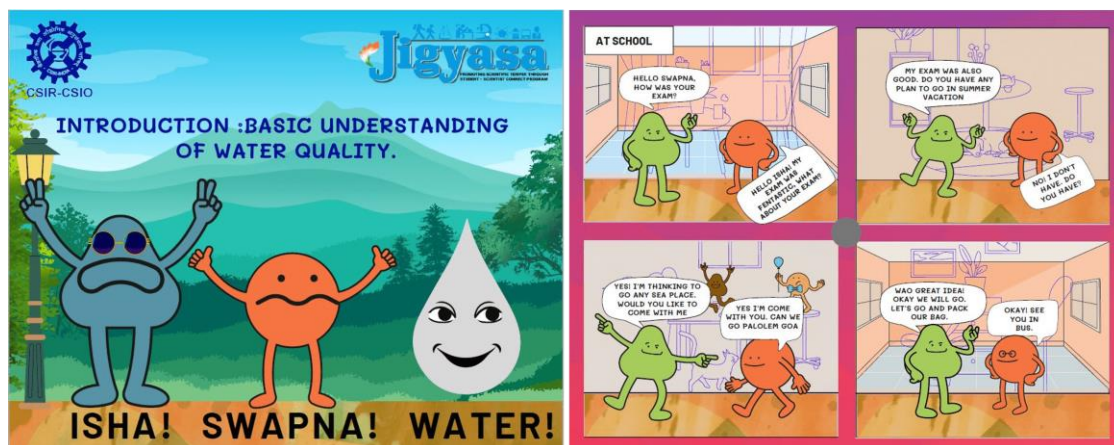

d) Animated Graphical story/ comic - 03
   1) Water Quality (Chemistry, for grade VI-X) To understand the physical and chemical properties of water its effect on human health

e) IPR (General Science, for VI-XII) - Basics of various types of Intellectual Property Rights

f) Atom and Matter (Physics, for grade VI-XII) - Understanding the structure of atoms, different forms of Matter, how Mass Number and Atomic Number are calculated.
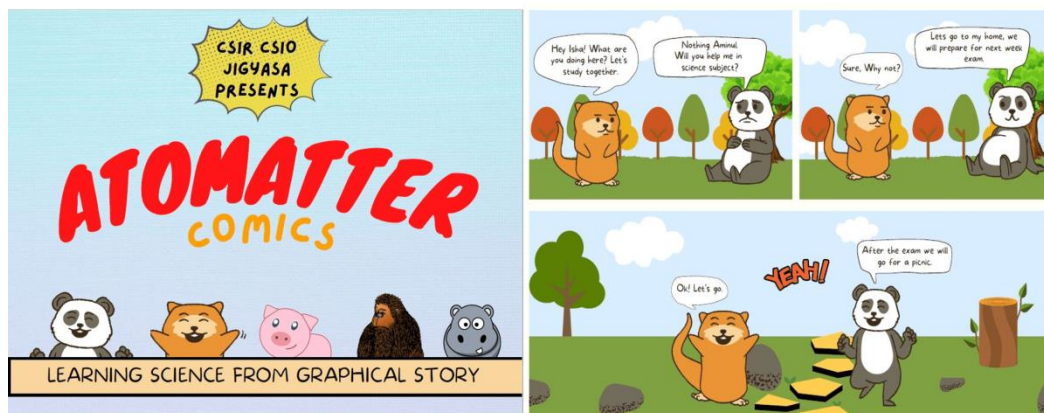
g) Animated Videos – 07
1) Medical Devices at Home Part I (Biology, for grade VI-VIII)
2) Medical Devices at Home Part II (Biology, for grade VI-VIII
3) Medical Devices at Home Part III (Biology, for grade VI-VIII)
4) Sensors around Us (Physics, for grade VIII-XII)
5) Solar to Hydrogen (Physics/Chemistry, for grade VI-XII)
6) Smart Farming (Environment Science, for grade VI-XII)
7) Robosurgeon (Physics, for grade VIII-XII)

To develop a CAD system for diagnosing compartment syndrome by using thermal imaging

Type of Project   *: CSIR funded*
Project No.   *: HCP0026 WP3.2 Part B*
Project Leader   *: Mr. Naveen Sharma*

Compartment syndrome (CS) one of the limbs/life-threatening conditions observed when perfusion pressure falls below tissue pressure in a closed anatomic space. CS remains a true orthopedic emergency as it leads to thousands of amputations and permanent nerve and tissue damage to patients who are undiagnosed for more than eight hours. Conventionally, diagnosis has been based upon clinical assessment; however, this can be unreliable, and the potential for missed compartment syndrome remains. The supplementary use of compartment pressure monitoring has addressed some of these issues, but it remains an invasive technique, the exact role of which is still debated in the literature. The proposed system centers upon the diagnosis of compartment syndrome using non-invasive and non-radiative thermal imaging techniques.

CS Prototype

Artificial Intelligence based vision for grasp classification in prosthetic hands.

Type of Project   : Grant-in-aid
Project No.   : GAP 0433
Project Leader   : Dr. Srikanth Vasamestti

In this project, a vision-based prosthetic hand is proposed. Commonly available EMG-based control for prosthetic hand requires placing the sensors at the right locations every time, and relies on continuous care of the skin surface. The downsides of EMG-based systems can be overcome/ rectified through a non-contact and intuitive grasp classification system for prosthetic hands. In this prosthetic hand, an unobtrusive camera mounted on the prosthetic hand which captures image of the object intended to be grasped. The image acquired then processed using a trained AI model and the grasp required for holding that particular object is identified. Thereafter, a suitable control signal is passed to the actuation unit so that it can pick and hold the object. Force sensors on the palmar side of the devices translate the grasp force into a force which is applied on the user's arm (via vibrators/motors) as feedback. The product design and development are carried out in-house. To achieve a low weight and affordable prosthetic hand a prosthetic hand has been designed and developed using a novel mechanism. The developed prosthetic hand has ability to mechanically achieve multiple grasping pattern using a single actuator. The novel mechanism has been patented. A prototype of the invention has been developed and images of the same have been provided below. To further reduce the weight of the prosthetic hand assembly, the concept of Fin-Ray has been explored. This is an alternative approach to overcome the issues related to heavy weight, wear and tear and obtrusive appearance occurring in existing rigid link based prosthetic hands. A prosthetic hand prototype has been designed and theoretical studies have been done. To estimate the working of the proposed prosthetic hand, experimentation has been done on a gripper having two Fin-Ray based fingers as an initial concept. The test results have been validated. Images of these have been provided below.

Manufacturing Science and Instrumentation

Dr. Harry Garg
harry.garg@csio.res.in

The Manufacturing Science and Instrumentation (MSI) research group came into existence with the vision of smart manufacturing of scientific and industrial instruments and products which are globally competitive in the market at par with international standards. This will majorly contribute in indigenisation of high end strategic and societal technologies under the Government initiatives *Aatmanirbhar Bharat* and Make in India programs. The group also aims at developing innovative technologies having the market potential and socioeconomic impact. The group is multidisciplinary in nature having the state-of-the-art facilities manned by highly qualified and well experienced scientific and supported by trained technical staff. The research group has the expertise in the areas of mechanical design, simulation, numerical analysis, material science, electronic design and control systems, additive manufacturing, laser technology and allied applications, surface finish and thin film, precision agriculture, electrostatics devices & systems, opto-mechanical and mechatronics. Currently, the group is working in the field of avionics, machine tools, functional materials for electromagnetic waves absorbers, thin film coatings for strategic components, biomedical devices and implants, charge particulate technology, precision agri-instrumentation, prosthetics, COVID-19 mitigation technologies and air purification.

Completed projects:

- **Design & Development of Optical Gunsight.**
- **Design & development of Drogue Light for LCA**
- **Design & development of Clean Air Systems.**
- **Design & development of Air Sampler**
- **Design and development of 300 Watts Xenon power supply**
- **Optics design & simulation of fiber coupling of laser diodes**

Ongoing Projects:

- **Design & development of Dual Mode Anti Collision Lighting system for LCA Mark2 and AMCA**

Design & development of Dual Mode Anti Collision Lighting system for LCA Mk2 and AMCA

Type of Project : Sponsored by Aeronautical Development Agency (ADA,Bangalore)
Project No. : GAP-434
Project Leader : Dr. Harry Garg

Anti-collision Light (ACL) is a flashing, external lighting equipment, to indicate presence of aircraft to avoid collision. ACL lights are flashing type instead of continuously ON. Proposed anti-collision light for LCA MK2 will operate in dual mode i.e., one mode offers light distribution in visible are used (aviation white) and second mode is meant for Covert operations. ACL for

Mark2 is fixed type and for AMCA is retractable type. Both Mark2 & AMCA A/c will be equipped with two units of such lighting system, which will be installed one each on top and bottom of fuselage to meet aircraft requirement. The system has been developed with following salient features:

- ❏ Customized non-imaging optics
- ❏ Uniform distribution in the full span
- ❏ Structural & Thermal compatible design
- ❏ Seal proof/ Nullified atmospheric effects
- ❏ Aero Load proof in motion Analysis
- ❏ Retro fit according to the cockpit size
- ❏ Rigid Aircraft mounting
- ❏ Modular Aerodynamic housing
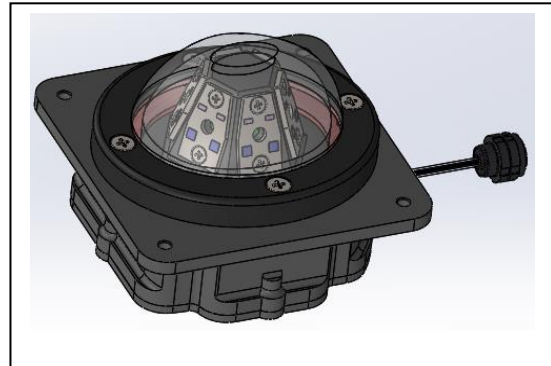
TECHNICAL SPECIFICATIONS.

- ❏ Weight (kg)   : <1.5
- ❏ Size(mm)   : 130X 110
- ❏ Power(W)   : <50(mark2) <100(AMCA)
- ❏ Operational Height : 6-9 Km
- ❏ Range   : -55 to 85 °C
- ❏ Speed of Aircraft   : 600-800 Km/hour
- ❏ Cool White Light, NVIS Friendly.
- ❏ Extension & retraction compatible
- ❏ Adaptive Modular Design
- ❏ MIL STD-810-G, 704-D

CERTIFICATION/APPROVAL

- ❏ Certified by: RCMA & Centre for Military Airworthiness and Certification (CEMILAC) Bangalore.
- ❏ Approving agency: DGAQA, Panchkula/Dehradun.
- ❏ Present Status: Under Qualification Testing

The proposed technology is a customized system for Mark 2 and AMCA A/c but meets all the electronic, optical and mechanical aviation standards and requirements. The same system can be used for different aircraft platforms. It will be a great asset and technological solution for MAKE IN INDIA and AATMANIRHAR BHARAT campaign of Government of India.

Design & development of Marker Light for LCA MK2

Type of Project   *: Sponsored by ARDC, HAL- ,Bangalore*
Project No.   *: SSP0054*
Project Leader   *: Dr. Harry Garg*

Wing tip marker lights are required for indication of aircraft wing edges during towing. These lights shall be visible to pilot and to ground crew standing in front of aircraft. There is a requirement of minimum one light each in the LH (Red) and RH (Green) wing tip of the aircraft. The lights can be controlled by separate switch (or through navigation light switch) from the cockpit.

TECHNICAL SPECIFICATIONS.

- ❏ Light   Output (cd):   : 80 cd
- ❏ Weight (gm)   : < 200
- ❏ Size(mm) : 100X 80

- ❑ Power(W) : <10
- ❑ Operational Height :> 8 Km
- ❑ Range : -55 to 85 °C
- ❑ Speed of Aircraft : 600-800 Km/hour
- ❑ MTBF(hours) :>>30,000
- ❑ Red & Green Light, NVIS Friendly.
- ❑ Adaptive Modular Design
- ❑ MIL STD-810-G, 704-D
- ❑ Airworthy MIL Qualification
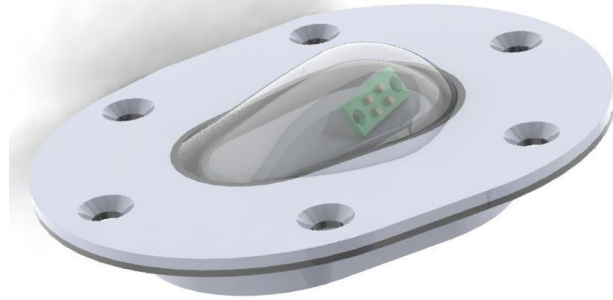
Electrostatic dust mitigation and environment protection device

Type of Project : In-house (FTC Project) (Sponsored by Council of Scientific and Industrial Research (CSIR), Government of India, New Delhi)
Project No. : MLP2011
Project Leader : Dr. Manoj Kumar Patel

The project aimed at developing the high range electrostatic sprayer for the dust mitigation and environment protection. The designed and developed device is very efficient and effective in addressing the major pollutants PM10 and PM2.5 (suspended particles) in the smog. The major source of such pollutants is dust, industrial, vehicular, domestic, agricultural and other emissions. Smog is a very serious concern in recent days and to solve such important challenges, an electrostatic dust mitigation and smog control device has been designed based on electrostatically charging principles especially, for smog control in Indian metro cities which has been a major concern in recent past. This technology uses an electrostatic field to generate charged spray droplets which combine with oppositely charged dust and smog particles and settle down onto the ground very efficiently and effectively.

Dust suppression systems help to control the dust while improving efficiency. An electrostatic dust mitigation device is highly useful in suppressing the dust particles entrained in the air and protect the environment in an efficient way. It produces uniform and fine spray particles that are nearly equal in the proportion to dust particles / particulate matter PM2.5 and PM10.

The technical specifications of the device
Applied high voltage : 2.5-3.0 kV
Charge-to-mass ratio : 0.45-0.50 mC/kg
Liquid flow rate : 60 L/hr
Applied liquid pressure : 50 Bar
Load current : 0.1 mA
Source current : 170 mA
Nozzle diameter : 0.15, 0.2 mm
Spray distance : 25 m
Pump power : 1 HP
Fan/motor power : 1.5 HP

The proposed technology is a kind of new practice in India and it will help in suppressing the dust as an environment protection tool. It will be a great asset and technological solution for SWACHH BHARAT, SWASTH BHARAT mission and MAKE IN INDIA and AATMANIRHAR BHARAT campaign of Government of India.

Edible and biodegradable materials for electrostatic coating to fruits and vegetables for enhanced shelf-life

Type of Project   : *CSIR funded*
Project No.   : *HCP0031 (W.P. 1.1)*
Project Leader   : *Dr. Manoj Kumar Patel*

As the population is increasing, the processed food is getting more popularity among the consumers. To provide the fresh and healthy fruits and vegetables to masses, the preservation, storage and shelf-life extension are the most essential parameters to be considered in food processing industries. Generally, fruits and vegetables are the perishable commodities since their tissues remain alive even after harvest. They gradually deteriorate through natural ageing, rotting or when they are consumed, cooked or usually when processed. To extend the post-harvest life of the fruits and delay ripening, its respiration rate needs to be reduced as far as possible. Edible coating on fruits and vegetables retards the respiration rate significantly, aids in extending shelf life of the produce.

In this work, an electrostatic spraying based edible coating system has been designed and developed to enhance the shelf-life, nutritional value and sensory attributes. Electrostatic coating system is one of the most efficient and effective coating methods in which higher uniformity is obtained with lesser amount of coating material and hence, saving the natural resources. It provides better coverage of the coating material on the target surface with homogeneity and uniformity in thickness which is a result of controlled aerodynamics conditions of charged droplets. The developed technology has a huge market potential in food processing industry.

Evaluation of shelf-life of apples coated with electrostatic coating and dip coating

Laser-fog interaction studies for path clearance applications

Type of Project   : *Grant-in-Aid*
Project No.   : *GAP 0435*
Project Leader   : *Dr. Manoj Kumar Bhuyan*

Towards developing laser-based vision and communication technology for fog environment, meter-long stable fog conditions with varied fog densities represented in terms of meteorological optical ranges i.e. 0.2 to 1 meter were created in the laboratory. In all the cases, the evolution and relaxation phases of fog medium with respect to time were monitored through transmission measurements. One of the prime aspects of this study is to achieve enhanced vision through fog. In this respect, objects of different materials and sizes were considered for this investigation. An imaging setup was built to image objects present inside fog of varied densities. The recorded images of objects are hazed in nature. Therefore, single-shot de-hazing methods

were developed and applied. The role of water droplet circulation and condensation will be investigated in future towards achieving enhanced vision through fog environment.
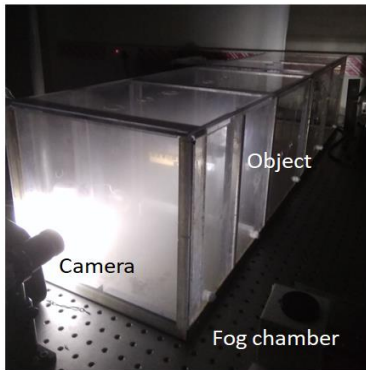
Experiments using laboratory fog medium:
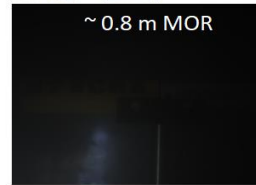
Left side: Meter-long fog chamber containing objects of different materials such as wood (321CBA), aluminum (METROLOGY) and plastic (CSIO-CHANDIGARH). Right side: Typical raw images of objects with and without the presence of fog recorded using an imaging setup are shown. The corresponding clear images retrieved using single-shot de-hazing methods are also shown.

Development of 3D printed Lattice Structured Hip Implant

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP-383*
Project Leader   *: Mr. Vijay Kumar Meena*

Lattice Structured Hip stem and Acetabular cup has been designed and developed for reduced stress shielding and biological fixation. Lattice structures of 0.6mm pore size has been used in implants. Additive Manufacturing Parameters have been optimized for printing of lattice structures. The Hip stem successfully completed ISO 7206 test requirement.

Lattice Hip stem　　　　　　　**Lattice acetabular cup**

Development of additive manufactured pelvis revision surgery implants

Type of Project   : *CSIR funded*
Project No.   : *HCP-26, Task 4.1*
Project Leader   : *Vijay Kumar Meena*

Revision surgery pelvis augments are being developed in the project. These augments are currently being imported and are priced at exorbitant rates. No Indian industry is manufacturing these implants. Shell augments design has been completed. Spinoff implants: AVN femur implant and Lattice Cone implant have been designed in the project.

AVN Implant

| Cone Cup ID48 OD55 | Cone Cup ID52 OD59 | Cone Cup ID56 OD63 |
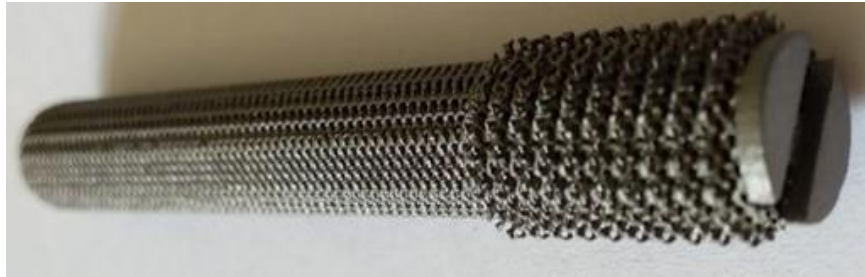
Cone Cup implant

Design and Development of precision Infrared optical elements for Thermal Imaging

Type of Project : *CSIR funded FBR Project*
Project No. : *MLP2013*
Project Leader : *Dr. Neha Khatri*

Infrared lens is used in infrared vision systems to collect radiation and focus the object onto the detector. Information such as pixel and temperature distribution can be captured and displayed as images. New optical design makes a single lens to achieve dual wavelength band (MWIR and LWIR) switchable. Zinc selenide (ZnSe) is a type of chalcogenides and has a band gap in the range of 2.7-2.72 e.V and good clearness in the infrared spectral areas (0.63-18 μm, .45-21.5 μm) and can be used for infra-red windows application. The proposed project is aimed at developing a novel machining process protocol in ultra-precision machining of ZnSe with in-situ measurement of temperature/heat generated at the cutting zone. These lenses can further be used for Infrared microscopy for obtaining the spatially-resolved temperature profile of fully operational microprocessors.

- During the period 2021-2022, fabrication of ZnSe lens using Optimized parameters on SPDT is carried out & profile compensation is done to achieve desired surface integrity
  - Chip morphology study is performed to investigate machining regime mode during fabrication.
  - Fabrication of ZnSe lens is done via using SPDT, in 1st iteration Pt value achieved is 0.9 μm
  - After Form Correction the Pt value is reduced to Pv-0.222μm
- Design & Development of basic setup for acquisition of images using ZnSe lens and acquired images.
  - Temperature variation at the cutting zone is studied using thermal camera during the machining of the lens with designed radius of curvature.
  - A Fine adjusting Basic Lens assembly designed and 3D- Printed to match back Focal length with IR Camera to reduce Blur issues.
 - Acquisition of images is done with Flat Lens & Lens designed for comparison of
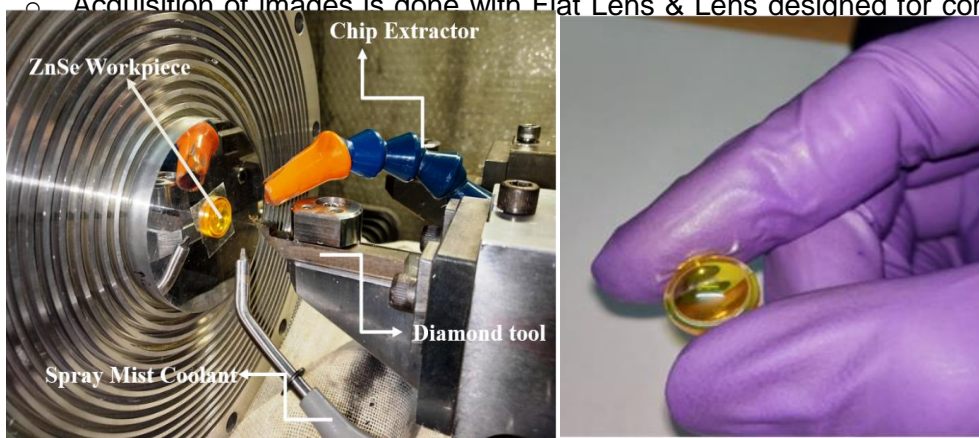
Experimental Setup & Developed ZnSe lens after process optimization

24

Design and Development of Precision Miniaturized Aspheric lenses for Helmet Mounted Displays (HMDs)

Type of Project   *: CSIR Mission Mode Project*
Project No.   *: HCP0036 (WP6)*
Project Leader   *: Dr. Neha Khatri*

A lightweight HMD is important for reducing wearable fatigue. The weight associated with the optics is important from both the ergonomic and safety perspectives. The additional head-supported weight of the HMD can produce neck muscle fatigue, which can degrade performance and increase the potential of injury due to dynamic loading during crashes. Thus, it is desirable to minimize the head-supported weight in HMD designs. The proposed project aims to design and develop precision aspheric lenses for the projection optics of HMDs which consist of sequence of optical elements in order to achieve better performance than conventional design and reduces the weight of the system. During the proposed project execution, a novel design comprising of aspheric and spherical optical components will be developed which in turn will provide better performance with reduced number of elements, thereby reducing the overall weight of the system.

The preliminary optical design layout of optical projection system for HMD is carried out as shown in Figure. It contains a green source which generates the require symbols to be projected in the pilot's helmet visor. A lens system is used to create an intermediate image of the symbols, which is then finally collimated by the helmet visor to project the symbols at infinity. Pilot's eye place near the exit pupil can see the magnified symbols from the source.
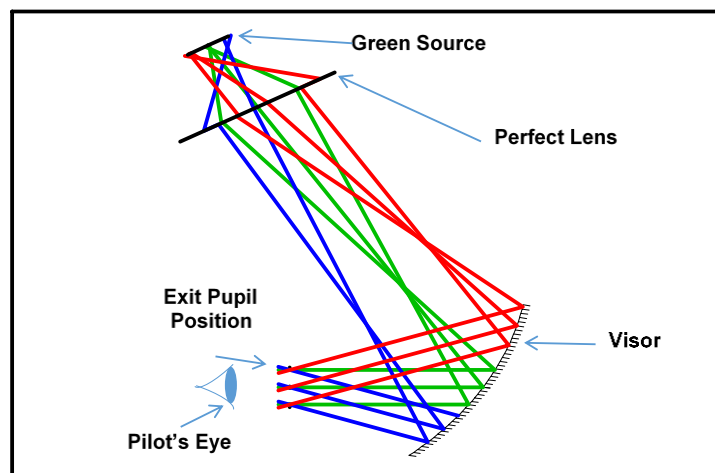
Design and Development of Precision Silicon Optics for Soft X-Rays by Micro-machining process Chain

Type of Project   *: CSIR funded (FIRST Scheme)*
Project No.   *: MLP2022*
**Project Leader**   *: Dr. Neha Khatri*

The project aims to develop high precision multilayer silicon mirrors that can be used for the focusing of x-rays for the examination of high-quality sub-micron accuracy images. A nanometric surface quality i.e. multilayer silicon mirror having surface roughness (up to 1 nm or

< 1 nm) will ensure the final image quality. Single crystal silicon is ideal optical material for infrared applications and other high added value products such as X-ray optics & X-ray interferometers. Silicon mirrors are essential components for guiding and focusing an X-Ray beam to a desired position. To avoid scattering of the beam, the level of finishing required by X-Ray mirrors is tighter than the IR and UV beam mirrors due to the fact that the wavelength of X-Ray is only about ~0.1 to 10 nm. It means that the functional performance of these mirrors is dictated strongly by the slopes presented by the reflecting surface or in essence the quality of the finished machined surface produced by the manufacturing process. A good SPDT machined component is limited by its use for X-Ray mirrors because of the periodic cusps and residual turning marks left by the cutting tool on the machined surfaces. These features could result in wide angle diffraction patterns, bringing reduction in the performance of an optical system. There is a definite necessity of carrying out a post-SPDT machining operation to remove such residual marks. The sequential process of combining SPDT and MRF provides one of the alternatives to slurry laden grinding and polishing processes towards sustainable manufacturing to machine brittle materials.

Dielectric and Magnetic Material based Composite for Microwave Absorption Applications

Type of Project   *: CSIR Funded*
Project No.   *: MLP 2007*
Project Leader   *: Dr. Sachin Tyagi*

In present project work, we are developing spinel ferrite material from industrial waste and carbon nanostructure material from biological waste. The few compositions proposed in the project has been synthesized and characterized for structural and morphological analysis at CSIO. All the developed powder material is casted into sample with size 30x30 cm^2 for RCS characterization. All the developed samples are tested at IIT Kanpur for microwave absorption analysis. The developed materials are observed to have -10 dB reflection loss for whole X band. The developed material is also explored for the development of microwave absorber foam and rubbers. All the developed foam and rubber samples are sent to CSIR-NAL Bangalore lab for RCS measurement.
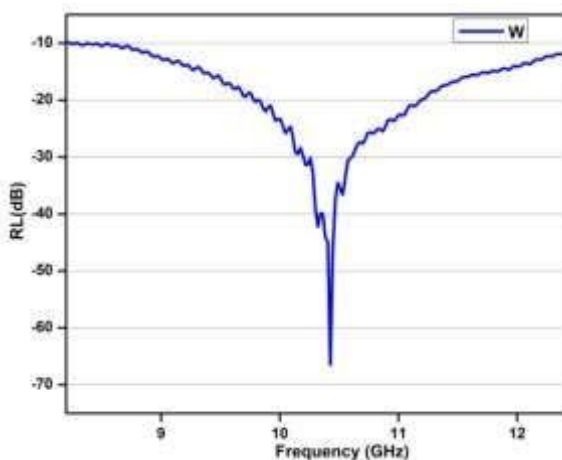
Microwave Absorbing Foam

-10 dB reflection loss pattern for whole X band

Development and testing of the partial finger prosthesis

Type of Project   : *In-house project*
Project No.   : *OLP 239*
Project Leader   : *S. Anup Chander*

Partial finger or digital amputations are very common in upper extremities amputations. They are most likely to happen when a person faces a physical trauma like an impact or an accident. Most of the prostheses used for partial finger amputations are for cosmetic purposes alone. The functional ability of such prostheses is limited. Due to this, the partial hand amputee does not use any prosthetics and leaves the affected part unattended. The project targets trans-phalangeal amputation where the stump or remnant part of the affected finger can be used to provide the functional partial finger prosthesis.

Through this project, a non-powered partial finger prosthetic was designed. The developed finger model was tested on a subject. The subject's load-carrying and grasping capability with the aid of a newly developed partial finger prosthetic was tested. The finger is being developed for other subjects too. The product images are shown below:

The subject wearing the prosthetic and lifting a bottle

Materials Science & Sensor Application

Materials Science & Sensor Application group is dedicated towards studying the various dimensions of materials for their successful application towards meeting sustainable goals like clean energy, clean water, good health, etc. The group has multidisciplinary team ranging from electronics to biology thus contributing together towards device fabrication to achieve the goal of 'From Lab to Market'.

Dr. Suman Singh

ssingh@csio.res.in

Low cost implant functionalization material for biomedical applications in hospitals

Type of Project : Grant-in-aid
Project No. : GAP 0373
Project Leader : Manisha Sharma/Dr. Suman Singh

This project involved synthesis of biocompatible materials like hydroxyapatite based composites for orthopedic implants application in the form of antimicrobial and anticorrosibve material. Various composites have been synthesized and characterised for their morphology dependented properties. These materials have been coated onto the biocompatible substrates using spin coating. These coated materials showed enhanced osteointegration and enhanced corrrosion resistance.
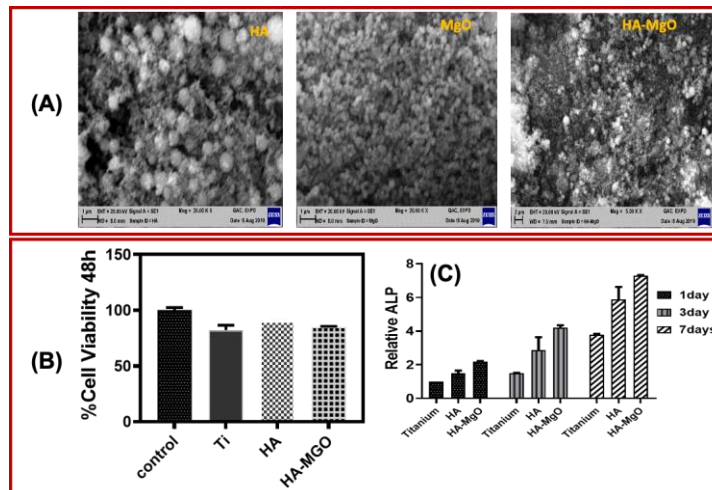
(A) L SEM of HA, MgO, HA-MgO (B) Biocompatibility of HA, Bare substrate and HA-MgO (C) ALP Activity of HA, Bare substrate and HA-MgO

Schematic of complete Process

Hand held FRET-APTACHIP for monitoring "Pinnatoxin" in food

Type of Project   *: Grant-in-aid*
Project No.   *: GAP 0393*
Project Leader   *: Dr. Suman Singh*

The project aims at designing and development of Forster Resonance Energy Transfer (FRET) based chip with portable fluorescence reader for detection of toxins using aptamers. This device can be used to determine toxicants like pinnatoxin, aflatoxin, mycotoxin etc which are likely to be present in food. For the developed platform, the optical probe and ligand have been synthesized, functionalized, characterized and further evaluated for its selectivity, performance and stability.
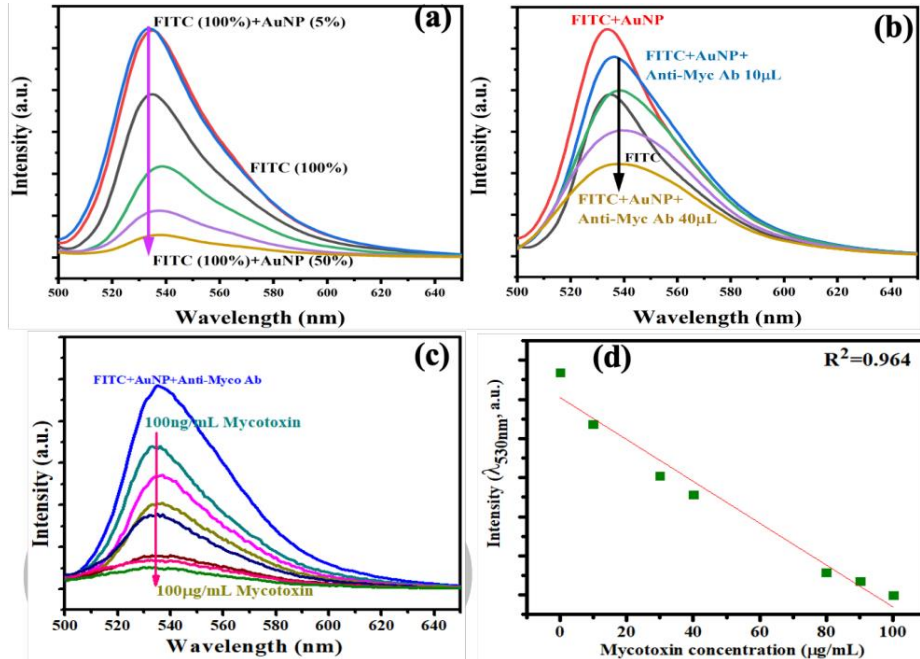
(a) Emission spectra of AuNPs-FITC FRET chip in presence of varying volumes of mycotoxin antibodies (b) In presence of varying concentrations of mycotoxin (c) Calibration graph obtained for FRET chip towards mycotoxin detection (d) Reproducibility study of FRET chip

Multiplexed lateral-flow device(s) for detection of COVID-19

Type of Project   : *Sponsored*
Project No.   : *MLP2009*
Project Leader   : *Dr. Suman Singh*

The project is for development of lateral flow device. The lateral flow device is based on colorimetric reaction which provide test line and control line. Test line will be colored in presence of covid related biomarkers and devices are highly selective to detect positive sense target RNA amplicon from nucleic acid sequence-based amplification (NASBA). The detection is based on nucleic acid hybridization reactions between probe, target RNA, and dDNA on the test line of the lateral flow device.

Development of a portable used-cooking oil tester

Type of Project   : *In-house*
Project No.   : *OLP0240*
Project Leader   : *Dr Sudeshna Bagchi*

In order to safeguard consumer health, Food safety and Standard Authority of India (FSSAI) has fixed a limit of total polar content (TPC) at 25 percent beyond which it cannot be re-used and has created protocols to monitor TPC. As a step further, FSSAI in collaboration with CSIR-IIP, Dehradun and SDC foundation have launched an initiative under 'RUCO'-(re-purposed used cooking oil) mission of MOP & NG which is attributed to convert used cooking oil into bio-fuel.Indigenous affordable testers are required to facilitate the 'RUCO' drive across the country. A prototype based on dielectric/impedance measurement technique has been developed for onsite monitoring of TPC in used-cooking oils. At present, it is being tested on field samples collected from various sources with the help of Food and Drug Administration, Chandigarh.

Optical Simulation of Skin model for Photoplethysmography Sensor Design

Type of Project   : *Consultancy*
Project No.   : *CNP0018*
Project Leader   : *Dr Sudeshna Bagchi*

The work in collaboration with M/s Pareto Tree has the vision to help healthcare professionals detect patient health deterioration early on and reduce the time to treat patients in critical conditions. The objective is to develop wearable photoplethysmography sensors to improve the treatment process by facilitating the clinicians with real time and continuous reading of the patients' vitals allowing them to take preventive measures for patient safety, thereby improving patient outcomes.

Dual Visible-light and Temperature Responsive Smart Hydrogels

Type of Project   *: Grant-in-aid*
Project No.   *: GAP-423*
Project Leader   *: Dr Kamlesh Kumar*

Two visible light-responsive actuators have been fabricated and demonstrated their application in soft grippers. These are based on anthracene and DR-1 dye. (a) A supramolecular strategy was used for the synthesis of a functionalized anthracene dye which absorbs light in the visible region due to red shift in the absorption band. This photoresponsive functionalized anthracene dye, mixed in the PVA matrix, has been used as a soft actuator acting as a microgripper to grasp, pick up, and transport cargo in response to the blue light. As a new finding, a two-fold increase in the bending angle deformation was achieved which is significantly greater than any other previously reported anthracene-based visible light-responsive soft actuator.

Furthermore, we have extended the application of light-responsive actuators into multi-responsive actuators. Here we fabricated a dual visible light and temperature-responsive thin film based on DR1 acrylate and PNIPAAm. The thin films exhibited blue light and temperature triggered actuation which was reversible in both cases. The temperature response of the thin films was attributed to the phase transition of PNIPAAm moieties above LCST whereas, the light response was a consequence of the trans-cis isomerization which led to macroscopic deformation in the thin films. These kinds of actuators broaden the horizon of the natural light and temperature-responsive soft actuators which may find applications in soft robotics, sensor, etc.

Development of irreversible thermochromic ultra-low temperature tags

Type of Project   *: In house*
Project No.   *: OLP-247*
Project Leader   *: Dr Kamlesh Kumar*

Thermochromic tags can enable the transporters and customers to easily recognize the goods when exposed to high temperatures during their storage and delivery. Therefore, the color change which cannot be reversed upon cooling provides permanent records that can be visualized offline. Here we prepared polymer strips that can be used as a warning indicator for deep freeze products, e.g., vaccines.

Design and development of Low Emissivity Coatings for Reduction of Thermal Infrared Emissions

Type of Project : *In house*
Project No. : *OLP-249*
Project Leader : *Dr Neelam Kumari*

Infrared-(IR) based weaponry and surveillance systems utilizing the short-wave, mid-wave, and long-wave IR emissions produced by ambient to high-temperature surfaces are an existing and continually evolving threat to military platforms. At longer wavelengths beyond the NIR, self-emissions from objects referred to as "thermal" radiation (TIR) become dominant. The survivability and sustainability of aircraft, helicopters, ships, and land vehicles depend on adequate protection against these threats. IR emissions from an object can be reduced by the use of an easily applied, low-weight, and passive low-emissivity coating. In this project the design and development of cermet based coating were carried out to estimate its feasibility to reduce thermal InfraRed signature. The Following work has been carried out:

- Metal – Cermet (based on W/Ni and Al_2O_3 /TiO_2) Design optimization by using estimated optical properties
- Fabrication of thin films of W:Al_2O_3 based cermets on different substrates including steel, aluminum, glass and PET.
- Process parameter optimization with respect to rate of evaporation, oxygen flow rate, substrate temperature and post-deposition annealing
- Thickness uniformity achieved on significantly large PET substrates (12 inch by 8 inch).
- The tuning of optical transmission by different thickness of the film and also by different metal content in cerments.
- The adhesion testing of the deposited coatings showed the mechanically stable nature of these films.
- The response of these coatings top thermal IR region has been studied using thermal IR cameras showing the variation in thermal signature by using these coatings. Further analysis of emissivity of these coatings is under progress.

Design and Development of Automated Lab-on-a-Chip Microfluidic System for Assessment of Cellular Reactive Oxygen Species

Type of Project : *Grant-in-aid (SERB)*
Project No. : *GAP-0412*

The project outcomes can be majorly divided into four sections. The first section deals with the development of nanomaterials based hydrogel platform for electrochemical detection of reactive oxygen species (ROS). In this section, cytochrome c, a cationic protein and rGO-CeO2 nanocomposite were incorporated into in situ synthesized alginate-polyacrylamide hydrogel. The nanocomposite-protein hydrogel modified screen printed electrode (SPE) was investigated

for various ROS such as hydrogen peroxide, hydroxyl and superoxide radicals. The method was successful for detection of micro molar levels of ROS, good sensitivity, a wide linear range, and a low detection limit that spans intracellular ROS levels. In second section, GNP-CeO2 nanocomposite and conducting polymer based in situ synthesized hydrogel was synthesized and utilized for detection of peroxynitrite, a representative of reactive oxygen/nitrogen species and an oxidative stress biomarker whose aberrant levels have pathophysiological implications. The prepared sensor demonstrated a significant dose dependent increase in peak current within a linear range, and a low detection limit with high sensitivity. Further, a customized microfluidic flow system was integrated with the GNP-CeO$_2$ hydrogel modified SPE to enable continuous electrochemical detection of ONOO- at low sample volumes. The third section deals with the detection of lipopolysaccharide (LPS) which is a well-known endotoxin found in gram negative bacteria and ROS inducer. In this context, GNP@Cytochrome c nanocomposite hydrogel modified SPE was used for electrochemical detection of LPS. Further, a customized microfluidic electrochemical device approach was established for continuous on-chip detection of LPS. The sensor was applied for determination of LPS in spiked lemon juice samples and showed satisfactory recovery. Overall, this sensing method holds great promise for screening of trace LPS contamination, especially for food safety applications. The fourth section deals with the prototype for detection and quantification of ROS. In this setup, the microfluidic pump and electrochemical detection protocol were integrated and synchronized for detection of ROS.

Smart Phone Imaging Dip-Stick Platform for Heavy Metals Detection in Water

Type of Project   *: Grant-in-Aid (DST-SEED)*
Project No.   *: GAP-0375*
Project Leader   *: Dr Pooja Devi*

Heavy metals contamination of water resources including ground water is a major problem worldwide. In Indian scenario, several states have been affected with high level contamination of heavy metals including arsenic, selenium, chromium, cadmium, etc., in water. It is therefore required to have end-to-end detection platform for their detection before water consumption as well as utilization in agriculture in affected regions. The heavy metals contamination has been found responsible for chronic diseases including arsenosis, selenosis, major organs damage, etc., and is well documented. The pain of the problem could be understood only be affected people. Moreover, the irrigation of crops with heavy metals contaminated water has been found to cause their elevated presence in major crops including rice, which has also led to Indian export consignment rejection by northern countries. The proposed proposal integrates successfully accepted colorimetric approach for heavy metals detection in water with mobile phone-based image processing to quantify the contamination level using affordable paper/membrane based disposable sensor strip. The developed mobile app ensures elimination of subjectivity of the colometric sensor, which limits their application to true extent by users in resource limited regions especially rural sector.

Progress:

§ A Portable Colorimeter and Mobile App to Read Paper Strips for Heavy Metals with specifications given below is developed:
   o Measure   : Heavy Metals in Water
   o Type of Heavy Metals   : Paper Strips for Metals
   o Mode   : Colorimetric Material and Reader Device
   o Measurement Range   : WHO limit

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- o Analysis Time   :2-3 min
- o Sensor   : Color Sensor
- o Power   : 5V DC Adaptor/Battery
- o Weight   : 500 gms
- o Accuracy   : +-0.50
- o Data Sending   : Bluetooth 2.0
- o Serial Communication   : USB 2.0

HMIGauge V1.0
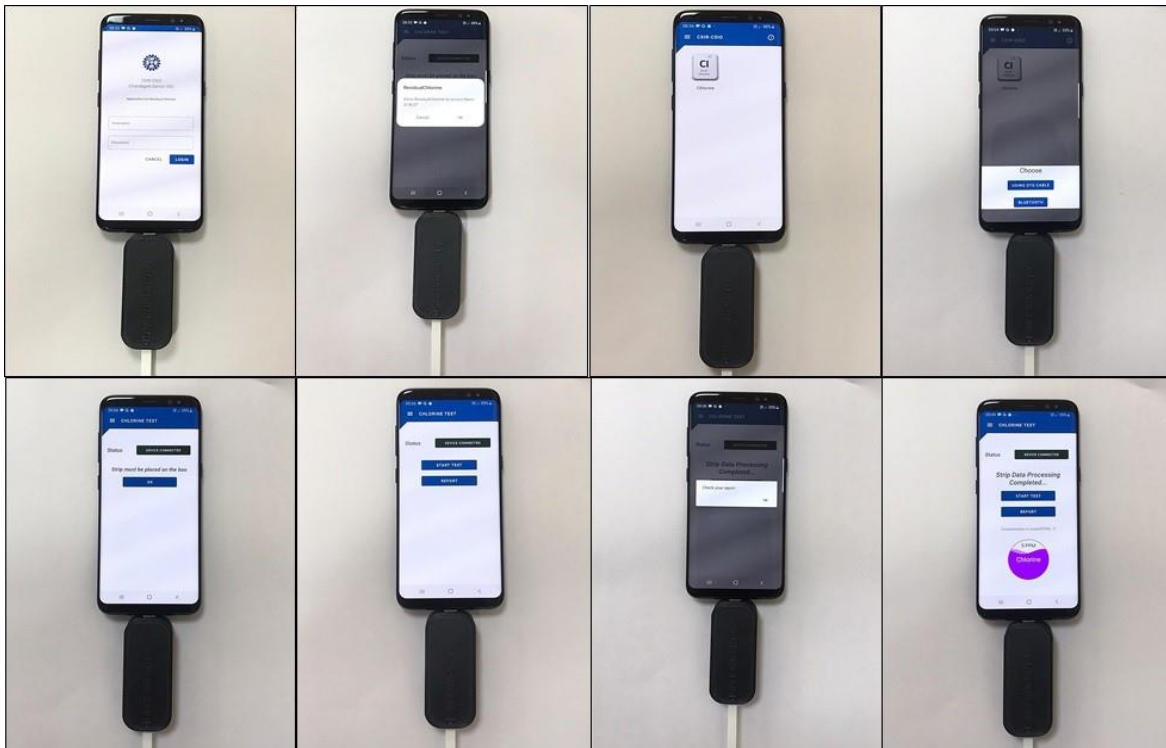
HMIGauge V2.0
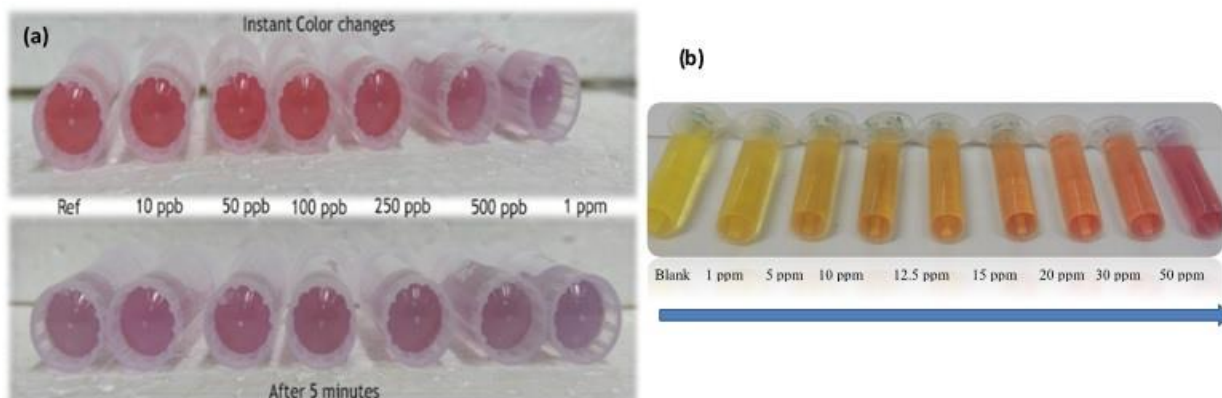
Colorimetric Reagent Kit for (a) Selenium and (b) Arsenic

Table 1: List of colorimetric kits developed for heavy metals/metalloids

S/n	Metal Ion	Probe Type	Kit Type	Detection range	Color change
1.	Arsenic	Colorimetric	Solution-based testing	1-50 ppm	Naked eyes (yellow to red)
2.	Selenium	Colorimetric	Solution based testing	0.01-1ppm	Naked eyes (pink to purple)
3.	Iron	Ratiometric	Solution-based testing	0.25 ppm - 25 ppm	Naked eyes (green to brown)
4.	Copper	Colorimetric	Solution-based testing /Test strips	>1ppm	Naked eyes (colorless to yellow)
5.	Mercury	Colorimetric	Solution-based testing /Test strips	1-5 ppm	Naked eyes (colorless to orange)

Design of Table Top Air Purifier System with Visible Light Photo Catalytic Oxidation (PCO) Technology for 100 square foot Room

Type of Project   : *In house Project*
Project No.   : *OLP 244*
Project Leader   : *Dr Pooja Devi*

Indoor Air is known to have a higher level of Volatile Organic Compunds (VOCs) than outdoor environments, which are hazardous to human health. With increased awareness of air qulity in COVID times, there is demand for developing safe solutions for VOCs treatment. Among various approaches for VOC degradation, photocatalytic oxidation is a promising approach as it mineralises the pollutants instead of its adsorption. But the existing solutions are based upon UV PCO which is harmful. Under this project, we have developed visible light active catalyst based upon doped oxides and demonstrated them for formahldehyde degradation. Also, a process is developed for large area coating of the synthesized catalyst on any kind of substrate. As photocatalytic oxidation depends upon design of an efficient catalyst system and testing thereof under variable parameters. For this, a customized test setup is also designed under this project to test both powder and thin film catalysts for indoor air pollutants degradation study. As an outcome of the project, following processes/technologies are developed:

1. Scalable Process for coating visible PCO catalyst onto any substrate including SS and Ceramic as a filter

2. A Controlled Test Setup for Visible PCO Testing
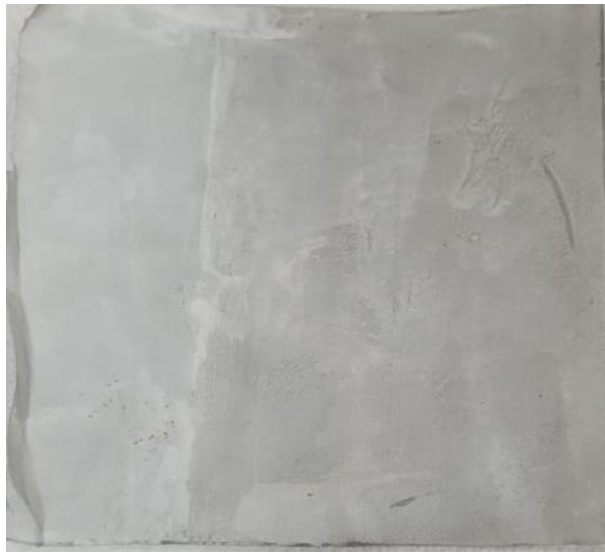
Visible PCO Filter Coated with Doped Oxides

Investigation of Nanostructured SERS Substrate for Pops Detection in E-Waste Recycling Site

Persistent organic pollutants such as dioxins, and polychlorinated biphenyls (PCBs), *etc.* are one of the harmful pollutants to human health due to their accumulation capability in human bodies through the food chain (vegetables, plants, animals, *etc.*), which leads to severe diseases. The recent study report the high level of these POPs in several states of the country involved in e-waste recycling. The soil and water areas near these sites is found to contain high level of more than 26 toxic and hazardous compounds of polychlorinated biphenyls (PCBs). The current practices of their analysis relies upon sample collection and their subsequent treatment for analysis with lab based Gas Chromatography-Mass spectrometer system. However, the GC/MS method is expensive and time-consuming, and is often not able to distinguish homologues.

In the present project, we are working towards design of a sensor system/technique for on-site qualitative/quantitative analysis of these pollutants in water and soil matrixes nearby to the e-waste recycling site. Since Surface Enhanced Raman Scattering (SERS), is one of the most favorable methods for environmental analysis as it provides vibrational spectroscopic fingerprints for specific analytes with high detection sensitivity. Thus, we are developing various SERS substrates including metallic nanostructures, quantum dots, etc., to enhance the sensitivity and selectivity of the technique.
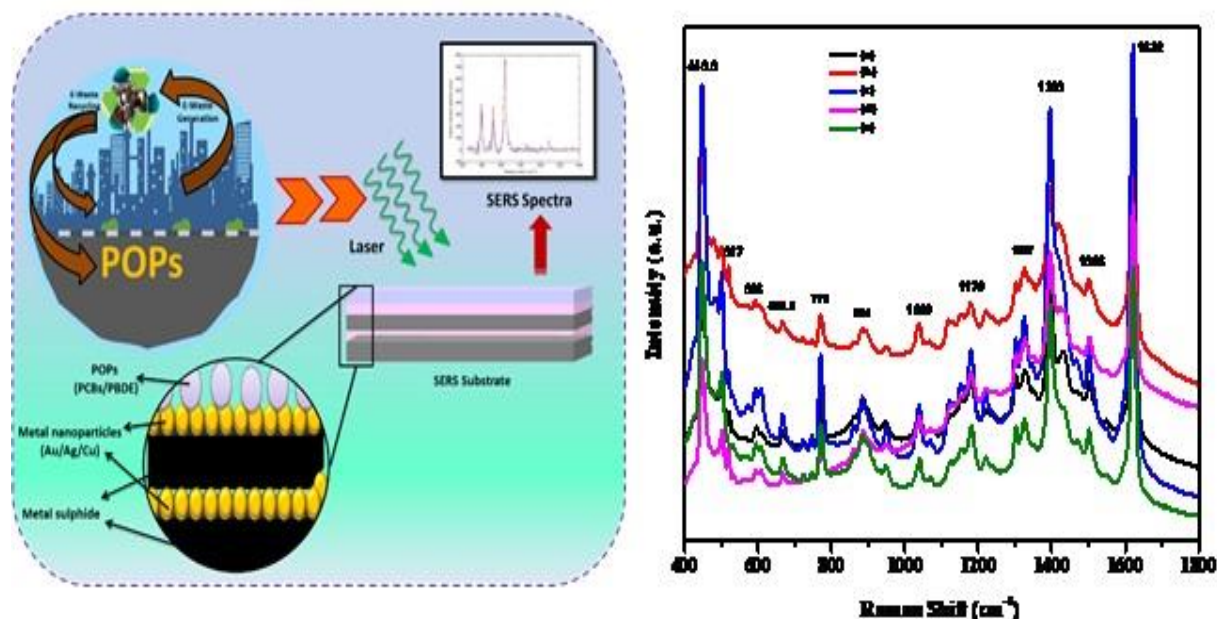
Multiplexed Point-of-Care detection Platforms for ovarian cancer biomarkers (Multi-COB)

Type of Project   : *Grant-in-aid*
Project No.   : *GAP 0417*
Project Leader   : *Dr. Suman Singh*

The current work focused on the development of a paper based microfluidic device for the sensitive and selective detection of multiple biomarkers of ovarian cancer simultaneously. In the absence of screening for ovarian cancer, diagnosis of this disease in the advanced stages leads to this cancer being considered as a fatal disease. Various iterations are required while designing and fabrication of any point of care devices, considering their diagnostic application. In its progress, paper devices have been designed and fabricated. These devices were then functionalized to make them selective for required biomarker. Study shows the capability of these devices to detect diverse range/concentration of biomarkers
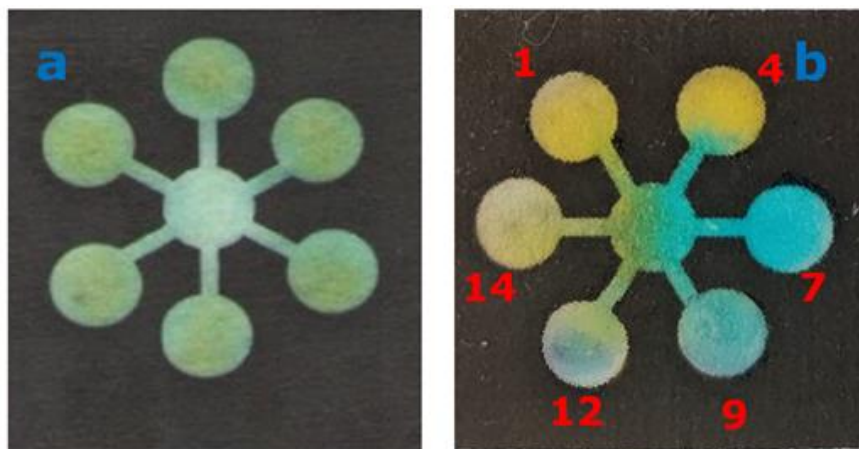
Reproducibility(a) and pH variation (b) in microfluidic device

Sensitive bio(chemo) sensing strip(s) for multiplexed detection of pesticides

Type of Project   : *Sponsored*
Project No.   : *HCP 031, W.P 3.2*
Project Leader   : *Dr. Suman Singh*

The project aims at the development of multianalyte detection platforms for the detection of pesticides. Pesticides have extensive applications in the agriculture division to increase the crop growth and quality but often result in health hazards and economic loses. And single pesticide detection doesn't serve the purpose of on-site detection. Hence platforms have been devised which can detect multiple pesticides in single run using low cost technologies.

Low cost platforms for multianalyte detection
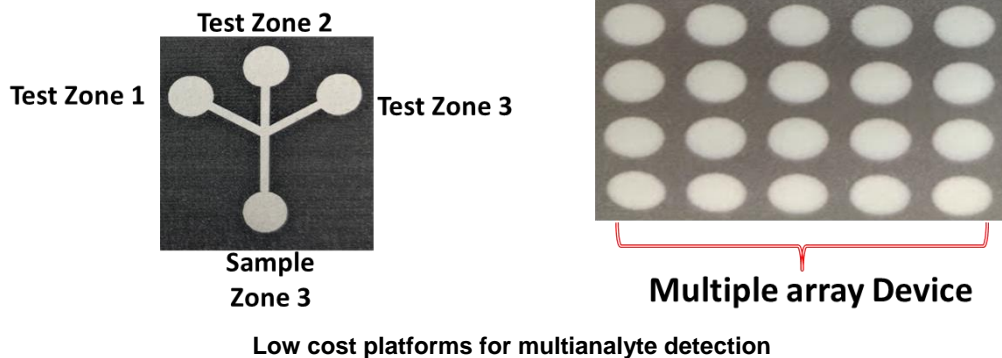
Development of sensing platforms for determination of spoilage of fruit juices

Type of Project : *Sponsored*
Project No. : *HCP 031, W.P 3.7*
Project Leader : *Dr. Suman Singh*

This project is about electrochemical detecion of fruit juice spoilage paramteres. The screen printed electrodes are being developed using natural product as well as material derived from waste. These electrtochemical detection electrodes are in process of optimisation for spoilage parameter estimation. This is collaborative work with CSIR-IITR.

There is a continuous need to analytically measure the color of an object for various applications such as quantitative chemical analysis, colour identification in food industry etc. Focused research and innovations in areas such as scientific principles, engineering designs etc. have led to development of more accurate, reliable, flexible and smaller colour measuring instruments. Their simplicity and lower cost relative to bench top colorimeters have led to widespread use in quality inspection areas, retail and fabric industries etc. However, they are not suitable for multiparameter testing and do not provide comprehensive information about different spectral parameters.

Development of pocket colorimeter for multiparameter testing

Type of Project : *CSIR Mission Mode*
Project No. : *HCO0034,WP 4.3*
Project Leader : *Dr. Sudeshna Bagchi*

The main aim of this project is to design a miniaturized pocket colorimeter with extended linear range and high precision calibration of available reagent based parametric tests (both liquid reagent and test strips) for different applications.

Hardware design of photoplethysmography sensor

Type of Project : *Sponsored*
Project No. : *SSP0055*
Project Leader : *Dr Sudeshna Bagchi*

The project is in continuation of the consultancy project on "Optical simulations for design optimization of PPG sensor" in collaboration with M/s Pareto Tree Pvt. Ltd.. Based on the

optimized design, the project involves hardware interfacing, integration and testing of PPG sensors.

Advanced functional nanosurfaces for optical sensing of emerging pollutants and their removal

Type of Project : CSIR Funded
Project No. : MLP-2006
Project Leader : Dr Akash Deep

The project deals with the development of optical interfaces for the sensing and removal of pollutants. The polymers (e.g., metal-organic frameworks), quantum dots, and the composites of nanoparticles have been prepared and investigated for the detection of pollutants like toxic gases, bacteria, heavy metals, and drug residues. Based on the fluorescence quenching properties, the detection of several analytes has been achieved with low limits of detection and desired selectivity. Simultaneously, the polymer and hydrogel composites have been synthesized which show exciting antimicrobial properties.

Molybdenum Disulphide Nanotemplates Based Electrochemical Nanosensor for Food Toxins AFBI and AFM1

Type of Project : SERB Funded
Project No. : GAP-397
Project Leader : Dr Akash Deep

Aflatoxins are the hepatotoxic secondary metabolites and are highly carcinogenic. They are known to cause adverse effects on human health. The research deals with the development of a sensitive electrochemical sensor for aflatoxin M1 (AFM1). The sensor has been prepared by modifying the screen-printed carbon electrodes with a nanocomposite of molybdenum disulfide (MoS2) quantum dots (QDs) and zirconium-based metal–organic framework (MOF, UiO-66-NH2). The MoS2/UiO-66-modified electrodes were immobilized with the AFM1-specific monoclonal antibodies. The electrochemical impedance spectroscopy based analysis allowed the detection of AFM1 from 0.2–10 ng mL–1 with a low limit of detection of 0.06 ng mL–1. The performance of the developed sensor has also been validated by detecting AFM1 in the spiked milk samples.

Design and development of fiber optic gas sensor and system for petroleum industries (Phase 1)

Type of Project : Centre for High Technology (CHT) funded
Project No. : GAP0422
Project Leader : Mr.Surjit Kaman

The project objective was to demonstrate laboratory level proof of concept of tunable diode laser absorption spectroscopy (TDLAS) technique for gas composition analysis of hydrogen sulfide and carbon monoxide gas for application in the petroleum industry in collaboration with Bharat Petroleum corporation Limited.

Laser diodes wavelength in near infrared region(NIR) are carefully chosen for targeting the isolated and strong absorption lines of hydrogen sulfide and carbon monoxide gas. The laser diodes are characterized for the optimum laser current and temperature to achieve the targeted wavelength. Gas mixtures of known composition of hydrogen sulfide ,carbon monoxide and balanced nitrogen gas are fed into the fiber coupled multi pass optical gas flow cell where light and gas interacts. The gas absorption was further correlated with twice the modulated frequency to obtain the gas concentration. The develop platform achieved a good linearity, selectivity with large dynamic range.

Development of hematite based sustainable floating photocatalyst for transformation of atrazine and bisphenol A

Type of Project : *Grant-in-aid*
Project No. : *GAP-424*
Project Leader : *Dr Avishek Saha*

This project aims at the development of visible light active, floating photocatalysts which has the potential for the degradation of organic pollutants. To this end, we have synthesized floating photocatalyst based sol-gel and hydrothermal techniques. Different hematite/titania-based photocatalysts have been immobilized on perlites. However, the photocatalytic degradation of originally proposed pollutants (bisphenol A and Atrazine) was not significant. Instead, we have selected rhodamine B as the model pollutant and studied the photocatalysis and photo-Fenton process. We observed best degradation efficiency with 20:0.2 $TiO_2/\alpha\text{-}Fe_2O_3$@perlite under visible light during the photo-Fenton process (20 mM H_2O_2 + 300 W light with 420 nm longpass filter).

Design & Development of portable devices for estimation of portable devices for estimation of life and color index of Lac samples

Type of Project : *NABARD funded project (GAP)*
Project Leader : *Mr. Saurav Kumar*

The project is all about the quality estimation of Shellac sample using two of its important parameters: Color index and heat of polymerization

Objective assessment of saltiness in salts and salt blends

Type of Project : *TCPL funded (SSP)*
Project Leader : *Mr. Saurav Kumar*

The project deals with the objective assessment of saltiness of the salt samples and its blends. Saltiness is one of the fundamental taste qualities on which not only food habit but the human health also depends. In this project, it will be tried to explore the reason for the variation in the saltiness of the salts of natural origin and salts obtained from different processes.

Design, Development, and Validation of Personalized Air Disinfectant/Purifying Device

Type of Project   *: Collaborative Project*
Project No.   *: CLP0032*
Project Leader   *: Prachi Rajput /Dr Pooja Devi*

COVID-19 was declared an air borne virus and spreads through aerosols. The frontliners are at high risk working in COVID environment as well as attending thousands of patients in COVID wards, OTs, OPDs, etc. The mask used creates an un-comfort for wearing 24 X 7 due to negative pressure and CO_2 build up. Also, despite of using mask several doctors got infected with COVID. To overcome this and provide a more comfortable solution, we developed a wearable pressurized air-breathing and SARS CoV-2 scavenging device called as V-Treat under this collaborative project between CSIR-CSIO, Chandigarh and Ideamines Pvt. Ltd., Noida.

The device works on three-level deactivation of virus and is tested for UVC safety by NPL and SARS-CoV 2 viricidal activity by CSIR-IMTECH. The device provides SARS CoV-2 free air while wearing PPE kits in COVID wards/OPDs. Currently the device is ready for commercialization and of TRL 7-8.
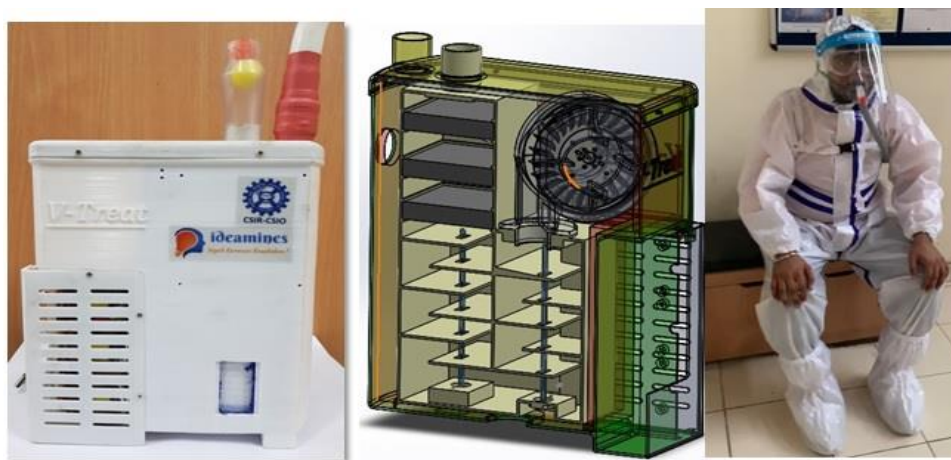
A wearable pressurized air-breathing and SARS CoV-2 scavenging device- V-Treat

DEEP-Development of an efficient photo electrode for hydrogen fuel from water

Type of Project   *: Grant-in-Aid (DST-HFC)*
Project No.   *: GAP 421*
Project Leader   *: Dr Pooja Devi*

Hydrogen as an element and as a gas (H2) is colourless, odorless, and tasteless. Hydrogen gas on burning (combustion) with oxygen (air) generates a humongous amount of energy. Generally, the combustion reaction releases around 286,000 joules of energy per mole of

hydrogen gas burned, which is a multitude higher than the fuels being used in present. Besides as a fuel, it has other excellent features such as (i) its high energy density/mass (120-142 MJ/kg, while for gasoline: 44.5 MJ/kg) (ii) low ignition temperature (iii) high combustion energy (2.86×10^5 J/mol H_2) (iv) no toxic combustion by-products. Thus, HYDROGEN has been projected as a clean future fuel. Amongst various methods of its production, photoelectrochemical (PEC) water splitting is a promising approach, which requires the design of efficient and stable photoelectrodes. In this project, we are working towards the growth of ordered and nearly defects-free nitrides nanostructures by epitaxy/hydrothermal methods and integration thereof with 2D materials including MoS_2, MoSe2, etc. The developed catalysts are characterized for their PEC characteristics and optimized to achieve higher Faradaic efficiency. The project aims to further develop a prototype based upon the optimized catalytic electrodes:
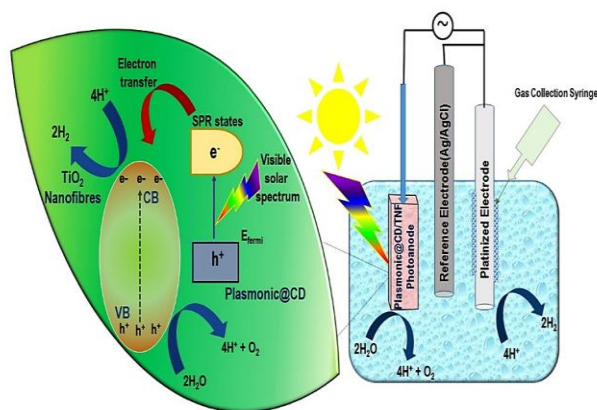
PEC setup for Hydrogen Production from Water

2D Materials Engineering for Simultaneous Hydrogen Production and Emerging Pollutants Degradation

Type of Project   *: Grant-in-Aid (SERB-WEA)*
Project No.   *: GAP 432*
Project Leader   *: Dr Pooja Devi*

Wastewater is a rich source of energy, but its improper handling leads to contamination of water bodies, soil, etc. Several organic pollutants categorized as emerging pollutants (EPs) such as textile dyes, antibiotics, drugs, personal care products, etc., are making their ways into water bodies. Further, the limited supply of fossil fuels and the associated carbon footprint upon their consumption raises alarm for the rapid development of clean and renewable alternatives. That is why the generation of hydrogen through photoelectrochemical (PEC) water splitting has been considered as the strategy future strategy for minimizing the usage of fossil fuels. In this project, we are working towards the development of smartly engineered 2D material heterostructures on various nanostructures semiconducting substrates like Si, GaN, FTO, etc. as efficient, stable, scalable, and cost-effective photoelectrodes for simultaneous treatment of wastewater and hydrogen production through PEC routes. We have investigated MoS_2, $MoSe_2$, $BiVO_4$, TiO_2, etc., and their hybrids with other oxides for improving their PEC performance. Currently, the work is undergoing to further engineer developed electrodes with MXenes ($M_{n+1}X_nT_x$) for the efficiency enhancement for simultaneous treatment of water pollutants and hydrogen production

through innovation in materials. This project is in direction of utilizing wastewater as a feedstock for hydrogen generation.
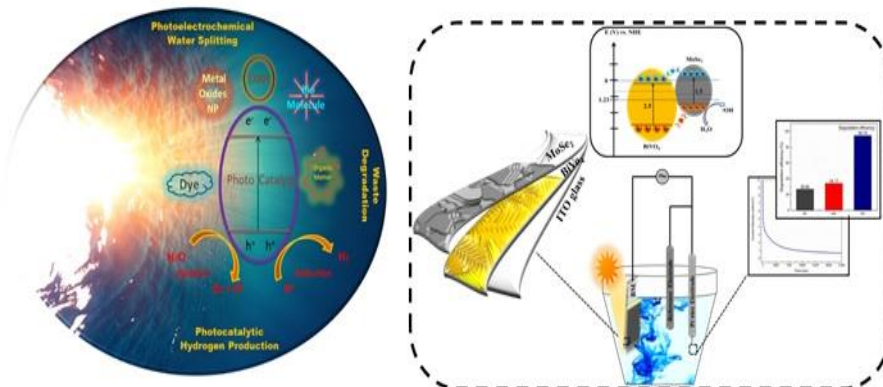
Materials for Simultaneous Hydrogen Production and Waste Water Treatment

Design and development of Pristine/Doped Photocatalytic Materials for Pollutants Degradation

Type of Project : *Sponsored Project*
Project No. : *SSP 51*
Project Leader : *Dr Pooja Devi*

Photocatalytic disinfection is an emerging method to purify the air from inorganic pollutants and pathogenic microorganisms, including viruses, bacteria etc. According to WHO, an estimated 1.5 million people died from the effects of air pollution in 2012. Ultraviolet/visible light-based photocatalytic air purification is an efficient strategy for degradation of broad range of common pollutants including NOx and SOx. M/s Novorbis Itus Pvt. Ltd., Indore is having solutions for air purification mainly in industrial setting, outdoor, industrial, and corporate air purification solutions. Under this project CSIO developed a process for the large-scale synthesis and coating of pristine and doped TiO_2 for further utilization in existing products of Novrobis Itus Pvt. Ltd., India for SOx and NOx degradation under industrial settings. The testing of the developed catalyst is under process for the degradation study.

Development of an affordable high resolution polarimeter using indigenous off the shelf components

Type of Project : *CSIR Mission Mode*
Project No. : *HCP-00034,WP 4.5*
Project Leader : *Dr Sunita Mishra(PI)/Dr Rajkumar (Co PI)*

The aim of the project is to develop an affordable, high performance polarimeter for studying the behaviour of chiral crystals, molecules and molecular assemblies potentially to be used in pharmaceutical industry and food industry. The differential-phase-based detection procedure is being used to measure the rotation angle using only low-cost off-the-shelf components. The instrument uses separate reference and object beams derived from a common laser source.

The reference beam and object beam passes through separate polarisers but through the same rotating polariser with a difference that the object beam passes through optical (sample) cell. The design of the polarimeter is developed by replacing a number of costly components by cheaper alternatives. The entire system will be developed at low cost by offering comparable performance to high-end commercial instruments. Its low cost will be ideally suited for its use in resource-constrained environments.

Bio-Medical Applications
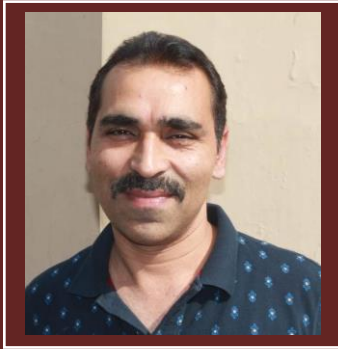
Sanjeev Verma
sanjeevverma@csio.res.in

Biomedical Applications Group is actively engaged in the development of medical technologies with focus on Diagnostics & therapeutic devices, Rehabilitation & Assistive technologies for elderly & differently abled population, Imaging based medical devices and Advanced manufacturing based Orthopaedic & Dental Implants. The group has expertise in the following areas specific to medical instrumentation: Analog & Digital Circuit Design and Signal Processing; Mechanical Design & Fabrication; CAD Modelling; Human Biomechanics & Gait Analysis; Rehabilitation and Assistive technologies; Medical Robotics; Machine Vision; Image Processing; Thermography; Bio-inspired computing; Machine Learning & Deep Learning; Orthopaedic Implant Design & Manufacturing; Bio-signal processing.

Completed projects:

- **Machine for performing Double Volume Exchange Transfusion**
- **A contactless Heart Rate (HR) monitoring system**
- **Skill Development Hands on Training Program on "Bio-signal Acquisition and analysis"**
- **Solid Tumor Targeting using homing Peptides and Plasmonic Photothermal Technique**
- **Convective blower machine for patient warming system**
- **Motor Rehabilitation of Children with Cerebral Palsy using Virtual Intelligence**

Ongoing Projects:

- **CSIR Mission Mode Project – Medical Instruments & Devices**
- **Plasmonic photothermal based sterilization device for surgical instruments**
- **Dialysis machine for haemodialysis of chronic kidney disease patients**
- **ROBOG - Robotic Gait Trainer for Rehabilitation of Spinal Cord Injury Patients**
- **Bio-Mechatronic Orthotic Devices for Rehabilitation of Motor Disorders (BioMOD)**
- **Thermal imaging based non-invasive technique for diagnosis of musculoskeletal disorders (MSD)**
- **To develop a CAD system for diagnosing compartment syndrome by using thermal imaging**
- **Automatic Brushing device for oral hygiene maintenance in elderly population**
- **Virtual Intelligence in Home Based Rehabilitation of Persons With Motor Disability**
- **Development of Gait Training Tools and Mobility Aids for Parkinson's Patients**
- **ICT based Tools for Assessment and Improvement of Efficacy of Upper Limb Robotic Rehabilitation using Thermographic Diagnostic Method (ThermoRehabRob)**
- **Contactless measurement of Respiration pattern, Respiration Rate and Heart Rate using Doppler Radar**
- **Development of Otoacoustic Emission Sensing System for Medical Applications**
- **Oxygen Optimiser**

- **Indigenous apex locator for root canal treatment**
- **A Novel Portable Wireless Automated Eye Moisturizing Sprayer**

Machine for performing Double Volume Exchange Transfusion

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP 0396*
Project Leader   *: Dr. Sanjeev Verma*

Severe jaundice (hyperbilirubinemia) is a common problem amongst newborn infants. Most infants with severe jaundice require only phototherapy but a few do not respond to phototherapy and end up requiring a double volume exchange transfusion (DVET). DVET involves replacing the entire blood volume of the neonate twice over with adult donor blood. In each cycle, the amount of neonatal blood that is removed is replaced by an equivalent volume of donor blood. Presently, these cycles go on in the same sequence manually until a total blood volume equal to twice the calculated neonatal blood volume is removed and an equivalent amount replaced. Since the average blood volume of a neonate is 80-100 ml/kg, the usual DVET procedure goes on for about an hour to an hour-and-a half and involves approximately 40 to 50 cycles. All these cumbersome processes occupy doctor's and his/her assistant's precious time and energy. There is a high risk of errors occurring with the current manual process. These errors include missing phases of a cycle, missing an entire cycle, incorrect volume of blood withdrawn or infused, accidental infusion of air bubbles or clots, that could potentially cause embolism.

Three prototypes of the machine for automating the double volume exchange transfusion process through umbilical route in neonates are developed, for which Ex-Vivo clinical evaluation and trials were carried out at Neonatal ICU, PGIMER, Chandigarh using donor blood bag. The device provides a non-fluctuating flow at the required rate and the results show that the haematological and biochemical parameters of the blood after passing through the device remains unchanged. The device improved the process accuracy as compared to the manual process and saves the time and energy of a doctor & nurse. The device can detect the presence of air bubbles or clots in the tubing thereby improving the safety of the device over the manual process.
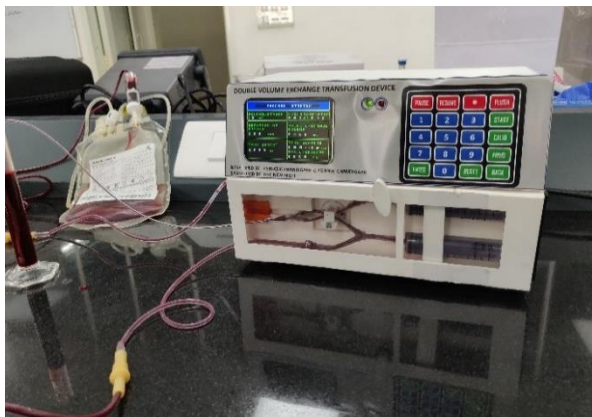
Photographs related to the clinical trial at PGIMER with donor's blood

A contactless Heart Rate (HR) monitoring system

Type of Project : *Grant-in-Aid*
Project No. : *GAP-0446*
Project Leader : *Dr. Sanjeev Kumar*

Human vital parameters monitoring are the first requirement of any healthcare profession. Conventional methods required physically testing of these parameters in contact with the subject under observation. During this COVID-19 pandemic, it is difficult for the healthcare professional to monitor the vital parameters of the patients. For this, a doppler radar based contactless method has been developed to monitor the Heart rate of the patient without placing any electrode/equipment on the patient.
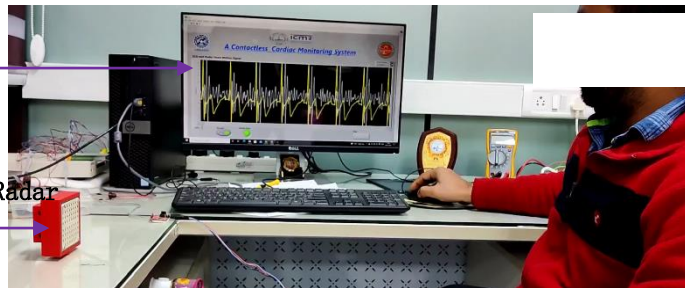
Prototype of the system
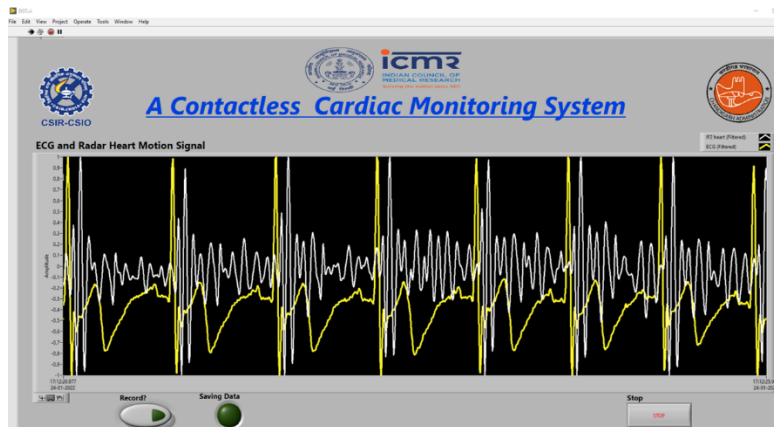
Algorithm for data recording and analysis

Skill Development Hands on Training Program on "Bio-signal Acquisition and analysis"

Type of Project : *TSP*
Project No. : *TSP-0024*
Project Leader : *Dr. Sanjeev Kumar*

The course was conceived on the request of BIRAC / BCIL under NBM Program for the benefit of engineers, technologist, device manufacturers, startup and researchers in the field. It is observed that a very little practical knowledge is available in public domain for Design/Development, Maintenance, Repair and Calibration of medical instruments as the field is multi-disciplinary in nature. Considering the above facts; this training program was conceived. Also, Biomedical Signal Analysis centers on the acquisition and processing of information bearing signals that emanate from living systems. These vital signals permit to probe the state

of the underlying biologic and physiologic structures and dynamics. Therefore, their interpretation has significant diagnostic value for clinicians and researchers. One of the important steps in production and launch of medical devices in market is the knowledge of the bio-signal, their acquisition, embedded system, design and fabrication of bio-amplifiers, interfacing and analysis of different bio-signals for diseases prediction and assistance to the physicians. This training program has provided in-depth knowledge and hands-on exposure to the participants in designing and analysis of bio-signals relevant to manufacturers, entrepreneurs and equipment operators.

Solid Tumor Targeting using homing Peptides and Plasmonic Photothermal Technique

Type of Project : *Grant-in-Aid*
Project No. : *GAP0384*
Project Leader : *Dr. Sanjeev Soni*

This research project involves development of a plasmonic photothermal based cancer therapeutic technique and in-vivo performance evaluation. Under this project, a near infrared light source of following specifications was developed and in-vivo performance was evaluated for skin cancer (B16F10 melanoma) in animal models. The light source is useful for a variety of applications like photochemistry, photobiology, biophotonics, microscopy, fluorescence and biomedical etc. Also, it can be used for photothermal applications to generate a set temperature within a medium/sample. Current TRL is 7.
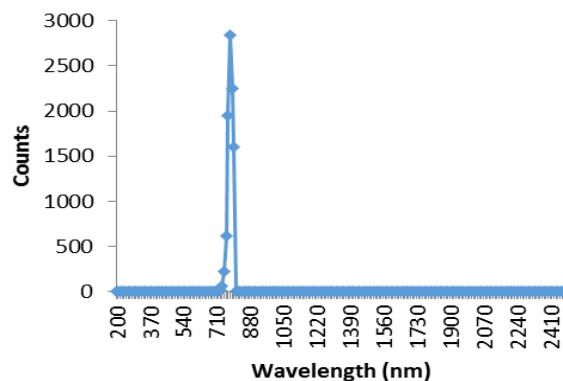
Near Infrared Light Source cum Photothermal Device and typical optical output

- Light source : Tungsten halogen lamp (250 W), air cooled
- Output wavelength/ Spectral tuning range : 725-950 nm (Customisable)
- Typical optical output power : 2.5 Watt (with 795/150 nm optical bandpass filter)
- Optical output / Output beam diameter : Fiber coupled or free space output /0-22 mm
- User set parameters : Time and temperature
- Displayed parameters : Voltage, Current, Run time, Time left and Temperature
- Audio – Visual Alarms : Lamp failure, Process completion
- Special Feature : High optical power handling and spectral extraction

Convective blower machine for patient warming system

Type of Project   : *Consultancy*
Project No.   : *CNP 0020*
Project Leader   : *Dr. Sanjeev Soni*

Under this project, we provided consultancy for convective blower machine for patient warming involving feedback on the design & operation including alternate sources for the components, safety interlocks & performance testing etc. Also, consultancy involved identification of the relevant testing standards and NABL testing agency for testing/certification of the developed prototype.

Motor Rehabilitation of Children with Cerebral Palsy using Virtual Intelligence

Type of Project   : *Grant-in-Aid*
Project No.   : *GAP0394*
Project Leader   : *Dr. Neelesh Kumar*

- Virtual reality-based system for rehabilitation of motor disability in children with cerebral palsy was developed

- Implementation and limited clinical trials at PGIMER Chandigarh of the developed system for rehabilitation of motor disability in children with cerebral palsy

- Improved manual ability of children with hemiplegic CP to grasp, lift and manipulate objects with greater range of motion and precision through Virtual Reality Training utilizes wearable sensors (Inertial motion unit) and non-wearable sensor (LEAP motion sensor)

Subject performing Collecting crystal activity (range of motion activity) using wearable IMU sensor

CSIR Mission Mode Project – Medical Instruments & Devices

Type of Project : CSIR MMP
Project No. : HCP0026
Project Coordinator : Mr. Dinesh Pankaj

This Mission Mode Project on "**Medical Instruments & Devices"** is being carried out with the aim to put focused S&T efforts for the development of medical device segment. The mission has four focus areas proposed as verticals are: Diagnostic & Therapeutic Devices; Rehabilitation and Assistive Technologies for Elderly & Differently Abled Population; Imaging based Medical Devices; and Advanced manufacturing based Orthopedic & Dental Implants. The broad objectives of the mission are given below:

(i) Development of therapeutic and biosensors based point-of-care diagnostic medical devices

(ii) Development of technological solutions for elderly & divyangjan focused towards assistive device and rehabilitation aids for improvement in their quality of life

(iii) Development of state-of-art imaging based technologies for non-invasive medical diagnosis applications

(iv) Development of state-of-art orthopedic implants particularly augment for revision surgery implants, extendable implants and dental implants using 3D printing technology

The program has 15 Tasks under 4 Verticals with eight CSIR labs, CSIR-CSIO (nodal lab), CSIR-IMTECH, CSIR-IICT, CSIR-CLRI, CSIR-CMERI, CSIR-CEERI, CSIO-CECRI and CSIR-CGCRI, participating in realizing the objectives of this mission. There are 10 project tasks are being carried out at CSIO. At present in most of the tasks development of prototype is in advanced stages. The details of different project tasks carried out in BMA is as under.

Plasmonic photothermal based sterilization device for surgical instruments

Type of Project : CSIR funded
Project No. : HCP0026-1.1
Project Leader : Dr. Sanjeev Soni

This research project involves development of a plasmonic photothermal based sterilization device and its performance evaluation in collaboration with CSIR-IMTECH Chandigarh.

Antimicrobial experiments were performed on B. subtilis culture and B. subtilis spores suspensions to quantify/assess the bacteria reduction for the considered process parameters (nanoparticle concentration, irradiation intensity and exposure duration).
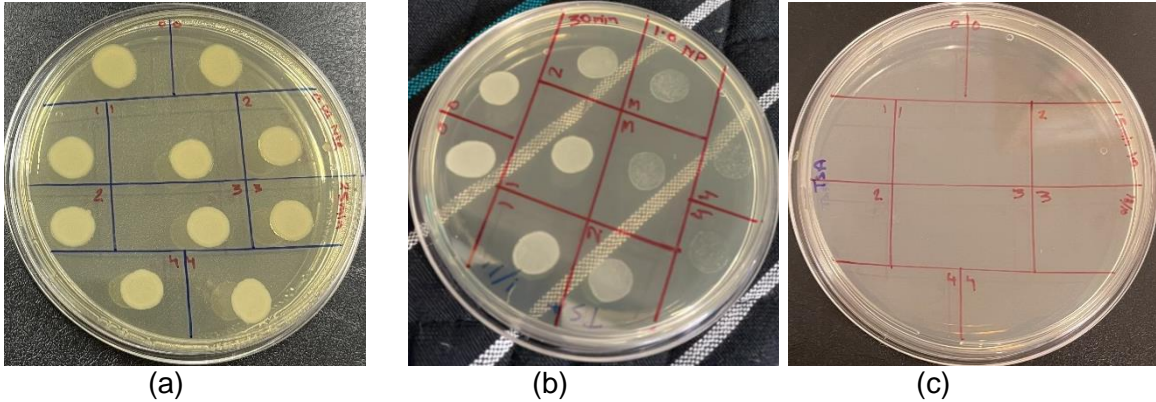
Plate assay showing viability of B. subtilis culture of OD 1.0 (a) in presence of PBS and NIR exposure (1.8 W) for 15 minutes (b) in the presence of silver nanoplates alone (c) in the presence of silver nanoplates and NIR exposure (1.8 W) for 15 minutes.

B. subtilis got completely killed for 15 minutes of NIR irradiation in the presence of silver nanoplates

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Dialysis machine for haemodialysis of chronic kidney disease patients

Type of Project   *: CSIR Funded Medical Mission*
Project No.   *: HCP-0026 - Task 1.2*
Project Leader   *: Mr. Arindam Chatterjee*

Chronic kidney disease (CKD) is a worldwide health crisis. 10% of the population worldwide is affected by CKD, and millions die each year because they do not have access to affordable treatment. The number of patients diagnosed with the disease continues to increase at a rate of 5-7% per year. The people affected with CKD require renal replacement therapy to sustain their lives. Renal replacement therapy remains unaffordable for the majority of the affected and causes severe financial hardship for those who have access to it. Over 600 million people cannot afford renal replacement, resulting in the death of over 1 million people annually from untreated kidney failure. So, it is proposed to develop a Haemodialysis machine, which is a cheaper alternative to the expensive renal transplant. Currently, there is only one Haemodialysis machine manufacturer in India and rest are being imported from Germany, Sweden, Japan, China and US at a cost of around Rs 10-11 lakhs.

The indigenous Haemodialysis machine produced at a lower cost will reduce the costs of dialysis procedure which currently lies between Rs 2,500 and Rs 4,000 for one session. Thus the poor people of India suffering from kidney disease will be treated at a low and affordable cost.

The system has following features:

- Blood pump for extraction of blood from human body and infusion after filtration through Haemodialyzers

- HDF pump for infusion of extra water for dialysis to clean the dialyzer

- Heparin pump for the infusion of heparin used as a blood thinner
- Dialysate pump for the continuous flow of Dialysate liquid throughout the process
- Biocompatible and disposable Blood flow circuit
- Monitoring of Body parameters, Sensor parameters, Machine calculated parameters and User set parameters
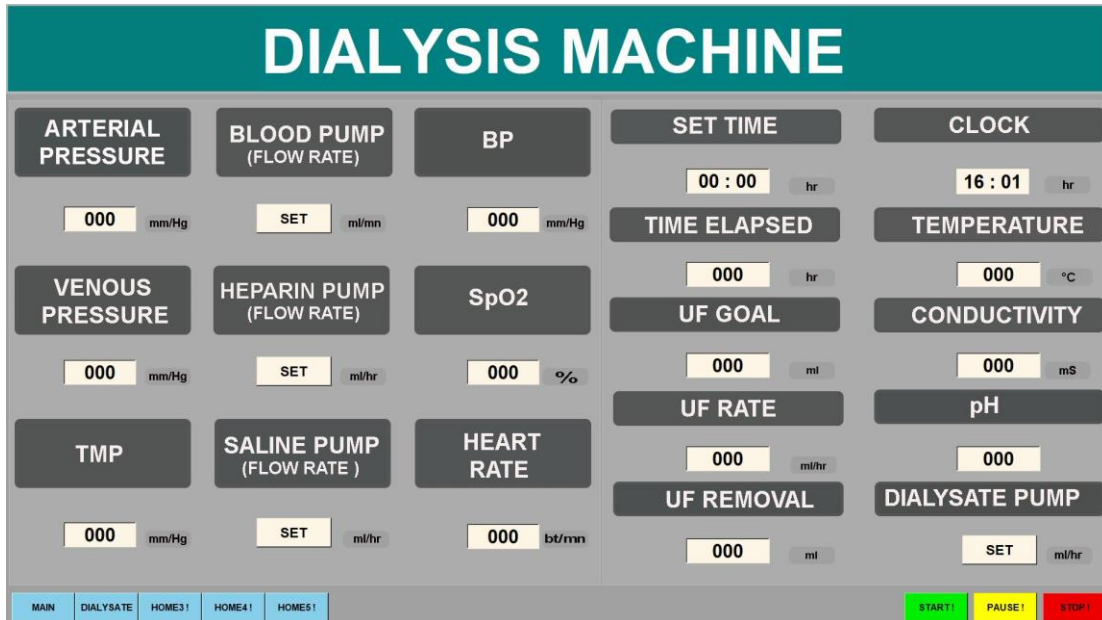
Main Page
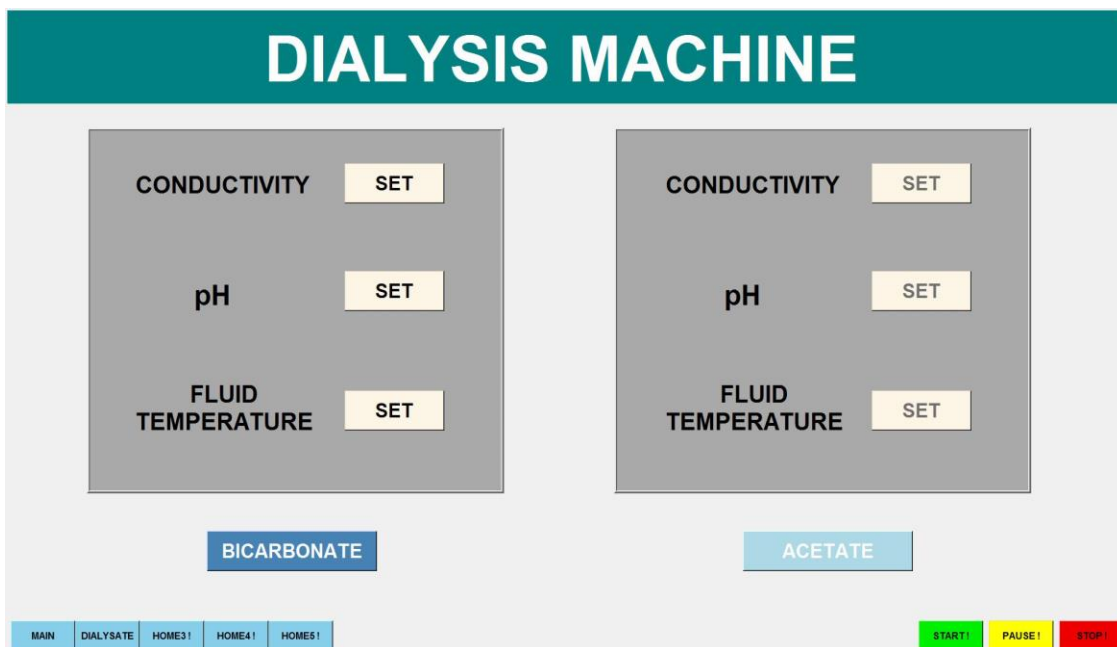
Dialysate Preparation Page
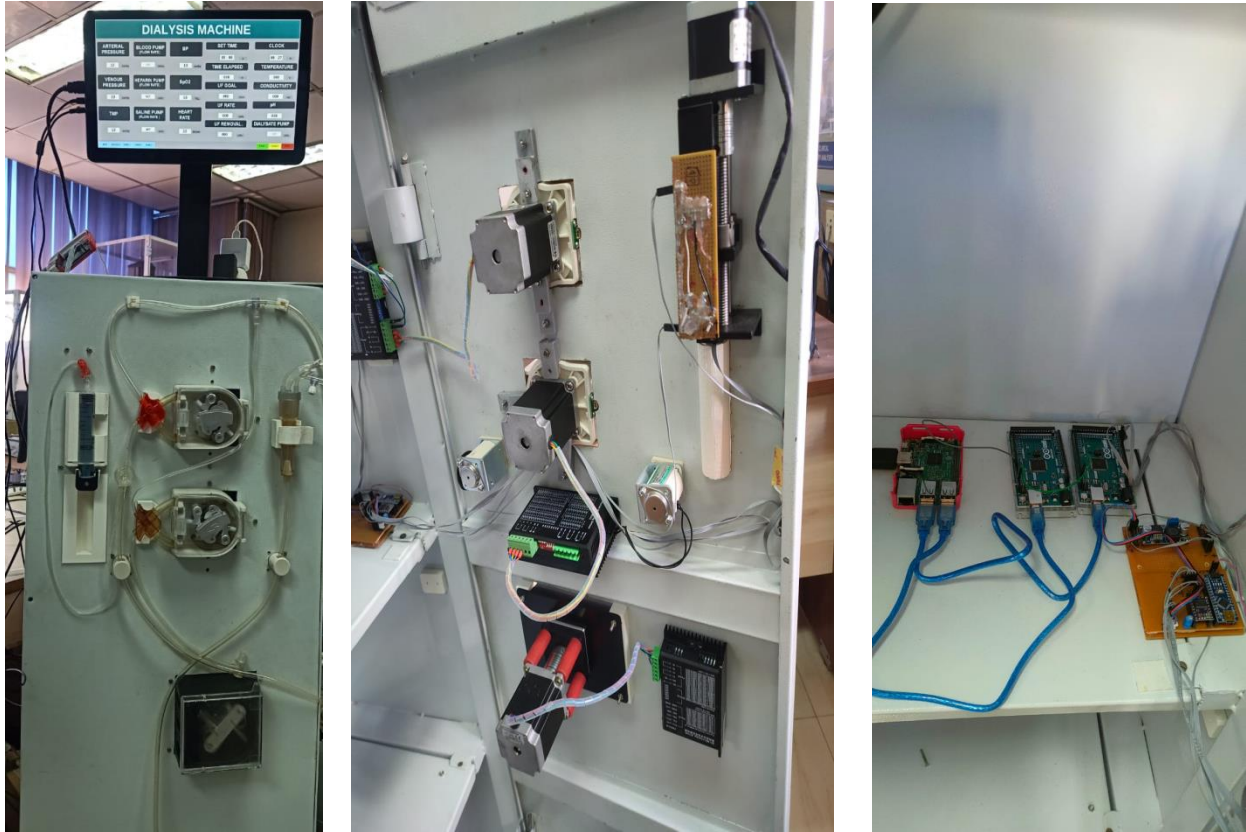
Dialysis Machine

ROBOG - Robotic Gait Trainer for Rehabilitation of Spinal Cord Injury Patients

Type of Project   *: CSIR Funded*
Project No.   *: HCP0026 – Task 2.1*
Project Leader   *: Dr. Neelesh Kumar*

Brief description of the progress of the project during FY 2020-21

- Design, fabrication and integration of sub modules of the prototype of Robotic Gait Trainer was completed.

| a) Prototype of Robog | b) System reliability trials |

Bio-Mechatronic Orthotic Devices for Rehabilitation of Motor Disorders (BioMOD)

Type of Project   : *CSIR funded*
Project No.   : *HCP0026 - Task 2.2 B*
Project Leader   : *Mr. Manjeet Singh*

A targeted systematic rehabilitation training system is necessary for improving the lower limb Range of Motion (RoM) and postural balance in cerebral palsy (CP) kids; and to enable them to achieve independent walking. For this purpose, CSIR-CSIO has been developing "Virtual Environment for Biofeedback" rehabilitative training software to augment the KAFO being developed by CSIR-CLRI as gait trainer for CP kids. This training system is named PRAViEN as its major objective is to enhance walking abilities in cerebral Palsy population through Rehabilitative Activities in motivating, interactive & safe Virtual Environments with real-time biofeedback. Developed version of PRAViEN consists of Wearable sensing modules to extract motor ingredients of lower limbs and software tools for assessment of lower limb active RoM and quantification of rehabilitation and Customizable training modules with visual bio-feedback for improving lower limb RoM & postural balance control through rehabilitative activities in motivating virtual environments.
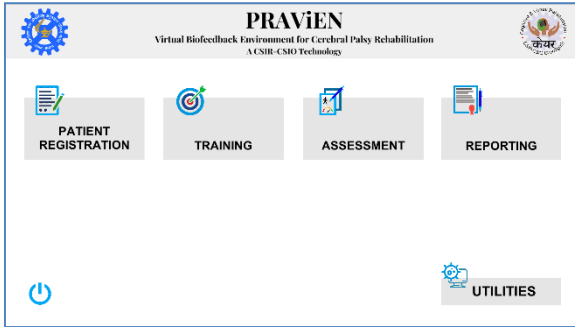
Homepage of PRAViEN software
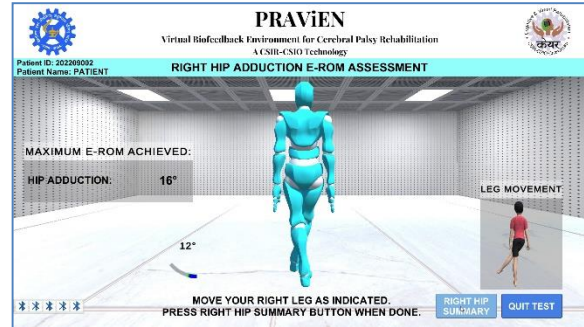
Screen shot of Hip RoM assessment module

Thermal imaging based non-invasive technique for diagnosis of musculoskeletal disorders (MSD)

Type of Project : CSIR funded
Project No. : HCP0026 – Task 3.2 A
Project Leader : Dr. Prasant K Mahapatra

There are two objectives in this project i.e. one is diagnosis of Knee Osteoarthritis (KOA) and its grading; other one is diagnosis of Compartment Syndrome (CS).

In KOA objective, data acquisition from Hospital is going on. Based on data acquisition, a Graphical User Interface (GUI) has been developed for analysis and disease prediction purpose and improvements are going on. The main GUI is as shown in figure below:
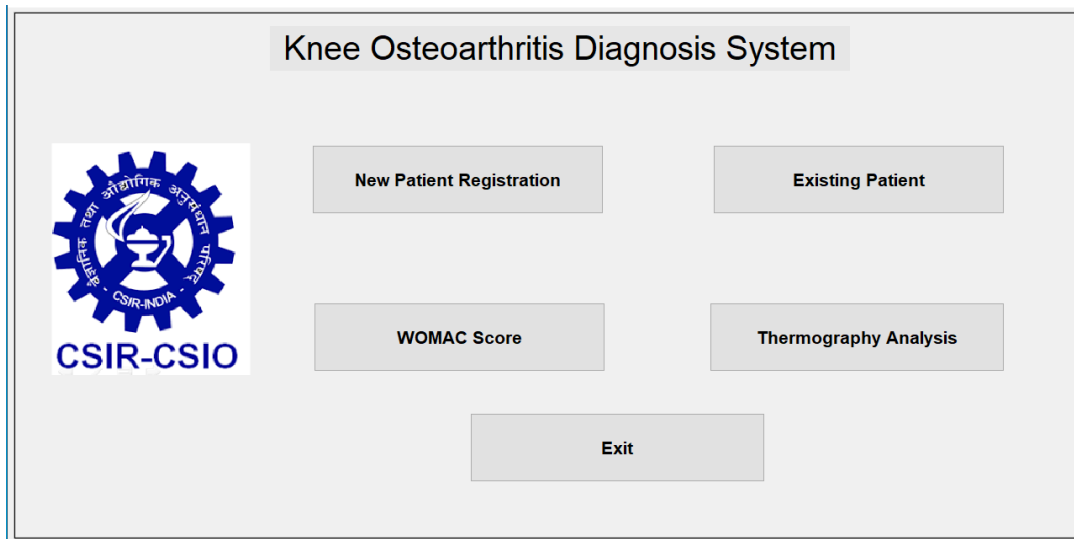
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To develop a CAD system for diagnosing compartment syndrome by using thermal imaging

Type of Project   : CSIR funded
Project No.   : HCP0026 – Task 3.2 B
Project Leader   : Mr. Naveen Sharma

Compartment syndrome (CS) one of the limbs/life-threatening conditions observed when perfusion pressure falls below tissue pressure in a closed anatomic space. CS remains a true orthopaedic emergency as it leads to thousands of amputations and permanent nerve and tissue damage to patients who are undiagnosed for more than eight hours. Conventionally, diagnosis has been based upon clinical assessment; however, this can be unreliable, and the potential for missed compartment syndrome remains. The supplementary use of compartment pressure monitoring has addressed some of these issues, but it remains an invasive technique, the exact role of which is still debated in the literature. The proposed system centers upon the diagnosis of compartment syndrome using non-invasive and non-radiative thermal imaging techniques.

Patient data analysis using developed CS System
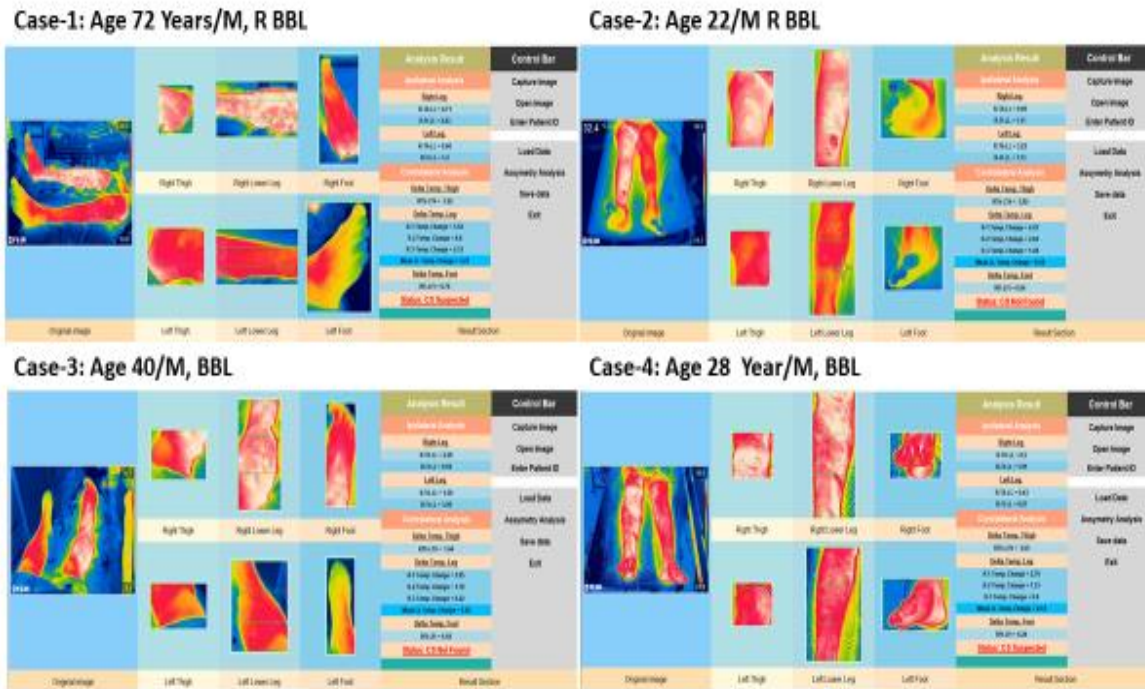
Comparative analysis of CS Vs Normal population

Lower Leg Mean Temperature Difference
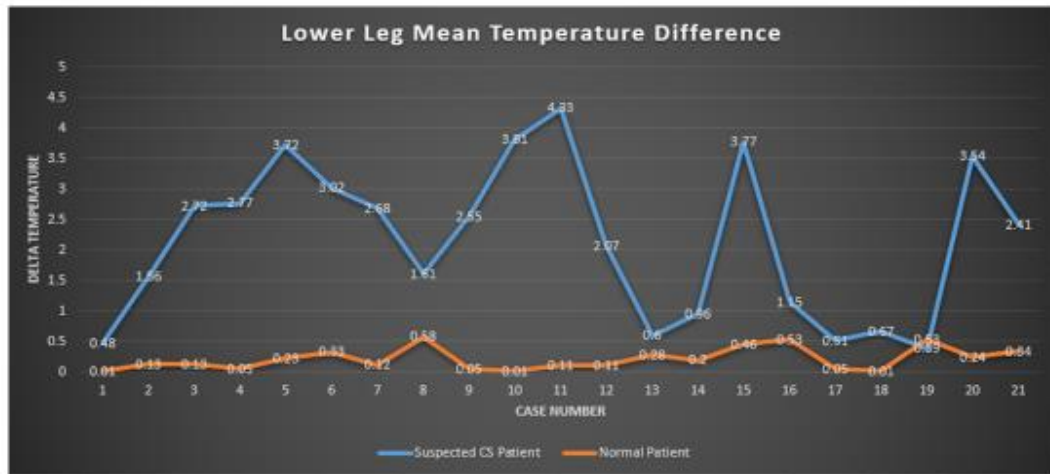
Automatic Brushing device for oral hygiene maintenance in elderly population

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP 0448*
Project Leader   *: Dr. Sanjeev Verma*

Elderly population needs specific care in term of oral hygiene maintenance. Presently, maintaining of good oral hygiene of this population is dependent on relatives, siblings or caregivers. Because of the neglected attitude toward oral care in relative to the other medical care and low availability of caregivers, the oral hygiene of such persons is often neglected. So, elderly often have poor oral hygiene, higher amount of plaque and calculus and higher incidences of periodontal disease. Due to their poor manual dexterity, plaque removal and dental caries are becoming less preventable.

Therefore, a work to develop an automatic U-shaped toothbrush to maintain the oral hygiene in such population group has started.

The "Automatic brushing device" will have the following features:

- Biocompatible and flexible material of construction
- Brushing for full coverage of teeth
- Fixing of bristles which are non-damaging to gums
- Battery operated micro-motor drive
- Provision of pumping water in and out
- Various mode of operation and speed, Timer

The device will be developed in collaboration with the Oral Health Science Centre, PGIMER, Chandigarh.
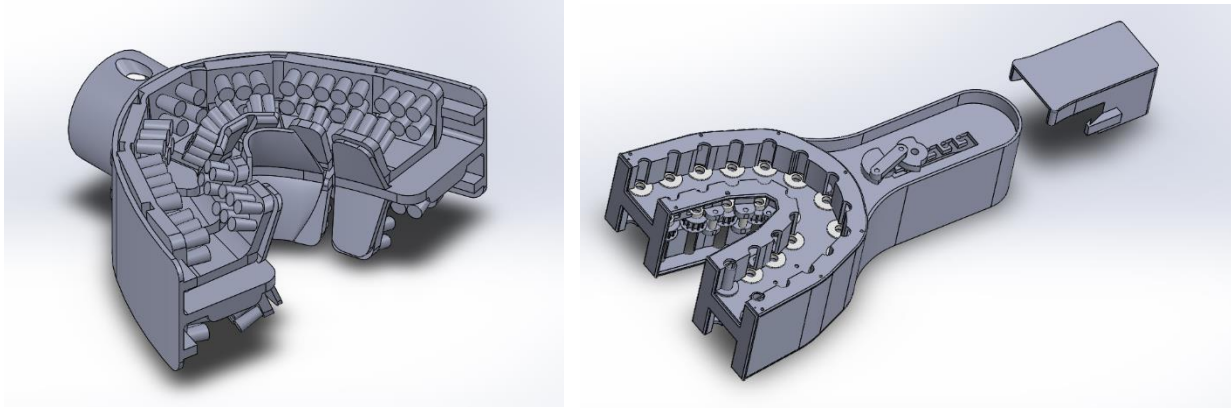
CAD models of the conceptual design

Virtual Intelligence in Home Based Rehabilitation of Persons with Motor Disability

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP 0404*
Project Leader   *: Dr. Neelesh Kumar*

Brief description of the progress of the project during FY 2020-21

- The mapping of conventional therapy and the developed VR modules are mapped for efficient rehabilitation and further will help in uniform sitting and sitting balance rehabilitation of Spinal Cord Injury patients.
- The system installed at ISIC New Delhi is under trials for rehabilitation of SCI patients.
- A collaboration with NIEPID Noida for research, development of the system for trials on Intellectual challenged kids. The modules for limited trials of the system for improving cognitive rehabilitation using virtual reality was developed. The modules are developed for **Activities of Daily Living, Time Concept** and **Number Concept.**
- Data sharing on AWS cloud and creation of dashboard: The entire trial data which is collected from the patient therapy sessions is stored in form of database at local drive of the system. This data is then transferred to the AWS console in storage services of the cloud.
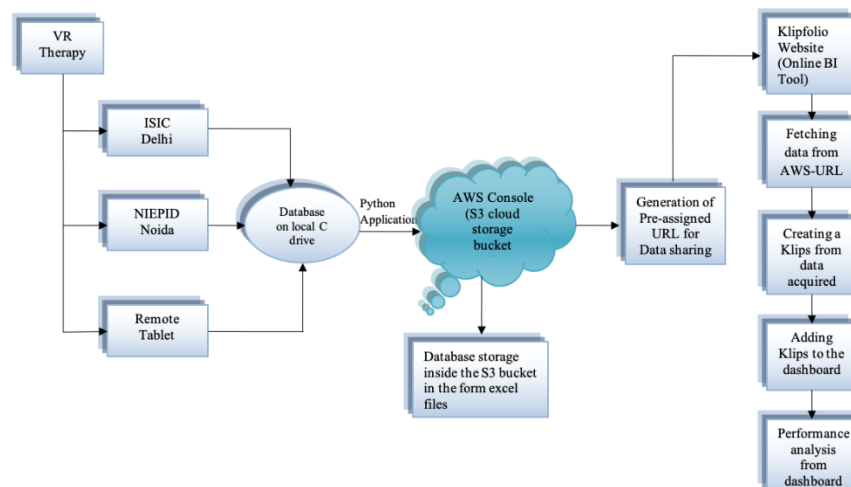
Implemented real time data collection and sharing from multiple sites

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Development of Gait Training Tools and Mobility Aids for Parkinson's Patients

Type of Project : *Grant-in-Aid*
Project No. : *GAP 0437*
Project Leader : *Dr. Neelesh Kumar*

Brief description of the progress of the project during FY 2020-21

- Development of data acquisition protocol using instrumented gait analysis. Recording of primary gait data on Parkinson's Patients for FOG. Deducing the data from secondary sources (open source) for FOG estimation
- Development of AI enabled wearable sensor vibrotactile module for gait assist during FOG event

Gait data collection

ICT based Tools for Assessment and Improvement of Efficacy of Upper Limb Robotic Rehabilitation using Thermographic Diagnostic Method (ThermoRehabRob)

Type of Project : *Grant-in-Aid*
Project No. : *GAP 416*
Project Leader : *Dr. Prasant K Mahapatra*

In this work, the assessment of motor recovery in stroke patient generally done by analysing the thermographs during the physiotherapy session. The comparative analysis of the thermograms taken before and after the session yields the parameters, which can be used as a

key to evaluate progressive assessment of a stroke patient. Comparing the physical parameter, subject feedbacks and mathematical analysis, the average efficiency of the tool has found to be 90%.

The thermal dataset of sequential thermal images was acquired with thermal camera. To circumvent the motion artefacts, the thermal camera was mounted on a photographic tripod with its lens aligned 90° to the frontal side of the human body, where its height was subject to adjust for sufficiently cover the arm and shoulder region. Prior imaging, the performance stabilization was ensured by keeping the camera ON for at least 10 min, then the sequential thermal images were captured. The first thermal image was captured before the exercise and second after the exercise, where three sessions were performed by each subject and last image was captured 1 min after the end of third session. In this way, the dataset of seven sequential thermal images was acquired for each subject.

To analyze the skin temperature changes, a fully automatic approach has been developed which extracts the shoulder and arm region from the thermal images and highlights the temperature rise with respect to time. In addition, the algorithm enables the automatic detection and thermal analysis of moving arm in thermal video files. Meanwhile, the algorithm is deployed into graphical user interface (GUI), specifically for our application, with wide range of thermal analysis and data presentation options.

The developed GUI provides the wide range of display and thermal analysis options with automatic detection of arm and shoulder region.
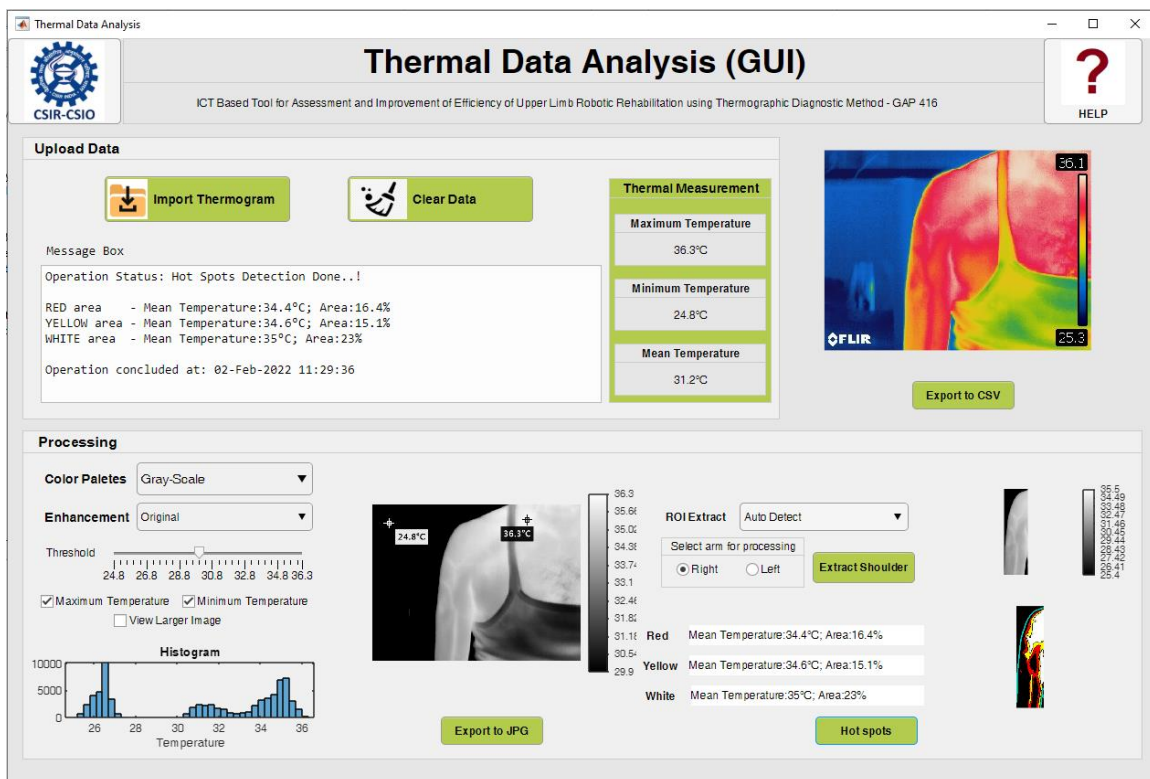
Thermal Data Analysis GUI

Contactless measurement of Respiration pattern, Respiration Rate and Heart Rate using Doppler Radar

Type of Project : CSIR
Project No. : MLP-2019-1
Project Leader : Dr. Sanjeev Kumar

The project aims at measurement of vital signs of a human subject using Non-Contact Multi Modal sensing system. Non-contact methods of estimating these vitals might be very useful for detecting and isolating people who have contracted Covid-19 virus. Considering the prevailing situation across the globe due to pandemic, it is aimed to work on Doppler Radar measurements to develop non-contacting sensing system. For this, a doppler radar based contactless method has been developed to monitor the Heart rate of the patient without placing any electrode/equipment on the patient.

Development of Otoacoustic Emission Sensing System for Medical Applications

Type of Project : Grant-in-Aid
Project No. : GAP-0446
Project Leader : Dr. Sanjeev Kumar

Developed setup for Otoacoustic Emission Sensing System for the non-invasive detection of hearing disability in infants.
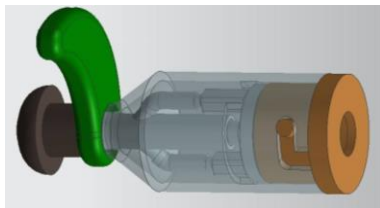
CAD Design

Fabricated prototype

Oxygen Optimiser

Type of Project : In-house
Project Leader : Dr. Sanjeev Kumar

In the conventional approach during the oxygen therapy to the patient, during inhalation cycle of the respiration, the supplied oxygen is consumed by the patient whereas during exhalation cycle, it get waste in the atmosphere. To stop this wastage of oxygen during the exhalation phase, it requires a technology intervention for its optimal use. Figure shows the developed prototype to save the oxygen during exhalation phase.

Developed prototype of Oxygen Optimiser

Indigenous apex locator for root canal treatment

Type of Project   *: DST funded*
Project No.   *: GAP0420*
Project Leader   *: Dr. Ranjan Jha*

This project focuses on the development of indigenous apex locator for root canal treatment. The outcome of the work is a low-cost device to measure the working length of root canals accurately and precisely. An electronic apex locator is an electronic device used in endodontics to determine the root canal space. The apex of the root has a specific impedance to electrical current, and this is measured using a pair of electrodes typically hooked into the lip and attached to an endodontic file. A porotype has been developed to measure the impedance of the root canal space. Also, the ethical clearance is obtained to test the developed prototype. Clinical trials on 100 patients' tooth have been performed with the developed device.

Clinical trials and Root canal treatment demonstration

A Novel Portable Wireless Automated Eye Moisturizing Sprayer

Type of Project : *CSIR funded and Industry sponsored*
Project No. : *CLP035/OLP251*
Project Leader : *Dr. Ranjan Jha*

The main objective of the project is to develop a portable, wireless automated eye moisturizing sprayer with an app-based user interface. The outcome of the proposed project is an eye sprayer that works more effective than conventional eyedroppers. The problem with ordinary eye drops, we have to bend our head back when we want to apply it, another problem would be germs in the cap. This proposed device is equipped with automated wireless piezoelectric based sprayer for accurate application. The ergonomic shape makes it easy to fit, press the button in the user interface (Android/iOS-based app) to release the spray, no need to bend your head back.

SPRAYER MODULE

PIEZOELECTRIC SPRAYER
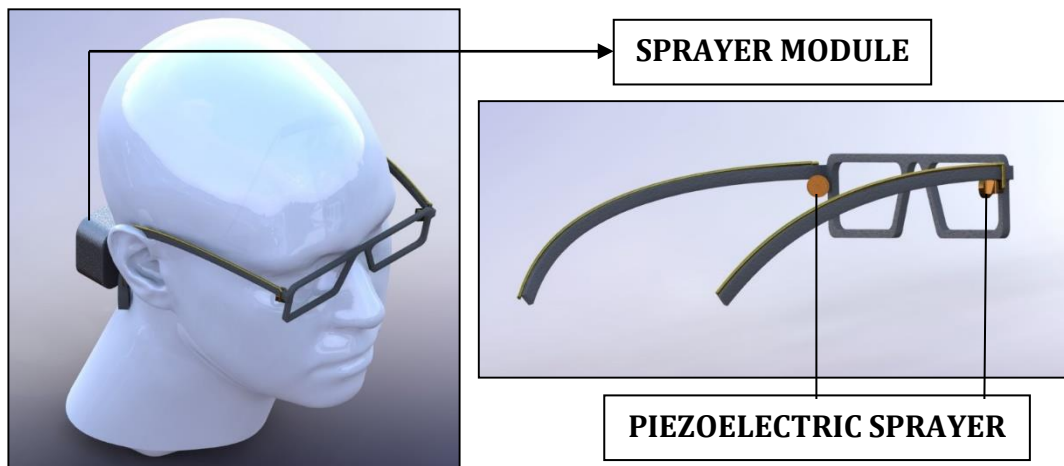
Conceptual Prototype design of Eye Sprayer Module

Intelligent Machines & Communication Systems

Amitava Das
adas@csio.res.in

IMCS group envisions delivering cutting-edge cyber-physical products and solutions for diverse domains from agriculture to industry and from health care to defense sector. IMCS plans to leverage advanced technologies such as Automation, Artificial Intelligence, Computer Vision, Data Analytics and Communication Technologies to usher in highly automated processes and systems for several application domains. IMCS group plan to actively engage in addressing the current-day societal, strategic and industrial challenges by innovative application of autonomous / intelligent systems and communication technologies leading to rapid economic development and strategic self-reliance.

Completed projects:

- **Design and development of Visual Odometry System**
- **Spatial and Temporal patterns of active tectonic deformation in the Beas River through Morphometric analyses and Fluvial Terrace studies**
- **Integration of space based SAR(BIG) data with ground based information for an improved near real time assessment and monitoring of seismic hazard**

Ongoing Projects:

- **Hand held moisture meter for made tea**
- **Surface Topography and kinematics of active faulting in the Sub-Himalaya close to Chandigarh: Implications to infrastructure development and seismic hazard for a proposed smart city**

Design and development of Visual Odometry System

Type of Project : *Grant-in-Aid*
Project No. : *GAP0430*
Project Leader : *Dr.Shashi Poddar*

Visual odometry plays one of the most essential roles in estimation motion during GPS denied environment using cameras. The visual odometry task requires estimating rotation and translation of the camera at every time instant by processing image frames captured by a stereo or monocular camera. Fruitful attempts have been made to improve upon the existing schemes of visual odometry such as joint forward- backward based visual odometry, mutual information based feature selection for visual odometry, implementation of self-learning based visual odometry pipeline, and evolutionary optimization usage for vision based navigation. The complete test setup, software design and development, testing and experimentation have been carried out on different platforms such as Matlab, python, and C++. Further, the hardware setup,

that is, the lab prototype of visual odometry system has been designed, developed and tested in the laboratory for different conditions.

(a) **(b)**

Dataset capturing in indoor environment using ground robot

The hardware and software integration of visual odometry system has been carried out and a lab-level demo unit is now available after carrying out testing and further development activities. The software framework of visual odometry has been developed and tested on KITTI vision benchmark and EuroC MAV dataset which are available online.

Spatial and Temporal patterns of active tectonic deformation in the Beas River through Morphometric analyses and Fluvial Terrace studies

Type of Project : *Grant-in-Aid*
Project No. : *GAP0363*
Project Leader : *Dr.Tejpal Singh*

The deduction of spatial and temporal patterns of surface deformation patterns using field and remote sensing investigation is the state of the art. The results are very encouraging. However, there are limitations related to 1) the scale and resolution of the field and remote sensing data and 2) the resolution and error range in geochronological estimates. Within the known limitations as mentioned in the above paragraph, the results from the project have been able to demonstrate the lateral variations in structural geometry as the principal tectonic control on the evolution and deformation of the Himalaya.
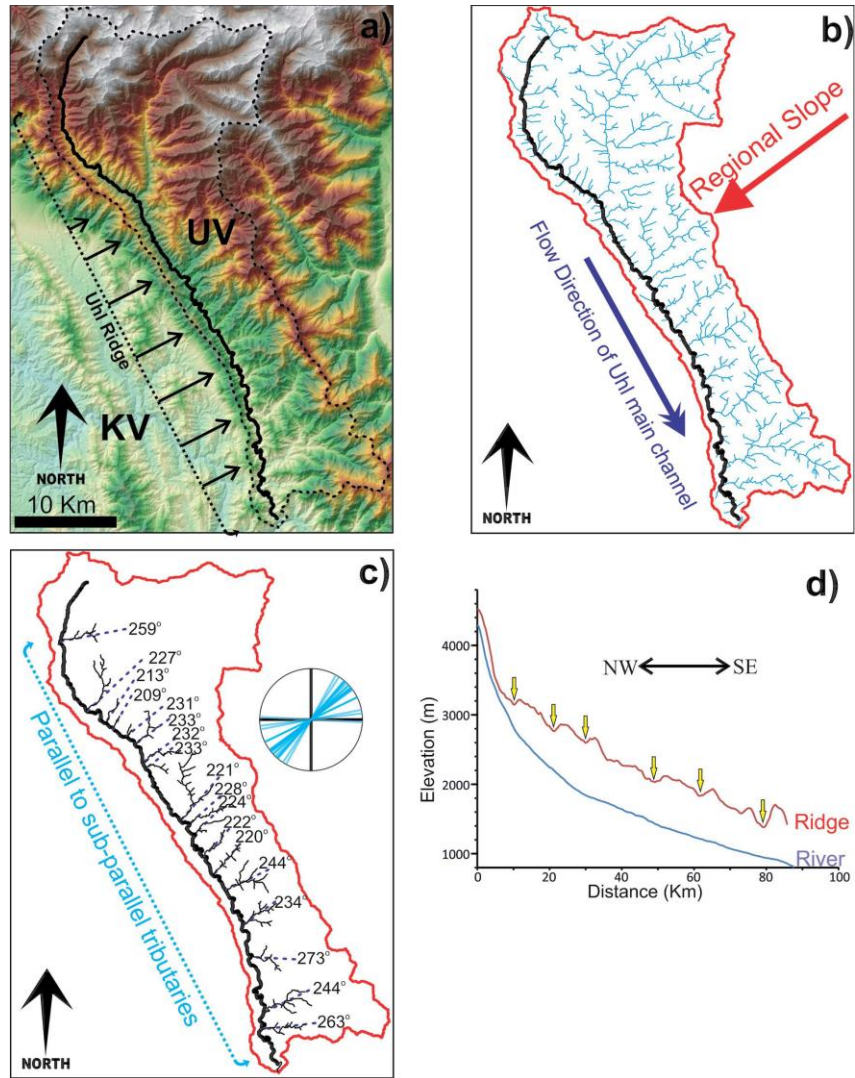
The Uhl basin (representative of zone 3). a) The Uhl basin corresponding to the Uhl Valley (UV) is anomalously elongate. It is bound by a topographic ridge on its southwestern edge. The foot of the ridge is marked by a series of black arrowheads. It is informed that the ridge is present in the hanging wall of the Main Boundary Thrust (MBT) which runs at the base of the ridge (MBT is not shown here in the figure). Kangra Valley (KV) is located to the south of the ridge. b) The Uhl basin has developed asymmetrically across the ridge with almost all the drainage on it left bank and no significant drainage on the right bank. The map also shows the direction of regional slope and the flow direction of the Uhl river (which are orthogonal to each other). c) All the tributary streams meet the Ulh river orthogonally, the streams are parallel to sub-parallel. The inset shows a rose plot showing preferential orientation of left-bank streams toward the regional slope (SW). d) The longitudinal profile of the Uhl river and the bounding topographic ridge towards SW. The two profiles slope towards the same direction i.e. SE and are near parallel. The arrows show prominent curvatures in the ridge profile that stand out with lower elevations than the ridge itself. These are typical of wind-gaps (Ramsey et al. 2007).

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Integration of space based SAR(BIG) data with ground based information for an improved near real time assessment and monitoring of seismic hazard

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP0398*
Project Leader   *: Dr.Tejpal Singh*

The project work emphasized on the following themes:

1. Developing the methodology through assessment of active fault kinematics by integration of space and ground based datasets (The results are now published in an international journal).
2. Application to large areas in NW Himalaya for evaluating impacts on infrastructure projects (two studies are in the process of completion).
3. Modelling the geometry of the Main Himalayan Thrust (MHT) and its role on the strain partitioning and seismic hazard (some preliminary investigations are available).

The project could successfully demonstrate the linkages between the space based and ground based observations, the utility of these results in identifying active structures, current deformation and its implication in terms of seismic hazard and infrastructure developments.
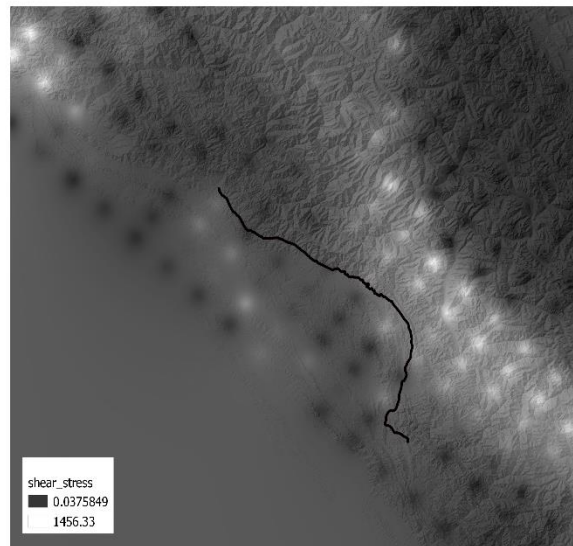
Shear Stress Map of the Western Himalaya.

Hand held moisture meter for made tea

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP0418*
Project Leader   *: Dr.VD Shivling*

The moisture content of made tea decides its quality in terms of taste, aroma, and shelf life. The developed system for measuring the Made Tea Moisture is based on microwave technology. The microwaves have the advantage of passing through the sample and telling the moisture content in the inner part of the sample. The developed Lab prototype is consisting of Electronics design, Power supply batteries, and Tea sample holder cum patch antenna along with the on board processor with developed measurement algorithm. All the assemblies are integrated in a mechanical chassis. The Lab prototype is tested in the lab for the various off the shelf Tea samples available in the market from many tea brands. The design of the sensing chamber is a patch antenna with an air gap between the patch and ground plane to carry Made Tea as a sample. The design of the patch antenna is simulated and further validated using a vector network analyzer (VNA). The system is based on the change in resonance frequency of the patch antenna with the moisture content of the sample. The resonance frequency of the patch antenna was observed to decrease with an increase in the moisture content of tea. The developed prototype is giving comparable results as per the calibration system.

Lab Prototype: Hand held moisture Meter for Made Tea
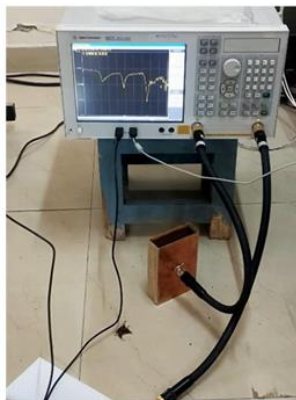
Testing of Patch Antenna based sample chamber with VNA
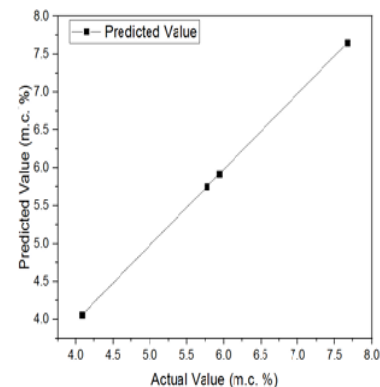
Developing a Public Health Informatics Platform in India for a systems View of Health and Diseases

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP0419*
Project Leader   *: Mr. Virendra Kumar*

A scalable healthcare data visualization web platform is developed using the open-source technologies. The following analytics and prediction model are deployed.

- Covid-19 Cases Analytics: Data processing, and visualization for Covid19 in India
- Covid Cases Prediction: LSTM is used to process the Covid19 data for one-month prediction.
- Child Health: The Longitudinal Indian Family Health (LIFE) Cohort Study

- (participants are being tracked from birth to 16 years)
- Population Statistics: Rural Effective Affordable Healthcare (REACH) - Data Management and Analysis
- (Demographic surveillance model for 50,000 in 40 villages located in Ranga Reddy District of Telangana)
- Leishmaniasis: Retrospective static data visualization with maps
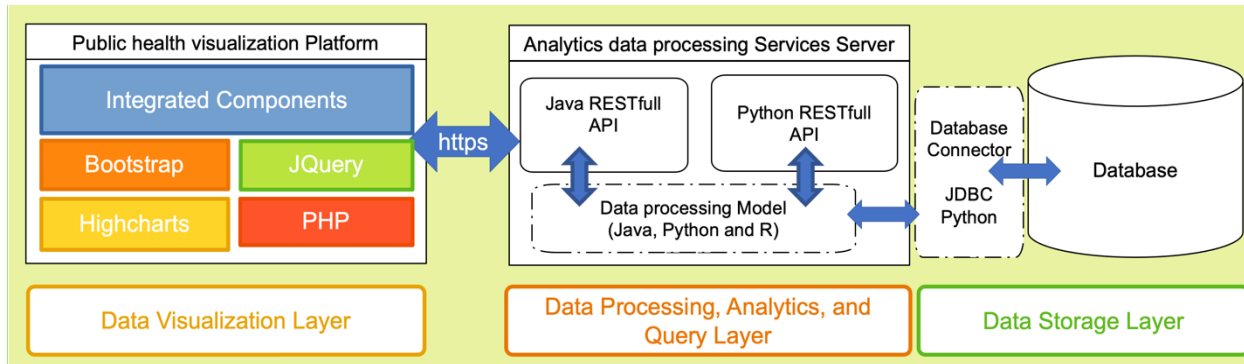
Scalable platform for organizing, visualization and sharing of public health data

Design, Development & Supply of Snow Making Machine

Type of Project *: Sponsored*
Project No. *: SSP0048*
Project Leader *: Mr. Amitava das*

Intact samples of natural snow specimens are collected from the open field for laboratory investigations of the properties of snow structure and allied studies. However, these usual methods for snow sample collection are susceptible to the full range of natural snow variability. In order to circumvent these limitations, the need for development of an automated natural snow making machine has been expressed for quite some time, wherein, it would be possible to produce aggregated (i.e. sintered) nature identical snow samples with controlled microstructural characteristics in the laboratory. CSIR-CSIO has designed, developed and tested a nature-identical snow making machine wherein, the nucleation of ice crystals on fine wires in a stream of supersaturated air, which enabled improved control of the snow crystal microstructure with reproducible characteristics. The snow making machine so developed by CSIR-CSIO, is unique in terms of the level of automation that is embedded in the operation of the machine. The automation processes of the machine are built on an industrial grade Programmable Logic Controller (PLC) and a touchscreen HMI is integrated into the control hardware for ease of operation, display of snow formation related parameters and data logging.

Nucleation Chamber, Instrumentation and Control System of the Snow Making Machine – designed and developed by CSIR-CSIO, Chandigarh

Design, development and testing of Precious Metals (jewellery) testing machine

Type of Project : *CSIR funded*
Project No. : *HCP0034, Task 4.2*
Project Leader : *Mr. Amitava Das*

The precious metal testing equipment market is dominated by few international manufacturers. Several Indian companies have brought their indigenous products in the market and are in competition with the international vendors. Given the volume of transactions of jewellery in our country, there is a huge potential for development of a low cost, accurate precious metal testing equipment. Jewellery testing equipment are scientific instruments that are used to determine the purity of gold and other precious metals with X-ray fluorescence.

These instruments are required to be highly precise and repeatable. These instruments employ X-ray fluorescence technique to determine the concentration of the various elements present in gold bars, gold jewellery, gold coins, gold alloys etc. Another requirement in this segment is the capability to detect coatings and nonstandard alloys. The project work has been planned to design and fabricate low-cost XRF assembly for testing of precious metal.

Test set-up

Power Supply, 35KV, 20mA

X-Ray Src, 30KV

PC Detector

Gold testing set-up used for experimentation and data collection

Centre of Excellence for Intelligent Sensors and System

The centre has initiated research towards intelligent sensing systems in societal and strategic sector and has recently developed Earthquake Warning System (EqWS), Unattended Ground Sensing System, Intelligent Elephant Movement Detection and Alert System, Artificial Organoleptic System (AoS) for flavour analysis etc. The centre is poised to make a significant contribution to the activities related to artificial intelligence based sensing applications, particularly for defence applications. This houses state of the art testing facilities for acoustic, seismic, infra-red imaging modalities, AoS etc., and networks with strong computational facilities to provide the artificial intelligence.

Dr. Satish Kumar
satish@csio.res.in

Ongoing Projects:

- **Maintenance of Earthquake Warning System**
- **CSIR-Digital Food Safety Portal System 2.0: Digital Food Safety Portal, analytics and Digitalization of the Indian Burden of Foodborne Diseases, Chemicals Risk Assessment as well as food design using Artificial Intelligence**
- **Characterizing Risk Indicators to cause Anaemia Prevalence among young Children and Adolescents in BRICS countries using Artificial Intelligence**
- **Green Tea bitterness masking evaluation**
- **OdorSpace-1**
- **Validation and demonstration of wild animal detection system deployed at Kansrao, RTR to stake holders**
- **Anthropogenic activity detection for unattended ground sensor systems.**
- **AI enabled multi-modal sensing system for Non-Contact Monitoring of vital signs to screen COVID-19 Suspects - Non-contact Skin Temperature Measurement**

Maintenance of Earthquake Warning Systems

Type of Project : *Technical Services*
Project No. : *TSP 0018*
Project Leader : *Dr. Satish Kumar*

CSIR-CSIO has developed Earthquake Warning System (EqWS) installed and commissioned since October 2015 at different sub-stations of Delhi Metro i.e. Huda City, Mundka, Faridabad, Botanical Garden, Metro Bhawan. EqWS-GUI is the exclusive user interface as the Central Control Server unit, deployed at DMRC, Metro Bhawan, New Delhi. The system is generating warning for local and major earthquakes to be alerted to DMRC network in real time. CSIR-CSIO has undertaken the annual maintenance work of EqWS since January 2019. During the

year, the necessary online and offline support has been provided for smooth functioning of EqWS.

CSIR-Digital Food Safety Portal System 2.0: Digital Food Safety Portal, analytics and Digitalization of the Indian Burden of Foodborne Diseases, Chemicals Risk Assessment as well as food design using Artificial Intelligence

Type of Project   : CSIR funded
Project No.   : HCP0031(WP 5.1)
Project Leader   : Dr. Rishemjit Kaur

The aim of this project is to develop algorithms for food recommendations using various resources available on web, government data and traditional knowledge base. To this end, we have collected a recipe data comprising of 10, 000 recipes, their methodology of preparation and nutritional content. We have developed recommendations for Indian family fulfilling nutrient requirements, incorporating dietary diversity, include locally cultivated food such that the recommendation is low cost. We considered a five-person Indian household with an adult male, an adult female, a teenage boy, a teenage girl, and an infant. This work will pave way towards algorithmic food recommendations considering the local diversity in mind.

Characterizing Risk Indicators to cause Anaemia Prevalence among young Children and Adolescents in BRICS countries using Artificial Intelligence

Type of Project   : DST-BRICS funded
Project No.   : TPN/28741
Project Leader   : Dr. Rishemjit Kaur

The aim of this project is to develop machine learning algorithms to characterize risk indicators for Anemia in BRICS countries. To this end we have developed algorithms to extract information and focus on nutritional anemia patents to compare the inventive activity between Eastern and Western countries. It was observed that the West is more active in medicine and treatment methods while focusing on food technology. It was also observed that Western inventions receive comprehensive protection in Asian countries. Asian inventors, on the contrary, rarely disseminate their results on a wide scale as patenting is limited to national jurisdiction and has a lesser impact on the state-of-the-art. This work was done in collaboration with CEMI RAS and under review in the World Patent Information journal. We developed machine learning algorithms for studying the conceptual structure of patents, impact analysis, etc.

Green Tea bitterness masking evaluation

Type of Project : *Consultancy*
Project No. : *CNP0021*
Project Leader : *Dr. Ritesh Kumar*

Tea is one of the highest consumed beverages in the whole world and green tea has been shown to be very useful for health and wellness. The primary components responsible for tea bitterness are caffeine and tea polyphenols such as epicatechin (EC), epicatechin gallate (ECg), epigallocatechin (EGC), and epigallocatechin gallate (EGCg)[Zou, G. et al 2018]. This project involved the green tea bitterness masking evaluation by using an electronic tongue and development of statistical measures for its efficiency.

OdorSpace-1

Type of Project : *Consultancy*
Project No. : *CNP0024*
Project Leader : *Dr. Ritesh Kumar*

Odor space is complex in nature. The search for novel and explainable features to predict olfactory perceptual descriptors has been at the forefront of the quantitative structure odor research. There have been notable works in this area recently and it is one of the most important problems being pursued by the food, beverage and perfume industries. The present consultancy project aims to solve some of the problems related to this domain.

Validation and demonstration of wild animal detection system deployed at Kansrao, RTR to stake holders

Type of Project : *Grant-in-aid*
Project No. : *GAP - 0442*
Project Leader : *Dr. Ripul Ghosh*

CSIR-CSIO has performed an initial feasibility study using seismic and thermal sensing for detection of moving pachyderms nearby railway tracks passing through forest area. With the initial findings, CSIR-CSIO have piloted a sensor deployment project with WWF-India and WII, Dehradun at Kansrao, Rajaji Tiger Reserve (RTR), Uttarakhand. The primary detections uses array based geophone sensors configured with an intelligent edge processing module (*eleSeisAlert*) which are being used to monitor two stretches (Zone 1 and Zone 2) of about 200m each. The algorithms detects the presence of wild animals and moving objects from about ~100m away from the railway track based on their seismic vibrations patterns and classifies into their respective categories. For further augmentation and complementary sensing, a secondary detection system with infrared cameras (*eleThermAlert)* monitor the stretch of the railway track

for automatic detection of animal crossings. All the information are transferred to a local server for alert generation and further pushed to a cloud server using IoT and 4G services. The total integrated system has been validated and demonstrated with testing done with captive elephants. A workshop on 'Intelligent Elephant Detection and Alert System' has also been conducted to probable end users such as forest departments, Indian Railways, RDSO, WWF-India for its usage in actual scenarios and large scale deployment.

Technology demonstration workshop on *'Intelligent Elephant Detection and Alert System'* conducted at Haridwar and Kansrao, RTR on 15th November, 2021.

Anthropogenic activity detection for unattended ground sensor systems

Type of Project : *CSIR funded*
Project No. : *OLP246*
Project Leader : *Dr. Ripul Ghosh*

Perimeter security of border areas and vital installations is of a major challenge due to diversity in nature of intrusion and landscapes. In India, perimeter has mostly been manned by human personals and armed forces. Autonomous monitoring of these areas remains a challenge as the requirements are very rigorous and diversified for different geographical landscapes. In this project, we have designed a preliminary strategy for detection of anthropogenic activities such as human walking, jogging, digging, hammering, vehicle movements using unattended ground sensor system. Also, a sandpit test bed has been laid out for carrying out experimental work and study the effect of soil conditions in the detection of these anthropogenic activities.

AI enabled multi-modal sensing system for Non-Contact Monitoring of vital signs to screen COVID-19 Suspects - Non-contact Skin Temperature Measurement

Type of Project : CSIR Project
Project No. : MLP 2019-2
Project Leader : Dr. Aparna Akula

Non-contact methods of physiological measurement might be very useful for detecting and further assisting to isolate the people who have contracted COVID-19 virus. Considering the expertise and research work carried out by CSIR laboratories (CSIO, CEERI and NAL), a system for non-contact monitoring of vital signs i.e. respiratory signals, heart rate and temperature of patients has been devised.

For automated non-contact monitoring of elevated skin temperature, a thermal imaging based module *(iThermScan)* has been designed and developed. The system uses an edge computing platform which is calibrated for accurate temperature measurement of human body. The system designed using low resolution thermal detector module which was coarsely calibrated in factory settings was further calibrated in the lab for the human body temperature range using a thermal blackbody calibrator. The images from both the visual camera and thermal camera were registered. The forehead region is detected automatically in RGB image, and the corresponding region in the thermal image is used for forehead temperature extraction. The total integrated system is currently under development.

Micro-Nano Optics Center

The activities of the center comprise of five major thrust areas, namely, (1) Design and fabrication of diffractive optical elements and metamaterials to tune light-matter interaction, (2) Holography with focus on computer generated holograms, development of dynamic holographic 3D displays and holography for non-destructive testing, (3) Nano photonics including development of optical fiber based nano-antenna for application in various fields such as near-field optics, optical imaging and optical tweezer, (4) Development of optical fiber based chemical/biological/gas sensors, fiber Bragg grating based sensors for accelerometer, hydrophone, strain-temperature monitoring and (5) Metrology of various optical components.

Dr. Sudipta Sarkar Pal
sudipta@csio.res.in

Completed projects:

- **Development of chirped fiber Bragg grating sensors.**
- **Design and development of Schlieren imaging system for visualization of transient events.**
- **Metal organic framework (MOF) based fluorescence-SPR dual mode sensing platform for explosive detection.**
- **Development of SERS based biosensing platform for the detection of mycotoxins.**

Ongoing Projects:

- **National micro-nano fabrication centre for optics and photonics**
- **Development of holographic systems for 3D dynamic displays**
- **Diagnostic System for circulating tumor cells in prostate cancer detection using optical fiber sensors**
- **Development of phase shifting Fizeau Interferometer for optical surface form and wave front sensing application**
- **Development of Whispering Gallery Mode (WGM) Resonator into optical fiber Axicon Tip for WGM Excitation and Sensing Application**
- **Frequency domain optical coherence 3D phase microscopy of Biological sample assisted by Bessel beam**
- **Bessel beam with a micrometer-size central spot and interferometry for small volume bioliquid refractive index measurement**

Development of chirped fiber Bragg grating sensors

Type of Project : *Grant-in-Aid*
Project No. : *GAP0401*
Project Leader : *Dr. Umesh Kumar Tiwari*

The performance characterization of high explosives material, the measurement of detonation wave velocity is a fundamental quantity obtained through experimentation which is used to accurately predict detonation propagation, energy delivery, and timing in complex geometries. For this type of applications, it is essential to develop a suitable scheme for the measurement of

physical length and location of the CFBG sensor within the optical fiber. A compact and modified Hot-tip probe system offers several valuable features such as non-destructive calibration, low-cost, simple in operation, and high-accuracy. In this method, a scanning hot-tip micro-probe is used to locally heat the CFBG at selected locations along its length while simultaneously observing the reflection spectrum in an optical spectrum analyzer.

The Hot tip CFBG system was designed and fabricated. The system consists of three axis control with forward and backward motion control. The total displacement can be provided upto 200mm with the resolution of 200 µm. The tip temperature can be maintained upto 200 °C with the accuracy of ± 2 °C. A HMI display with a touchscreen also provided with the system to set all the parameters as per the requirement of the experiments.

Design and development of Schlieren imaging system for visualization of transient events

Type of Project : *Grant-in-Aid*
Project No. : *GAP400*
Project Leader : *Dr. Raj Kumar*

When light travels through a non-homogenous medium, due to presence of turbulence, thermal convection, weather phenomena, and so on the density and its refractive index of the medium changes on a broad range of scales. Similarly, shock waves are characterized by an abrupt or random change in pressure, temperature and density of the medium. To know about the characteristics of shock waves, we should know about the basic features of shock waves like energy, velocity, temperature, pressure and flow turning. By studying them, one could know about the effect of shock waves on the particular medium in which they are travelling. For that purpose, we need a system, by which we can extract information about the properties of shock waves. Schlieren is one such technique which can be used to characterize the shock waves. Using schlieren systems minute changes in transparent media can be visualized.

(b)

(a)

(c)
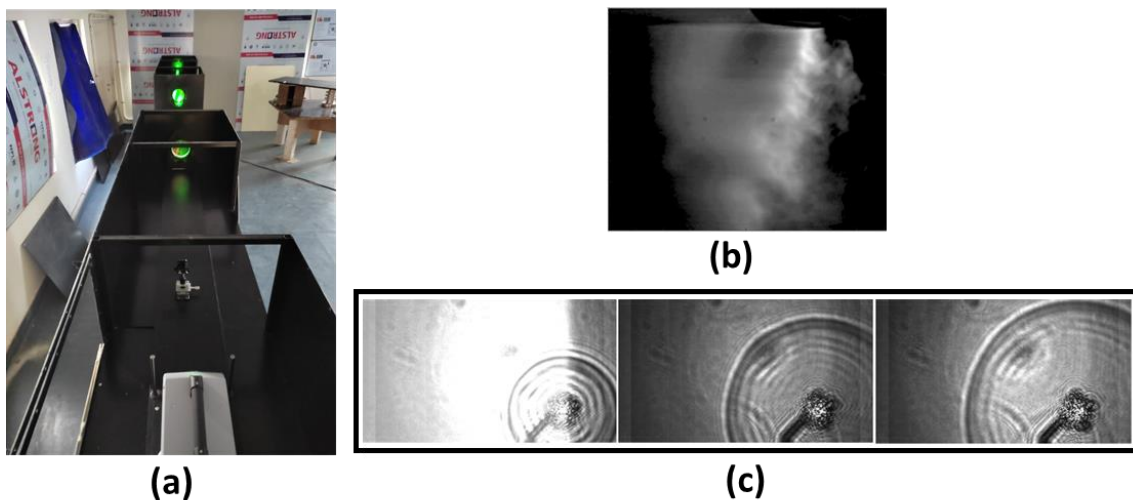
(a) Photograph of the High Speed Schlieren Imaging System, (b) Visualization of human breathing, (c) Evolution of shock waves generated with an electric spark.

Under this project we developed a high speed Schlieren imaging system for imaging of dynamic events in order to study the physics underlying that phenomenon. It is a two-lens based 7-meter-long, 1-meter-wide and 1.4-meter height linear configuration. A high speed camera with 20,000 frames per second at full resolution has been used in this system for imaging of high speed events. In order to increase the field of view we designed, and fabricated at CSIO high

optical quality collimating lenses of 150 mm diameter, f/11 for this Schlieren system. The system has been successfully developed, tested and commissioned and thus the project has been completed successfully.

Metal Organic Framework (MOF) based fluorescence-SPR dual mode sensing platform for explosive detection

Type of Project   : *Grant-in-Aid*
Project No.   : *GAP0392*
Project Leader   : *Dr. Sudipta Sarkar Pal*

Under this project, a method of preparing a cladding-modified fiber-optic probe for measuring trace amount (up to ppm level) of nitroaromatic compounds (NAC) particularly nitrobenzene (NBz) and 2- nitrotoluene (2-NT)in gaseous phase is developed. The detection is accomplished by depositing a layer of luminescent metal organic framework (LMOFs) over the optical fiber surface and monitoring the fluorescence-quenching ability of NAC vapors. LMOFs layers are also deposited on metal thin film coated optical fiber surface to detect NACs through surface plasmon resonance(SPR) and fluorescence-quenching dual-mode detection. It is real-time, field-deployable and user-friendly. Optical fiber is used here as sensing probe as well as waveguide for collecting light signal making the system compact and easy-to-use. Integration of porous sensing materials helps to pre-concentrate vapors around the surface of the probe resulting in an
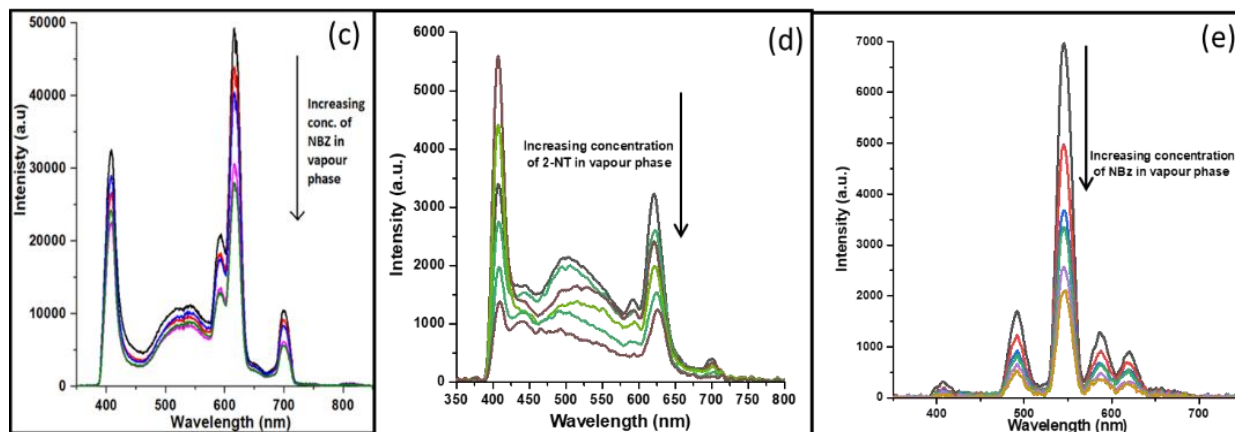
Optical fiber probe with (a) Eu-MOF coating and (b) Tb-MOF coating (both are excited at λ=365nm); Fluorescence quenching of Eu-MOF coated fiber for (c) NBz and (d) 2-NT vapours; (e) Fluorescence quenching of Tb-MOF coated fiber for NBz vapours.

increase in interaction volume and hence towards highly sensitive (ppm level detection capability) detection. The design of the probe and method of detection ensure its implementation in a hand-held device with option for easily detachable and exchangeable probes functionalized with different sensing materials which are selective to different target analytes.

This project aimed to develop a Surface-enhanced Raman Spectroscopy (SERS) based bio-sensing platform which is cost-effective. Optical fiber-based sensing platform has been developed. We have utilized two different types of well-known biomolecular interactions; antibody-antigen and streptavidin-biotin, to combine fiber optic surface plasmon resonance (FO-SPR) biosensor system and SERS tags-based detection on a single platform. The FO-SPR biosensing is achieved by immobilizing antibodies over plasmonic thin film coated optical fiber surface followed by its interaction with different concentrations of antigen. We are successful in detecting surface biomolecular interactions between the antibody-antigen pair through surface plasmon resonance spectroscopy and in confirming their interaction by using a SERS tag in a sandwich format. The antigen utilized for interaction study is biotinylated which allowed its secondary interaction with streptavidin-coated SERS tags. As expected, the secondary interaction with SERS tags not only enhanced the SPR response of the FO-SPR system, but appearance of distinct Raman signal also validated the observed SPR response.
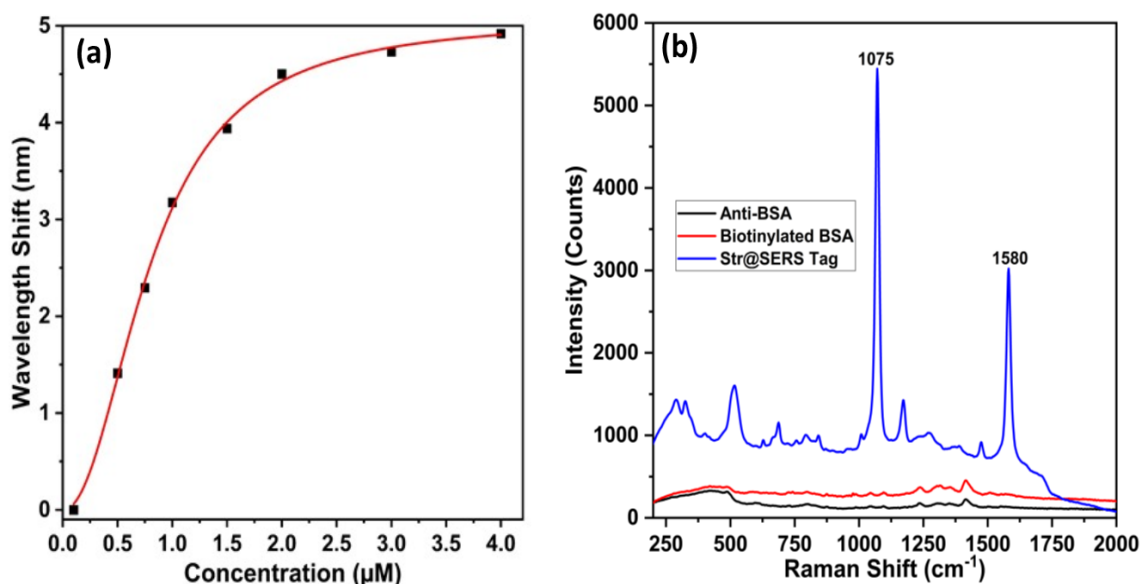
(a) Shift in resonance wavelength after antibody-antigen interaction for different concentrations of biotinylated-antigen, (b) Characteristic Raman peaks after immobilization of streptavidin functionalized SERS tag on the FO-SPR sensor region.

National micro-Nano fabrication centre for optics and photonics

Type of Project **:** *CSIR funded Facility Creation Project*
Project No. **:** *MLP 2027*
Project Leader(s) **:** *Dr. Sudipta Sarkar Pal and Dr. Bhargab Das*

The aim of this project is to establish a state-of-the-art national facility for micro-nano fabrication of optical and photonic components. We aim to address the existing and future challenges obstructing the growth of optical/photonic technologies in India and to take lead for a step change in photonics innovation in the country. The main objectives of the proposed facility are as follows:

- To provide a state-of-the-art facility to the country to cater the needs of large area micro-nano fabrication based optical and photonics technologies.

- To support the fundamental research in the field of optics and photonics which will be the foundation of tomorrow's technologies.

- Provide support to industries from research & development to scalable process and product development.

- To reduce the import dependency of our country for specialized optical components such as diffraction gratings, diffractive beam splitter, beam shaper etc.

- Cater to the urgent need of indigenization of technological solutions in the field of strategic, biomedical, sensing, automobiles etc.

The three major tasks of the project are (1) Construction of micro-nano center building (through renovation of an existing structure) and setting up of the clean room facility (2) Setting up of micro-nano fabrication facilities which includes lithography tools, etching tools, deposition tools, characterization tools and other essential amenities and (3) Fabrication of diffractive optical elements and nanostructures.

Development of holographic systems for 3D dynamic displays

Type of Project **:** *CSIR funded*
Project No. **:** *MLP 2014*
Project Leader **:** *Dr. Raj Kumar*

Holography is a lens less technique to provide realistic three-dimensional displays. Conventional holographic displays are static in nature i.e. the image recorded in the hologram cannot be updated. There is huge demand for dynamic holographic display for applications such healthcare, telepresence, teleconferencing, entertainment, avionics, communication etc. Digital holography and electronic holography could generate dynamic holographic displays but due to limitations of the space bandwidth product of commercially available digital image sensors and digital 3D displays devices, these displays are limited to very small in size and field of view.
Under this project CSIR-CSIO is working on development of dynamic holographic displays with enhance field of view and physical size. Techniques of conventional holography, digital holography and computer-generated holography are being actively investigated to achieve the goal of the project. During this period a preliminary optical setup of the holographic printer has been developed and computer-generated hologram (CGH) have been obtained using various CGH generation techniques. An electro-holographic project system has been developed to display the CGH and generate dynamic holographic displays. Initial results on holographic waveguide have also been achieved.
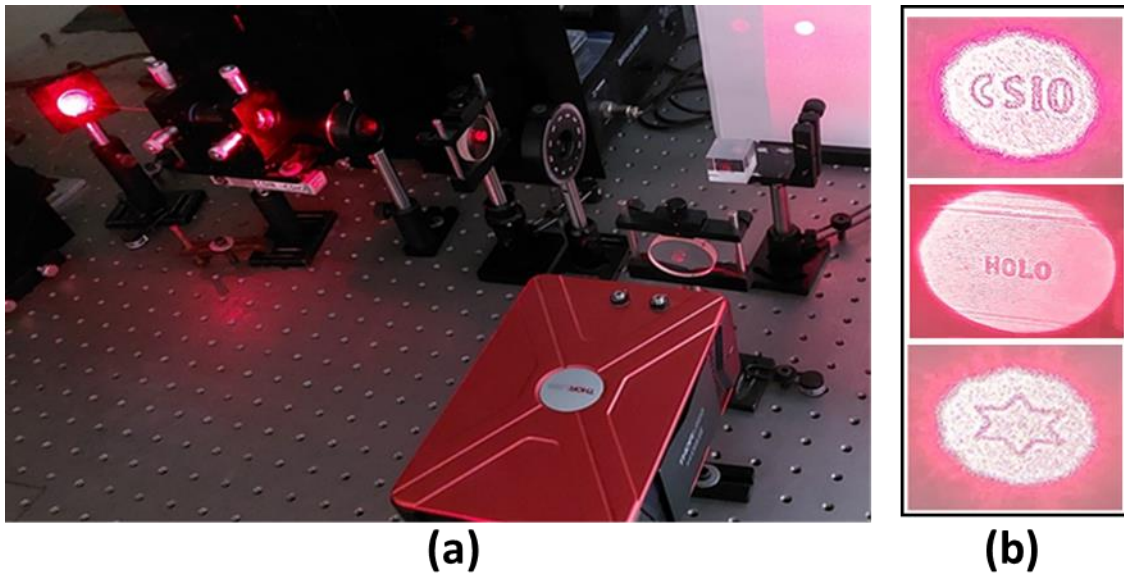
(a) Photograph of the experimental setup of electro-holographic projector; (b) Holographic images projected through the electro-holographic projector
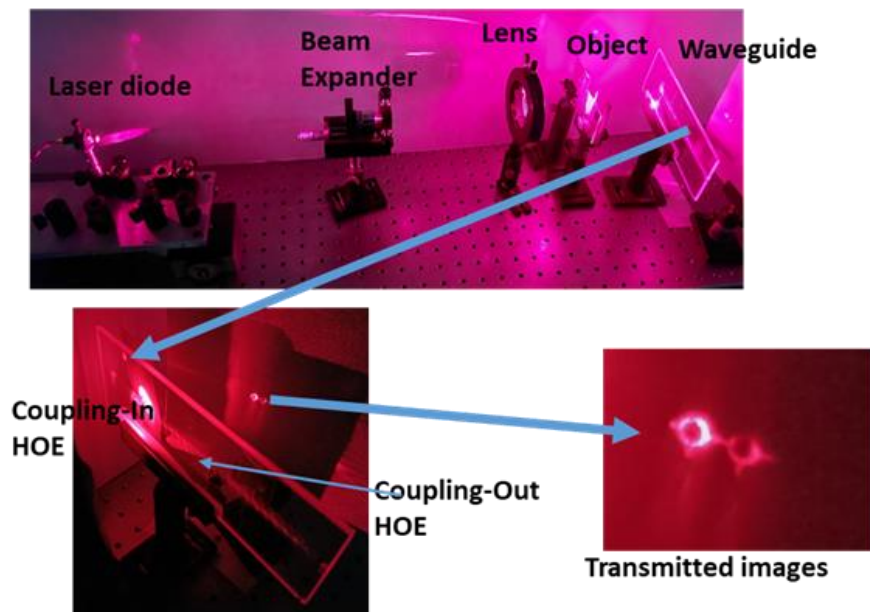
Experimental scheme of image transmission through the fabricated holographic waveguide.

The circulating tumor cells (CTC) are cells that get detached from the primary tumors and circulate in the blood stream. The CTC are capable of metastasizing in other organs also. As the CTC are vital cancer biomarkers, their detection and monitoring in the blood stream can be very useful to screen cancers. Therefore, the development of the point-of care devices for sensing of CTC is of great clinical significance as they can facilitate an early stage detection and management of cancer. The project aims to develop a fiber optic immunosensing platform for the detection of CTCs. The technique is primarily based on the covalent immobilization of CTC specific antibodies over the 2-dimensional nanomaterials (e.g., MoS_2) modified gold coated optical fibers and collection of SPR (surface plasmon resonance) signal. The proposed optical fiber-based detection technique involves lesser analytical steps than other cell detection protocols, e.g., Cell Search and immunohistochemistry.

The D-shaped SPR sensor has been found to yield greater detection sensitivity toward the RI changes than the conventional one. The optical fiber biosensor has been immobilized with the anti-epithelial cellular adhesion molecule (EpCAM) antibody through covalent conjugation protocols. The prepared biosensors have been used to detect the concentration of liver cancer CTCs (Hep G2 cells) over a wide concentration range of 10 to 10^8 cells. Figure (a) & (b) shows the SPR response of the sensor against the different as well as at lower concentrations of Hep G2 cells. Noticeable wavelength shifts have been observed for each concentration.
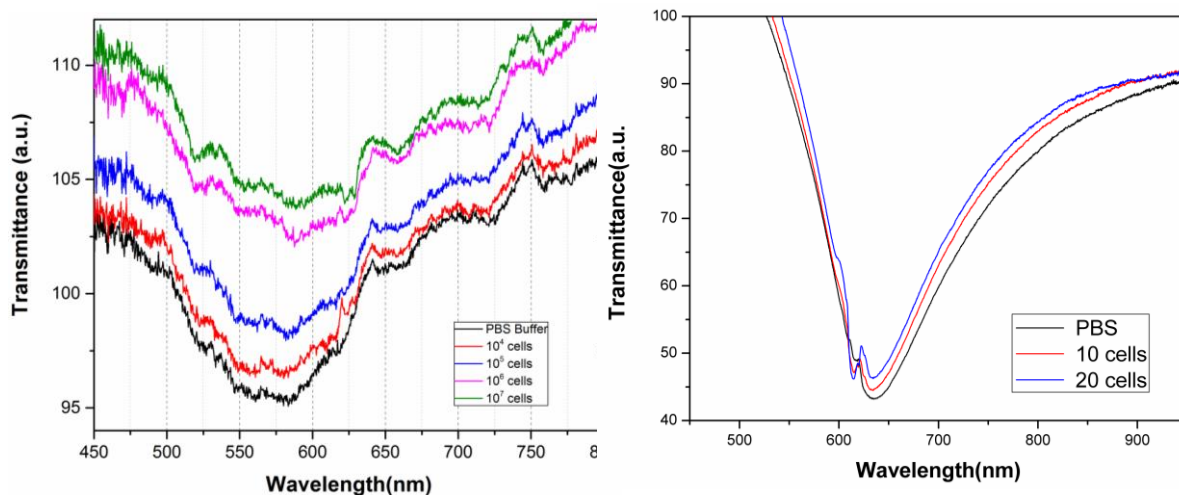
(a, b): The response of D-SPR biosensors for different concentrations of CTC (Hep G2 cells) and D fiber SPR sensors for lower concentrations of CTC

Development of phase shifting Fizeau Interferometer for optical surface form and wave front sensing application

Type of Project : *Grant-in-Aid*
Project No. : *GAP-406*
Project Leader : *Dr. Sanjit Kumar Debnath*

Various optical instruments like telescopes, microscopes, etc. use optical components like lenses, glass plates, etc. Surface characteristics of these optical components like form, shape, roughness play an important role in determining the performance of these instruments. So the measurement of these parameters of the optical components is necessary before using them in the instruments. Interferometric methods are well suited for this application as these are non-destructive in nature and have a resolution comparable to the wavelength of the light. Our objective is to develop a prototype of phase shifting Fizeau Interferometer for determining these parameters.

Light from a monochromatic source is split into two where one part is incident on the test surface and another into the reference surface. These two reflected beams, known as test and reference beam respectively, are allowed to interfere to produce a fringe pattern. This fringe pattern carries the information of the test surface in the form of optical path difference which is related to phase. This phase can be calculated by various algorithms available in the literature. Calculated phase using "Hyper accurate least square ellipse fitting" algorithm from phase shifted interferogram are shown in the figure.
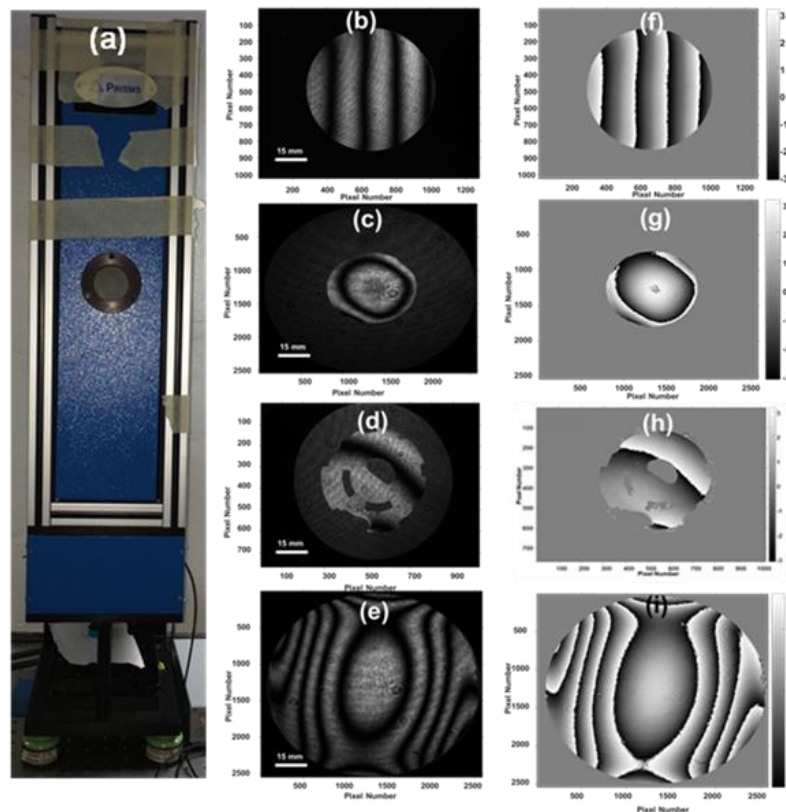
(a) Prototype phase shift Fizeau Interferometer. Interferogram recorded by the interferometer for (b)plane surface, (c) spherical surface (d) non continuous surface and (e) non spherical surface. Calculated phase (f, g, h and I) for the respective samples calculated using five step algorithm. (Colorbar in radian)

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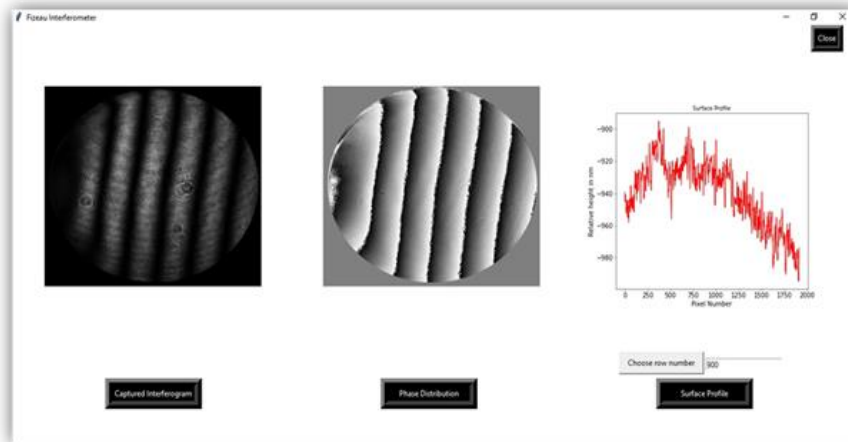
Graphical User Interface of phase shift Fizeau Interferometer.

Development of Whispering Gallery Mode (WGM) Resonator into optical fiber Axicon Tip for WGM Excitation and Sensing Application

Type of Project   *: Grant-in-Aid*
Project No.   *: GAP0429*
Project Leader   *: Dr. Samir Mondal*

The project has completed two years in the last financial year. Significant progress has been made for the objectives of this project. We have fabricated a novel design in a photosensitive optical fiber where a nano antenna having potential to produce a well-focused beam is fabricated well shielded in an etched conical cavity. The fabricated nanoantenna has shown abilities to excite Whispering Gallery modes in microresonators. To optically characterize the fabricated probe, reflected spectra have been studied and high Q-factors ~104 in the developed probe is achieved. The said results are ready to be communicated in a journal. The high Q-factor achieved makes the developed probe suitable to be used as sensor which will be explored further. Following are the representative images of fabricated probe and its reflected spectra to achieve the objectives of the project.
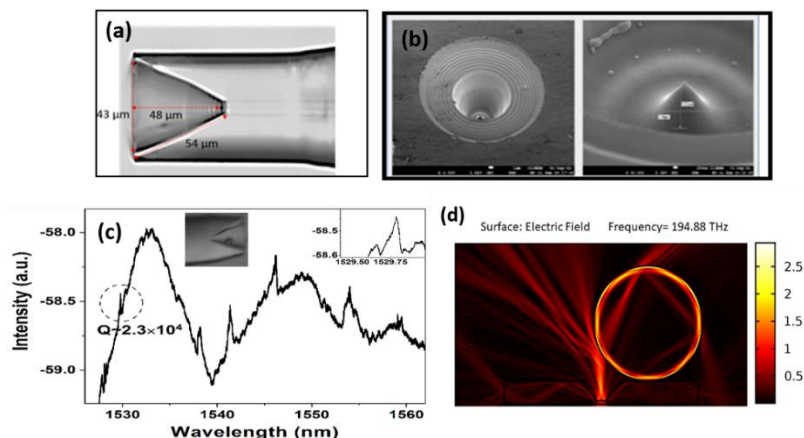
(a) Optical microscopic image of fabricated probe (b)SEM image of fabricated nanoantenna (c) Reflectivity spectrum of WGM resonator of diameter 15µm (Barium titanate resonator), optical microscopic image of WGM resonator inside the developed probe, (d) FEM simulation of Electric Field distribution inside WGM resonator.

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Frequency domain optical coherence 3D phase microscopy of Biological sample assisted by Bessel beam

Type of Project : *SRF funding*
Project No. : *5/3/8/77/ITR-F/2020*
Project Leader : *Dr. Samir Mondal/Ms. Pooja Gupta*

An all-fiber negative axicon probe with a Bessel beam has been developed for low coherence phase microscopy including refractive index measurement of a cellular level sample in reflection mode. The negative axicon chemically incised at the distal end of the optical fiber spawns the Bessel beam. The system provides a phase sensitivity of ~0.28 mrad and optical path length sensitivity of ~23 pm in air. The lateral resolution and working distance are found to be ~3.91 µm and 650 µm to exhibit the performance of the system experimentally. The three-dimensional (3D) phase map of the cheek cell along with the refractive index is obtained from the reflected power spectrum. The combined low coherence phase microscopy and refractive index measurement provides the system with a potential for biological application.
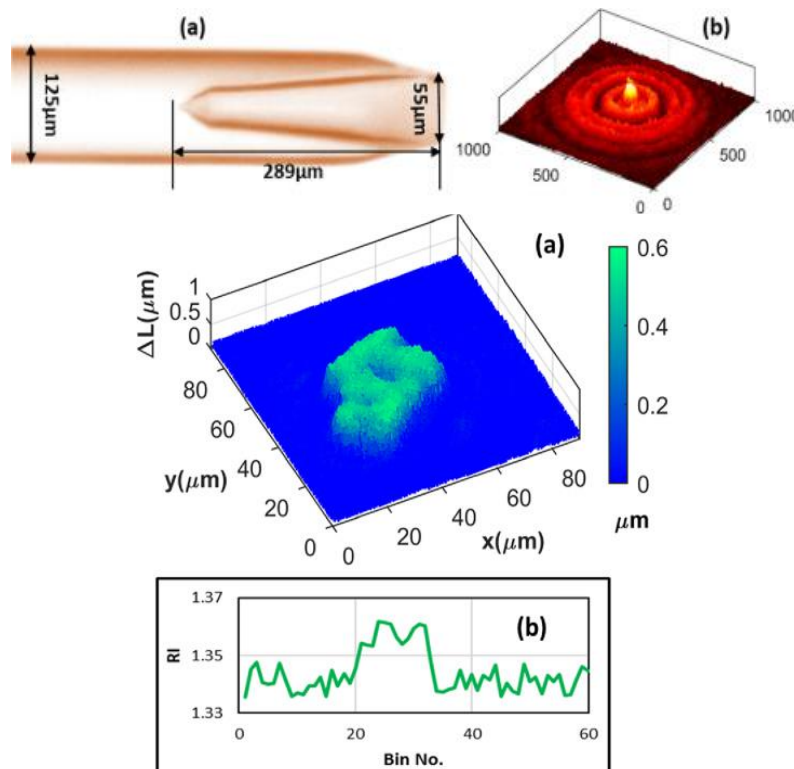
(a) 3D phase map (90 × 90 µm2) with color bar showing optical thickness of the human epithelial cheek cell.
(b) Refractive index distribution across a randomly chosen line through the center of the cheek cell.

The quantitative information about the cellular level specimen structure and its dynamics has immense potential in the field of biology. It can be integrated with an endoscopic system and provide an ability to image the sample remotely.

An optical fiber refractometer based on a common-path Bessel beam interferometry has been developed. It utilizes a packaged deep seated negative axicon (DSNA) optical fiber tip that generates a high-quality Bessel beam. The developed refractometer is demonstrated the refractive index measurement of small volume bio liquid sample. The results of the method are shown below.
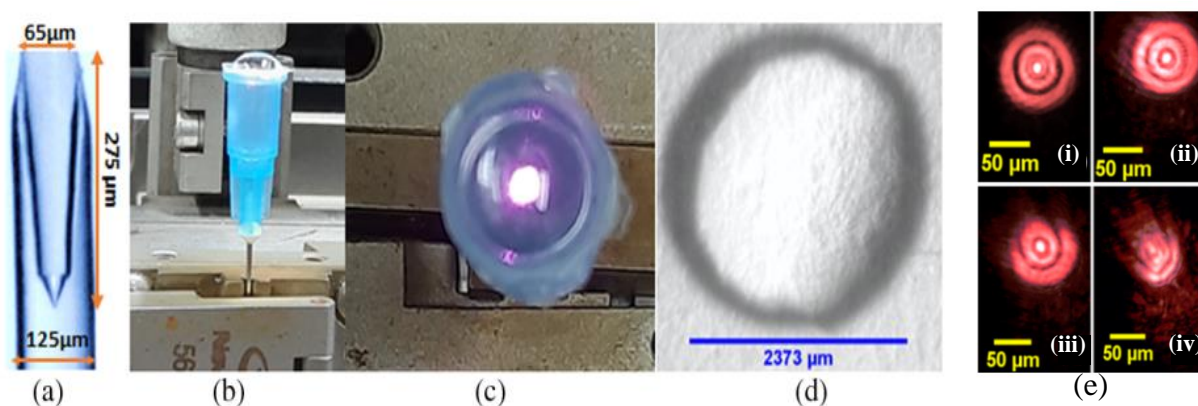
(a) Microscopic image of negative axicon. (b) Photograph of the packaged probe vertically held with liquid sample volume. (c) Photograph of the top view of the sensor head. (d) Microscopic image of 2 µl volume drop;(e) Bessel beam profile from packaged probe (i) without DI water drop, (ii) with 2 µl DI water drop, (iii) with 1.5 µl DI water drop, and (iv) with 1 µl DI..

CSIO Chennai Centre

Dr A. Robert Sam
siccsio@csircmc.res.in

The Centre is equipped with state-of-art facilities to carry out research in the area of Energy Management Systems (EMS) & Biosensor Based Systems for the healthcare diagnostics. CSIO has executed several projects and consultancy services for Industrial Energy Management Systems, Efficiency Monitoring Systems, Energy Studies, and Health Care Sector. The Test and Calibration laboratory of the Centre is in the process of obtaining accreditation in accordance with standard ISO/IEC/17025:2017. The Centre is actively interacts with various institutions, academia and other Government Agencies to work jointly to provide solutions for the societal problems. The Centre has created awareness about the technologies developed by CSIO to Industries, Institutions, User Agency, etc., for its utilization by the Society.

Completed projects:

- **Energy Management using Non-Intrusive Load Monitoring Technique**

Ongoing Projects:

- **Development of Structural Health Monitoring Technology for the Composite Structures using Fiber Optic Sensors**
- **Portable & Universal Pump Efficiency Monitoring System (PU-PEMS)**
- **IoT enabled Performance Evaluation System for Transformers in Rural Areas (IPEST)**
- **IoT Enabled 3-In-1 Power Quality Analyzer**
- **IoT Enabled Air Quality Monitoring System (iAQMS)**
- **Design & Development of Static Var Generators (SVG) for Power Management**
- **Common Research and Technology Development Hub (CRTDH) in Renewable Energy/Electronics**
- **Energy Audit and Analysis for CSIR-IGIB, New Delhi**

Energy Management using Non-Intrusive Load Monitoring Technique

Type of Project   : CSIR funded
Project No.   : MLP 2003
Project Leader   : Dr. Mukesh Kumar

Under this project, e-SENSE device has been designed and developed intelligent energy monitoring system using Non-Intrusive Load Monitoring (NILM). The developed device is used to monitor the energy consumption and status like on/off of individual electrical loads connected in building. The objective of this project is to convert lab prototype into product (P2P). The developed product has unique and robust features to disaggregate individual appliances/load's status and energy consumption including **similar power appliances** from the aggregated data using **ML/DL** approach. Low cost, 3 phase measurement board has been designed and interface with high-speed microcontroller as part of hardware for the e-SENSE. Further

Deployed at commercial building as field trials to monitor the set of ACs using single device and also in industry as field trial to monitor the spotwelding machine. Furthermore, this developed technology has been transferred to **M/s. AI-DEA LAB Pvt. Ltd**. on 15th Feb 2022.
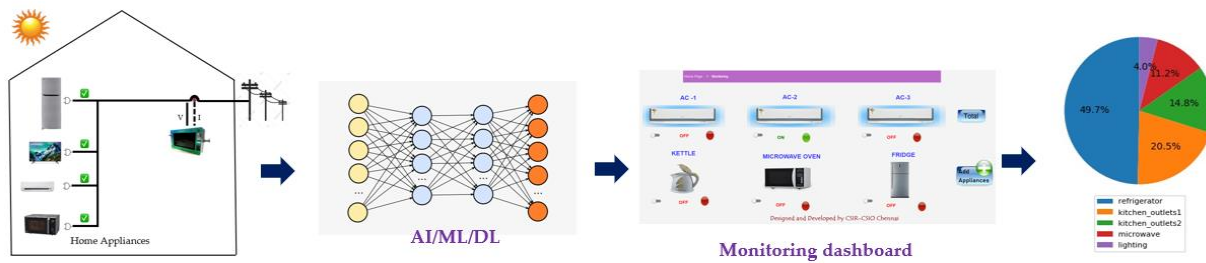
Typical view of developed Energy Management using NILM Technique

Field Trail

1. **Commercial Environment:**
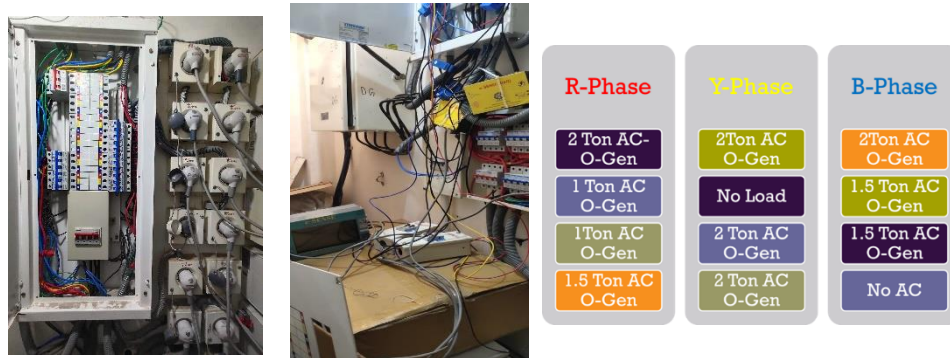
Typical view of the deployment of e-SENSE in the commercial building for monitoring of set of ACs

2. *Industry Environment*:

Typical view of deployment of e-SENSE in the industry for monitoring of five spot welding *machine*

Common Research and Technology Development Hub (CRTDH) in Renewable Energy/Electronics

Type of Project   *: Grant in Aid (funded by DSIR)*
Project No.   *: GAP 0402*
Project Leader   *: Mr. Anand VP*

Overview of the Project:
CSIR CSIO Chennai Centre is establishing CRTDH center to provide technical R&D, infrastructure, and equipment testing facilities to the local renewable energy and electronic MSMEs for carrying out competitive research for translating innovative ideas into marketable products. The CRTDH Centre will support cutting-edge investigations into some of the most important questions facing the Renewable Energy Sector today.

30 kVA Solar Inverter & Solar Panel Test/R&D Facility for MSEs
CRTDH has recently established an R&D facility for testing/R&D consultancy of solar PV inverters with a rating of up to 30 kVA. The setup comprises of solar array simulator, grid array simulator, RLC load, and power measurement instrumentation. The team has validated the facility for the following tests as per international standards.

- Testing of Power Efficiency of Solar Inverter (as per IEC 61683 :1999)
- Testing of Static MPPT Efficiency of Solar Inverter (as per EN 50530 :2010)
- Testing of Dynamic MPPT Efficiency of Solar Inverter (as per EN 50530 :2010)
- Testing for Characteristic Interface of Solar Inverter (as per IEC 61727 :2004)

Apart, from the inverter test facility, the CRTDH team is in the process of setting up a solar PV testing laboratory whose function is to evaluate solar panels for their performance, which could help solar project owners and operators to capitalize on the production.

CRTDH Centre in COVID-19 Pandemic - UVGI Characterization Facility
CRTDH had implemented an optical sensor setup and darkroom setup for measuring the irradiance, dose, temporal stability, and leakage of the UVGI (Ultraviolet germicidal irradiation) systems at various planes and heights according to the type of the systems and developed SOPs for testing & validating the same. The UVGI testing facility has served around 70 MSEs across the country.

CRTDH HRD Programs
CRTDH conducted a series of Technologist – Industrialist "Meet & Expos" which sensitized around 70 industrial participants from different parts of India in the areas of Energy and Energy Infrastructure Instrumentation. This also facilitated the opportunity for industries & users to know about the technologies & facilities of CSIO and CRTDH.

Solar Inverter Test Facility at CRTDH Chennai

Development of Structural Health Monitoring Technology for the Composite Structures using Fiber Optic Sensors

Type of Project : *CSIR Funded*
Project No. : *HCP-0036*
Project Leader : *Dr. A. Robert Sam*

Fiber Optic Distributed acoustic sensing (DAS) is one of the cutting-edge technology. The phase-sensitive optical time-domain reflectometry allows DAS to sense the perturbations produced either through physical strain or temperature. DAS allows sensing the perturbations along the continuous standard telecom single-mode fiber optic cable of a few meters in length by analyzing the backscattered signals. This technology has strong ambient adaptability, including anti-electromagnetic interference, chemical resistance, good concealment, etc. For the structural Health monitoring of the aircraft composite, the fiber is deployed inside the composite material. In a phase-OTDR system, the performances such as the sensing dynamic range, spatial resolution, are sensitivity are governed by the system signal-to-noise ratio, which is limited by the low intrinsic Rayleigh scattering coefficient of the optical fiber. The desired signals can be extracted from the backscattered signals using appropriate machine-learning techniques. Coherent OTDR finds its application in Distributed Acoustic Sensing (DAS), Distributed Temperature Sensing (DTS), and Distributed Temperature Strain Sensing (DTSS)

The experimental setup consists of a laser source of operating wavelength 1550 nm. A beam splitter splits the beam into a reference beam and the test beam. The test beam is modulated by an acoustic-optic modulator (AOM) to produce a pulsed wave of a few nanosecond pulse width.
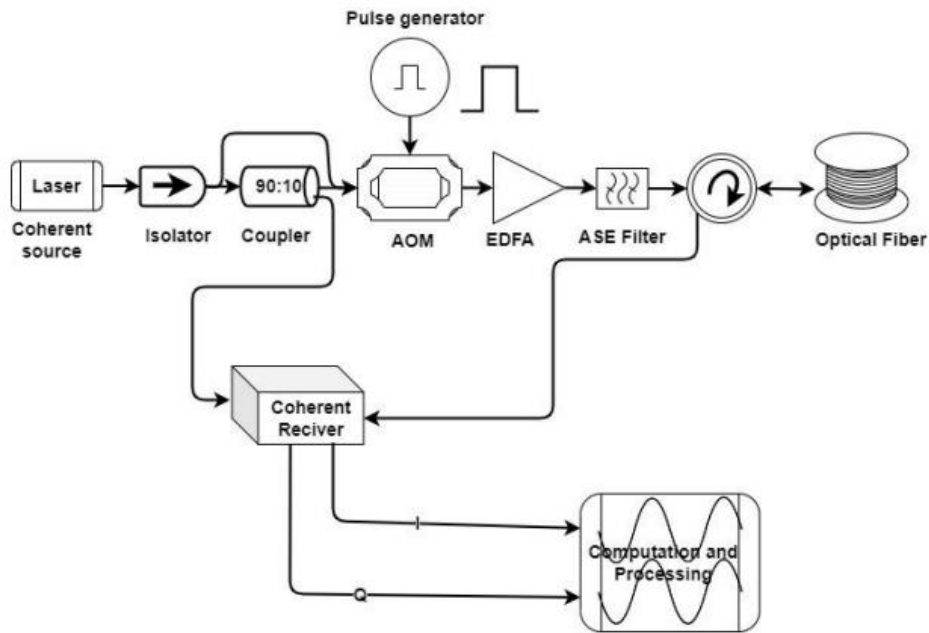
The probe pulse from the AOM is amplified using EDFA and fed into the sensing fiber (500 m to 1 km) connected to port 2 of the circulator. The Rayleigh backscattered signal is collected from port 3 of the circulator and is connected to the signal port of coherent receiver. The other branch of the laser output is used as the Local Oscillator (LO) signal. The LO is connected to coherent receiver through a polarization controller (PC). The two outputs (I and Q Channel) of the hybrid are fed into DSO for data extraction and processing.

Certification of Ultraviolet germicidal irradiation (UVGI) systems for irradiance, spatial uniformity of leakage and fluence rate

Type of Project   *: Technical Services*
Project No.   *:TSP-0027*
Project Leader   *: Dr. A. Robert Sam*

CSIO Chennai Centre had established a facility and infrastructure for testing the Ultra Violet Germicidal Irradiation system (UVGI Systems). The distribution uniformity of the irradiance, dose, temporal stability, and leakage of the UVGI systems are tested as per standard developed protocols.

Key Testing Parameters of Interest for UVGI products
1. Minimum Irradiance: Minimum radiant power from all (hemispherical) directions incident upon an infinitesimal element of flat surface area. Measurement Unit: mw/cm^2 .
2. Spatial Non-uniformity of the Irradiance
3. UV dose, or fluence rate, representing total radiant energy incident upon a surface or a microorganism and has the units mJ/cm2 (mW-s/cm2).
4. Spectral Mismatch: Compliance with respect to 254 nm.

5. Leakage Irradiance – Measured using dark room setup.
6. Temporal Instability (Repetition): The output of a UVGI system must be stable over time to ensure that lamp fluctuations do not distort measurements.

Portable & Universal Pump Efficiency Monitoring System (PU-PEMS)

Type of Project : GAP
Project No. :GAP0445
Project Leader : Dr. G.S. Ayyappan

Introduction

This project was funded by Directorate of Indigenisation, Indian Navy, New Delhi. Under this project CSIR-CSIO Chennai Centre has designed and developed a prototype named as Portable and universal Motor-cum-Pump Performance Monitor (PU-MPPM). PU-MPPM is an ultimate cost-effective tool for monitoring the efficiency of the pump, motor and overall on-line, on-site and in-situ. Presently the efficiency of the pump is monitored either off-line or by measuring the flow using commercial flow meters or using high-cost ultrasonic flow meters and then the efficiency is back calculated. PU-MPPM involves an indirect method of calculating the flow by measuring the efficiency of the pump along with the electrical power input to the motor. The system integrates pump and motor performance monitoring into a single system providing a portable and universal solution for any range of motor and pump. The developed prototype was field trialed at Machinery Trial Unit (MTU), Vizag on a dedicated pump test bed and also on an identified ship.

Features

- The methodology is based on estimating the wire-to-fluid efficiency, which is defined as the product of pump and motor efficiency.
- The overall performance monitoring of the system, comprising of both the pump and the motor driving the pump will be carried out by the hybrid technique of measurement.
- The temperature, pressure on both suction and discharge side along with the electrical power measurement and shaft speed are monitored and processed.
- The motor operating efficiency, torque & losses are calculated from the equivalent circuit using a proprietary algorithm called GA.

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- The overall efficiency along with motor and pump efficiency will be displayed on a GLCD/TFT display, and the same information will be transmitted to the remote monitoring system using Ethernet.

Product Differentials

- Computing the efficiency of the Pump without measuring the flow
- Flow rate is indirectly derived from the efficiency
- Reduced cost of maintenance
- Detection of abnormality in Motor and Pump separately can be accomplished

Field Trial Conducted at Machinery Trial Unit (MTU, Vizag)

IoT enabled Performance Evaluation System for Transformers in Rural Areas (IPEST)

Type of Project : GAP
Project No. :GAP0427
Project Leader : Mr. M. Raja Ragahavan, Dr. G. S. Ayyappan (Mentor)

Design & Development of a cost effective online, onsite & in-situ IoT enabled Performance Evaluation System for Transformers (IPEST) to diagnose the internal health of the transformers using the latest state of art Instrumentation & Information Technology. This system will be using active & passive type sensors to measure the required parameters such voltage, current, energy, temperature, vibration, power quality etc. The proposed system is IoT enabled and can be used as real-time continuous monitoring system with remote access. In the proposed system, the unique feature will be monitoring all the electrical & physical parameters online and estimating the overall performance & health of the internal components in the transformer with the help of Artificial Intelligence algorithms. The technology is mainly developed for the upliftment of rural people and to increase the quality of life by providing continuous power supply to the rural area or minimize power shut down by continuously monitoring the unmanned transformers in the remote area and assess the heath of the transformer online.
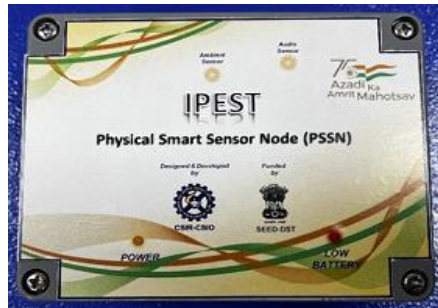
Features

- The IPEST consists of three subsystems namely
  - ✓ Control unit
  - ✓ Electrical Smart Sensor Node (ESSN)
  - ✓ Physical Smart Sensor Node (PSSN)
- Physical Smart Sensor Node (PSSN) senses various mechanical effects in the transformer by using MEMS sensors.
- Electrical Smart Sensor Node (ESSN) senses the electrical parameters using highly sensitive current sensors and voltage probes from which power quality can be analyzed.
- The ESSN has a 3-in-1 node feature which are, it can measure all three phase electrical parameters, power quality event detection and spectrum analyzer.
- Both PSSN and ESSN are IoT enabled which transmits the sensed data to the cloud based real-time database.
- The battery-operated Control unit integrates with the PSSN & ESSN information from the cloud database and evaluates the performance of the transformer utilizing Artificial Intelligence based Machine Learning algorithms.
- All the subsystems of the IPEST are battery powered systems.
- The sensors can be installed without interrupting the normal operation of the transformer.

Product Differentials

- Continuous monitoring of unmanned transformers in remote areas minimizes the power shut down
- Early detection of performance & health status of transformer
- The system targets distribution transformer and power transformer up to 1000kVA or lower capacity transformer which are presently available in the rural areas
- The system is battery powered and IoT enabled to access anywhere from the world through internet.
- Spectrum Analysis & Lissajous curve Analysis is used to identify the electrical faults
- Other analysis like Vibration, Magnetic flux and Audio analysis are used to identify mechanical faults.
- The system is portable, standalone and easy to carry for onsite evaluation.

IOT ENABLED 3-IN-1 POWER QUALITY ANALYZER

Type of Project   : In-House
Project No.   :XXX
Project Leader   : Dr. G. S. Ayyappan

Need and Relevance

A perfect power supply would be one that is always available, always within voltage and frequency tolerances, and has a pure noise free sinusoidal wave shape. Naturally, long power interruptions are a problem for all users, but many operations are very sensitive to even very short interruptions, harmonics, transients and unbalance. Voltage sags and power interruptions lasting a few hundredths of a second can be dangerous. Analysis of power being received is hence very important particularly in industries. Poor quality of power may result in breakdowns and consequent production loss. The industry needs to know its power supply quality by means of a tool, which takes the inputs and quantifies the power quality parameters at an affordable cost. PQA will help to take corrective steps for improving the power quality of the supply, which in turn will reduce the down time and increase the productivity.

iPQA is an IoT enabled Instrument to analyse the Quality of Electrical Power in terms of harmonics, THD, voltage Sag & Swell, Interruptions, transients etc. iPQA is a by-product of IPEST project (GAP-0427), which was funded by SEED-DST, New Delhi. iPQA was further enhanced modified the instrument with additional smart features as in-house activity .
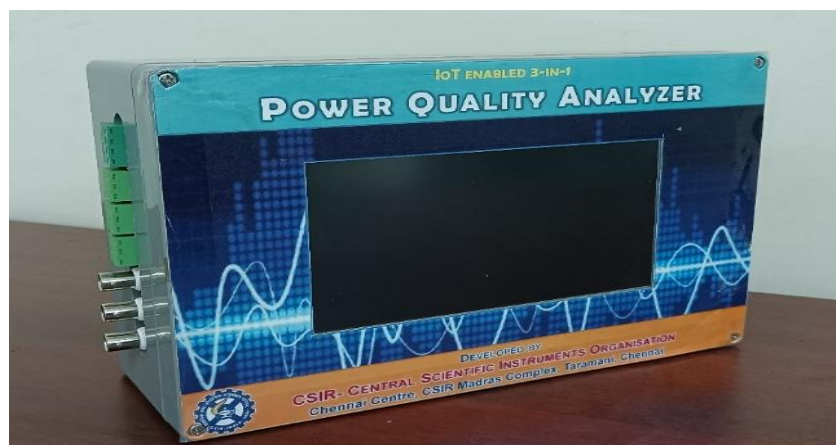
3-in-1 Features of iPQA

☞ **Basic Electrical Parameters**
  ▪ 3-Phase Line/ Phase Voltage, Current, Power Factor, kW, kVA, kVArh, Energies etc.
☞ **Power Quality Parameters**
  ▪ Up to 50th Order Harmonics
  ▪ Sag, Swell, Interruptions, Surges events with Time stamp
☞ **Frequency Spectrums** of all three phase Voltage and Current channels for condition Assessment of Machinery
☞ **Real-time Waveform Data** with a frequency bandwidth of 3.3 kHz

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IOT ENABLED AIR QUALITY MONITORING SYSTEM (AQMS)

Type of Project   *: In-House & Industry Sponsored*
Project No.   *:OLP-0253*
Project Leader   *: Dr. G. S. Ayyappan*

CSIR-CSIO has developed a system for monitoring the indoor and outdoor air quality that follows Central Pollution Control Board. Ambient air monitoring is the monitoring of the quality of the air in a particular area. The local ambient air quality can be degraded by a number of sources such as diesel vehicles and power station emissions. The usual substances monitored include dust deposition, PM10, PM2.5, NOx and SOx. Ambient monitoring is often necessary as a condition of an IED license, permit, planning condition, to support license applications or as part of an EIS. A typical example of this is dust monitoring at a quarry to ensure dust levels are below those specified in the planning conditions.
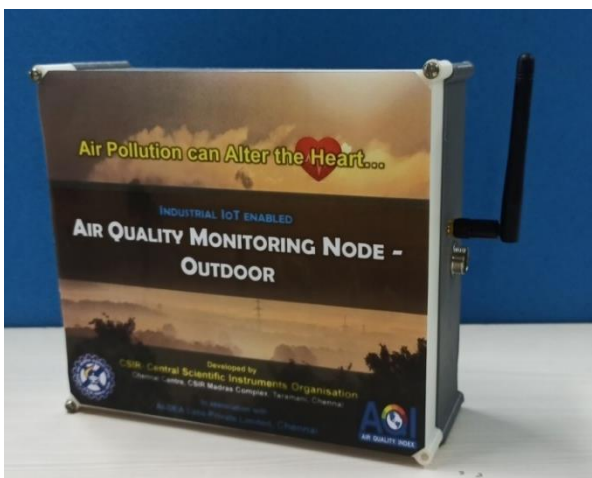
Applications:
Industrial Perimeter Monitoring
Roadside Pollution Monitoring

Indoor Air Quality Management (Commercial buildings and Pharma Industries)
Planning Condition for Industrial Equipment

List of air quality parameters monitored by iAQMS:

Gases
- Carbon monoxide (CO)
- equivalent Carbon dioxide (eCO_2)
- Total Volatile Organic Compound (tVOC)
- Ozone (O3)
- Carbon Dioxide (CO_2)
- Sulphur Dioxide (SO_2)
- Nitrogen Oxide (NO_2)
- Ethanol (C_2H_5OH)
- Hydrogen (H_2)
- Ammonia (NH_3)
- Methane (CH_4)
- Propane (C_3H_8)
- Iso butane (C_4H_{10})

- Mercury

Ambience Parameter
- Temperature
- Humidity
- Pressure
- Altitude

Particulate Matter
- PM 2.5
- PM 10

Other Parameters *(optional)*
- Solar Radiation
- Wind Speed
- Rain Fall

Design & Development of Static Var Generators (SVG) for Power Management

Type of Project : *Industrial Collaborative In-house Project*
Project No. : *OLP-0252*
Project Leader : *Dr. C. Sethuraman*

This project is supported by an Industrial Partner M/s Sunon Technologies, Chennai contributing with 10% of the project cost. The project cost is Rs. 6.50 Lakhs. Non-Disclosure Agreement was signed between CSIO and SUNON Technology on 10th Aug. 2021. NDA signing Photos are shown below:

Regarding the progress of the project, in close coordination with Sunon Technologies i) the required project components were identified and procured, ii) designed and developed circuits for SMPS, Power Unit, Control Unit and Filter Unit iii) Making of PCBs for power, control and filter units iv) assembling and fabrication of lab prototype SVG to test upto 5kVA load is completed v) installed 10kVAr Lead/Lag PF Panel having the capacitive loads 1kVAr (2Nos), 2.1kVAr (1No), 4.2kVAr (1No) and inductive loads with 1kVAr (1No) and 2kVAr (1No.) in CSIO for testing the performance of developed SVG. To lineup 10kVAr Lead/Lag PF Panel with CRTDH main distribution panel by fixing the relays taking the signal from 400/5A CTs is in progress as shown below photos.

Common Research and Technology Development Hub (CRTDH) in Renewable Energy/Electronics

Type of Project   *: Grant in Aid (funded by DSIR)*
Project No.   *: GAP 0402*
Project Leader   *: Mr. Anand VP*

Overview of the Project:
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Solar Inverter Test Facility at CRTDH Chennai

Energy Audit and Analysis for CSIR-IGIB, New Delhi

Type of Project   *: Services*
Project No.   *: TSP 033*
Project Leader   *: Dr. Mukesh Kumar*

The main objective of this technical project is to carry out energy audit and analysis for both campus of CSIR-IGIB, New Delhi. As part of this project, energy audit of the mall road campus of CSIR-IGIB has been carried out systematically to investigate the energy saving potential. Electrical data has been analysed and energy saving potentials have been identified which will help to reduce the energy wastage. Further, a technical report has been prepared with finding and suggestion to save energy at CSIR-IGIB, Mall Road campus.

Typical view of centralized AC system and electrical panels at CSIR-IGIB, New Delhi

R&D Support Facilities
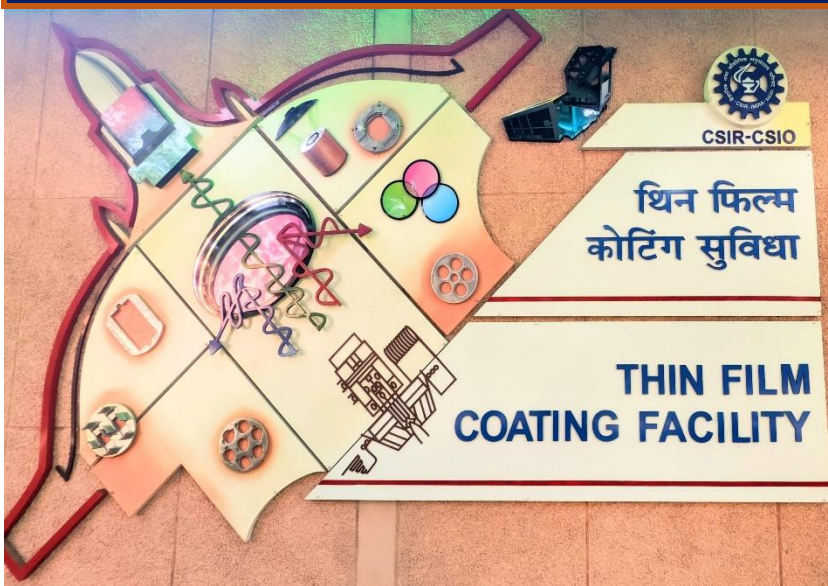
CSIO Analytical Facilities (CAF)

Dr. Amit L. Sharma
amitsharma_csio@csio.res.in

CSIO Analytical Facility (CAF) Division has various sophisticated techniques such as Spectroscopy (FT-IR, FT-NIR, UV-visible/UV-visible-NIR, Raman, Fluorescence/Photoluminescence etc.), Microscopy (NSOM), Chromatography (GC, HPLC, LC-MS), electrochemical (potentiostat/galvanostat, electrochemical workstation, impedance analyzer etc.), XRD, drop shape analyzer, taste analyzer etc.

The division is responsible for the operation, maintenance and continuous supervision of these facilities and also provides uninterrupted technical services to CSIR-CSIO and other R&D institutions, government/private universities and industries.

Ongoing projects

1. **Project Title:** Setting up of NABL accredited Modern Lab at Chandigarh/Panchkula
   Type of Project: Consultancy Project
   Project Number: CNP 0023
   Project Leader: Dr. Anupma Sharma
   Total Budget (in Rs): 24.5 Lakh

2. **Project Title:** Setting up of NABL accredited Modern Lab at Raipur, Chhattisgarh
   Type of Project: Consultancy Project
   Project Number: CNP 0025
   Project Leader: Dr. Udaybir Singh
   Total Budget: Rs 24.40 Lakh

3. **Project Title:** Setting up of NABL accredited Modern Lab at Hyderabad, Telangana
   Type of Project: Consultancy Project
   Project Number: CNP 0026
   Project Leader: Dr. Udaybir Singh
   Total Budget: Rs 24.34 Lakh

4. **Project Title:** Setting up of NABL accredited Modern Lab at Bhubaneswar, Odisha
   Type of Project: Consultancy Project
   Project Number: CNP 0027
   Project Leader: Dr. Udaybir Singh
   Total Budget: Rs 24.45 Lakh

Keeping in view the expertise of CSIR-CSIO in setting up sophisticated laboratories, the consultancy projects for a period of two years have been approved by Food Corporation of India (FCI) for setting up of NABL accredited modern quality control laboratories at its Regional Centers, Panchkula (Haryana), Raipur (Chhattisgarh), Hyderabad (Telangana) and Bhubaneswar (Orissa). Preparation of area wise layouts for setting up the laboratories, assistance in procurement and installation of equipment, preparation of quality manuals,

assistance in preparation of technical manuals with testing methodology and training of selected staff by FCI, are the main objectives of the project.
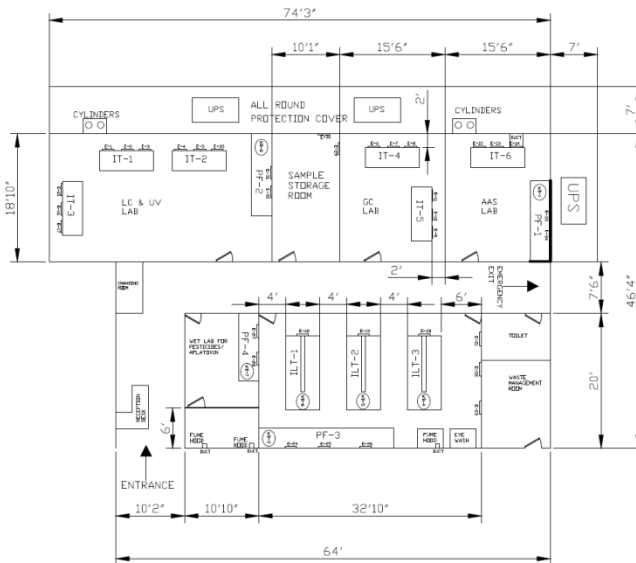
Hyderabad (Telangana) laboratory layout prepared by CSIR-CSIO

In this context, the CSIR-CSIO team organized and attended the meetings physically and virtually, with the said regional centers of FCI from time to time to meet the objectives of the project. The selected area wise layout was prepared after visiting the space provided by the regional centers of FCI for setting up the laboratory.

Based on this, the work of construction of laboratories started and is now almost complete. Purchase of furniture, civil work and electrical work are also in progress. The procurement process of the equipment is being done on the basis of technical evaluation of the specifications sent by the vendors. The procurement process of small equipment is also in progress based on technical evaluation.
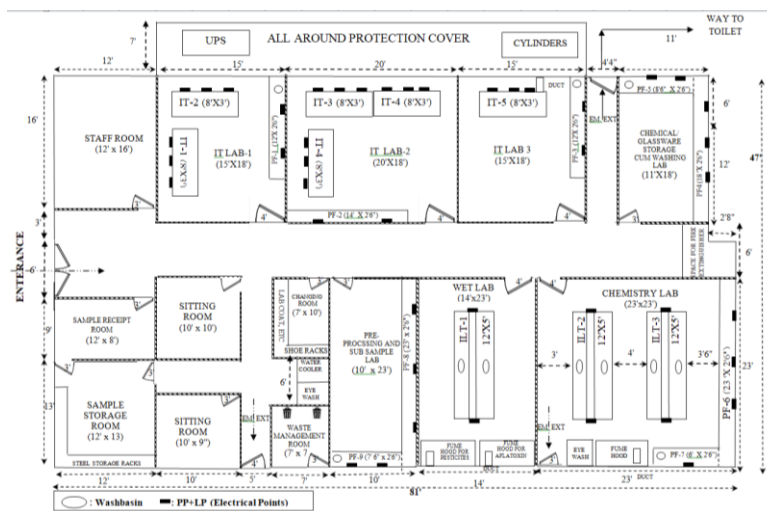
Raipur (Chhattisgarh) laboratory layout prepared by CSIR-CSIO

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Mechanical Design and Fab Facility (MDF)

Dr. Sanjeev Soni
ssoni@csio.res.in

Mechanical Design and Fab Facility comprises of technical manpower engaged in mechanical design, fabrication & metrology related work for various R&D activities. Major work involves mechanical design & fabrication, optical fabrication & assembly, measurements for mechanical and optical components and support to ISTC for teaching & lab work in the allied area. The group having expertise in following,

Multiphysics engineering simulations, Rapid prototyping through 3D printers, fabrication & assembly of optical as well as mechanical components, grinding & polishing of metals and optical materials, electric discharge machining, laser machining, CNC vertical machining center, mechanical and optical metrology, measurements of surface roughness & surface profiles, tensile and compressive strength measurements, 3D scanning of components, welding, tool and cutter grinding, coordinate & contour measurements, wear and hardness testing etc.

Ongoing Projects:

- **Design and Development of Light Source**

Design and Development of Light Source

Type of Project	*: Collaborative with Industry*
Project No.	*: CLP 0034*
Project Leader	*: Dr. Sanjeev Soni*

Developed a halogen lamp based visible light source in collaboration with joint funding from the industry M/s ATOS Instruments Marketing Services Bengaluru. The device provides tunable optical output within visible spectrum for a desired centre wavelength and spectral bandwidth through replaceable optical bandpass filters. The Light source can be used for a variety of applications like Photochemistry, Photobiology, Microscopy, Fluorescence, Life Sciences, Plasmonics, Material science and Electro-optical characterization etc. Also, it can be used for photothermal experiments to generate confined temperature within a medium/sample.

The device utilizes a halogen lamp, optical assembly comprising of lenses & thermally managed spectral filter elements to tune the optical output. Also, there is provision for PC based/motorized control of intensity and optical filter selection. Further, an attachment to get optical fibre coupled output and/or rotatable mirror to orient the output beam in free space can be provided.

Halogen lamp based visible light source
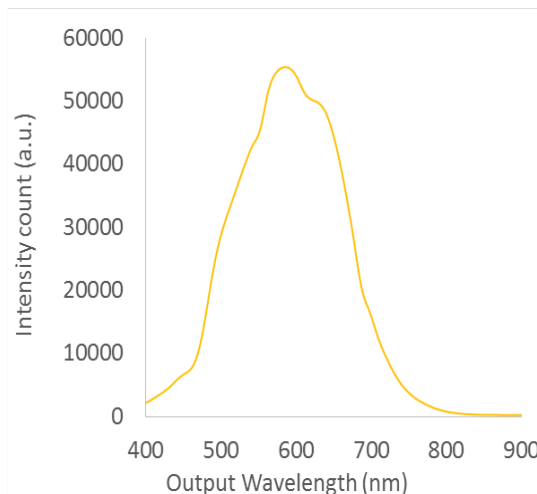
Typical Optical output

Feature	Specification
Light Source	Tungsten halogen lamp (250 W, air cooled)
Spectral Output Range	400-750 nm (Customisable)
Maximum Optical Output Power	7-8 Watt (direct beam in free space)
Output Beam Diameter	45-50 mm in free space or Fibre coupled
Operational Modes	Manual/Motorized/PC based
Intensity Attenuation	Motorized control
Output Beam	User adjustable orientation
Spectral Tuning	Replaceable optical band pass filters
Optical Filter Selection	Motorized
Physical Size	27 x 43 x 30 cm
Input Power Supply	230V AC, 50 Hz
Special Feature	High optical power handling & spectral extraction

Major Facilities available in MDF

Sr. No.	Name of machine
1.	Plastic 3D Printer (Fortus 250mc)
2.	Plastic 3D printer (STRATASYS F370)

3.	Metal 3D Printer (EOS M290)
4.	Precision Force Measurement System (Starrett FMS-1000)
5.	CNC Grinding and Polishing Machine (Optotech – MCG150, MCP250)
6.	Optics Metrology (MARFORM MFU 200)
7.	Ultra-Precision Single Point Diamond Turning (Nanoform-200)
8.	Contact profilometer (Form Talysurf PGI120)
9.	Optical profiler (Taylor Hobson CCI optic)
10.	Conventional Glass Slicing Machine (Wilhelm bothner-B20)
11.	Laser centering machine for Optical assembly (Loh 1982M1)
12.	Auto collimators (Tri Optics Optispheric, Opticentric MOT)
13.	Laser cutting machine (Mehta make)
14.	CNC Vertical Machining Centres (Jyoti 640)
15.	CNC turning center (Ace LT-16 LM300)
16.	Coordinate measuring machine (Accurate, Cordimesur)
17.	Contour measuring machine (Mitutoyo CV-3100)
18.	Wire EDM (Electronica/Elektra/AGIE)
19.	Milling machines (ACIERA SWISS/ HMT 2015/Schaublin SV-13)
20.	Surface grinder (PRAGA HMT)
21.	Lathe machines (Schaublin 120-VM/HMT/Kirloskar/ Gedee Weiler)
22.	Tool and cutter grinder (HMT)
23.	Jig boring machine (SIP)

Electronic Design and Fabrication (EDF)

Dr. Sanjeev Kumar
Virdi205@csio.res.in

Being a multi-disciplinary organization, CSIO have well equipped laboratories manned by highly qualified and well-trained staff with various infrastructural facilities. As a national laboratory in the area of Instrumentation, a well-established centralized Facility for Electronics Design and Fabrication (EDF) is available in the organisation.

This facility offers following instrumentation related expertise:

➢ Analog and Digital Circuit Designing.
➢ Analog and Digital Circuit Fabrication.
➢ Analog and Digital Circuit Modification.
➢ Embedded System Designing, fabrication and modification.
➢ PCB Designing.
➢ PCB Fabrication (2 layer without PTH).
➢ PCB Modification.
➢ PCB Assembly (SMD Level).
➢ PCB Testing.

The facility is supporting various R&D projects within the organisation and is also available to external users on nominal charges.

Thin Film Coating Facility (TFCF)

Dr. Mukesh Kumar
mukeshk@csio.res.in

Thin Film Coating Facility in CSIR-CSIO houses state-of-the-art vacuum deposition tools such as Ion Assisted Dual e-Beam Gun Coating System, RF Sputtering System, Thermal Evaporation and Spray Pyrolysis System. Apart from these, this facility also has various characterization equipment such as spectrophotometer, thin film analyzer, sheet resistance measurement set-up etc. Design, deposition and characterization of thin films and associated support services are offered through this facility. The facility is backed by an experienced team of scientific and technical staff that caters to the need of in-house researchers as well as external users.

Facilities Available:

Thin Film Coating Facility (TFCF) has the following deposition and characterization tools related to vacuum deposition and optical coatings:

- Ion Assisted Dual e-Beam Gun Coating System
- RF Sputtering System
- Thermal Evaporation System
- Spray Pyrolysis System
- UV-Vis-NIR Spectrophotometer with Diffuse and Specular reflection accessory
- FTIR Spectrophotometer
- Thin Film Analyzer
- Variable Angle Spectroscopic (UV-Visible) Ellipsometer
- Four probe conductivity measurement set-up

Apart from supporting in-house and external researchers in deposition and characterization of thin films, this group also executes various R&D projects related to optical coatings and assemblies.

Ongoing Projects:

- **Design & Development of Optical Beam Combiners for Pilot Display Unit (PDU) of Hawk Aircraft**
- **Development of Optical Multilayer Mirrors with Enhanced Laser Induced Damage Threshold (LIDT)**
- **Development of Common Aperture IR-Laser Electro-Optical System for Avionics Search & Range Finder**
- **Design & Development of Glass Combiners for HUD of Sukhoi-30 MKI Aircraft**

Design & Development of Optical Beam Combiners for PDU of Hawk Aircraft

Type of Project   *: Sponsored Project*
Project No.   *: SSP0050*
Project Leader   *: Dr. Mukesh Kumar*

Pilot Display Unit (PDU) is an essential navigational and weapon-aiming aid to the pilot of aircraft, especially fighter or trainer aircraft. The PDU is an airborne equipment fitted into the cockpit of the aircraft. The PDU displays the flight information of several selectable modes in collimated form so that a pilot can view this information superimposed on his view of the outside world without having to change his line of sight or visual accommodation. The optical beam combiners in the PDU act as a projection window on which the collimated symbols are projected.

Glass Combiner assembly undergoing endurance test in Humidity Chamber

The combiners are a parallel set of coated glass substrates that reflects only a narrow zone of wavelength centered around the emission wavelength of the CRT. The progress made in this project during this year are:

- Fabrication and assembly of glass combiner customized for the Hawk aircraft platform
- Qualification testing and certification of the developed combiner assembly as per existing military airworthy standards such as MIL-810F/G, JSS55555: 2012 etc.
- Aircraft integration and clearance for flight trials received.

Development of Optical Multi-layer Mirrors with enhanced laser induced damage threshold (LIDT)

Type of Project   *: CSIR funded*
Project No.   *: MLP2021*
Project Leader   *: Dr. Mukesh Kumar*

Under this project, it was envisaged to fabricate and study a series of dielectric material multilayer thin film combinations (such as TiO2-SiO2, HfO2 – SiO2, ZrO2 – SiO2, Ta2O5 – SiO2 etc.) in the form of a high reflective (>99.9%) multilayer stack for steering continuous-wave laser. A 24 layer TiO_2-SiO_2 multilayer laser reflective mirror was fabricated for 1064 nm Nd:YAG laser and its laser induced damage threshold studies were carried out.

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Development of Common Aperture IR-Laser-Electro-Optical System for Avionics Search & Range Finder

Type of Project   *: CSIR funded*
Project No.   *: HCP0036 WP7*
Project Leader   *: Dr. Mukesh Kumar*

This project aims to develop a common aperture IR – Laser – Elcetro-Optical system that covers 3 – 5 μm MWIR zone, 1064 nm laser and 400 – 700 nm visible wavelengths for better situational awareness during maneuvering of military aircrafts. Instead of using three different optical axes for handling each of the above bands, a triple band common optical axis based optical system is proposed. This will include development of a hemispherical outer fairing with an environmentally rugged anti-reflective coating for enhancing the transmission in the broad range from visible to MWIR region. During this year, the preliminary system conceptualization and simulations of the optical systems were carried out.

Design & Development of Glass Combiners for HUD of Sukhoi-30 MKI Aircraft

Type of Project   *: Sponsored Project*
Project No.   *: SSP0053*
Project Leader   *: Dr. Mukesh Kumar*

Head up Display (HUD) is an avionics display fitted in the cockpit of aircraft in front of the pilot that displays the required flight information to the pilot. The role of combiner assembly in HUD is similar to its role in PDU as described earlier except for the properties of the optical coatings on the glass assembly. The combiner assembly is required to be customized for cockpit layout of a specific aircraft. Depending on the cockpit layout and functional requirement with respect to symbol brightness, see-through transmittance and field-of-view of HUD, the multilayer optical coating is designed.
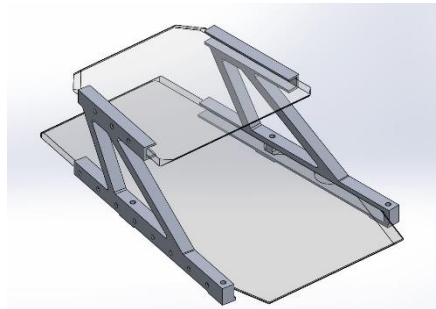
Model of combiner assembly of HUD for Sukhoi-30 Aircraft

During this year, the optical fabrication, coating and assembly of the glass combiner assembly for HUD of Sukhoi-30 aircraft was completed. The certification and qualification testing procedures were initiated for subsequent aircraft integration and flight trials.

Business Development & Project Management

Business Development & Project Management

Business Development & Project Management (BDPM) plays an important role for the enablement of the scientists of the institute to do industry driven R&D. In its endeavour to support the scientists, BDPM transfers the technologies, executes Memorandum of Understandings (MoUs) and Project Agreements for both with industries and academia as well as manages the R&D projects. To strengthen the industry linkages, it takes the responsibility from the inception of the projects to the commercialization of the technologies.

During the period under report, cross-sectoral linkages were established with industries in the area of strategic, agriculture, energy, medical etc. Apart from this, to boost the industry participation, it has started widely publicising the technologies for transfer by publishing Expression-of-Interest and floating it on various public and private portals.

Dr. AK Shukla
head.bdpm@csio.res.in

During the year 2021-22, our focus was commercialization of technologies that have wider impact for air disinfection with a view to prevent spread of COVID 19 like viruses, fungi, bacteria etc. Trials were conducted in Railways, Parliament and AC buses. The UVC Air Disinfection technology has now been installed in railway coaches, AC buses, closed spaces etc. In order to spread the technology to the masses, 40 new commercialization partnerships were established with industries across the nation. Besides, we have entered into collaborative partnerships with BEL Panchkula for manufacturing various products in the areas of aerospace for defense, aviation and homeland security.

Transfer of Technology

In 2021-22 the major activities including technology transfers, MoUs and Agreements signed are briefly mentioned below:

1. **Technology Transfer of versions of UVC Air Disinfection Technologies to 40 industries**
   a. **UV Disinfectant retro-fit systems for HVAC Ducts was transferred to 32 private industry partners.**

Sr. No.	Name of the firm	Date
1.	M/s TICEON-HSE LLP, Kottayam	Tuesday, May 11, 2021
2.	Aarco Engineering Projects Pvt Ltd	Monday, May 10, 2021
3.	Flexatherm Expanllow Pvt. Ltd.	Wednesday, May 12, 2021
4.	Aeon Creations Pvt. Ltd.	Friday, May 14, 2021
5.	Shreeson Technologies Pvt Ltd	Monday, May 10, 2021
6.	Reiz Electrocontrols Pvt. Ltd.	Wednesday, May 12, 2021
7.	Saras Engineering and Projects Pvt Ltd	Wednesday, May 12, 2021
8.	Indicare Health Solutions Pvt. Ltd.	Wednesday, May 12, 2021
9.	Devintec Electrical Technologies	Thursday, May 13, 2021
10.	SRIAS ENGINEERING Pvt Ltd.	Monday, May 10, 2021
11.	Ozone Research & Application (I) Pvt. Ltd.	Thursday, May 13, 2021

12.	Elite Air Techniques Pvt. Ltd.	Wednesday, May 12, 2021
13.	Airific Systems Pvt. Ltd.	Wednesday, May 12, 2021
14.	QUALITY NEEDS AUTOMOTIVES	Thursday, April 22, 2021
15.	Alpha Linear	Tuesday, May 11, 2021
16.	Koyna Engineers	Monday, May 10, 2021
17.	Ultrafresh Marketing Pvt. Ltd.	Friday, June 11, 2021
18.	Cenaura Technologies Pvt Ltd	Tuesday, May 11, 2021
19.	Ideamines Management Consultants Pvt. Ltd.	Tuesday, May 11, 2021
20.	Penguins India	Wednesday, May 12, 2021
21.	Softrays Power Solutions	Tuesday, May 11, 2021
22.	KIRIT Engineering	Tuesday, May 11, 2021
23.	Chola Geoenergy Pvt. Ltd.	Friday, May 14, 2021
24.	BDS Décor & Prefab Pvt Ltd	Monday, May 10, 2021
25.	LADDHA ENTERPRISES	Tuesday, May 18, 2021
26.	Sukrut UV Systems Pvt. Ltd.	Thursday, May 13, 2021
27.	ABS Air Tech Pvt. Ltd.	Tuesday, May 11, 2021
28.	Synergy Enterprises	Monday, May 10, 2021
29.	Unisem Electronics Pvt. Ltd.	Wednesday, May 12, 2021
30.	Magneto Cleantech Pvt. Ltd.	Tuesday, May 25, 2021
31.	M/s Paras Defence & Space Technologies Ltd., Navi Mumbai	Wednesday, June 2, 2021
32.	MG Cooling Solutions, Delhi	Thursday, September 23, 2021

b. **Standalone UV Air Disinfection System for Rooms was transferred to 7 private industry partners.**

Sr. No.	Name Of The Firm	Date
1.	M/s Paras Defence & Space Technologies Ltd., Navi Mumbai	Thursday, June 17, 2021
2.	Quality Needs Automotives	Tuesday, September 21, 2021
3.	M/s TICEON-HSE LLP, Kottayam	Friday, October 1, 2021
4.	Alpha Linear, Bangalore	Monday, October 11, 2021
5.	M/s Aadvik Design Solutions, Mohali	Thursday, December 2, 2021
6.	MG Cooling Solutions, Delhi	Tuesday, February 15, 2022
7.	Omniscient Treatment Technologies Pvt. Ltd., Nagpur	Saturday, March 26, 2022

    c. Spaces and UVC Disinfectant Circulating Air-Flow Systems for Elevators, Toilets etc. was transferred to 2 private industry partners.

Sr. No.	Name of the firm	Date
1.	M/s Paras Defence & Space Technologies Ltd., Navi Mumbai	Wednesday, June 2, 2021
2.	Alpha Linear, Bangalore	Friday, October 8, 2021

The retrofit UV-C system is designed to fit into any existing air-ducts / AHU with very minimal modifications. The virucidal dosages using UVC intensity and residence time have been optimized according to the existing spaces after considering the necessary air flow rates, shape and size of the air duct. The virus is deactivated in any aerosol particles or freely floating virus/bacteria in air and at the surfaces of the air ducts by the calibrated levels of UVC light.

UV-C Disinfection Systems
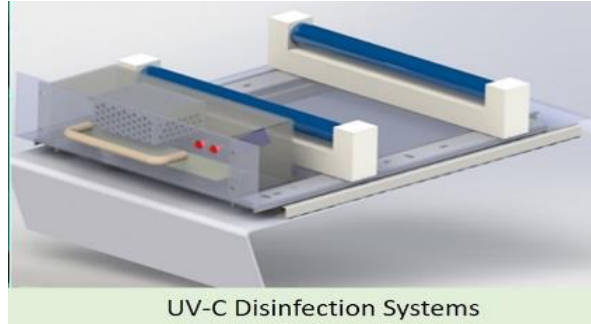
2. **LED based NVG compatible Wing and Fin Navigation Lights, Taxi & Landing Lights (TLL) and Drogue Lights along with associated Test Rigs for LCA Tejas - Indian Air Force**

The technology "LED based NVG compatible Wing and Fin Navigation Lights, Taxi & Landing Lights (TLL) and Drogue Lights along with associated Test Rigs for LCA Tejas - Indian Air Force" was transferred to BEL, Panchkula on Saturday, October 30, 2021.

Field Units of Left Wing Navigation Light - Aviation Red, Right Wing Navigation Light – Aviation Green, and Fin/Tail Navigation Light – Aviation White Lights

Left Wing Navigation Light   Right Wing Navigation Light   Fin Navigation Light

3. **e-SENSE/Non Intrusive Load Monitoring System (NILM)**

The technology "e-SENSE/Non Intrusive Load Monitoring System (NILM)" was transferred to M/s AI-DEA Labs Pvt. Ltd., Chennai on Tuesday, February 15, 2022.

'e-SENSE" (Energy Sense) is a device which is used to monitor the on/off status and energy consumption of individual appliances (loads) using Non-intrusive Load monitoring (NILM)

technique. The developed e-SENSE is plug and play type device which can be connected to entry point of residential / commercial buildings. The e-SENSE uses AI/ML approach to disaggregate the individual appliance's status and energy consumption from the aggregated energy data.

4. Digital Grain Moisture Analyser

The technology "Digital Grain Moisture Analyser" was transferred to M/s Agnext Technologies Pvt. Ltd., Mohali on Thursday, March 31, 2022.

The instrument is based on power efficient, high speed microcontroller (MCU) while sensing system is made up of capacitive transducer that converts moisture contents into an electrical signal. Presence of a very small quantity of water causes considerable change in the dielectric constant of the sensor cell. These moisture variations change capacitance which in turn is measured in terms of frequency variations. These variations are then further linearized and calibrated in terms of percentage moisture. The final result in terms of moisture percentage, temperature of sample, date and time of measurement is displayed on LCD for a given sample under measurement.

Memoranda of Understanding (MoUs) Signed

During 2021-22, the following Memoranda of Understanding were signed by CSIR-CSIO:

S. No.	With Whom Signed	Scope of MoU	Date	Duration (in Years)
1.	MoU with Indian Spinal Injuries Centre (ISIC), New Delhi	Design, Development and Clinical Evaluation of Rehabilitation Devices	Tuesday, April 13, 2021	5
2.	MoU with Ecole Centrale de Nantes, FRANCE	Sharing of expertise, domain knowledge and available facilities, Exchange of Staff and Students , collaborating on the design, development, and implementation of workshops and conferences etc	Monday, April 19, 2021	5
3.	MoU with IIT Ropar - Technology and Innovation Foundation for the Agriculture & water technology development Hub (AWaDH), Rupnagar	Development and Commercialization of products in the field of agriculture and water.	Wednesday, December 8, 2021	5
4.	MoU with Engineers India Ltd. (EIL), New Delhi	Joint Research in the fields of Industrial Instrumentation	Wednesday, December 8, 2021	5
5.	MoU with Fragrance & Flavour Development Centre (FFDC), Kannauj		Wednesday, August 18, 2021	5
6.	MoU with Monell	Exchange of staff and students,	Monday,	5

		sharing of expertise and domain knowledge	September 20, 2021	
7.	MoU with IIT Kanpur	Collaborative initiation of designing, developing and manufacturing various technologies in the areas of Stealth/Camouflage material, micro-fabrication, micro-machining, medical technologies, unmanned aerial vehicle technologies, Avionics and Aerospace technologies.	Thursday, December 2, 2021	**1**
8.	MoU with PGIMER Chandigarh	To protect the IP Rights arising out of the project titled "Design and development of Cricoid Pressure Sensor Device"	Wednesday, December 8, 2021	**5**
9.	MoU with NIPER, Mohali	Cooperation and Support for M.Tech Course (Medical Devices)	Friday, December 31, 2021	**5**
10.	MoU with STPI, Mohali	To foster collaboration, provide opportunity for global experience and to facilitate the advancement of knowledge on the basis of reciprocity, best effort, mutual benefit and frequent interactions	Tuesday, January 25, 2022	**5**
11.	MoU with National Institute of Food Technology Entrepreneurship and Management (NIFTEM)	To share the expertise, domain knowledge, and the available facilities in advanced Thrust areas of Science & Technology	Tuesday, February 15, 2022	**5**
12.	MoU with Amrita University, Coimbatore	Joint research and enhancement of knowledge and skills of the students and faculty.	Friday, February 18, 2022	**10**
13.	MoU with Punjabi University, Patiala	To share the expertise, domain knowledge, and the available facilities in advanced Thrust areas of Science & Technology	Tuesday, April 13, 2021	5

Project Agreements Signed

The institute entered into Project Agreements with the following organisations:

S. No.	With Whom Signed	Scope of Agreement	Date
1.	Agreement for Collaborative Research with ATOS Instruments Marketing Services, Bangalore	Development of Light Source	Thursday, April 8, 2021
2.	NDA with M/s. E-Spin Nanotech Pvt Ltd, Kanpur	collaborative research and commercialization of transparent face mask	Thursday, April 29, 2021
3.	NDA with Paras Defence & Space Technologies, Navi Mumbai	Collaborative Research and Commercialization of UV disinfectant retro-fit systems for HVAC ducts in buildings and transport systems, circulating disinfectant"Purelevator" for Lifts, bathrooms etc.	Monday, May 17, 2021
4.	NDA with Voltas, Mumbai	Collaborative Research and Commercialization of UV disinfectant retro-fit systems for HVAC ducts in buildings and transport systems, circulating disinfectant"Purelevator" for Lifts, bathrooms etc.	Wednesday, June 9, 2021
5.	NDA with Rite Water, Nagpur	Collaborative Research and Commercialization of Electrostatic Disinfection Device	Thursday, June 10, 2021
6.	MoA with PGIMER, Chandigarh	Development of Gait Training Tools and mobility aids for Parkinson's patients	Friday, June 25, 2021
7.	MoA with Elcome Integrated Systems Pvt. Ltd., Navi Mumbai	Design conceptualization and development of Control and Interface Electronics of the Periscope	Friday, June 25, 2021
8.	MoA with AI-DEA Labs Pvt. Ltd., Chennai	Collaborative Research to develop an IoT-enabled Air Quality Monitoring Systems	Wednesday, August 4, 2021
9.	MoA with Sunon Technologies, Chennai	Collaborative Research to design and develop Static Var Generators	Thursday, August 5, 2021
10.	Consultancy Project Agreement with Foodpairing NV, Belgium	Algorithm development for aroma and flavor analysis	Friday, October 22, 2021
11.	NDA with Defsys Solutions Pvt Ltd	To provide industry exposure to few of technical staff of CSIR-CSIO	Thursday, December 16, 2021
12.	NDA with Horizon Aerospace (India) Pvt Ltd	To provide industry exposure to few of technical staff of CSIR-CSIO	Thursday, December 16, 2021
13.	NDA with Vega Aviation Products Pvt. Ltd., Karnataka	To provide industry exposure to few of technical staff of CSIR-CSIO	Friday, December 17, 2021

14.	MoA with Plastisurge Industries, Amravati	For development of " Portable colorimeter for water quality testing"	Friday, January 14, 2022
15.	MoA with PGIMER, Chandigarh	Collaborative work under project " Thermal Imaging based non-invasive technique for diagnosis of musculoskeletal disorders (MSD)"	Tuesday, February 1, 2022
16.	MoA with ICMR	Development of Additive Manufactured Lattice structured Lumbar Spinal Implants	Tuesday, February 1, 2022
17.	MoA with ICMR	Embedded vision based intraoral scanner for dental diagnostics (Scan-D)	Tuesday, February 1, 2022
18.	MoA with PGIMER	Cancer Selective Molecular Theranostic to Overcome Multidrug Resistance (MDR) in preclinical models	Tuesday, February 15, 2022
19.	NDA with Raj Engineers, Mohali	Collaboration for Robotic Gait Trainer (ROBOG)	Tuesday, February 15, 2022
20.	NDA with Honeywell Technology Solutions Lab Pvt. Ltd., Bangalore	To carry out intensity measurement, CFD analysis & Particle Tracer Studies of certain Honeywell Products	Tuesday, March 8, 2022
21.	NDA with Adefolorunsho Technical Ventures Ltd., Nigeria	To work in collaboration on "Recycling of PET Waste into functional material for 'Waste to Wealth'	Tuesday, March 22, 2022

Human Resource Development

INDO-SWISS TRAINING CENTRE (ISTC)

Indo-Swiss Training Centre (ISTC), a constituent unit of CSIR-Central Scientific Instruments Organization (CSIR-CSIO) awards Engineering Diploma and Advanced Diploma to the students. During these courses, emphasis is laid on practical training to build up skills.

The course contents cater to the demand of all major industries dealing in Mechatronics, Electrical, Design & Manufacturing, Die & Mould, Electrical, Design & Manufacturing, Die & Mould, Electronics and Mechanical Engineering.

At present, ISTC alumni hold senior positions across the globe. Around 25% of the ISTC graduates have established their own industries and are thus generating employment. The institute is of National importance for imparting technical skills and education. ISTC has the mandate to nurture future leaders for Science & Technology through a combination of innovative and novel curricula, pedagogy and evaluation.

Narinder S Jassal, Principal ISTC
nsjassal@csio.res.in

The institute aims to produce young technical personnel with sound practical knowledge to fill the gap between the engineer/designer and the skilled worker. During the course, all the trainees are required to work on the machines individually and are given hands-on training to execute industrial jobs as well as prepared to face the challenges in real life work environment. A rigid system of performance evaluation has been devised by the institute to maintain the quality of the training. At present, ISTC is offering the following skill based training programmes:

S. No.	Name of Programme	Duration	Intake in 2021-22
1.	Advanced Diploma in Die & Mould Making	4 Year	30
2.	Advanced Diploma in Mechatronics & Industrial Automation	4 Year	30
3.	Diploma in Electronics Engineering	3 Year	60
4.	Diploma in Mechanical Engineering (Tool & Die)	3 Year	60
	Total Intake During 2021-22		**180**

The various activities carried out by CSIO-ISTC during the year 2021-22 are as follows.
56th Convocation of ISTC
The 56th Convocation of ISTC was held on 13th August, 2021 at CSIR-CSIO. **Prof. Arvind, Vice-Chancellor, Punjabi University, Patiala (Punjab) graced the event as a chief guest.** A total of 132 students (including 54 students of Mechanical Engineering and 50 students of Electronics Engineering, 15 students of Die & Mould Making, 13 students of Mechatronics & Industrial Automation) received their diploma certificates.

The total number of graduate students as well as the winners of gold and silver medals in the various courses of the session 2021-22 are mentioned below:

Diploma in Mechanical Engineering (Tool & Die) graduates students : 54
Director's Gold medal : Shivansh
Principal's Silver medal : Deepanshu
Diploma in Electronics Engineering graduates students : 50
Director's Gold medal : Abhishek Kumar
Principal's Silver medal : Sakshi
Advanced Diploma in Die & Mould Making graduates students: 15
Director's Gold medal : Akshay
Principal's Silver medal : Himanshu Mahajan
**Advanced Diploma in Mechatronics & Industrial Automation : 13
graduates students**
Director's Gold medal : Rupesh Batra
Principal's Silver medal : Priyam Gupta

**Prof. S. A. Ramakrishna, Director CSIR-CSIO awarded Diploma to graduate
Student during 56th Convocation of ISTC on 13th August, 2021**

**Chief Guest Prof. Arvind, Vice-Chancellor, Punjabi University, Patiala (Punjab) presenting medal to graduate
student during 56th Convocation of ISTC**

**Mr. Narinder Singh Jassal, Principal ISTC presented model of Canon manufactured by ISTC trainees to Chief
Guest during 56th Convocation of ISTC on 13th August, 2021**

ISTC Entrance Exam-2021

Entrance exam was successfully conducted on 29th August, 2021 at two centres (CSIR-NPL, New Delhi and CSIR-CSIO, Chandigarh). A total of 392 candidates appeared out of 459 (Registered Candidates- 524) for the examination. All the SOPs related to COVID19 were followed during the examination.

Students appearing for ISTC Entrance Exam-2021 on 29th August, 2021

ISTC Admission-2021

Admissions Counseling for ISTC courses with a total intake of 180 seats for the session 2021-22 were held at CSIO-ISTC on 28th & 29th September, 2021. As part of the CSIR-CSIO, ISTC offers AICTE approved diploma courses in Electronics and Mechanical Engineering with an intake of 60 seats in each course and advanced diploma courses in Mechatronics & Industrial Automation and Die & Mould Making with an intake of 30 seats in each course. A total of 524 candidates applied for ISTC Admission-2021 for admission to 180 seats.

A total of 176 students were admitted for the session 2021-22 on the basis of the merit of ISTC Entrance Exam-2021.

Students appearing for Admissions Counseling on 28th & 29th September, 2021

ISTC Campus Placements

With the sincere efforts of the placement team, headed by Sh. PK Manjhi, Sr. Tech. Officer (3) various reputed companies visited ISTC and led to the campus placements of nearly all the eligible students with the highest package of Rs. 8.00 lakh per annum.. The remaining students opted for higher studies.

NCC Activities at ISTC

The NCC activity is compulsory and regular activity for the ISTC students. The NCC Cadets have attended Annual Training Camps at the National level. The highlights of the NCC activities during the year 2021-22 are listed below:

- One Cadet attended combined ATC from 14th to 20th February, 2022.
- 7 cadets attended ATC from 13th to 17th December, 2021 at GMSSS-47 Chandigarh.
- Harshit Kumar was selected for DCAT, Pre-RDC-1 and Pre-RDC-2 Camp from 18th November, 2021 to 17th December, 2021 at NCC Academy Ropar.
- ANO was detailed for Directorate Combined Annual Training Camp at NCC Academy Ropar from 18th to 27th November, 2021.
- 25 cadets attended ATC from 7th to 14th September, 2021 at NCC academy ROPAR.
- Cadets also participated in various other activities such as Fit India Freedom Run, Cleanliness drive, International Yoga Day, Nashe se Azadi awareness drive, etc.

National Service Scheme (NSS) Activities at ISTC

ISTC NSS Cell conducted various online awareness social activities includes plays, lectures, etc. to create awareness amongst the students of ISTC. The following activities were performed by NSS Voluntaries:

- AIDS Awareness Day on 1st December 2021.
- Pledge on "Beti Bachao, Beti Padhao" on 2nd March, 2022.
- Women's day celebration on 8th March, 2022.
- Online Program 'Azadi Ka Amrit Mahotsav' on 2nd March, 2022.
- Women's day was celebrated with the interaction of Principal ISTC with the girl student on the occasion of Women's Day Celebration on 8th March, 2021 At present. ISTC has good strength of girl students and ISTC looks forward to increasing this strength.

Student Induction program organized at ISTC

The Student Induction Program was organized from 25th to 29th October, 2021. The five days long induction program included expert talks on various themes, like awareness lectures on fire safety and disaster management, importance of time management, yoga, awareness lecture on Traffic rules by Chandigarh Police, motivational lectures by alumni & ISTCOSA, human values and stress free life. The students were introduced to the Principal, Registrar, Head of the departments and all the members of the academic fraternity of ISTC. The program also included various sessions to make the students aware about the functioning of the institute like Academic

Rules, Extracurricular activities like sports, NCC, NSS E-Yantra Cell, Robotics Club, ISTC Innovation Council.

ISTC Day-2021 Celebrations

To welcome the new batch of 2021 in ISTC, a cross country race, a street play and a scintillating cultural program was organised by first years students on 10th December, 2021.

ISTC Innovation Cell

Ministry of Education established 'MoE's Innovation Cell' with the mandate to work closely with Higher Education Institutions (HEIs) to encourage the creative energy of our student population to work on new ideas and innovation as well as promote them to create start-ups and entrepreneurial ventures. Following the guidelines of MoE, Institute's Innovation Council has been established at CSIO-ISTC since October 2018. The cell has conducted the yearly calendar activities of MoE's Institution's Council with more than 30 webinars/workshops on the themes of Innovation, IPR, Design & Entrepreneurship; alongwith this self-driven activities were organized under the leading role of Mr. Harsh Kumar, Technical Officer.

National Skill Competition-2021

ISTC students participated in 13 various skill based Chandigarh State level skill competition such as CNC Milling, CNC Turning, Industrial Control, Joinery, Plastic Die Engineering, Welding, Mobile Robotics, Mechatronics, Electrical Installations, Electronics, Industrial Control, Prototype Modeling, Hair Dressing. In all these competitions, 19 students of ISTC received prizes in various skill trades.

India Skills Competition Regional- 2021 conducted at Chandigarh

CSIO-ISTC organised "North Skill India Competition-2021" from 15th to 18th November, 2021 in which students of 8 States & 2 UTs participated in various skill trades. The ISTC had conducted 16 skill trades, the highest amongst the partner Institutes in the competition on behalf of NSDC.

5 ISTC students won various positions/medals in the region and were selected for National Level Skill Competition (India Skills-2021) in 5 different Niche Skill trades namely:

1) In CNC Milling: Navam won 1st Position
2) In Industrial Control: Manav Middha won 2nd Position
3) In Joinery: Gurveer Singh won 2nd Position
4) In Plastic Die Engineering: Parveen Kumar won 2nd Position
5) In Prototype Modeling: Gourang Mishra won 2nd Position

ISTC Winners of "North Skill India Competition-2021" from 15th to 18th November, 2021 held at Chandigarh

Glimpses of "North Skill India Competition-2021" from 15th to 18th November, 2021 conducted at CSIO-ISTC, Chandigarh

National Skill Competition (India Skills Competition – 2021)

ISTC student Mr. Manav Midha won the Gold medal in the skill trade of 'Industrial Control' during "National Skill Competition-2021" held at New Delhi from 6th to 10th January, 2022. Now, He will represent India in World Skill Competiton-2022 in the trade of 'Industrial Control' that is to be held in Shanghai, China.

Mr. Manav Midha, ISTC student, won the Gold medal in the skill trade of 'Industrial Control' during "National Skill Competition-2021"

ISTC students participated in India Skills Competition – 2021 in 13 skill trades. They won various positions/medals as listed in the following table:

Sr. No.	Name of ISTC Student	Name of the Skill	State position	Regional Position	National Participant (Y/N)	National Position
1.	Gaurav Sokhal	CNC Milling	2nd	-	N	
2.	Navam	CNC Milling	1st	1st	Y	
3.	Harish Godara	CNC Turning	1st	-	N	
4.	Ritesh Godara	CNC Turning	2nd	-	N	
5.	Manav Middha	Industrial Control	1st	2nd	Y	**Gold Medal (1st)**
6.	Gurveer Singh	Joinery	2nd	2nd	Y	
7.	Karanveer Singh	Plastic Die Engineering	1st	-	N	
8.	Parveen Kumar	Plastic Die Engineering	2nd	2nd	Y	
9.	Rahul Sirswal	Welding	2nd	-	N	
10.	Rupesh Batra	Mobile Robotics	1st	-	N	
11.	Paras Mittal	Mechatronics	1st	-	N	
12.	Mohit Bhatt	Mechatronics	2nd	-	N	
13.	Hrithik Sharma	Electrical Installations	1st	-	N	
14.	Ajay	Electrical Installations	2nd	-	N	
15.	Anirudh Panwar	Electronics	2nd	-	N	
16.	Yogesh Sharma	Industrial Control	2nd	-	N	
17.	Anmol Kumar	Prototype Modeling	1st	-	Y	
18.	Gourang Mishra	Prototype Modeling	2nd	Directly qualifiedfor national	Y	
19.	Kuldeep	Hair Dressing	2nd	-	N	
	Total Positions Won by ISTC Students		**19**	**4**	**5**	**1**

Renowned Visitors at ISTC

Various dignitaries, academicians, Researchers, industrialist, alumni, foreign representatives visited ISTC during the year 2021-22. They all appreciated the skill development activities of ISTC and its contribution towards national growth as well as for the upliftment of society. They also praised the state-of-the-art facilities created and maintained in the areas of Mechanical, Manufacturing, Die & Mould and Mechatronics & Industrial Automation.

1. Prof. Arvind, Vice-Chancellor, Punjabi University, Patiala (Punjab) visited ISTC on 13th August, 2021. He was impressed with the teaching pedagogy , practical training and facilities at ISTC.

Prof. Arvind, VC, Punjabi University, Patiala (PB) visited ISTC on 13th August, 2021

Alumni of Batch-1977 of ISTC

2. Reunion of ISTC Batch-1981

ISTC Batch-1981 celebrated its 40th jubilee of graduation & reunion on 25th September, 2021. Two following ISTC alumni visited the Centre on 24th September, 2021 and revived the memories of their golden student days:

- Mr. Ashutosh Khosla, Roll No. 8129, completed his Diploma in Instrument Technology from ISTC in 1981 and is currently President, Sales, Service & Marketing, Force Ltd.
- Mr. Vipin Sharma, Roll No. 8131, completed his Diploma in Instrument Technology from ISTC in 1981 and is currently Head, Quality, Subros Ltd.

ISTC Alumni of Batch-1981 visited the Centre on 24th September, 2021

ISTC Batch-1981 celebrates reunion on 25th September, 2021

Industrial Visits of ISTC Students

ISTC Students visited Bharat Electronics Limited (BEL), Ministry of Defense, Panchkula which oraganised week long celebrations of "Azadi ka Amrit Mahostav" for showcasing products manufactured at Panchkula unit for defense and non-defense customers and their focus towards Atma Nirbhar Bharat.

Glimpses of Industrial Visits of ISTC Students at BEL, Panchkula

Workshops organised at ISTC:

To enhance the knowledge of faculties and students, number of workshops were organised at ISTC during the year 2021-22.

1. 3-weeks "Soft Skills Techniques" Workshop

Workshop was conducted successfully from 1st to 23rd March, 2022 at ISTC, CSIR-CSIO Chandigarh in collaboration with Mahindra and Mahindra group for final year ISTC students. A valedictory function was organised on 23rd March, 2022 to distribute prizes to best performers during the workshop by Mahindra and Mahindra group and Sh. Pawan Kumar, was Chief Guest for prize distribution ceremony. Ms. Jyotsana Gupta, Soft Skills Trainer, M&M Group & Naandi Foundations had delivered their knowledge's/ Skills.

3-Weeks Workshop conducted successfully from 1ˢᵗ to 23ʳᵈ March, 2022 at CSIO-ISTC with collaboration of Mahindra & Mahindra Group

2. **Regional Skills Conference Chandigarh-2021 on "Education, Skill Development and Employment"**

   The Regional Skills Conference Chandigarh-2021 on the theme "Education, Skill Development and Employment " wasconducted on 16ᵗʰ November, 2021 at the CSIR-CSIO, Chandigarh during India Skills Regional Competition-2021(North). The academicians, industrialists, NSDC officials, representatives of SSCs, and othersattended the this workshop.

Regional Skills Conference Chandigarh-2021 on "Education, Skill Development and Employment" on 16ᵗʰ November, 2021 at the CSIR-CSIO, Chandigarh

3. **One Day workshop on "Drone Technology"**

   One Day workshop was conducted on "Drone Technology" on 12ᵗʰ October 2021 along with IETE, Chandigarh and CEC, Landran, Mohali for ISTC students at IETE Chandigarh Centre.

**Workshop on "Drone Technology" organised on
12th October 2021 for ISTC students at IETE, Chandigarh**

4. Ideathon Challenge won by ISTC student

ISTC student Anmol Wadhera (2019-096) secured first position in the Ideathon Challenge for his project 'Brain Controlled Bionic Arm'. This was held by the Department of Electronics and Communication Engineering and Electronics Projects Club (EPC) of the CGC Landran (PB) at the National Level Technical Fest 'Spectrum-2K22' on 17th & 18th February, 2022.

**ISTC students Anmol Wadhera (2019-096) and Sunil Kumar (2019-105)
participated in technical competition**

Trade Tests of Regular Recruitment of CSIR lab at CSIO-ISTC

CSIO-ISTC has the state-of-the-art facilities in the areas of Electronics, Electrical, Computer and Mechanical. The trade tests for various regular posts of Technical officer, Technical Assistant, Technician in different engineering filed was conducted at ISTC of CSIR lab. The trade test for the recruitment of regular posts of Technicians of CSIR-Central Mechanical Engineering Research Institute (CSIR-CMERI), Durgapur (West Bengal) was conducted at CSIO-ISTC, Chandigarh from 26th to 28th November, 2021. The trade test was conducted successfully in trades of 'Machinist' and 'Electrical' fields.

Awards/ Achievement:

1. ISTC Received Appreciation Award

ISTC received Appreciation Award from NSDC, MSDE for the excellent contributions to conduct successfully "North Skill India Competition-2021" from 15th to 18th November, 2021 in which students of 8 States and 2 UTs participated in various skill trades. The

ISTC had conducted 16 skill trades, the highest amongst the partner Institutes in the competition on behalf of NSDC.

2. उपेंद्र कुमार वरिष्ठ तकनीकी अधिकारी (3) ने विज्ञान पर हिन्दी मे सेमिनार प्रतियोगिता में द्वितीय पुरस्कार प्राप्त किया सेमिनार का विषय "उद्योग 4.0" (Industry 4.0) था । यह पुरस्कार हिन्दी दिवस समहरोह पर 14 सित्म्बर 2021 को दिया गया था ।

3. Mr. Harsh Kumar contributed in India Skills Competition – 2021 as Jury member in the skill trade of 'Additive Manufacturing' during following events:
   - India Skill Regional Competition held at CSIO-ISTC, for the skill trade- Additive Manufacturing (November 2021).
   - India Skill National Competition held at AKGEC, Ghaziabad for the skill trade- Additive Manufacturing (January 2022).
   - Mentoring in the Boot Camp at AKGEC, Ghaziabad for the participants in the National competition in skill - Additive Manufacturing.

Contribution of ISTC in Other Projects
ISTC is also involved in different projects for various organisations like DST, DSIR, AICTE, Govt of India and others.

➢ **Training & Apprenticeship Cell**

During the year, 140 B.Tech, M. Tech., M.Sc and other students joined for industrial training at CSIR-CSIO in various departments. The training period ranged from six weeks upto one year for M.Tech students.

➢ **AICTE Sponsored Project**

The AICTE, New Delhi has approved lab development project "Establishment of IOT Lab" under MODROB-Polytechnic scheme with total project cost of Rs 10.00 lakh. After development of IOT lab, ISTC students will get the practical training on Industrial IOT applications.

➢ **DST Project "Publication of Directory of Scientific Instruments and Component Manufactured in India"**

DST sanctioned the project entitled "Publication of Directory of Scientific Instruments and Component Manufactured in India" to CSIR-CSIO, Chandigarh. DST has sanctioned the above project in March 2017 with a total cost of Rs. 46.00 lakh. The main objectives of this project are to make a database in form of Directory of Scientific Instruments and Components Manufactured in India with following information:
   - Overview of Instruments Industry in India
   - Classified list of Instruments and components and their manufacturers
   - Alphabetic list of instrument and components manufacturers
   - State wise instruments and components manufacturer profile
   - Web based directory link to promote online trading
   - Web based link information to promote export of Indian instruments
   - Hard copy alongwith CD

Findings/ Summary and Recommendations: The data of Scientific Instruments & Components Manufactured in India have been summarized as follows on 31st December, 2021:
   - No. of states/UTs registered: 23 states and 3 UTs
   - No. of industries registered: 3980

- No. of Registered Users: 4779
- No. of scientific instruments/products registered: 13679
- Most of the companies registered have ISO certification and a few are ISA certified.

End project Deliverables: Database on Scientific Instruments & Components Manufactured in India, that inter-alia includes the following:

- Details about instruments and components manufacturers including name of industry addresses, telephone numbers, fax numbers, E-mails and websites, names of Chief executives, scale of operations, quality certifications, etc.
- Instruments and components manufactured in India with corresponding Harmonised System (HS) Code Nos.
- Website of scientific directory having a complete detail of the registered scientific companies and products. Indian manufacturers can also update the details. https://sdirectory.csio.res.in/
- Web based link information to promote export of Indian instruments.

➢ **DSIR-TePP Outreach cum Cluster Innovation Centre (DSIR-TOCIC) at CSIR-CSIO**

❖ **Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM)**

PRISM scheme has been re-launched by the Department of Scientific & Industrial Research (DSIR), New Delhi for the next 5-years i.e. upto 31st March 2026. The main motive of PRISM scheme is to tap the vast innovative potential of the citizens of India and to develop technology solutions aimed at helping MSME units in Clusters. It is a mechanism to promote individual innovators to become technology based entrepreneurs (Technopreneurs) and to develop technology solutions.

❖ **PRISM Activities at DSIR-TOCIC, CSIR-CSIO Centre during the year 2021-22:**

No. of activities has been initiated at CSIR-CSIO for the publicity of PRISM scheme in this region.

DSIR-TOCIC, CSIR-CSIO Centre was ranked 2nd among all twelve TOCIC centers opened by DSIR throughout India to promote PRISM scheme during TOCIC Review Meet for the year 2021-22.

❖ **The following new Linkages were established with Institutions in the regions to promote the PRISM scheme:**
   ➢ Association with **Regional Centre of Entrepreneurship Development (RCED),** Chandigarh to promote the PRISM Scheme.
   ➢ Association with **Software Technology Park of India (STPI), Mohali** to promote the PRISM Scheme.
   ➢ Association with **Startup Punjab** to promote the PRISM Scheme.
   ➢ Association with **Chandigarh Region Innovation and Knowledge Cluster (CRIKC)**, Chandigarh to promote the PRISM Scheme.
   ➢ Association with **Atal Community Innovation Centre (ACIC) RISE Association**, Chandigarh Engineering College, Landran, Mohali to promote the PRISM Scheme.
   ➢ **Technology Enabling Centre, Panjab University, Chandigarh** to promote the PRISM Scheme.
   ➢ Association with **Technology Business Incubator-Indian Institute of Integrative Medicine, CSIR-IIIM, Jammu** to promote the PRISM Scheme in J & K region.

➢ Association with **R & D Centre for Bicycle & Sewing Machine, Ludhiana, Punjab** to promote the PRISM Scheme.

PRISM Awareness Camp & Academia-Industrial Meet organised during the Machine Expo, Ludhiana by DSIR-TOCIC, CSIR-CSIO on 12th March, 2021

➢ **PRISM Awareness Camp organised at Regional Science Congress 2021-22 at Jawahar Navoday Vidhyalay (JNV), Mohali, Punjab** by DSIR-TOCIC, CSIR-CSIO, Chandigarh on 3rd January, 2022. The school children (6th to 12 classes) attended this camp from schools located in Punjab, Haryana, HP, Chandigarh, J&K.

PRISM Awareness Camp organised at Regional Science Congress 2021-22 at Jawahar Navoday Vidhyalay (JNV), Mohali, Punjab on 3rd January, 2022

➢ **PRISM Awareness lecture organised at IIT, Jammu on** 16th & 17th December, 2021. The faculties, students, PhD scholar attended this lecture.

PRISM Awareness lecture organised at IIT, Jammu on 16th & 17th December, 2021

- **CSIR Integrated Skill Initiative Program**

    ISTC and CSIR-CSIO are engaged in conducting industry oriented training/ skilling programmes that have been well accepted by users. In view of the Government Policy on Skill Mission, CSIR in its Platinum Jubilee Year initiated a major programme on "CSIR Integrated Skill Initiative" across various CSIR labs. The aim of the project is to equip young minds with the necessary technological skills through exposure to research laboratories at national facilities that will address the critical need for the technical skill gap created by the enormous usage of advanced technology. The purpose of CSIR Integrated skill initiative is to encapsulate all CSIR skill/training programme under one umbrella which will cater to diverse cross section of people at various levels beginning with school dropouts to Farmers to ITI diploma holders to graduates.

    After the successful completion of Phase-I of CSIR Integrated Skill Initiative programme, CSIR has re-launched 2nd phase of CSIR-ISI programme for next five years i.e. upto 31st March, 2025. The various skill oriented course, industry sponsored programme, semi sponsored skill/training programme, NSDC (Skill Councils) aligned programme, societal skill/training programmes, others skill training programme, etc. were conducted. In the year of 2021-22, CSIR-CSIO conducted a total 47 training programs in offline and online in which total 3370 trainees from different States & UTs were trained in different domain areas like Engineering (Mechanical/Electrical/ Electronics/Robotics & Industrial Automation), Entrepreneurship, Solar Energy, Bio-Medical, Health & Safety, IOT, AI, etc. on pan India basis. Among all these trainees 2380 belong to urban area and 990 belong to rural area.

Academy of Scientific & Innovative Research (AcSIR)
CSIR-CSIO Chandigarh Campus

Dr. Vinod Karar
vkarar@csio.res.in

CSIR-CSIO Chandigarh is a participating lab of Academy of Scientific & Innovative Research (AcSIR) since its inception. AcSIR was established in 2010 (by a resolution of GOI on July 17, 2010) and formalized by an Act of Parliament vide The Gazette of India (dated February 7, 2012) and notified on April 03, 2012 as an Institution of National Importance.

AcSIR CSIR-CSIO Chandigarh Campus

The mandate is to undertake high quality teaching and advanced research in frontier areas of Science and Technology with a mission to create highest quality personnel with cross-disciplinary knowledge, aiming to provide leaders in the field of science and technology. The AcSIR-CSIO Chandigarh campus offers courses in PhD (Sciences), Direct PhD (Sciences), Sponsored PhD (Sciences), PhD (Engineering), Integrated Dual-Degree PhD (IDDP) Program and M.Tech in Advanced Instrumentation Engineering. The broad expertise includes avionics, optics & photonics, nanoscience, nanotechnology & nanophotonics, advanced materials & sensors, optical devices & systems, multi-sensors & computational instrumentation, seismic sensors & systems, ubiquitous analytical techniques, bio-medical engineering & instrumentation, Agrionics, precision mechanical systems, etc.

Currently, about 200 Ph.D. and M.Tech students are enrolled with AcSIR at CSIR-CSIO, admissions are conducted twice a year and CSIO scientists serve as AcSIR faculty.

A. ***Major Milestones During 2021-2022 are as Under:***

- Nos. of Colloquium held : 16

- Nos. of Thesis submitted : 12

- Nos. of Students enrolled in August 2021 Session : 18

- Nos. of Students enrolled in January 2022 Session : 05

- Nos. of Students awarded by Ph.D. degree : 16

B. ***Following Students Successfully Defended their Ph.D. Theses:***

1. Mr. Javed Ahmad
2. Mr. Ratan Das
3. Mr. Rajiv Dubey
4. Mr. Bir Bahadur Sherpa
5. Mr. Mayank Garg
6. Mr. Gaurav Singhal
7. Mr. Manish Kalra
8. Ms. Anupma Thakur
9. Ms. Priyanka

10. Mr. Shivanshu Goel
11. Mr. Lingaraj A. Hadimani
12. Mr. Viney
13. Ms. Harmeet Kaur
14. Mr. Sandeep Singhai
15. Mr. Vishal Shrivastav
16. Mr. Virender Singh

CSIO OPTICA Student chapter activities 2021-2022

Various experimental demonstrations have been organized by the CSIO OPTICA Student chapter this year. Scientific Quiz Contests and games with lasers were held for schools and undergraduate students on the occasion of:
• National Science Day
• CSIR-Foundation day
• CSIO- Foundation day
• National Technology Day
• International Day of Light.

National Science Day

National Technology Day

International Day of Light

IEEE AcSIR-CSIO Students Branch Activities 1st April, 2021 to 31st March, 2022

- IEEE Virtual Talk Series 2021 on Physical Metallurgy of Advanced Steels for Green Future Scientific and Technological Innovations on 23rd April 2021

- Hindi Talk on COVID-19 Vaccination titled "टीकाकरण पर संदेय सत्र: मिथक और तथ्य" on 5th May 2021.

- Celebrating International women in Engineering (WIE) day 2021: IEEE Virtual Talk Series 2021 on Value of Intellectual Property Rights for Researchers and Innovators on 23rd June 2021.

- IEEE SPS Summer School on "Deep Learning for Sensor Analytics" from 2nd August to 6th August 2021.

- IEEE membership drive on Oct 29, 2021.

- Joining of newly elected IEEE Team on 21st January 2022.

- Celebration of National Science Day: Experimental Demonstration for School Students and organized quiz contest on 28th February 2022.

- Celebration of International Women's Day on 8th March 2022

    - Keynote Lecture on *"Gender Equity in Academia and Entrepreneurship"*

    - Panel discussion, the theme of the panel discussion on *"Challenges for women in leadership and decision-making spaces"*, *Prachi Rajput, Chair volunteered to be a part of this discussion.*

    - Photography Contest on the theme of *"Women Empowerment"* Discussion.

Awards & Honours

Honours/ Awards

Dr.Satish Kumar
- Awarded IETE Hari Ram ji Toshniwal Award 2021
- Appointed as Board member of School of Engineering & Technology, Central university of Punjab, Bhatinda

Dr.Aparna Akula
- Awarded IET India Young Woman Engineers Award 2021
- Featured in the 2022 Indian Women, Transgender and Non-binary Persons in Science Calendar, amongst 50+ contemporary women, transgender and non-binary persons working in STEM in India brought out by TheLifeofScience.com.

Dr.Ripul Ghosh
- Received Outstanding Reviewer Recognition 2021 award by IEEE Instrumentation and Measurement Society

Dr.Rishemjit Kaur
- Received fellowship from ICML-2021 to organise WiML sessions on deep learning techniques for natural language processing
- Selected as a member of prestigious Indian National Young Academy of Sciences (INYAS), under INSA

Dr.Raj Kumar
- Awarded IETE-Lal C Verman Award 2021

Dr.Vinod Karar
- Awarded IEEE India Council Technologist of the Year 2021
- Awarded IEEE TEMS India's Engineering Manager of the Year 2021
- Serving as Senate Member, IIIT Una
- Contributing as Member, Experts Advisory Group of Device Development Programme under Technology Development & Transfer Division
- Contributing as Chairman, Optics and Photonics Sectional Committee, BIS.

Mr. Naveen Sharma
- Received Best Paper Award in the category of 'Data Science Challenges' at International Conference on Data Science and Applications ICDSA-2022.

IMCS Group
- "Best Poster" award for poster presentation entitled "A review of Air Quality Index Models" at the 1st International Conference on Pollution Prevention and Clean Technologies (ICPPCT) & Taiwan-India Workshop on Emerging Environment and Energy Challenges of Technology Exchange from December 6th to 7th at IIIT-D, New Delhi, India.

Dr.Suman Singh
- Among top 2 % of scientists worldwide, database compiled by Stanford University in Association with Elsevier based on research publications, 2021

Dr.Akash Deep

- Among top 2 % of scientists worldwide, database compiled by Stanford University in Association with Elsevier based on research publications, 2021
- Received Ranking 100 in 1st edition of top scientists (India) ranking for Chemistry by Research.com
- Received Ranking 60 in 1st edition of top scientists (India) ranking for Material Science by Research.com

Dr.Pooja Devi

- Received Haryana Yuva Vigyan Ratan Award
- Awarded with NASI- Young Scientist Platinum Jubilee Award (2021)
- IEI Young Engineer Award (2020-21) (Material Science)
- Featured Article on 'Thought Leader' by AzoMaterials on International Women Day 2022.
- Selected as Governing Council Member of Electrochemical Society of India.
- Selected as Member, National Academy of Science in India (2021)
- Elected as core committee member of Indian National Young Academy of Science (2022)
- Featured in STEM Women Asia: An initiative by Women in Science and Engineering (WISE) Committee of the Association of Academies and Societies of Sciences in Asia (AASSA). Link: https://stemwomen.asia/profile/pooja-devi.
- Covered under "We THE SCIENTISTS" compendium, released by Prof. Rohini Godbole and Prof. Ram Ramaswamy, 7th March 2022. (Link: https://www.youtube.com/watch?v=Wuzx6FXs3Zs)
- Featured under #365IndianWomeninSTEM Series by TheLifeofScience.com's

Dr. Inderpreet Kaur
- Research highlighted by Nature India, Nov 2021.

Dr.Sethuraman
- Received the Best Scientist Award for his contribution in the field of Engineering and Technology from PEARL Foundation for Educational Excellence, Madurai.

Dr. Neha Khatri
- Awarded with INAE Young Engineer Award 2021 for notable contribution in the area of ultra-precision machining
- Awarded with "Raman Research Fellowship" for the year 2021 to carry out Research at College of Optical Sciences, University of Arizona, Tucson, USA
- Awarded with "Serb Women Excellence Award" given by Science and Engineering Research Board (A statutory body under Department of Science & Technology)
- Selected as Young Associate of Indian National Academy of Engineering

Dr. Vijay Kumar Meena
- Received Best Paper Presentation Award at International Conference on Industrial and Manufacturing Systems (CIMS-2021), November 11-13, 2021, Department of Production and Industrial Engineering, Punjab Engineering College, Chandigarh

Dr. Manoj K Patel
- Recipient of COVID-19 Ignition Grant 2020 by United States - India Science and Technology Endowment Fund (USISTEF) in collaboration with Rite Water Solutions (I) Pvt. Ltd., Nagpur, India and University of Florida, USA.
- Fellow, Indian Social Science Academy (ISSA), Allahabad 2021-2022.
- Fellow, The Institution of Electronics and Telecommunication Engineers (IETE), 2021-2022.
- Selected for the prestigious National Academy of Sciences, India (NASI) membership under the physical sciences, 2021-2022.
- Member, Electrostatics society of America, USA, 2021-2022.
- Member, Board of Studies (BOS), Department of Electronics and Communication Engineering (ECE), NIT Jamshedpur.

MAJOR EVENTS

C. **EVENTS**

- IEEE SPS Summer School on 'Deep Learning for Sensor Signal Analytics' sponsored by the IEEE Signal Processing Society has been organized in association with IEEE Women in Engineering Affinity group of IEEE Student Branch AcSIR-CSIO, Chandigarh during 2-6, August 2021, as a virtual event.
- CSIR-CSIO, CSIR - IITR and IIT Ropar - AWaDH have jointly organised a webinar series on "Food quality analytics and the Role of AI" during February 22-25, 2022 in the framework of national initiative of 'Vigyan Sarvatra Pujyate
- CSIR-CSIO has organized 'Dr. R.S. Khandpur Memorial Inaugural Lecture' by Prof. K. VijayRaghavan, PSA in association with CDAC Mohali on 15th April 2021
- Organised National Science Day, under the umbrella of ACS International Student Chapter at CSIR-CSIO
- Organised for the celebration of International Women's Day
- Organised One day 1st Bilateral Meeting on Smart Materials for Energy and Environmental Technology (Smart MEET-2022), jointly with INST, Mohali on 25th March 2022.
- Organised a Doubt Clearance Session on Vaccination: Myths and Facts" (5th May 2022)
- Coordinated IISF Curtain Raiser event, **Science Creativity for the Future Theme**, organised by CSIR-CSIO under the banner of IISF 2021, 2nd December 2021
- Organised, National Symposium on Electrochemical Science and Technology, NSEST-2022 as Co-Convener. (Scheduled June 23-25, 2022)
- Organised session on Introduction to JIGYASA Virtual Lab, April 2021 under Let's Talk Science Series 2.0.
- Coordinated, CSIO Virtual Tour and Talk in VIGYAN MANTHAN YATRA '' under Mission Excellence Programme being organized by Madhya Pradesh Council of Science and Technology (MPCST)
- Coordinated, Jalkatha: Inclusion of CSIO Technologies on Water-Related Vedios under Tech4Seva Event
- Coordinated, Virtual Webinar Series, Let's Talk Science 2.0: What, Why, and How? under CSIR-JIGYASA program.
- Coordinated, Open Discussion on Experience Sharing by Women Scientist, International Day for Women and Girls in Science, 11th Feb 2022.
- Coordinated, Comics and Energy Theme, JIGYASA VIGYAN MAHOTSAV 2022 Competition, CSIR JIGYASA.
- Dr Sethuraman organised one day training programme from CSIO Chennai Centre in association with ISTC, Chandigarh on "Solar Energy / Renewable Energy Smart Technologies" under CSIR Integrated Skill Initiative Programme on 30th June 2021.
- Technologist & Industrialist Meet & Expo 2021 Winter Edition (TIME-2021) was organised at Amrita School of Engineering, Coimbatore in association with Amrita Vidya Vishwa Peetam, Coimbatore on 2nd December 2021. Around 60 industrials and academicians (faculties & research scholars) participated from different parts of India. Technologies of CSIO Chennai Centre were exhibited. TIME-2021 Winter Edition has created a good impact on the industries and attracted more industrial handshakes with CSIO Chennai Centre.
- Organised State level mentorship workshop for the winners of INSPIRE Awards-MANAK 2022 on May 05-06, 2022 at CSIR-CSIO, Chandigarh.

a. Distinguished visitors to the lab:

- Air Marshal RKS Shera visited iSenS Division on 21st Sept 2021 to interact with scientific staff towards the R&D opportunities
- Dr. Manjit Singh Ex-Director, DRDO-TBRL, Ramgarh visited iSenS on 22nd Sept 2021 to interact with scientific staff towards the opportunities in the strategic area mainly for 'Unattended Ground Sensing System'
- Prof. K N Pathak, Former VC Panjab University, Dr. Girish Sahni, Ex-DG, CSIR; Dr. Satish Kumar, Ex-DG Missile, Ex-Director NIT, Dr. P K Khosla, Director CDAC Mohali has visited CSIR-CSIO to attended lecture by Dr. H K Sardana entitled 'Lessons I learned in AcSIR/CSIR-CSIO' on the eve of his superannuation on 30th Nov 2021
- Vice-Admiral Sandeep Naithani, Chief of Materiel, Indian Navy along with Cmde Nelson D'Souza, NM, Cmde (WE), and Cdr Mahesh Khochare, Cdr (WE) visited IADS on 15th Dec 2021
- Vice Admiral SR Sarma (Chief of Materiel) along with Rear Admiral Sanjay Dutt, ACOM (IT&S), Cmde Nelson D'Souza, NM, Cmde (WE), and Cdr Mahesh Khochare, Cdr (WE) visited CSIR-CSIO on 09th April 2021.
- Vice Admiral SR Sarma (Chief of Materiel) along with Cmde Nelson D'Souza, NM, Cmde (WE), and Cdr Mahesh Khochare, Cdr (WE) visited CSIR-CSIO on 29th May 2021.
- Lt Cdr Akshay Thapliyal, Lt Cdr (WE) visited CSIR-CSIO on 06th Aug 2021.
- Capt Mahesh Khochare, Capt (WE) visited CSIR-CSIO on 20th Nov 2021.
- Lt Cdr Pradeep Attri, Lt Cdr (WE) visited CSIR-CSIO, Chandigarh on 11th Mar 22.
- Prof. Achanta, Director, CSIR-NPL visited CSIR-CSIO.
- Dr. S K Pandey (Member Secretary, DRDO - ARDB, Scientist 'F') and Dr. Ashish Dubey (DMSRDE, DRDO- Kanpur, Scientist 'F') visited CSIR-CSIO.
- Mr. Sachin Kumar Mishra, HiMedia visited CSIR-CSIO on 5th August 2021 for the Technology transfer of Colorimetric Kits and Devices
- Mr. Parikshit Bansal, CEO and Founder, HiSafe Electronics Corporation, Panchkula, India visited CSIR-CSIO.

b. Visits of scientific/technical staff

- Dr. Satish Kumar, Chief Scientist visited the 'Centre for Automotive Technology (iCAT)at Manesar along with Shri Dharam Pal, UT Advisor, Prof Baldev Setia, Director PEC and Prof. Manu Sharma, PU to study and explore the possibilities of 'Tech-Hub' in Chandigarh
- Mr. Mukesh Kumar visited M/s. Chemin Controls Pvt. Ltd., Pondicherry on 12th January 2021. He presented and demonstrated the technologies of CSIR-CSIO such as EMS, e-SENSE and BEMS to the staff members of the Chemin C&I

and explored the possibility of Technology transfers and joining hands together for other combined activity.

- Mr. Mukesh Kumar visited M/s. **Kewaunee Labway Pvt. Ltd., Bengaluru** on 3rd and 4th August **2021. He presented and demonstrated e-SENSE on their site** to the staff members of the **Kewaunee Labway** Pvt. Ltd. and explored the possibility of field trial, Technology transfers and joining hands together for other combined activity.
- Mr. Mukesh Kumar visited **CSIR-IGIB, Mall Road and** conducted energy audit as part of **the project**.
- Mr. Mukesh Kumar visited CSIR-NPL, New Delhi and captured detailed design for the installation of e-SENSE and BEMS.

- Shri Ashish Gaurav has visited Preet Tractor along with team of PU, IIT Ropar and PEC to explore the need of industry towards formation of 'Tech-Hub' in Chandigarh.

Appendices

Patents

1. Title   : Machine for performing doube volume exchange transfusion
    Inventors   : Arindam Chatterjee, Sanjeev Verma, Sourabh Dutta, Dinesh Pankaj, Gurinderjit Singh, Sarbjeet Singh
    Filling Date   : 09/May/2021
    Application No. : 202111020979
    Country   : IN

2. Title   : Air disinfection and purification system for indoor applications
    Inventors   : Nagesh Babu Balam, Tabish Alam, Ashok Kumar, Nishant Raj Kapoor, Chandan Swaroop Meena, Kishor Sitaram Kulkarni, Harry Garg, Supankar Das
    Filling Date   : 22/Jun/2021
    Application No. : 202111028079
    Country   : IN

3. Title   : Method and device for arecanut harvesting
    Inventors   : Sekar Anup Chander, Banibrata Datta, Yash Makwana, Bhupinder Singh, Vhatkar Dattatraya Shivling
    Filling Date   : 30/Jun/2021
    Application No. : 202111029399
    Country   : IN

4. Title   : Modular system and method for the fabrication of paper microfluidic analytical devices
    Inventors   : Abhay Sachdev, Harish Swaminathan, Ishita Matai, Vijayesh Kumar, Sunita Mishra
    Filling Date   : 20/Jul/2021
    Application No. : 202111032728
    Country   : IN

5. Title   : A portable optical device and process for selenium (IV) detection in water
    Inventors   : Pooja Devi, Sudeshna Bagchi, Anupma Thakur, Shipra Singh, Vaibhav Kumar
    Filling Date   : 24/Sep/2021
    Application No. : 202111043409
    Country   : IN

.6 Title   : Cresol derived carbon quantum dots (cr-cqds) based chemo sensor for arsenic detection in water
    Inventors   : Pooja Devi, Anupma Thakur, Manish Kumar

	Filling Date	:	24/Sep/2021
	Application No.	:	202111043408
	Country	:	IN

7. Title : One-step method for the synthesis of reduced graphene oxide using plant based resin (Rosin)

   Inventors : Saurav Kumar, Nandkishore Thombare, Anupma Sharma, Sudeshna Bagchi, Kewal Krishan Sharma, Amol Purshottam Bhondekar

   Filling Date : 05/Nov/2021

   Application No. : 202111050947

   Country : IN

8. Title : AAHAR - A manual handheld multi functional catering system

   Inventors : Neelesh Kumar, Harpreet Singh, Nitin Koundal, Davinder Pal Singh, Keshav Totla

   Filling Date : 08/Dec/2021

   Application No. : 202111057197

   Country : IN

9. Title : Cannulated avascular necrosis (AVN) solid-lattice integrated femur implant

   Inventors : Vijay Kumar Meena, Tarun Panchal, Ramesh Sen, Prashant Kumar, Rahul Bhardwaj

   Filling Date : 29/Dec/2021

   Application No. : 202111061665

   Country : IN

10. Title : Method and system for excitation of whisper gallery mode

    Inventors : Rashmi Achla Minz, Jasleen Kaur, Kaushal Vairagi, Anupama Satyarthi, Varun Kumar Mathuri, Samir Kumar Mondal

    Filling Date : 28/Jan/2022

    Application No. : 202211004683

    Country : IN

11. Title : A transparent breathable antimicrobial and antifogging face mask

    Inventors : Sunita Mehta, Pradipta Samanta, Sunita Mishra

    Filling Date : 10/Feb/2021

    Application No. : 202111005774

    Country : IN

12. Title : Variable height for thrust correction through pressure sensing in electrostatic coating system

    Inventors : Manoj Kumar Patel, Anil Jangra, Ankit Khanchi

	Filling Date	:	07/Apr/2021
	Application No.	:	PCT/IN2021/050343
	Country	:	WO

13. Title : Machine for performing doube volume exchange
transfusion
Inventors : Arindam Chatterjee, Sanjeev Verma, Sourabh Dutta,
Dinesh Pankaj, Gurinderjit Singh, Sarbjeet Singh
Filling Date : 04/Mar/2022
Application No. : PCT/IN2022/050195
Country : WO

Granted

1. Title : A shield braiding machine for coaxial cable to produce a product
    Inventors : Supankar Das
    Grant Date : 07/Apr/2021
    Application No. : 0604DEL2009
    Country : IN

2. Title : A device for sensing the pose and motion of human`s arm hand
    Inventors : Sanjeev Soni, Sanjeev Verma, Dinesh Pankaj, Amod Kumar
    Grant Date : 31/May/2021
    Application No. : 201611009446
    Country : IN

3. Title : Emg based prosthetic arm with automatic position locking and adjustable grip force drive
    Inventors : Arindam Chatterjee, Sanjeev Verma, Harpreet Pal Singh, Supankar Das, Amod Kumar, Kanta Garg, K.S. Rattan
    Grant Date : 24/Feb/2022
    Application No. : 0372DEL2013
    Country : IN

4. Title : Method and system for activity recording, visualisation and analysis for identified segments of forest
    Inventors : Ripul Ghosh, Naga Vara Aparna Akula, Siddhartha Sarkar, Anirudh Vajpeyi, Harish Kumar Sardana, Satish Kumar, Amarendra Goap
    Grant Date : 22/Aug/2021
    Application No. : 319/2018
    Country : BD

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107.	Singh, S., Singh, T., Singh, S. and Awasthi, A.K., 2022. Morphometric characterization and tectonic geomorphology of the upper beas basin, Himachal Himalaya, India. *Himalayan Geology*, *43*(1 B), p.371-382.
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111.	Sundriyal, S., Shrivastav, V., Bhardwaj, S.K., Mishra, S. and Deep, A., 2021. Tetracyanoquinodimethane doped copper-organic framework electrode with excellent electrochemical performance for energy storage applications. *Electrochimica Acta*, *380*, p.138229.
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117.	Thakur, A., Chopra, T. and Devi, P., 2021. Green synthesized Cu@ Carbon quantum dots for histidine and arsenate sensing. *IEEE Sensors Journal*, *21*(15), p.16464-16468.
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120.	Vibhuti, V. and Kumar, N., 2021. Realisation of a virtual reality based remedial module for cognition and hand function rehabilitation. *Journal of Scientific and Industrial Research (JSIR)*, *80*(10), p.887-893.
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122.	Wang, T., Huang, L., Vescovi, M., Kuhne, D., Zhu, Y., Negi, V.S., Zhang, Z., Wang, C., Ke, X., Choi, H. and Pullen, W.C., 2021. Universal dwell time optimization for deterministic optics fabrication. *Optics Express*, *29*(23), p.38737-38757.
123.	Yadav, N., Dass, R. and Virmani, J., 2022. Despeckling filters applied to thyroid ultrasound images: a comparative analysis. *Multimedia Tools and Applications*, *81*(6), p.8905-8937.
124.	Yang, Y., Wu, M., Vázquez-Guardado, A., Wegener, A.J., Grajales-Reyes, J.G., Deng, Y., Wang, T., Avila, R., Moreno, J.A., Minkowicz, S. and Dumrongprechachan, V., 2021. Wireless multilateral devices for optogenetic studies of individual and social behaviors. *Nature Neuroscience*, *24*(7), p.1035-1045.
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126.	Zhang, Y., Zhang, X., Yang, H., Yu, L., Xu, Y., Sharma, A., Yin, P., Li, X., Kim, J.S. and Sun, Y., 2021. Advanced biotechnology-assisted precise sonodynamic therapy. *Chemical Society Reviews*, *50(20),* p.11227-11248.

Books

1. Praveen Kumar and Pooja Devi (Ed.) 2022, "Photoelectrochemical Hydrogen Generation: Theory, Materials Advances, and Challenges", Part of the book series: Materials Horizons: From Nature to Nanomaterials (MHFNN), Springer, 2022, ISSN: 2524-5384.

Book Chapters

1. Abhishek Saha and Arindam Indra, "Photoelectrochemical Water Splitting with Nitride-Based, in book Photoelectrochemical Hydrogen Generation", Theory, Part of the Materials Horizons: From Nature to Nanomaterials book series (MHFNN). Springer, pp 225–248, (2022).
2. Abhishek Anand, Pooja Devi and Praveen Kumar, "Introduction to Hydrogen and World Energy Scenario", Photoelectrochemical Hydrogen Generation: Theory, Materials Advances, and Challenges", Part of the Materials Horizons: From Nature to Nanomaterials book series (MHFNN), Springer, ISSN: 2524-5384. (2022).
3. Vijay Kumar Meena, Prashant Kumar, Tarun Panchal, Parveen Kalra and Ravindra Sinha, "Investigation of Titanium Lattice Structures for Biomedical Implants, Advanced Material for Biomechanical Applications", CRC Press. eBook ISBN-9781003286806, (2022).
4. Neha Khatri, Mukesh Kumar and Ranjan Jha, "Opportunities and Challenges in Medical Robotic Device Development". Advanced Micro-and Nano-manufacturing Technologies, Part of the Materials Horizons: From Nature to Nanomaterials book series (MHFNN), pp 299-313, (2022).
5. Mansi Gupta, Navneet Singh Aulakh and Inderdeep Kaur Aulakh, "Clustering Protocol Based on Game Theory in Heterogeneous Wireless Sensor Networks", Proceedings of First International Conference on Computational Electronics for Wireless Communications, Part of the Lecture Notes in Networks and Systems book series (LNNS), Vol 329, pp 451–464, (2022).
6. Vipender Singh Negi, Harry Garg, R. R. Shravan Kumar, Umesh Kumar Tiwari, Vinod Karar and Dae Wook Kim, "Smoothing effect analysis for Active Fluid Jet Polishing", OSA Technical Digest (Optica Publishing Group, 2021), ISBN: 978-1-943580-88-0, (2021).
7. Bhupinder Singh, Sekar Anup Chander and V D Shivling, "Design and Development of a Climb-Free Telescopic Mechanism for Harvesting from Tall Trees", In Machines, Mechanism and Robotics, Proceedings of iNaCoMM 2019, (2021).
8. Saurabh Kaushik, Pawan Kumar Joshi, Tejpal Singh and Mohd Farooq Azam, "Spatio-Temporal Heterogeneity in Glaciers Response Across Western Himalaya", In Mountain Landscapes in Transition, Part of the Sustainable Development Goals Series book series (SDGS), Springer, pp 185–206, (2021).

9. Krishna Gopalakrishnan, Arun Sharma, Neela Emanuel, Pramod K. Prabhakar and Ritesh Kumar, "Sensors for Non-Destructive Quality Evaluation of Food, Food Chemistry: The Role of Additives", Preservatives and Adulteration, Chapter 13, 397–449. (2021).

10. Mayank Garg, Neelam Vishwakarma, Amit L. Sharma and Suman Singh, "Different types and intense classification of 2D materials", in book series Materials Horizons: From Nature to Nanomaterials, 1st Edition book "Advanced Applications of 2D Nanostructures: Emerging Research and Opportunities", ISSN 2524-5384, Springer, 2021.

Conference Papers

1. **3rd International Conference on Data Science and Applications (ICDSA 2022), Springer SCOPUS, Kolkata, March 26-27, 2022**
   Performance Evaluation of a Novel Thermogram Dataset for Diabetic Foot Complications
   Naveen Sharma, Sarfaraj Mirza, Ashu Rastogi, Prasant K Mahapatra and Satbir Singh

2. **ICACCS 2022: 2022 8th International Conference on Advanced Computing and Communication Systems, Sri Eshwar College of Engineering, Coimbatore, Tamilnadu, March 25-26, 2022**
   Gradient and Color Intensity Based Dense Disparity Estimation using Adaptive Weight Aggregation
   S. Poddar, V. Kumar, H. Sahu and A. Das

3. **Bulletin of the American Physical Society, Chicago, March 14-18, 2022**
   All-dielectric Double Split Ring Metasurface for Structural Colour Generation
   KS Modi, SP Singh, U Tiwari and RK Sinha

4. **3rd International Conference on Aspects of Materials Science and Engineering, Panjab University Chandigarh, March 04-05, 2022**
   Experimental Investigation of Polishing Process for Schott BK-7 Optical Glass
   Pal, R.K., Kumar, M. and Karar, V.

5. **5th IEEE Workshop on Recent Advances in Photonics (IEEE WRAP'2022), SAMEER, Mumbai, March 04-06, 2022**
   Topological Surface State by Hierarchical Concatenation of Photonic Stopbands
   Nitish Kumar Gupta, Aditi Chopra, Mukesh Kumar, Anjani Kumar Tiwari, Sudipta Sarkar Pal, Harshawardhan Wanare and S. Anantha Ramakrishna

6. **Optical Fibers and Sensors for Medical Diagnostics, Treatment and Environmental Applications XXII, San Francisco, California, USA, March 02, 2022**
   Fabrication of D-SPR Biosensor
   Priyanka and Umesh Tiwari

7. **SPIE Photonics West 2022, San Francisco, USA, January 22-27, 2022**
   A Self-Validating Fiber-Optic Surface Plasmon Resonance (FO-SPR) Sensor System
   Aditi Chopra, Girish C. Mohanta and Sudipta Sarkar Pal

8. **DAE-BRNS National Laser Symposium (NLS-30), DAE Convention Centre, Anushaktinagar, Mumbai, January 19-22, 2022**
   Micron-Scale Zero-Order Bessel Laser Beam Generation and Characterization
   P. Praharaj, V. Mishra and M. K. Bhuyan

9. **3rd International Conference on Data Science, Machine Learning & Applications (ICDSMLA 2021), Proceedings by LNEE Springer, Pune, Mandya, December 26, 2021**
    Multilayer Perceptron based Early On-site Estimation of PGA during an Earthquake
    Siddhartha Sarkar, Satish Kumar, Anubrata Roy and Bhargab Das

10. **ITME-2021 International Conference on Innovative Technologies in Mechanical Engineering, Department of Mechanical Engineering, KIET Group of Institutions, India & London South Bank University, United Kingdom, December 17-18, 2021**
    Surface Roughness Prediction in Milling using Long-Short Term Memory Modelling
    Manjunath, K., Suman Tewary and Neha Khatri

11. **2nd IEEE International Conference on Communication, Computing and Industry 4.0 (C2I4) 2021, CMR Institute of Technology Bengaluru, Bengaluru, Karnataka, December 16-17, 2021**
    Investigation of Near Field EMI in Ferrofluid Based Miniature Electronic Devices and Systems
    V. Kumar, H. Garg and V. Karar

12. **3rd International Conference on Machine Learning, Image Processing, Network Security and Data Sciences (MIND 2021), Department of Information Technology National Institute of Technology(NIT) Raipur, LNEE Springer, December 11-12, 2021**
    Neuro Evolution based Earthquake Intensity Classification for Onsite Earthquake Early Warning
    Siddhartha Sarkar, Anubrata Roy, Bhargab Das and Satish Kumar

13. **ICPPCT: 1st International Conference on Pollution Prevention and Clean Technologies and "Taiwan-India in Emerging Environment and Energy Challenges of Technology Exchange Workshop, Indraprastha Institute of Information Technology Delhi (IIIT-Delhi), December 06-07, 2021(Virtual)**
    A review of Air Quality Index Models
    Priti and Prashant Kumar

14. **International Online conference on Recent Advances and Innovations in Solar Energy (RAiSE)-2021, DST IITM Solar Energy Harnessing Centre (DSEHC), Indian Institute of Technology Madras (IITM), December 02-04, 2021**
    Solar-powered Membrane Distillation for Brackish Water: An unconventional Approach
    Sonam Berwal, Gaurav Goel and Neha Khatri

15. **17th International Conference on Advanced Data Mining and Applications (ADMA'21), Sydney, Australia, February 02-04, 2022**

Mining Social Networks for Dissemination of Fake News Using Continuous Opinion-Based Hybrid Model
Maneet Singh, SRS Iyengar Kaur and Rishemjit Kaur

16. **International Ergonomics Conference, IIT Guwahati, December 01-03, 2021**
Digitized visual fatigue detection for humanizing digital work environments
Prerita Kalra and Vinod Karar

17. **42nd National ISPPD (Virtual) Conference, PED'O'DISHA, 2021, Bhubneswar, November 25-27, 2021**
Artificial Intelligence to Predict the Morphological Characteristics of Sella Turcica on Lateral Cephalogram Images: A Pilot Study
Manoj kumar Jaiswal, Kaushlesh Singh Shakya and Amit Laddi

18. **International Conference on Industrial and Manufacturing Systems (CIMS-2021), Department of Production and Industrial Engineering, Punjab Engineering College, Chandigarh, November 11-13, 2021**
Comparative Study of Solid, Hybrid and Topology Optimized Spinal Cages for Stress Shielding Effect: A Finite Element Analysis. **(Best Paper Presentation Award)**
Vijay Kumar Meena, Prashant Kumar, Rahul Bhardwaj, Tarun Panchal, Parveen Kalra and Ravindra Sinha

19. **3rd IEEE Bombay Section Signature Conference (IBSSC-2021), ABV-Indian Institute of Information Technology and Management, Gwalior, IEEE Bombay Section, November 18-20, 2021**
Automatic target detection with instantaneous amplitude and frequency-based features of EWT modes
Manish Kalra, Satish Kumar and Bhargab Das

20. **Sankalchand Patel University, Visnagar, Gujarat organized GUJCOST (DST) sponsored Two days International E-symposia2021 on Multidisciplinary Research Aspects in Artificial intelligence and Machine learning", October 22-23, 2021**
Sella Turcica Segmentation in Lateral Cephalometric Radiograph by Using U-Net Convolutional Network
Kaushlesh Singh Shakya, Manoj Kumar Jaiswal and Amit Laddi

21. **Conference on Advancements in Engineering, Management, Science and Technology (ICEMST- 2021), CSI College of Engineering, Ketti, Tamilnadu and Global Conference Hub, Coimbatore, Tamilandu, September 10-11, 2021**
Performance Evaluation of a Small Vertical Axis Wind Turbine (SVAWT) System
Sonu Kumar, Sethuraman, C and Chandru G.

22. **44th Annual Symposium of the Optical Society of India, IIT Delhi, September 24-27, 2021**
Simulation and Experimental Characterisation of Tilted FBG for biosensing Applications
Priyanka, Palak Gupta, Satya Pratap Singh and Umesh Tiwari

23. **XLIV Annual Symposium of the Optical Society of India: Frontiers in Optics and Photonics (FOP21), IIT Delhi, September 24-27, 2021**
Investigation of Optical Path Difference for Interferometric Interrogation of Fiber Grating Based Sensors
Deepa Srivastava, Sudipta Sarkar Pal, Divya Dhawan and Bhargab Das

Spatial Characteristics of Aberrated Micro-Bessel Laser Beams
M. K. Bhuyan, P. Praharaj and V. Mishra

24. **6th International Conference on Recent Trends in Electronics, Information & Communication Technology (IRTEICT), Sri Venkateswara College of Engineering, Bengaluru, Karnataka, August 27-28, 2021**
Design of Control Unit for Off-grid and Grid Connected Solar-Wind Hybrid System
Sonu Kumar, Sethuraman, C. and Chandru, G.

Design of Control Unit for Off-grid and Grid Connected Solar-Wind Hybrid System Suitable for Supplying Power to both AC and DC Loads
Sonu Kumar, Sethuraman, C and Chandru G.

25. **5th National Innovators-Industry Meet – 2021, IETE HQ, August 26-27, 2021, New Delhi**
Aviation Maintenance using Wearable Augmented Reality Display
Divya Agrawal and Vinod Karar

Study of Head Tracking Techniques for Head-Mounted Displays in Aviation
Aman Kataria, Divya Agrawal and Vinod Karar

26. **First International Virtual Conference on Environment, Economy, Management, Science and Technology ICEEMST 2021, SIES Nerul College of Arts Science and Commerce, Nerul, Maharashtra, August 24-25, 2021**
Design and Development of Web Based Solar-Wind Hybrid Efficiency Monitoring System
Sonu Kumar, Sethuraman, C., Chandru G and Induja Udayakumar

27. **AI4SG-21 The 3rd Workshop on Artificial Intelligence for Social Good at International Joint Conference on Artificial Intelligence, August 21, 2021**
Can Self-Reported Symptoms Predict Daily COVID-19 Cases
Parth Patwa, Viswanatha Reddy, Rohan Sukumaran, Sethuraman TV, Eptehal Nashnoush, Sheshank Shankar, Rishemjit Kaur, Abhishek Singh and Ramesh Raskar

28. **National Symposium- Shaping the Energy Future: Challenges and Opportunities (SEFCO), CSIR-IIP, August 27, 2021**
Characterization Study of Groundnut Shell, Dry Leaves and Cow Dung Powder for Eco-Friendly Biomass Briquetting. **(3ʳᵈ Prize in poster presentation)**

29. **2nd Data-driven Humanitarian Mapping workshop at the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining, August 15, 2021**
What a million Indian farmers say?: A crowdsourcing-based method for pest surveillance
Adhikari, P., R. Kumar, S. Iyengar, and R. Kaur

30. **International Conference on Advanced Manufacturing and Materials Processing (CAMMP 2021), Department of Mechanical Engineering, Malaviya National Institute of Technology Jaipur, Rajasthan, July 24 - 25, 2021**
Investigation of Elastic Modulus of Additively Manufactured Titanium Lattice Structures for Biomedical Implants
Vijay Kumar Meena, Prashant Kumar, Tarun Panchal, Parveen Kalra and Ravindra Sinha

31. **OSA Optical Design and Fabrication 2021 (Flat Optics, Freeform, IODC, OFT), Washington, DC, United States, June 27– July 01, 2021**
Smoothing effect analysis for active fluid jet polishing
V. S. Negi, H. Garg, R. S. Kumar, U. K. Tiwari, V. Karar, and D. W. Kim

32. **IEEE/CVF Conference on Computer Vision and Pattern Recognition, June 20-25, 2021**
Thermal Image Super-Resolution Challenge-PBVS 2021
Rivadeneira, R.E., Sappa, A.D., Vintimilla, B.X., Nathan, S., Kansal, P., Mehri, A., Ardakani, P.B., Dalal, A., Akula, A., Sharma, D. and Pandey, S

33. **OSA, Optical Design and Fabrication, Washington, DC United States, June 27, 2021**
Smoothing Effect Analysis for Active Fluid Jet Polishing
Vipender Singh Negi, Harry Garg, RR Shravan Kumar, Umesh Kumar Tiwari, Vinod Karar and Dae Wook Kim

34. **International Conference on Recent Trends in Science, Humanities & Engineering (RTSHE-2021), June 18-19, 2021**
Neural Network based Power Prediction for Solar-Wind Hybrid System
Sonu Kumar, Sethuraman, C. and Chandru G.

Optimum Configuration of Hybrid Renewable Energy System using HOMER Pro to Meet the Constant Energy Demand at Different Indian Regions
Sonu Kumar, Sethuraman, C and Chandru G.

35. **The first Deployable AI conference organized by the Center of Excellence on Deployable AI, IIT June 16-18, 2021**
Building Energy Management System using Non-Intrusive Load Monitoring Technique (Poster Presentation)
Gopinath, R., Kumar, M.,

36. **E-International Conference on Advances in Renewable Energy and Electric Vehicles (ICAREEV-2021), Sagar Institute of Research and Technology (SIRT), Bhopal, May 13-14, 2021**
Design and Development of PWM based Charger for Wind Energy System using Multisim Simulation
Sonu Kumar, Sethuraman, C. and Chandru G.

37. **Workshop on Smart & Precise Agriculture Pacific-Asia- Conference on Knowledge Discovery and Data Mining PAKDD 2021, Delhi, May 11, 2021**
Identification of Harvesting Year of Barley Seeds using Near-Infrared Hyperspectral Imaging Combined with Convolutional Neural Network
Singh, T., Garg, NM., and Iyengar, S.R.S.

38. **E-National Conference on Advances in Mechanical Engineering (NCAME-2021), Sagar Institute of Research and Technology, Bhopal, May 06-07, 2021**
Design and Development of Hybrid Controller for Solar-Wind Hybrid System using Proteus Simulation
Sonu Kumar, Chandru G. and Sethuraman, C.

39. **High Power Lasers and Applications, SPIE, April 19-23, 2021**
Design and Comparative Analysis of Fiber-Coupled Laser Diode System using Ball, Cylindrical, and Toroidal Lens
Berwal, Sonam and Neha Khatri

Conference/ Workshop attended

Date of Event	Name of Conference/ Workshop/Symposia/Trainings	Venue	Participation By
March 29, 2022	One Day GNSS Simulator Training by Orolia Pvt. Ltd	Online	Mr. Naveen Sharma
March 21, 2022	Workshop on Electronics Control Unit(ECU) used in Automobile vehicles	TEC- PU Chandigarh	Mr. Narinder Singh Jassal
March 12, 2022	Machines Tool Exhibition, Mac-Expo 2022, Ludhiana(Industrial Meet)	Exhibition Ground, Ludhiana (PB)	Mr. Narinder Singh Jassal
February 28 – March 11, 2022	Online Training Program under FurtureSkills Prime on Augmented and Virtual Reality (AVR)	Online	Mr. Naveen Sharma
February 28 – March 11, 2022	Training Programme on Augmented and Virtual Reality under future Skills PRIME Scheme Organized by NIELIT		Dr Amit Laddi
February 25, 2022	Attended the training program given by Dr. G. Radhakrishnan, Chief Scientist, CSIR-CECRI on ERP's Store and Purchase Module		Dr. Sethuraman
February 20-22, 2021	Industrial Visit for Training/Exposure	M/s Defsys Solution Private Limited, Gurugram	Mr. Harsh Kumar
February 16, 2022	Industrial Visit to Tractors/Automobiles Industry	Swaraj Tractors, Mohali	Mr. Narinder Singh Jassal
February 15, 2022	Industrial Visit to Tractors/Automobiles Industry	Indo-Farm Tractors Baddi	Mr. Narinder Singh Jassal
February 11, 2022	Industrial Visit to Tractors/Automobiles Industry	SML Ropar	Mr. Narinder Singh Jassal
February 09, 2022	Industrial Visit to Tractors/Automobiles Industry	Preet Tractors, Nabha, Punjab	Mr. Narinder Singh Jassal

January 20-23, 2022	Research & Industrial Conclave (RIC) 2022 - An amalgamation of Academia, Industry & Start-up"	IIT Guwahati, Guwahati, Assam [Online]	Dr. Manoj K. Nayak
January 20-21, 2022	Two-Day Online Hands-on Workshop under National Training Program on Patent Search & Analytics (NTP PSA-2022)		Dr. Amit Laddi
January 19-20, 2022	International Training Workshop on Industry 4.0 and Energy Management organized jointly by NAM S&T Centre and Society of Energy Engineers and Managers (SEEM), India.		Mr. Mukesh Kumar
January 04-05, 2022	Attended Platinum Jubilee events conducted by CSIR-NPL and demonstrated the CSIR-CSIO developed BEMS and e-SENSE technology		Mr. Mukesh Kumar
December 23-24, 2021	Industrial Visit for Training/Exposure	M/s Horizon Aerospace (India) Private Limited, Gurugram	Mr. Harsh Kumar
December 10-13, 2021	India International Science Festival (IISF) 2021	Online	Dr. Manish Kumar
December 11-12, 2021	3rd International Conference on Machine Learning, Image Processing, Network Security and Data Sciences (MIND 2021), organized by Department of Information Technology, National Institute of Technology Raipur		Mr. Siddhartha Sarkar
December 10, 2021	Attended One-day Training given on NABL requirements as per ISO/IEC 17025:2017	CSIR-CSIO, Chennai	Dr. Sethuraman

November 27, 2021	Industrial Meet of Bicycle Manufactures	R & D Centre for Bicycle & Sewing Machine, Ludhiana, Punjab	Mr. Narinder Singh Jassal
October 27, 2021	Punjab Startup Summit and Industrial Meet, Ludhiana	Startup, Punjab, Ludhiana	Mr. Narinder Singh Jassal
October 25-29, 2021	Training Program on Leadership and Organisational Development for Women Scientist/ Technologist at Centre of Organisation Development, Hyderabad- DST Sponsored	Online	Ms. Geetha
October 25-26, 2021	International conference on Artificial Intelligence, Photonics and Revolutionary Smart Materials (AIPRSM-2021)	L.N. Mithila University, Darbhanga (Online)	Dr. Manish Kumar
October 18-22, 2021	F-EIR Conference 2021 on Environment Concerns and its Remediation	Hotel Mountview, Chandigarh	Dr. Manoj K. Nayak
October 04-05, 2021	Training Program on Workshop Practices and Dimensional Metrology at CSIR-NPL, New Delhi	Online	Ms. Geetha & Mr. Vineesh
September 27 – October 01, 2021	A program on Enhancing Accountability & Responsiveness in Scientific Organizations organized by Institute of Public Enterprise, Hyderabad (under the aegis of Indian council of Social Science Research, MHRD, GoI)		Dr. Prashant Kumar
September 09, 2021	CII conference on Urban Water Management	Online	Dr. Manish Kumar
August 26-27, 2021	5th IETE Innovators – Industry Meet under the theme Technological Innovations in Electronics & Related Fields for Aerospace and Defence Production Towards	IETE, New Delhi	Dr. Manish Kumar

	Atmanirbhar Bharat		
August 17, 2021	Workshop as an Expert on Curriculum Development of Advanced Diploma in Tool & Die Making of MSME Centre, Rohtak organized by Curriculum Development Department of NITTTR, Chandigarh	NITTTR, Chandigarh	Mr. Narinder Singh Jassal
August 02-06, 2021	2021 IEEE SPS Summer School on Deep Learning for Sensor Signal Analytics		Mr. Naveen Sharma
June 21, 2021	Workshop as an Expert on Curriculum Development of Diploma in Mechanical Engineering (Tool & Die) of HSBTE, Panchkula organized by Curriculum Development Department of NITTTR, Chandigarh	NITTTR, Chandigarh	Mr. Narinder Singh Jassal
June 10-11, 2021	3rd International Conference on Data Science, Machine Learning & applications (ICDSMLA 2021) organized by Institute for Engineering Research and Publication (IFERP), Chennai		Mr. Siddhartha Sarkar
June 06, 2021	Attended Awareness Program Given on Implementation of System for Expenditure Tracking & Project Management given by Dr. A K Shukla		Dr. Sethuraman
May 30, 2021 - June 3, 2021	ECS Meeting Abstracts, Volume MA2021-01, IMCS 02: Chemical and Biosensors, Medical/Health, and Wearables	New Jersey, USA [Online]	Dr. Manoj K. Nayak

Lectures Delivered

Mr. Amitava Das

- Online Lecture - "Artificial Intelligent Embedded Systems", Centre for Artificial Intelligence, NIT, Jalandhar, March 31, 2022.
- Invited Online Lecture - "Artificial Intelligence in Embedded Systems", National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, March 25, 2022.

Dr. Akash Deep

- Invited Talk – "Nanomaterials Based Sensors for Different Analytes", Short Term Course on Emerging Trends and Modeling in Advanced Functional Materials and Devices, NIT Jalandhar, March 28, 2022.
- Talk – "Conversion of e-waste into nanoproducts", 1st Bilateral Meeting on Smart Materials for Energy and Environment Technology (Smart MEET-2022), CSIO-INST, INST Mohali, March 25, 2022.
- Invited Talk – "Graphene and Metal-Organic Frameworks for Supercapacitor Applications", International Conference on Multi-disciplinary Aspects of Materials in Engineering (IC-MAME-2021), UIET-PU, Chandigarh, October 09, 2021.
- Expert Talk - "Some New Advanced Functional Materials and Design of Interfaces for Biosensing Applications", Department of Biotechnology, UIET-PU, Chandigarh, August 28, 2021.
- Invited Lecture – "Functional Materials for Applications in Sensing and Energy Storage", Mini Symposium, The Indian Institute of Technology (IIT) Roorkee, Roorkee, July 31, 2021.
- Invited Talk - "Application of Sensors in the Detection of Environmental Pollutants", World Environmental Day, Reimagination, Recreation and Restoration, CCS Haryana Agricultural University, Hisar, Haryana, June 05, 2021.

Dr. Amit Laddi

- Hindi Seminar- "छवि आधारित (इमेज़ गाइडेड) प्रणाली द्वारा चिकित्सीय परीक्षण निदान एवं उपचार", सीएसआईआर-सीएसआईओ, जनवरी 27, 2022.

Dr. Aparna Akula

- Invited Talk - "Introduction to Basics of Convolutional Neural Networks and Concepts of Transfer Learning", One Week AICTE Sponsored Online Faculty Development Program (FDP) on the topic Artificial Intelligence & Machine Learning, Guru Jambheshwar University of Science & Technology, Hisar, Haryana.(Virtual), February 09, 2022.
- Invited Talk - "Intelligent Sensing systems", Induction Programme for Newly Admitted Engineering Students, Chandigarh College of Engineering and

Technology, Sector 26, Chandigarh (Degree Wing). (Virtual), November 24, 2021.

Dr. Abhay Sachdev
- Invited Talk - "Nanomaterial-based Microfluidic Platforms for Bioanalytical Applications", 7th International Conference on Advanced Nanomaterials and Nanotechnology, IIT Guwahati, December 14-17, 2021.

Amarendra Goap
- Expert Lecture -"Object Tracking by Color using OpenCV", STC on Computer Vision using Open CV, Department of Computer Science and Engineering, National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, October 27, 2021.

Dr. C Sethuraman
- Technical Lecture - "Performance evaluation of Air-conditioning system", Technologist Industrial Meet & Expo: 2021 – TIME-Winter Edition "Industrial Awareness Program on Energy and Energy Efficiency", Amrita Vishwa Vidyapeetham, Ettimadai, Coimbatore, December 02, 2021.
- Technical Lecture - "Basics of Solar Energy/ Measurements Techniques and Performance Evaluation of Solar Water Heating/ Air Dryer & SPV System", One day training programme on "Solar Energy / Renewable Energy Smart Technologies", CSIO Chennai Centre under CSIR Integrated Skill Initiative Programme in association with ISTC, Chandigarh, June 30, 2021.
- Technical Lecture - "Importance of Instrumentation and Continuous Monitoring to Enhance Energy Efficiency in Pulp and Paper Industry", Industry Meet, on "Integrated Energy Audit and Sustainability Management for the Pulp and Paper Sector", CSIR-Indian Institute of Petroleum, Dehradun, April 09, 2021.

Ms. Geetha
- Lecture Delivered – "Mass, Thermal Parameters" for Training requirement by Bhutan (Training of Biomedical Personnel) and Demo in Calibration Lab on Mass, Thermal and Pressure parameters, August 03 and August 06, 2021.
- Lecture Delivered – "Best Practices: Calibration" for Industrial Awareness Program on Energy and Energy efficiency in TIME 2021-Winter Edition, December 02, 2021.

Gurpreet Singh
- Expert Talk – "Design of embedded system", BIRAC sponsored Hands on training program on "Bio-Signal Acquisition and Analysis" CSIR-CSIO, Chandigarh, November 30, 2021.

Dr. Manoj K Patel

- Invited Talk - "Road to Scientific Success", India International Science Festival 2021, "Vigyanika", Panjim Goa, December 11-12, 2021.

- Invited talk - "Technological Interventions for Sustainable Society", Pushpa Gujral Science City, Kapurthala, Punjab on International Youth Day 2021, August 12, 2021.
- Invited Lecture -"Technological Interventions for Sustainable Environment", Faculty Development Program, Rural Development Department, National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, July 07, 2021.

Mr. Mukesh kumar
- Lecture - "Energy Data Analytics", one day workshop/seminar on Green Energy Technologies- Energy and Energy Efficiency, CSIR-CSIO, Chennai Center jointly with CSIR-CSIO, DSIR, New Delhi and Amrita Vishwa Vidyapeetham , Coimbatore, December 01, 2021.

Narinder Singh Jassal
- Expert Talk – "CNC Machines & Part Programming", Govt College of Engg. & Tech., Jammu, March 12, 2022.
- Expert talk – "Computer Integrated Manufacturing Systems (CIMS)", Model Institute of Engg. and Tech., Jammu, January 21, 2022.
- Expert Talk – "Flexible Manufacturing Systems (FMS)", NIT, Jalandhar, December 20, 2021.
- Expert Talk – "Flexible Manufacturing Systems (FMS)", Shri Mata Vashno Devi University (SMVDU), Jammu, December 16, 2021.
- Expert Talk – "Importance of Skill Development", STC, Curriculum Development Department of National Institute of Technical Teachers Training & Research, Chandigarh, July 28, 2021.

Dr. Neelam Kumari

- Invited Talk - "Thin Film Coating for Thermal Management and Light Manipulation", 1st Bilateral Meeting on Smart Materials for Energy and Environmental Technology (Smart MEET-2022), jointly with INST, Mohali, March 25, 2022.
- Invited Talk - "Precision Thin Film Coatings for Demanding Optical Applications", One Day Workshop on Smart Materials jointly organized by Department of Physics, ASAS, Amity University Haryana and NSYSU, Taiwan, Virtual, September 29, 2021.

Dr. Neha Khatri
- Invited Talk - "Technologies of Tomorrow", Azadi ka Amrit Mahotsav week of the Ministry of Heavy Industries, Innovative India – Machines and Processes, Virtual January 10-16, 2022.

- Invited Talk - "Micromachining Process Chain for the Development of Ultra-Smooth Silicon Mirrors", IIT Madras on Recent Advances and Innovations in Solar Energy (RAISE) in the mechanical processing of silicon session, Virtual, December 02, 2021.
- Invited Talk - "Contemporary Engineering & Technology", INAE Youth Conclave 2021, Virtual, September 24, 2021.
- Invited Talk - "Ophthalmic Lenses", New Medical Devices, National Institute of Pharmaceutical Education and Research, Chandigarh. August 17, 2021

Dr. Neerja Garg

- Delivered Talk – "Artificial Intelligence Practices in Agriculture and Environment", ATAL Faculty Development Programme on 'Application of Artificial Intelligence in Research and development', CSIR-AMPRI, Bhopal, July 5-9, 2021.

Mr. Naveen Sharma

- Invited Lecture – "Prototype: Laboratory to Market", under IIC 4.0, NIT Silchar Assam, February 14-18, 2022.
- Invited Lecture - "Evolvement of Machine Learning in Biomedical Imaging", NIT Jalandhar Punjab, December 2021.

Dr. Pooja Devi
- Invited Talk – "Materials engineering for energy recovery from wastewater", 1st bilateral meeting on Smart Materials for Energy and Environmental Technology (Smart meet-2022), CSIO-INST, March 25, 2022.
- Invited Talk – "2D Materials Heterostructure for Green H2 generation", Indo-US SPARC, IIT Mandi, Virtual, March 16, 2022.
- Invited Speaker – "Strategies for Atam Nirbhar Bharat through SDGs and Gender Equality", AMITY University, Noida, March 09, 2022.
- Panellist – "Challenges for Women in Leadership and Decision Making Spaces", International Women Day, CSIO, Chandigarh, March 8, 2022.
- Invited Talk - Role of Women in Science, International Women Day, MCM DAV College for Women, Chandigarh, March 07, 2022.
- Invited Talk – "Materials Engineering for Environmental Application: Lab to Land Translation", Research Conclave '22, IIT Indore, February 11, 2022.
- Invited Talk – "Hydrogen: A clean future energy currency", Regional Science Congress 2021-22, Jawahar Navodaya Vidyalaya Niwarsi, Kurukshetra, Februray 05, 2022.
- Invited Talk – "Hybrid Materials for Photo-electrochemical Wastewater Splitting to Hydrogen", DST-UKIERI Partnership Development, International Workshop on 'Water for all: Addressing issues surrounding water quality, quantity and waste

water treatment in India', Department of Agricultural Biotechnology, Aasam Agricultural University, Virtual, January 12, 2022.

- Invited Talk – "How to present project online?", National Children Science Congress Teachers Workshop, October 29, 2021.
- Lecture - Introduction about CSIR Virtual Lab to ATL Schools, CVJL, November 11, 2021.
- Lecture - Experience Sharing HYVRA under Vigyan Utsav, Haryana DST, October 28, 2021.
- Lecture – "Presentation Skills and Plagiarism", Refresher Course on 'Research Methodology in Sciences', Panjab University, September 20, 2021.
- Lecture – "Nanoengineered Materials for Catalytic Water Splitting: Fundamental Aspects and Challenges", Pachaiyappa's College, Chennai, September 11, 2021.
- Lecture – "Women Empowerment Emerging Dimensions", Chandigarh University, September 11, 2021.
- Invited Talk - "Hydrogen: A Wonder Molecule for Energy, Role Model Interaction", JNV Chandigarh, July 15, 2021.
- Invited Talk – "Green Synthesized Hybrid Nanostructured Materials for Green Hydrogen, NatFoE", IIT Hyderabad, July 10, 2021.
- Invited Talk – "IoT Enabled Smart Sensor Technologies for Water Quality Monitoring", Faculty Development Programme, 'Application of Artificial Intelligence in Research and development', CSIR-AMPRI, July 06, 2021.
- Invited Talk – "Women and Technology", IEEE Student Branch LBS Institute of Technology for Women, May 4, 2021.
- Invited Talk - "Materials in Waste Water Treatment and Energy Generation", Trends in Wastewater treatment and resource recovery for energy and environmental applications, National University of Ireland, Republic of Ireland, April 29, 2021.

Dr. Prashant Kumar
- Invited Lecture -"Groundwater Vulnerability Assessment – Challenges and Opportunities", Regional Science Congress 2021-22, Jawahar Navodaya Vidyalaya, Kurukshetra, Haryana, February 03, 2022.
- Lecture - "Groundwater Vulnerability and Risk Mapping using GIS and Sustainable Development Goal 6 for Punjab Resource", Six days online faculty development programme, Waste Management & Environmental Protection for Sustainable Development Department of Civil Engineering, Baba Farid College Of Engineering & Technology, Bhatinda, Punjab, January 13, 2022.
- Lecture - "Multi-Objective Optimization and its Applications in Engineering Problems" Resource Faculty for One Week STC, 'Emerging Wireless Communication Technologies', National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, August 05, 2021.

Dr. Ritesh Kumar

- Invited Talk -Machine Learning and AI, GGDSD-32, Chandigarh, March 29, 2022.
- Invited Talk – "Olfaction and the role of AI in Biomedical Research", GBU, Noida. (Virtual), February 24, 2022.
- Invited Talk – "Designing Machine Learning Algorithms to Predict Smell", CS department NIT Jalandhar, (Virtual), December 17, 2021.
- Invited Talk – "NLP Applications: Olfaction, Agriculture", National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, (Virtual), November 17, 2021.
- Invited Talk – "Designing algorithms to predict smell", NISER Bhubaneshwar, CS Kathabrata. (Virtual), October 17, 2021.

Dr. Suman Singh

- Expert Talk - "Role of Scientific in upliftment of Society", 'Vigyan Sarvatra Pujyate- festival of Scope', Hans Raj Mahila Maha Vidyalaya Jalandhar, February 22-28, 2022.
- Invited Talk- "Chemical & Bio-chemical waste management", AICTE & MRSPTU sponsored 6 days online faculty development programme on Waste Management & Environmental Protection for Sustainable Development, January 10-15, 2022.
- Invited Talk – "Graphene and graphene like nano-dimensioned materials for diagnostic Applications", International Conference on Environmental Science & Green Energy, December 06 - 07 2021.

Dr. Satish Kumar

- Invited Talk – "National Science Day Lecture", Indo Global College, Chandigarh, February 28, 2022.
- Invited Talk – "Intelligent Sensors and Systems", Jigyasa program during Vigyan Sarvatra Pujyate, CSIR-IIIM Jammu, February 25, 2022.
- Invited Talk – "IoT and Industrial Applications", Workshop on Process of Innovation Development and Technology Readiness Level in Edge Computing organized by Institution Innovation Council, International Industry Interface and Electronic Project Club at Chandigarh Engineering College, Landran, Mohali on 26th November 2021
- Invited Talk – "Emerging trends in the area of Data Science", Mahatma Jyotiba Phule Rohilkhand University, Bareilly, November 12, 2021. (Online mode)
- Invited Talk – "IETE Hari RamJi Toshniwal", Chandigarh, November 02, 2021.
- Invited Talk – "Edge Computing and IoT", AICTE sponsored online 3rd International Conference on recent trends in Communication & Intelligent Systems (ICRTCIS 2021), Arya College of Engineering & IT, Jaipur, October 22, 2021 .

- Invited Talk – "Automatic Target Recognition using Multi Sensing Modalities", 5th Innovators-Industry Meet, IETE New Delhi, August 27, 2021.
- Invited Talk – "Latest Technology Trends that will Impact Future", One-week online STC on 'Emerging Wireless Communication Technologies', ECE Department of National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, August 02-06, 2021.

Dr. Shashi Poddar

- Lecture - "Kalman Filter, Vision based Navigation & SLAM", Workshop on Motion Estimation Sponsored by SERB, CSIR - CSIO, Online, February 21-22, 2022
- Lecture - "Perception, sensor fusion and navigation for Mars Rotorcraft", Workshop of design and development of Mars Rotorcraft, Astronautical Society of India (ASI), Online, December 04, 2021.
- Lecture - "Sensor fusion and its application for navigation of Autonomous Vehicles', Faculty Development Programme on Innovative Research & Development Trends in Electronics & Communication Engineering", G. L. Bajaj institute of technology and management, Noida, Online, September 09, 2021
- Lecture - "A Snapshot of Research Sensor Fusion and Vision Based Navigation" 2020-2021 Seminar Series, University of New Hampshire, Online, September 09, 2021.
- Lecture -"Proposal writing for Fulbright Grant", Fulbright mentoring program, USIEF, New Delhi, Online, June 24, 2021
- Seminar Series - "अगली पीढ़ी की विरासत: प्राकृतिक और निर्मित पर्यावरण", Hindi seminar series, CSIR - CSIO, Online, June 11, 2021.
- Lecture - "Fulbright Experience and a Snapshot of Research on Sensor Fusion", MAE, seminar series, University at Buffalo, New York, Online, May 06, 2021.

Sanjay Kumar

- Expert Talk - "Hydraulic & Pneumatic Techniques for Industrial Automation", CSIR-Integrated Skill Initiative, Online, March 15, 2022.
- Expert Talk -"PLC Programming and Its Application", CSIR-Integrated Skill Initiative, Online workshop, January 28, 2022.
- Expert Talk - "Fundamentals of Embedded Systems", CSIR-Integrated Skill Initiative, Online workshop, November 26, 2021.
- Expert Talk - "Fundamentals of Mechatronics & Industrial Automation", CSIR-Integrated Skill Initiative, Online workshop, September 22-23, 2021.
- Expert Talk -"PLC Programming and Its Application", CSIR-Integrated Skill Initiative, Online workshop, July 23, 2021.
- Expert Talk - "Hydraulic & Pneumatic Techniques for Industrial Automation", CSIR-Integrated Skill Initiative, Online, June 16, 2021.

Dr. Tejpal Singh

- Invited Lecture - "Geospatial Applications of Remote Sensing Data", School of Energy and Environment, Thapar Institute of Engineering and Technology, Patiala, Online, September 24, 2021.

- Invited Lecture - "Introduction to Remote Sensing", School of Energy and Environment, Thapar Institute of Engineering and Technology, Patiala, Online, September 22, 2021.

Dr Udaybir Singh

- Invited Talk - "Simulation of Magnetron Injection Gun", IEEE-Indigenous Development of Simulation Tools for Vacuum Electronic Devices: Challenges and Opportunities, November 27-28, 2021.

Dr. Umesh K. Tiwari

- Invited Talk -"Functionalized Optical Fiber Based Biosensors: Principles and Developments", 91st Annual Session of the National Academy of Sciences, India (NASI), NASI HQ, Prayagraj, December 4, 2021.
- Invited Talk - "Advances in Fiber Optic Sensing Technology: Principles & Applications" Workshop on photonics sensors for the chemical and gas detection, IIT (ISM), Dhanbad, October 18, 2021,
- Invited Talk - "Recent Trends and Developments in Immobilized Optical Fiber for Biosensing Applications", 2nd - IEEE Workshop on Advances in Nanophotonic devices & Sensors 2021, NIT Karnataka, October 4, 2021.
- Expert Talk – "Fiber Optic Sensors: Principle & Developments", National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh, September 24, 2021.

Dr. Vinod Karar

- Keynote Talk - "Situation awareness of the naval aviation pilots through visual navigation and landing aid systems", 9th National Conference on 'Nanoscience and Instrumentation Technology' (NCNIT-2021), Physics Department, National Institute of Technology Kurukshetra on November 20, 2021.
- Webinar - "Weapon Aiming Avionics for Fighter Aircrafts: An Aid to Pilot's Target Through Advanced Instrumentation" as a part of the Äzadi Ka Amrit Mahotsav and CSIR 80 Years Success Stories", August 31, 2021.
- Keynote Speaker - "Innovations in Avionic Displays: What to Expect in Future Aviation Platforms" 5th IETE Innovators- Industry meet, August 26, 2021.

Vijay Kumar Meena

- Lecture – "Additive Manufacturing & Applications", Chandigarh Engineering College, Jhanjehri, Mohali, Punjab, March 07, 2022.
- lecture – "Additive Manufacturing & applications, Recent Trends & Issues in Mechanical Engineering", Guru Jambheswar University of Science & Technology, Hisar, Virtual, January 15, 2022.

- Lecture – "Additive Manufacturing", One Day Online Workshop on Additive Manufacturing Under CSIR Integrated Skill Initiative (CISI) Programme, August 04, 2021.
- Lecture – "Medical Additive Manufacturing", Online Faculty Development Program on Applications of Computers in Biology, Galgotoa University, June 11, 2021.
- Webinar - "Bioactive glass, Ceramics & Composites in Healthcare: Current Technological Trends, 2021, (BIOCOM 2021)", CSIR-Central Glass and Ceramic Research Institute, Kolkata, May 28, 2021.

RTI Implementation

The Right to Information (RTI) Act came into existence in the year 2005. It applies to all states and UTs of India. It provides the right to any citizen to request for the information from the public/Govt. funded institutions, schemes, etc. which must be replied within the 30 days period. The concerned officer or deemed PIO is liable for a penalty of Rs 250 per day of default upto a maximum of Rs 25,000 per application for providing wrong information or not providing the information in time. It works for greater transparency in administration.

The CSIR-CSIO RTI Cell comprised of following persons during 2021-22:

Transparency Officer: Sh. Jaswant Rai , Sr. CoA

1. Appellate Authority : Dr. Shravan Kumar RR, Sr. Principal Scientist

2. Public Information Officer (PIO) : Dr. Prasant K. Mahapatra, Sr. Principal Scientist

3. Assistant Public Information Officer (APIOs) : Dr. Sanjiv Soni, Pr. Scientist

4. Ms Anupma Sharma

The summary of cases during 2021-2022 is:

Year 2021 - 2022					
Application Received	Rejected	Accepted	Transferred	1st Appeal	Referred to CIC, New Delhi
98 including Transfer cases	01	97	00	15	00

Budget Statement

Expenditure (2021-22)

Rupees in Lakhs

Head of Account	Source of Expenditure	
	CSIR Funds	**Lab Reserve**
Recurring		
Pay of Officers	2200.018	
Pay of Establishment	662.843	
Dearness Pay	0.000	
Allowances	1268.143	5.396
Contingencies	228.309	0.400
Staff Quarters maintenance	63.248	
Chemical & Consumables	224.900	60.285
Human Resource Development	0.000	
Total Recurring	**4647.461**	**66.081**
Capital		
Works and Services	101.038	
Appartus & Equipment *(including computer Equipment and Software)*	117.279	6.101
Workshop Machinery		
Office Equipment		
Furniture & Fitting		0.400
Library Books & Journals	12.490	45.742
Vehicles		
Tools & Plants		
Models & Exhibits		
Staff Quarters (Construction)	3.035	
Total Capital	**233.842**	**52.243**
Total (Recurring + Capital)	**4881.303**	**118.324**
IRR-Construction		
IRR-ICT		

Networked/Supra Projects		787.627	86.107
Grand Total		**5668.930**	**204.431**

GENERATION OF ECF DURING LAST 5 YEARS					
					(Rs. In lakh)
Budget Head	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
1	**2**	**3**	**4**	**5**	**6**
1. GOVT DEPTT/PSU's	1013.418	1425.049	1726.585	875.971	1520.854
2. PRIVATE AGENCIES	9.724	1.931	1.756	38.938	35.693
3. FOREIGN GOVT AGENCIES	0.000	0.000	1.040	0.000	19.603
4. S&T RECEIPTS(ROYALTY/PREMIA,JOB WORK,TESTING & ANALYTICAL CHARGES AND OTHER TECH SERVICES	74.772	126.263	63.770	42.268	134.164
TOTAL	**1097.914**	**1553.243**	**1793.151**	**957.177**	**1710.314**

GENERATION OF LRF DURING LAST 5 YEARS					
					(Rs. In lakh)
Budget Head	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
1	**2**	**3**	**4**	**5**	**6**
1. ROYALTY & PREMIA	51.435	99.681	50.139	30.180	119.154
2. TESTING & ANALYTICAL CHARGES	22.291	19.035	10.947	10.987	13.250
3. OTHER TECHNICAL SERVICE	0.802	7.463	2.634	1.101	1.616
4. JOB WORK	0.244	0.084	0.050	0.000	0.144
5. REST OF R071 HEADS	86.862	206.387	185.790	148.040	243.871
TOTAL	**161.634**	**332.650**	**249.560**	**190.308**	**378.035**

प्रो. एस. अनन्त रामकृष्ण
निदेशक

वैज्ञानिक

1	प्रो. सुब्रमण्यम अनंथा रामकृष्णा, निदेशक
2	डॉ. विनोद करार, मुख्य वैज्ञानिक
3	डॉ.सतीश कुमार, मुख्य वैज्ञानिक
4	डॉ. श्रवण कुमार आर. आर, मुख्य वैज्ञानिक
5	डॉ. व्हाटकर दत्तात्रय शिवलिंग, मुख्य वैज्ञानिक
6	श्री दिनेश पंकज, वरिष्ठ प्रधान वैज्ञानिक
7	डॉ.अनिल जी सोनकुसरे, वरिष्ठ प्रधान वैज्ञानिक
8	डॉ. सुनीता मिश्रा, वरिष्ठ प्रधान वैज्ञानिक
9	डॉ. संजीव वर्मा, वरिष्ठ प्रधान वैज्ञानिक
10	डॉ. नीलेश कुमार, वरिष्ठ प्रधान वैज्ञानिक
11	डॉ. विपन कुमार, वरिष्ठ प्रधान वैज्ञानिक
12	श्री अमितवा दास, वरिष्ठ प्रधान वैज्ञानिक
13	डॉ. समीर कुमार मण्डल, वरिष्ठ प्रधान वैज्ञानिक
14	डॉ. अमोल पी भोंडेकर, वरिष्ठ प्रधान वैज्ञानिक
15	डॉ. सुरेन्द्र सिंह सैनी, वरिष्ठ प्रधान वैज्ञानिक
16	डॉ. प्रशांत कुमार महापात्रा, वरिष्ठ प्रधानवैज्ञानिक
17	डॉ. अमित लोचन शर्मा, वरिष्ठ प्रधान वैज्ञानिक
18	डॉ. हैरी गर्ग, वरिष्ठ प्रधान वैज्ञानिक
19	श्री ए. रॉबर्ट सेम, वरिष्ठ प्रधान वैज्ञानिक
20	डॉ. बबन कुमार श्याम बन्सोड़, वरिष्ठ प्रधान वैज्ञानिक

21	डॉ. अवधेश कुमार शुक्ल, वरिष्ठ प्रधान वैज्ञानिक
22	डॉ. संजीव सोनी, वरिष्ठ प्रधान वैज्ञानिक
23	श्री नरेन्द्र सिंह, वरिष्ठ प्रधान वैज्ञानिक
24	श्री जी. एस. अय्यप्पन, वरिष्ठ प्रधान वैज्ञानिक
25	डॉ. सी. सेथुरमान, प्रधान वैज्ञानिक
26	श्री मंजीत सिंह, प्रधान वैज्ञानिक
27	डॉ. नवनीत सिंह औलख, प्रधान वैज्ञानिक
28	श्री राजेश, प्रधान वैज्ञानिक
29	डॉ. इन्द्रप्रीत कौर, प्रधान वैज्ञानिक
30	डॉ. सुदीप्ता सरकार पाल, प्रधान वैज्ञानिक
31	श्री विधु शेखर पांडे, प्रधान वैज्ञानिक
32	डॉ. उमेश कुमार तिवारी, प्रधान वैज्ञानिक
33	श्री अरिंदम चटर्जी, प्रधान वैज्ञानिक
34	श्री विजय कुमार मीना, प्रधान वैज्ञानिक
35	डॉ. सुमन सिंह, प्रधान वैज्ञानिक
36	डॉ. मनोज कुमार नायक, प्रधान वैज्ञानिक
37	डॉ. अमित लादी, प्रधान वैज्ञानिक
38	डॉ. आकाश दीप, प्रधान वैज्ञानिक
39	सुश्री आर. गीता, प्रधान वैज्ञानिक
40	डॉ. नागावारा अपर्णा अकुला, प्रधान वैज्ञानिक
41	डॉ. मनोज कुमार पटेल, प्रधान वैज्ञानिक
42	डॉ. संजीव कुमार, प्रधान वैज्ञानिक
43	डॉ. राज कुमार, प्रधान वैज्ञानिक
44	श्री श्रीकांत वसमसेट्टी, प्रधान वैज्ञानिक
45	सुश्री पूजा देवी, प्रधान वैज्ञानिक
46	श्री आशीष गौरव, प्रधान वैज्ञानिक
47	डॉ. रिपुल घोष, प्रधान वैज्ञानिक
48	डॉ. राज कुमार पाल, प्रधान वैज्ञानिक

49	डॉ. सुदेशना बागची, प्रधान वैज्ञानिक
50	डॉ. दिव्या अग्रवाल, प्रधान वैज्ञानिक
51	डॉ. रिश्मजीत कौर, प्रधान वैज्ञानिक
52	डॉ गिरीश चन्द्र मोहन्ता, प्रधान वैज्ञानिक
53	डॉ. सचिन त्यागी, प्रधान वैज्ञानिक
54	डॉ. नीलम कुमारी, प्रधान वैज्ञानिक
55	डॉ. रितेश कुमार, प्रधान वैज्ञानिक
56	डॉ. नेहा खत्री, प्रधान वैज्ञानिक
57	डॉ.शशि पोद्दार, प्रधान वैज्ञानिक
58	डॉ. मुकेश कुमार, प्रधान वैज्ञानिक
59	डॉ. नीरजा गर्ग, प्रधान वैज्ञानिक
60	श्री अजय यादव, प्रधान वैज्ञानिक
61	श्री वीरेंद्र कुमार, वरिष्ठ वैज्ञानिक
62	डॉ. रीतिका सिंह, वरिष्ठ वैज्ञानिक
63	डॉ. भार्गब दास, वरिष्ठ वैज्ञानिक
64	डॉ. प्रशांत कुमार, वरिष्ठ वैज्ञानिक
65	सुश्री प्रियंका राघव, वरिष्ठ वैज्ञानिक
66	डॉ. मनोज कुमार भूयान, वरिष्ठ वैज्ञानिक
67	डॉ. संजीत कुमार देबनाथ, वरिष्ठ वैज्ञानिक
68	डॉ. कमलेश कुमार, वरिष्ठ वैज्ञानिक
69	डॉ. तेजपाल सिंह, वरिष्ठ वैज्ञानिक
70	श्री जितेंद्र कुमार, वरिष्ठ वैज्ञानिक
71	डॉ. सुमन तिवारी, वैज्ञानिक
72	श्री सौरव कुमार, वैज्ञानिक
73	श्री हेमंत सिंह अजल, वैज्ञानिक
74	सुश्री निशा यादव, वैज्ञानिक
75	श्री सिद्धार्थ सरकार, वैज्ञानिक
76	डॉ. अभय सचदेव, वैज्ञानिक

77	श्री बलजीत सिंह, वैज्ञानिक
78	श्री मुकेश कुमार, वैज्ञानिक
79	सुश्री रूबल, वैज्ञानिक
80	श्री विकाश चंद्रा, वैज्ञानिक
81	श्री आनंद वी. पी., वैज्ञानिक
82	श्री एस अनूप चंद्रा, वैज्ञानिक
83	श्री नवीन शर्मा, वैज्ञानिक
84	श्री सुरजीत कमान, वैज्ञानिक
85	डॉ. रंजन कुमार झा, वैज्ञानिक
86	डॉ. अविशेक साहा, वैज्ञानिक
87	श्री आर वेणुमाधव, वैज्ञानिक
88	श्री सत्य प्रताप सिंह, वैज्ञानिक
89	धैर्य सिंह आर्य, वैज्ञानिक

तकनीकी अधिकारी/ कर्मचारी

1. श्री संजय शर्मा, प्रधान तकनीकी अधिकारी
2. श्री सज्जन कुमार बोथरा, प्रधान तकनीकी अधिकारी
3. श्री हरिचंद सिंह, प्रधान तकनीकी अधिकारी
3 ए श्रीमती कविता सिंह, प्रधान तकनीकी अधिकारी
4. श्री मदन शर्मा, वरिष्ठ अधीक्षक अभियंता
5. श्री मांगे राम, वरिष्ठ तकनीकी अधिकारी (3)
6. सुश्री हरजीत कौर, वरिष्ठ तकनीकी अधिकारी (3)
7. श्री उपेंद्र कुमार, वरिष्ठ तकनीकी अधिकारी (3)
8. सुश्री रजनी, वरिष्ठ तकनीकी अधिकारी (3)
9. श्री माता दीन मीना, वरिष्ठ तकनीकी अधिकारी (3)
10. डॉ अनामिका कोठारी, महिला चिकित्सा अधिकारी ग्रुप III (6)
11. श्री राजेन्द्र सिंह शौंडा, वरिष्ठ तकनीकी अधिकारी (3)
12. सुश्री बंदना खुल्लर, वरिष्ठ तकनीकी अधिकारी (3)

13 श्री प्रदीप कुमार मांझी, वरिष्ठ तकनीकी अधिकारी (3)

14 श्री शशि भूषण कुमार, वरिष्ठ तकनीकी अधिकारी (3)

15 श्री कुम्हार लाल, वरिष्ठ तकनीकी अधिकारी (3)

16 श्री तरविन्दर कौर, वरिष्ठ तकनीकी अधिकारी (3)

17 श्री मदन लाल, वरिष्ठ तकनीकी अधिकारी (3)

18 श्री धन्ना लाल मीना, वरिष्ठ तकनीकी अधिकारी (3)

19 श्री मेहर चन्द, वरिष्ठ तकनीकी अधिकारी (3)

20 श्री हरी दास, अधीक्षक अभियंता (विद्युत)

21 श्री सुंदर लाल, अधीक्षक अभियंता (विद्युत)

22 डॉ. जितेंद्र विरमानी, वरिष्ठ तकनीकी अधिकारी (2)

23 सुश्री आशा रानी, वरिष्ठ तकनीकी अधिकारी (2)

24 श्री अमित गुप्ता, वरिष्ठ तकनीकी अधिकारी (1)

25 श्री जागेश्वर रामचन्द्र खापेकर, वरिष्ठ तकनीकीअधिकारी (1)

26 श्री अरुण कुमार, सहायक कार्यपालक अभियंता

27 डॉ. उदयबीर सिंह, वरिष्ठ तकनीकी अधिकारी (1)

28 श्री गोरज सिंह, वरिष्ठ तकनीकी अधिकारी (1)

29 श्री अशोक कुमार, वरिष्ठ तकनीकी अधिकारी (1)

30 श्री सुपंकर दास, वरिष्ठ तकनीकी अधिकारी (1)

31 श्री सर्वेश कुमार, वरिष्ठ तकनीकी अधिकारी (1)

32 डॉ. मनीष कुमार, वरिष्ठ तकनीकी अधिकारी (1)

33 डॉ. विनोद मिश्रा, वरिष्ठ तकनीकी अधिकारी (1)

34 डॉ. अनुपमा शर्मा, वरिष्ठ तकनीकी अधिकारी (1)

35 सुश्री ममता शर्मा, तकनीकी अधिकारी

36 श्री हिशविन्दर सिंह, तकनीकी अधिकारी

37 सुश्री दीपा श्रीवास्तव, तकनीकी अधिकारी

38 श्री अमरेन्द्र गोप, तकनीकी अधिकारी

39 डॉ. प्रीतिस्मिता बोरा, तकनीकी अधिकारी

40 श्री दीपक कश्यप, तकनीकी अधिकारी

41	श्री विक्रम, सहायक अभियंता
42	श्री हरबीर पल सिंह, तकनीकी अधिकारी
43	श्री संदीप कुमार, सहायक अभियंता
44	श्री ओमेन्द्र सिंह, तकनीकी अधिकारी
45	श्री मुकेश कुमार, तकनीकी अधिकारी
46	श्री सूरज प्रकाश, तकनीकी अधिकारी
47	श्री हिमांशु कुमार सिंह, तकनीकी अधिकारी
48	श्री वरुण धीमान, तकनीकी अधिकारी
49	श्री हर्ष कुमार, तकनीकी अधिकारी
50	सुश्री सोनाली वात्स्यायन, बागवानी सहायक
51	श्री मनु शर्मा, तकनीकी सहायक
52	श्री अजय कुमार, तकनीकी सहायक
53	श्री अनिल जांगरा, तकनीकी सहायक
54	श्री कृष्ण गोपाल मीना, तकनीकी सहायक
55	श्री विनीश मोहनन, तकनीकी सहायक
56	श्री केवल कुमार, तकनीकी सहायक
57	श्री विनोद कुमार, तकनीकी सहायक
58	श्री हरकिरत सिंह, तकनीकी सहायक
59	श्री गुरप्रीत सिंह, तकनीकी सहायक
60	श्री परवेज़ आलम, तकनीकी सहायक
61	श्री प्रदीप कुमार, कनिष्ठ अभियंता (सिविल)
62	श्री दुर्गेश मिश्रा, तकनीकी सहायक
63	श्री अभिनव कौशल, तकनीकी सहायक
64	श्री इन्द्रजीत सिंह, तकनीकी सहायक
65	श्री तरुण पांचाल, तकनीकी सहायक
66	श्री संजय कुमार, तकनीकी सहायक
67	श्री बलदेव सिंह, वरिष्ठ तकनीशियन (3)
72	श्री अमरीक सिंह, चालक ग्रुप II(4)

68	श्री अशोक कुमार, वरिष्ठ तकनीशियन ग्रुप (2)
69	श्री मलकीत सिंह कल्याण, वरिष्ठ तकनीशियन ग्रुप (2)
70	श्री बलवंत सिंह, वरिष्ठ तकनीशियन ग्रुप (2)
71	श्री ज्ञान चन्द, वरिष्ठ तकनीशियन ग्रुप (2)
73	श्री संदीप कुमार, फार्मिसिस्ट
74	श्री जसपाल सिंह, चालक ग्रुप II(2)
75	श्री सुमन कुमार, स्टाफ कार चालक
76	श्री दिलबग सिंह, तकनीशियन (2)
77	श्री सुरेन्द्र कुमार जांगड़, तकनीशियन (2)
78	श्री इन्द्रजीत, तकनीशियन (2)
79	श्री चन्दर पाल सिंह, तकनीशियन (2)
80	सुश्री ज्योत्सना, तकनीशियन (2)
81	श्री पंकज कुमार, तकनीशियन (2)
82	श्री गुरजीत सिंह सैनी, तकनीशियन (2)
83	सुश्री कृष्णा, नर्सिंग सिस्टर
84	श्री इरशाद, तकनीशियन (1)
85	श्री अनूप कुमार, तकनीशियन (1)
86	श्री अनन्त राम वर्मा, तकनीशियन (1)
87	श्री अभिषेक घानेकर, तकनीशियन (1)
88	श्री कंवलजीत, तकनीशियन (1)
89	श्री प्रदीप कुमार, तकनीशियन (1)
90	श्री अभिषेक कुमार, तकनीशियन (1)
91	श्री कर्मवीर, तकनीशियन (1)
92	श्री सुप्रिया रंजन पाल, तकनीशियन (1)
93	श्री अक्किरेडडी शिवा रामा कृष्णा, तकनीशियन (1)
94	श्री अमूल्य मांडल, तकनीशियन (1)
95	श्री सूर्य देव कुमार, तकनीशियन (1)
96	श्री दीपक कुमार, तकनीशियन (1)

97   श्री बलवीर कुमार जाँगिड़, तकनीशियन (1)

98   श्री लखविन्द्र, तकनीशियन (1)

99   श्री दिवाकर सिंह, तकनीशियन (1)

100   श्री राहुल रंजन, तकनीशियन (1)

101   श्री महावीर प्रसाद जाँगिड़, तकनीशियन (1)

102   श्री पवन कुमार, प्रयोगशाला सहायक

103   श्री कनही, प्रयोगशाला सहायक

104   श्री हरपाल सिंह, प्रयोगशाला सहायक

105   श्री राकेश कुमार, प्रयोगशाला सहायक

106   श्री शिव राज कुमार, प्रयोगशाला सहायक

107   श्री बिपन कुमार आचार्या, प्रयोगशाला सहायक

108   श्री राकेश कुमार शर्मा, प्रयोगशाला सहायक

109   श्री रमेश चन्द, प्रयोगशाला सहायक

110   श्री राजपाल सिंह, प्रयोगशाला सहायक

111   श्री एम रमेश, प्रयोगशाला सहायक

112   श्री बैजनाथ, प्रयोगशाला सहायक

113   श्री अवतार अली, प्रयोगशाला परिचारक (2)

114   श्री राकेश कुमार बैरवा, प्रयोगशाला परिचारक (2)

115   श्री मोहन सिंह, वरिष्ठ तकनीशियन ग्रुप (2)

प्रशासनिकअधिकारी/ कर्मचारी

1   श्री संजीव कुमार बोहरा, वरिष्ठ वित्त एवं लेखा नियंत्रक

2   श्री जसवंत राय, प्रशासन नियंत्रक

3   श्री मोहिन्दर कुमार, भण्डार एवं क्रय नियंत्रक

4   अवतार सिंह, प्रशासनिक अधिकारी

5   शंकर दास ऋषि, प्रशासनिक अधिकारी

6   सुरेन्द्र कुमार नारद, वित्त एवं लेखा अधिकारी

7 श्री बनवारी लाल मीणा, भण्डार एवं क्रय अधिकारी

8 श्री सतीश कुमार, प्रिंसिपल निजी सचिव

9 श्री सुकेश कुमार, प्रिंसिपल निजी सचिव

10 सुश्री नवनीत आनन्द, वरिष्ठ हिन्दी अधिकारी

11 डॉ लोकेश शर्मा, हिन्दी अधिकारी

12 श्री अरविंद कुमार, अनुभाग अधिकारी (भण्डार एवं क्रय)

13 श्री अर्पण महेश्वरी, अनुभाग अधिकारी (भण्डार एवं क्रय)

14 श्री व्योमकेश पाण्डेय, अनुभाग अधिकारी (वित्त एवं लेखा)

15 श्री अभिषेक चंद्र, अनुभाग अधिकारी (सामान्य)

16 निशि शर्मा, अनुभाग अधिकारी (सामान्य)

17 श्री अंगद विर्क, अनुभाग अधिकारी (सामान्य)

18 सुश्री पदम अरोड़ा, निजी सचिव

19 श्री कपिल वर्मा, निजी सचिव

20 श्री सरवण सिंह, सुरक्षा अधिकारी

21 सुश्री सुषमा रानी, वरिष्ठ आशुलिपिक

22 सुश्री गरगी देवी, वरिष्ठ आशुलिपिक

23 इन्द्रजीत कुमार, वरिष्ठ आशुलिपिक

24 सुश्री मीना रानी, वरिष्ठ आशुलिपिक

25 सुश्री सरिता कुमारी, वरिष्ठ आशुलिपिक

26 सुश्री रितु पुंडीर, वरिष्ठ आशुलिपिक

27 श्री सोहन सिंह, सहायक अनुभाग अधिकारी (वित्त एवं लेखा)

28 सुश्री अनीता, सहायक अनुभाग अधिकारी (सामान्य)

29 श्री पवन कुमार बैंस, वरिष्ठ सचिवालय सहायक (भण्डार एवं क्रय)

30 श्री विनोद कुमार, सहायक अनुभाग अधिकारी (सामान्य)

31 श्री कमलेश कुमार, सहायक अनुभाग अधिकारी (सामान्य)

32 सुश्री आशा जोशी, सहायक अनुभाग अधिकारी (सामान्य)

33 श्री थाम बहादुर सोनरी, सहायक अनुभाग अधिकारी (सामान्य)

34 श्री रमेश कुमार, अनुभाग अधिकारी (भण्डार एवं क्रय)

35 सुश्री कविता चौहान, सहायक अनुभाग अधिकारी (वित्त एवं लेखा)

36 श्री रईस अहमद, सहायक अनुभाग अधिकारी (भण्डार एवं क्रय)

37 श्री कमलेश कुमार, सहायक अनुभाग अधिकारी (भण्डार एवं क्रय)

38 श्री रमेश चन्द, सहायक अनुभाग अधिकारी (सामान्य)

39 सुश्री मंजोत कौर, सहायक अनुभाग अधिकारी (सामान्य)

40 सुश्री कुसुम लता, सहायक अनुभाग अधिकारी (वित्त एवं लेखा)

41 श्री आर गोपीनाथ, सहायक अनुभाग अधिकारी (सामान्य)

42 श्री अनिल कुमार यादव, सहायक अनुभाग अधिकारी (सामान्य)

43 श्री राजिन्द्र कुमार, सहायक अनुभाग अधिकारी (भण्डार एवं क्रय)

44 श्री ब्रिज मोहन, सहायक अनुभाग अधिकारी (सामान्य)

45 श्री मनोज कुमार, सहायक अनुभाग अधिकारी (सामान्य)

46 श्री चाँद राम, सुरक्षा सहायक

47 श्री नवीन कुमार, सुरक्षा सहायक

48 सुश्री प्रियंका गुप्ता, वरिष्ठ सचिवालय सहायक (वित्त एवं लेखा)

49 सुश्री निहारिका चौधरी, वरिष्ठ सचिवालय सहायक (सामान्य)

50 श्री जयंत मोहन राव, वरिष्ठ सचिवालय सहायक (भण्डार एवं क्रय)

51 श्री रवि कान्त, वरिष्ठ सचिवालय सहायक (सामान्य)

52 श्री हर्ष पति, सहायक प्रबन्धक सह स्टोर कीपर

53 श्री रंजीत सिंह, क्लर्क

54 श्री किशोर सिंह, चालक

55 श्री अशोक कुमार, चालक

56 श्री जगमोहन सिंह, वरिष्ठ सचिवालय सहायक (सामान्य)

57 श्री सुनील कुमार, वरिष्ठ सचिवालय सहायक (वित्त एवं लेखा)

58 श्री साहिल, कनिष्ठ सचिवालय सहायक (सामान्य)

59 श्री रामबीर सिंह, कार्य सहायक

60 सुश्री चंदरकांता, कार्य सहायक

61 श्री धन सिंह, कार्य सहायक

62 श्री करतार चन्द, कार्य सहायक

63　श्री राजिन्द्र सिंह, कार्य सहायक

64　श्री उमेश कुमार, वॉश बॉय

65　श्री अभिषेक कुमार, कार्य सहायक

66　सुश्री कमला, कार्य सहायक

67　सुश्री सुशीला देवी, कार्य सहायक

68　श्री प्रेम चंद, कनिष्ठ सचिवालय सहायक (भण्डार एवं क्रय)

69　श्री दीना नाथ, कार्य सहायक

70　श्री काली चरण, बीयरर

71　श्री इंदरजीत सिंह, आरसीटीओ

72　श्री पवन कुमार, सहायक अनुभाग अधिकारी (सा.)

नई नियुक्ति, पदोन्नति/मूल्यांकन/वित्तीय उन्नयन, सेवानिवृत्ति, स्वैच्छिक सेवानिवृत्ति, स्थानांतरण व त्यागपत्र

नई नियुक्ति

क्र. सं.	नाम	पद	कार्यग्रहण की तिथि
1.	डॉ. सत्य प्रताप सिंह	वैज्ञानिक	07.02.2022
2.	श्री धैर्य सिंह आर्य	वैज्ञानिक	10.03.2022

पदोन्नति एवं मूल्यांकन

क्रम सं.	नाम/वर्तमान पदनाम	मूल्यांकित पदनाम	मूल्यांकन पदोन्नति की तिथि
1.	Dr. B.S. Bansod Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	19.04.2019
2.	Dr. Amit Lochan Sharma Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	09.08.2018
3.	Dr. A.K. Shukla Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	24.04.2019
4.	Dr. Sanjeev Soni Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	16.08.2019
5.	Dr. Harry Garg Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	03.01.2019
6.	Dr. Akash Deep Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	05.07.2018
7.	Sh. Ashish Gaurav Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2019
8.	Sh. Ripul Ghosh Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2019
9.	Sh. Raj Kumar Pal Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2019
10 .	Ms. Naga Vara Aparna Akula Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2018
11.	Ms. Sudeshna Bagchi Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2019
12.	Dr. Divya Agrawal Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	14.10.2019
13.	Dr. Ritesh Kumar Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	17.10.2020
14.	Dr. Rishemjit Kaur	Principal Scientist	17.10.2019

	Senior Scientist Pay Level-12	Pay Level-13	
15.	Dr. Srikanth Vasamsetti Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	09.08.2019
16.	Dr. Pooja Devi Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	09.08.2019
17.	Sh. Girish Chandra Mohanta Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	26.10.2019
18.	Dr. Manoj Kumar Patel Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	22.11.2018
19.	Sh. Jitendra Kumar Scientist Pay Level-11	Senior Scientist Pay Level-12	31.12.2020
20.	Dr. Viren Sardana Senior Scientist Pay Level-12 *(transferred to CSIR-IGIB w.e.f. 27.02.2020)*	Principal Scientist Pay Level-13	09.08.2019
21.	Sh. Prabhat Kumar Baghel Principal Scientist Pay Level-13 (*transferred to CSIR-AMPRI w.e.f. 06.11.2020)*	Sr. Principal Scientist Pay Level-13A	18.12.2019
22.	Sh. G.S. Ayyappan **(CSIR-CSIO, Chennai Centre)** Principal Scientist Pay Level-13	Sr. Principal Scientist Pay Level-13A	19.01.2022
23.	Dr. Raj Kumar Senior Scientist Pay Level-12	Principal Scientist Pay Level-13	01.05.2019
24.	Dr. Satish Kumar Senior Principal Scientist Pay Level-13A	Chief Scientist Pay Level-14	10.05.2018

वित्तीय उन्नयन (10, 20 एवं 30 साल की सेवा पूरी करने पर)

क्र. सं.	नाम	पदनाम	वित्तीय उन्नयन की तिथि
1.	Ms. Kamla Work Assistant Pay Matrix Level-1 ID: 1057	Work Assistant Pay Matrix Level-2	**09.08.2021** 1st financial upgradation (on completion of 10 years of regular service in the same Grade Pay/ Pay Level)
2.	Sh. Anil Kumar Yadav Assistant Section Officer (G) Pay Matrix Level-7 ID: 1056	Assistant Section Officer (G) Pay Matrix Level-8	**24.10.2021** 1st financial upgradation (on completion of 10 years of regular service in the same Grade Pay/ Pay Level)

अधिवर्षिता प्राप्ति पर सेवानिवृत्ति

क्र. सं.	नाम	पद	सेवानिवृत्ति की तिथि
1.	श्री विजय सिंह	बीयरर	30.04.2021
2.	श्री बी. के. भटनागर	अनु. अधि. (भं एंव क्रय)	31.05.2021
3.	श्री सुनील कुमार गुप्ता	वित्त एवं लेखा नियंत्रक	31.07.2021
4.	श्री बनवारी लाल	लैब सहा.	30.09.2021
5.	श्रीमती विरमिता मल्होत्रा	पीटीओ	30.09.2021
6.	श्री पराग सक्सेना	प्रशा. नियं.	30.09.2021
7.	श्रीमती शशि मोइत्रा	पीटीओ	30.11.2021
8.	डॉ. एच. के. सरदाना	चीफ वैज्ञानिक	30.11.2021
9.	श्री कुलवीर सिंह	वरि. तक. (।।)	31.12.2021
10.	श्री नरेश कुमार खुराना	वरि. आशु.	31.01.2022
11.	श्री पवन कुमार	सहा. अनु. अधि. (सा.)	31.03.2022
12.	श्री मोहन सिंह	वरि. तक. (।।)	31.03.2022

स्वैच्छिक सेवानिवृत्ति

क्र. सं.	नाम	पद	तिथि
1.	कोई नहीं	---	---

स्थानांतरण

क्र. सं.	नाम	पद	स्थानांतरण की तिथि एवं संस्थान
1.	श्री अवतार सिंह	प्रशासनिक अधिकारी	09.04.2021, (सीएसआईआर–इमटैक से सीएसआईआर–सीएसआईओ)
2.	श्री शिवराम मिश्रा	तक. अधि.	31.05.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–सीडीआरआई)
3.	श्री हरप्रीत सिंह शेखों	वित्त एवं लेखा अधि.	16.04.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–इमटेक)
4.	श्री शंकर दास ऋषि	प्रशा. अधि.	15.04.2021 (सीएसआईआर–एचआरडीजी से

			सीएसआईआर–सीएसआईओ)
5.	श्रीमती डौली कौशल	वरि. आशु.	16.04.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर मुख्यालय)
6.	श्री एस. के. नारद	वित्त एवं लेखा अधि.	13.04.2021 (सीएसआईआर–इमटेक से सीएसआईआर – सीएसआईओ)
7.	डॉ. अजय यादव	प्रिंसिपल वैज्ञानिक	14.06.2021 (सीएसआईआर–सीएमईआरआई से सीएसआईआर–सीएसआईओ)
8.	श्री सी. ए. बौद्ध	प्रशासनिक अधि.	09.08.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एनसीएल)
9.	श्री हरीश कुमार	प्रशासनिक अधि.	09.08.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–नीरी)
10.	श्री बनवारी लाल मीणा	भं एव क्रय अधि.	09.08.2021 (सीएसआईआर–सीआईएमएपी से सीएसआईआर–सीएसआईओ)
11.	श्री अरविंद कुमार	अनु. अधि. (भं एवं क्रय)	19.08.2021 (सीएसआईआर–सीएसएमसीआरआई से सीएसआईआर–सीएसआईओ)
12.	श्री एल. एस. नेगी	वरि. प्रशा. नियं.	18.08.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर मुख्यालय)
13.	श्री रवि गर्ग	भं एवं क्रय अधि.	18.08.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर– निसकेयर)
14.	श्री सतीश कुमार	प्रशा. अधि.	24.08.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–आईआईसीटी)
15.	श्री अभिषेक चंद्रा	अनु. अधि (सा.)	01.09.2021 (सीएसआईआर–यूआरडीआईपी से सीएसआईआर–सीएसआईओ)
16.	श्री राजेश विश्वनाथ कनवाड़े	वैज्ञानिक	30.11.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एनसीएल)
17.	श्री मुकेश	कनि. आशु.	30.12.2021 (सीएसआईआर–सीएसआईओ से

			सीएसआईआर–एनपीएल)
18.	श्रीमती पूनम	वरि. सचि. सहा. (सा.)	30.12.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एनपीएल)
19.	श्री विनोद कुमार	वरि. सचि. सहा. (भं एवं क्रय)	30.12.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–आईआईआईएम)
20.	श्री व्योंकेश पांडे	अनु. अधि. (वित्त एवं लेखा.)	29.12.2021 (सीएसआईआर–इमटैक से सीएसआईआर–सीएसआईओ)
21.	श्री अर्पण महेश्वरी	अनु. अधि. (भं एवं क्रय)	31.12.2021 (सीएसआईआर–सीबीआरआई से सीएसआईआर–सीएसआईओ)
22.	श्रीमती आशा जोशी	सहा. अनु. अधि. (सा.)	31.12.2021 (सीएसआईआर–आईआईपी से सीएसआईआर–सीएसआईओ)
23.	श्री कमलेश कुमार	सहा. अनु. अधि. (सा.)	31.12.2021 (सीएसआईआर–सीएमईआरई से सीएसआईआर–सीएसआईओ)
24.	श्री टी. बी. सोनारी	सहा. अनु. अधि. (सा.)	31.12.2021 (सीएसआईआर–सीएमईआरई से सीएसआईआर–सीएसआईओ)
25.	श्री दिनेश कुमार वर्मा	अनु. अधि. (भं. एवं क्रय)	17.12.2021 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एनपीएल)
26.	डॉ. संदीप सिंघई	प्रिंसिपल वैज्ञानिक	11.02.2022 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एम्री)
27.	श्री हरनेक सिंह	प्रिंसिपल निजी सचिव	20.01.2022 (सीएसआईआर–सीएसआईओ से सीएसआईआर–इमटेक)
28.	श्री जसवंत राय	प्रशासन नियंत्रक	01.02.2022 (सीएसआईआर–आईआईपी, से सीएसआईआर–सीएसआईओ)
29.	श्रीमती सुदेश यादव	वैज्ञानिक	28.02.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एनपीएल)
30.	श्री सुमन तिवारी	वैज्ञानिक	31.03.2022 (सीएसआईआर–सीएसआईओ से सीएसआईआर–एनएमएल)

31.	श्री दीपक शर्मा	वरि. वैज्ञानिक	28.02.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एनपीएल)
32.	श्रीमती कृष्णा कौशिक	सहा. अनु. अधि. (सा.)	28.02.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एचआरडीजी)
33.	श्री धीरेन्द्र बंसल	प्रिंसिपल वैज्ञानिक	28.02.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एचआरडीजी)
34.	श्री कैलाश चंद	पीटीओ	28.02.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एचआरडीजी)
35.	डॉ. परमिता गुहा	वरि. वैज्ञानिक	14.03.2022 (सीएसआईओ, दिल्ली केन्द्र से सीएसआईआर–एनपीएल)
36.	श्री कपिल वर्मा	पी.एस.	31.12.2021 (समान लैब में तैनाती)
37.	श्री अंगद विर्क	अनु. अधि. (सा.)	29.12.2021 (समान लैब में तैनातीा)
38.	श्रीमती निशी शर्मा	अनु. अधि. (सा.)	29.12.2021 (समान लैब में तैनाती)
39.	श्रीमती पदम अरोड़ा	पीएस	28.12.2021 (समान लैब में तैनाती)
40.	श्री अनिल कुमार	पीएस	28.12.2021 (समान लैब में तैनाती)
41.	श्री रमेश कुमार	अनु. अधि. (भं एवं क्रय)	28.12.2021 (समान लैब में तैनाती)

त्यागपत्र

क्र. सं.	नाम	पद	*त्यागपत्र* की तिथि
1.	श्री नितिन	कनि. सचि. सहा. (सा.)	30.09.2021

मृत्यु

क्र. सं.	नाम	पद	मृत्यु की तिथि
1.	श्री धर्मेन्द्र कुमार सिंह	तक. अधि.	19.10.2021

प्रो. एस अनन् त रामकृष्ण निदेशक, सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	अध्यक्ष
डॉ. संजीव खोसला निदेशक, सी.एस.आई.आर - सूक्ष्मजीव प्रौद्योगिकी संस्थान चण् डीगढ़ – 160030	सदस्य
डॉ. सतीश कुमार चीफ़ वैज्ञानिक सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	सदस्य
डॉ. सुनीता मिश्रा वरिष्ठ प्रिन्सिपल वैज्ञानिक सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	सदस्य
डॉ. मनोज कुमार पटेल प्रिन्सिपल वैज्ञानिक सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	सदस्य
डॉ. रंजन झा वैज्ञानिक सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	सदस्य
डॉ. अनुपमा शर्मा वरिष्ठ तकनीकी अफसर सीएसआईआर - सीएसआईओ चण् डीगढ़ - 160030	सदस्य

डॉ. अवधेश कुमार शुक्ल वरिष्ठ प्रिन्सिपल वैज्ञानिक प्रमुख बीडीपीएम सीएसआईआर - सीएसआईओ चण्‍डीगढ़ - 160030	सदस्य
ववत्त एवं लेखा नर्यंत्रक/ ववत्त एवं लेखा अचधकारी सीएसआईआर - सीएसआईओ चण्‍डीगढ़ - 160030	सदस्य
प्रशासन नर्यंत्रक/प्रशासर्नक अचधकारी सीएसआईआर - सीएसआईओ चण्‍डीगढ़ - 160030	सदस्य सचिव

प्रो. संगीता रेड्डी

संयुक्त प्रबंध निदेशक

अपोलो हॉस्पिटल्स एंटरप्राइज़िस

बेनरघाटा रोड, 154/11

बेंगलुरू – 560076

डॉ. रूपामंजरी घोष

कुलपति एवं निदेशक

प्राकृतिक विज्ञान विद्यालय

शिव नादर विश्वविद्यालय

एनचएच-91, तहसील दादरी

गौतम बुद्ध नगर, उत्तर प्रदेश – 201314

प्रो. कृष्णन् बालसुब्रह्मण्यम्

डिपार्टमेंट ऑफ मकेनिकल इंजीनियरिंग

भारतीय प्रौद्योगिकी संस्थान, मद्रास

चेन्नै – 600036

श्री बीएचवीएस नारायण मूर्ति

निदेशक

रिसर्च सेन्टर इमारत

आरसीआई रोड, विज्ञानकंछा

हैदराबाद – 500069

डॉ. चिरासरी रॉय चौधरी

सहायक प्रोफेसर

इलेक्ट्रॉनिक्स एंड टैलिकम्युनिकेशन्स

आईआईईईएसटी, शिबपुर

पो.आ.-बोटेनिक गार्डन, हावड़ा

पश्चिम बंगाल – 711103

श्री उद्यंत टोबी मल्होत्रा

प्रबंध निदेशक एवं सीईओ

डायनामैटिक टैक्नोलॉज़ीस लि.

डायनामैटिक पार्क, पीनिया इंडस्ट्रियल एरिया

बेंगलुरू – 560012

प्रो. रुद्र प्रताप
डिपार्टमैंट ऑफ मकेनिकल साइंस
सेन्टर फॉर नैनो साइंस एंड इंजीनियरिंग
भारतीय विज्ञान संस्थान
बेंगलुरू – 560012

डॉ. जिलेलामुडी मंजुला
डीएस एवं महानिदेशक
इलेक्ट्रॉनिक्स एंड कम्युनिकेशन्स सिस्टम्स
एलआरडीई कैम्पस, सी वी रमन नगर
बेंगलुरू – 560093

श्रीमीत वर्तिका शुक्ल
निदेशक (तकनीकी)
इंजीनियर्स इंडिया लि. (ईआईएल)
ईआईएल भवन, 1 भीकाजी कामा प्लेस
नई दिल्ली – 110066

डॉ. पी. सी. पंचारिया
निदेशक
सीएसआईआर–केन्द्रीय इलेक्ट्रॉनिक अभियांत्रिकी अनुसंधान संस्थान (सीरी)
पिलानी – 333031

प्रो. एस. अनन्त रामकृष्ण
निदेशक
सीएसआईआर–सीएसआईओ
चण्डीगढ़ – 160030

श्री हेमंत कुलकर्णी
वरिष्ठ प्रिंसिपल वैज्ञानिक
प्रौद्योगिकी प्रबंधन निदेशालय (इंडस्ट्री इंटरफेस)
14 सत्संग विहार
नई दिल्ली – 110067