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Confederation of Indian Industry

CII National Forum on Industry-Academia Partnership for Research and Development and Innovation

Compendium

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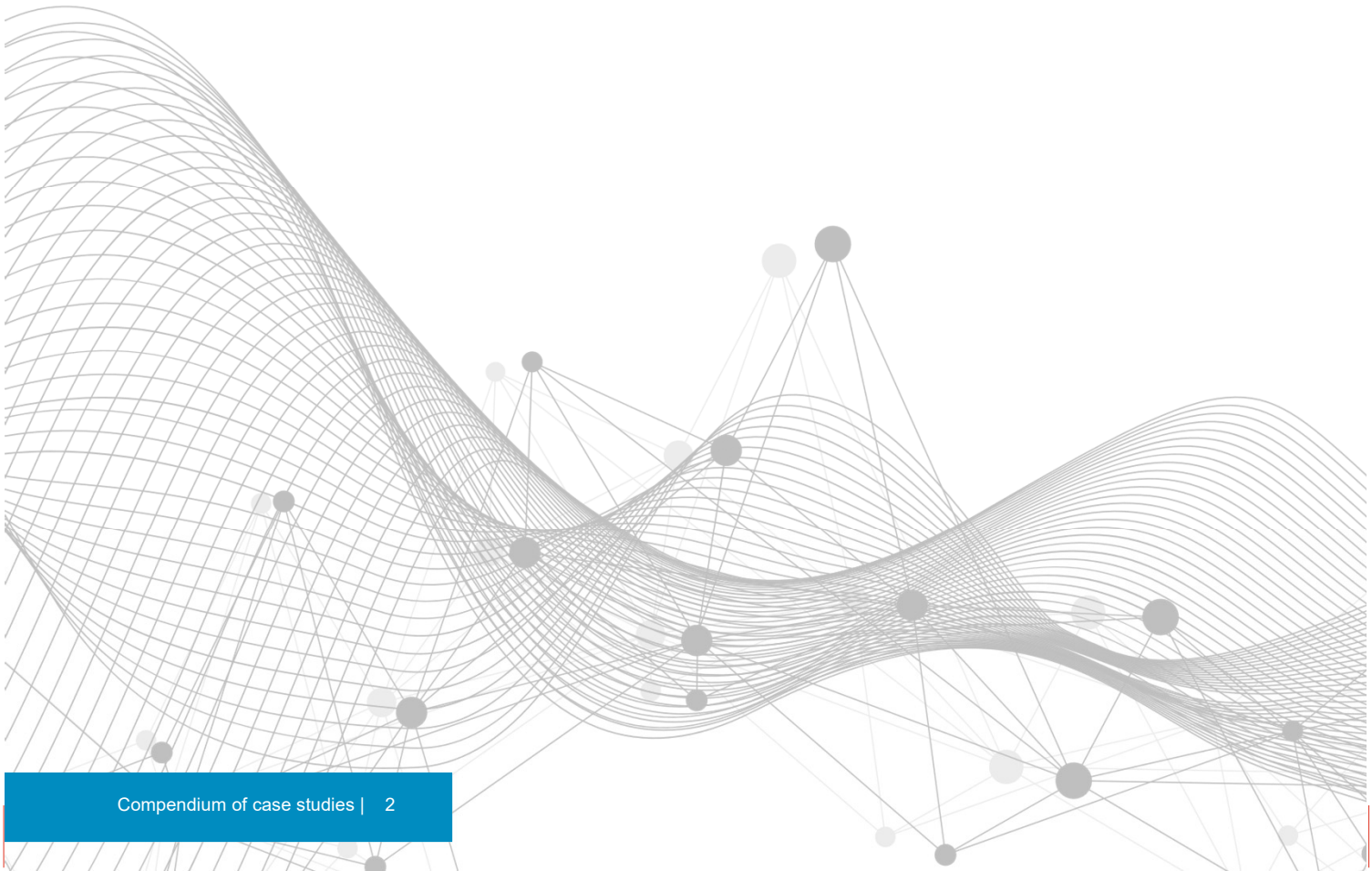

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Foreword by Taskforce Chair

Dr. Naushad Forbes

Chairman - CII National Forum on Industry-Academia Partnership

Co-Chairperson Forbes Marshal

Today, the fusion of industry expertise and academic research has become more crucial than ever. Synergy between these two spheres fosters innovation, drives economic growth, and addresses complex societal challenges. For India to achieve its science and technology goals, industry and academia need to collaborate more closely and effectively.

CII has constituted a National Forum for Industry-Academia Partnership dedicated to fostering collaboration between industry and academia for R&D and innovation. A key objective is to promote collaboration among industry, academia, research labs, and startups, collectively referred to as the National Research Quad, with the government playing a vital enabling role.

The Forum has prepared this Compendium of successful case studies of industry-academia collaborations across various themes, demonstrating dedication and enthusiasm from both industry and academia. Each case study is a narrative of partnership, detailing the objectives, processes, and outcomes of various collaborative initiatives. We hope it will serve to ignite new ideas and scale up existing collaboration.

We are grateful to all the forum members and stakeholders who have contributed to this initiative. Their constant support has been instrumental in bringing this to fruition.

Message from Former Taskforce Chair

Vipin Sondhi

Former Chairperson, CII National Forum on Industry – Academia Partnership for R&D and Innovation

India is on the cusp of momentous transformation. Riding the wave of economic expansion, the country may have a lot going for it, but it is not without its share of challenges. Adapting to the future entails reimagination and reinvention with evolving technologies as the fulcrum. Strategic partnerships hold the key to creating and delivering tangible value amidst unforeseen disruptions. Today, embracing technology is an imperative, as much as innovating and collaborating with relevant stakeholders to ensure that businesses are future-fit and equipped to stay ahead of the curve amidst the confluence of crisis facing business leaders.

In these circumstances, the industry-academic partnership is no longer a choice but rather, a compulsion that enables one to see what everybody else is seeing but think what nobody else has thought of, and most importantly execute what may have seemed unthinkable. Working in tandem, the industry in conjunction with academia could help shape the future by producing outcomes that have an impact not only on the domestic front, but also beyond borders.

This document comprising a compendium of 40+ case studies and a policy communique classified under seven distinctive tracks outlines the rewards and challenges of a collaborative journey entailing research and development, and innovation. Research and development in these specific tracks, namely Key Drivers, Mobility, Robotics & AI, Healthcare, Semiconductors, Energy Transition and AgriTech, underscores its significance in ensuring the survival and sustainability of businesses, by way of anticipating market trends, meeting evolving customer demands and embracing climate change adaptation.

Innovation, on the other hand, has been critical in transforming ideas into real, tangible solutions that address societal challenges and create value. The detailed case studies showcased under each track therefore go to show how innovation can actually be the future better delivered by reading crisis as an opportunity. They elaborate on a problem statement, actions undertaken, task and technology used, results, project impact, challenges and learning to indicate the meaningful contribution that has resulted from the industry-academia partnership to improve the quality of life and productivity of the respective target audience for each track.

The recommendations offered in each track – be it research of alternative fuels and adoption through PLI, implementation of a system to recognise and reward collaborating team members' achievements to maintain motivation, investments in skill development programmes for collaborating teams, streamlining of regulatory mechanisms governing various aspects such as patents, grants, technology transfer, compliance, or an increase in R&D initiatives for manufacturing semiconductor raw materials – are accompanied by corresponding policy actions that if taken up, could fulfill the nation's aspirations of becoming a USD 35 trillion economy by 2047.

Sincere thanks to our knowledge partner PwC for supporting CII on this engagement. We do hope you will find this document useful and will be able to draw lessons to trigger further research and innovations that could stimulate the economy and touch the lives of people in every corner of the country.

Message from CII Director General

Chandrajit Banerjee

Director General
Confederation of Indian Industry (CII)

As we embark on the vision of Viksit Bharat@ 2047, we need a robust foundation built on R&D and innovation. This requires a strong, synergistic partnership between industry, academia, research labs, and startups—what we at CII call the National Research Quad—with the Government acting as a key enabler.

The genesis of this initiative lies on the premise that by combining the strengths of academia's deep research capabilities with industry's practical expertise and resources, we can create a synergistic effect that helps us achieve competitiveness not just in the Indian market but also in establishing India as a global force across various industry sectors.

It is with this intent that this Compendium has been prepared. The Compendium serves as a powerful testament to the transformative potential of collaboration between the two critical stakeholders of academia and industry. Through the lens of these case studies, we explore the myriad ways in which academic rigor and industrial acumen converge to drive innovation, solve pressing challenges, and create substantial value for society.

We extend our deepest gratitude to all the contributors who have generously shared their projects for the Compendium.

We hope this Compendium not only informs but also inspires further dialogues and action. By sharing these stories, we aim to encourage more institutions and organizations to embrace collaboration, driving forward the frontiers of knowledge and innovation.

Message from Knowledge Partner

Vivek Prasad

Markets Leader – PwC India

India at its current pivotal juncture is undergoing change. Changing times and new challenges throw up opportunities that call for innovation. And innovation, as Steve Jobs had once said, is the ability to see change as an opportunity, not threat. Opportunity in the business context demands both industry involvement and in-depth research, entailing a strategic partnership between the industry and academia. Research and innovation are critical enablers for the nation’s progress. In fact, the importance of research and innovation extends beyond economic growth, as they play a crucial role in addressing societal challenges, improving the quality of life, and creating a sustainable future.

This Compendium serves as a testament to the power of collaborative research and innovation in shaping India's future by addressing pressing issues such as healthcare, energy transition, agriculture and climate change. Comprising 40+ case studies bundled under seven tracks namely key drivers, mobility, robotics and AI, healthcare, semiconductors, energy transition and AgriTech, the Compendium traces a few encouraging research outcomes and viable breakthroughs that lay the groundwork for future innovations. The common thread in each case study is the drive towards more indigenization, while streamlining operations and improving existing solutions.

The Policy Communiqué to be read in conjunction with this Compendium highlights the rewards and challenges of collaborative research and development between the industry and academia. The recommendations offered in each track, accompanied by policy actions, provide a roadmap for leveraging these partnerships to achieve India's goal of becoming a USD 35 trillion economy by 2047. Implementing some of these recommendations could help unlock the full potential of collaborative research and innovation, accelerating India’s journey towards becoming a global economic powerhouse.

We are grateful to CII for giving us this opportunity to collaborate with them and the wider Forum members on this important initiative.

Messages from the Track Chair and Co-chairs

Prof. V Ramgopal Rao
Former Director, IIT Delhi and Group Vice-Chancellor, BITS Pilani

Industry is the missing link between research and innovation. While India ranks 3rd in the world for research, it ranks 40th in innovation. This wide gap is due to the inadequate collaboration between academia and industry. To enhance our innovation potential, it is imperative to strengthen the partnership between these two sectors."

N. Saravanan
President & CTO, Ashok Leyland

Industry-academia collaboration bridges the gap between theoretical knowledge and practical application. It benefits both sectors by fostering innovation, developing a skilled workforce, and enhancing research with real-world applications. Let us collaborate for the greater good of the society."

Prof. K.K. Pant
Director, IIT Roorkee

The pivotal tripartite collaboration involving Academia, Industry, and State plays a distinctive role in shaping a transformative landscape towards India's holistic Development by providing creative opportunities. Our goal is to cultivate an ecosystem defined by holistic development and creativity. The strategic emphasis on inculcating quality in industrial production and prioritizing capacity building are catalysts to foster the agility of startups and propel advancements in deep tech. At this juncture, strategic R&D investments pave the way for a future characterized by innovation and sustained growth."

Messages from the Track Chair and Co-chairs

Anuj Kapuria
Founder and Chief Executive Officer, Hi-Tech Robotic Systemz

Industry-academia collaboration in deep tech robotics , Autonomous and Smart Mobility is key to pioneering innovations in India. Together, we can transform groundbreaking research into real-world applications, driving India's technological future forward towards an Atma Nirbhar Bharat.“

Anurag Srivastava
Chief Operations Officer, ARTPARK @IISc

With shift in consumer demography & their expectations from products globally, Autonomous Systems & AI will be changing the world in an unprecedented manner across industry domains to drive Innovation, agility & future proofness (resilience) for Sustainable business is key. A collaborative global start-up & supply-chain ecosystem has to enable that and make the world a better place for our future generations.“

Nilanjan Guha
Country Academia and Research Business Manager, Agilent Technologies

Innovation and development come from collaborations. It’s the need of the hour to build a robust collaborative platform that would drive innovation, foster growth, and build a pool of future-ready skilled work force. Together lets drive this mission and build a brighter tomorrow.”

Messages from the Track Chair and Co-chairs

Anurag S. Rathore, Ph.D.
Coordinator, DBT COE for Biopharmaceutical Technology Professor, Department of Chemical Engineering (Jointly with) Yardi School of Artificial Intelligence, Indian Institute of Technology, Delhi

“India stands at a critical juncture where it can make a meaningful impact on affordability and accessibility of biotherapeutic products, not only for Indians but for the world. To make this happen, we need to be an innovator and not just a follower with respect to biomanufacturing technology. Academia-Industry collaborations are the need of the day.”

Dr Debashish Bhattacharjee
Vice President Technology & R&D Tata Steel Limited

“Innovation is vital for differentiation and business sustainability. Collaboration between industry and academia and start-ups accelerates innovation and is the engine for a business or nation to attain leadership.”

Rishikesha T Krishnan
Director, Indian Institute of Management, Bangalore

“Energy transition is a critical problem for many industries. I am delighted to see that some of India’s top technology institutions are collaborating with industry to help navigate this transition through advanced technology solutions.”

Messages from the Track Chair and Co-chairs

Shreepad Karmalkar
Director, IIT Bhubaneswar

"India has embarked on a bold mission to become a global hub for semiconductor fab, fabless and packaging. Academia should assist in this endeavour wholeheartedly, by commercializing their new research ideas via collaboration with industries and incubation of start-ups, and develop a skilled semiconductor workforce through interdisciplinary courses. "

Nipun Mehrotra
Founder, The Agri Collaboratory

"The agriculture sector is vital to India's goals for "Viksit Bharat" by 2047 - driving economic growth, improving sustainability, and lifting millions out of low-income levels. The resurgence of Agriculture needs an improved focus on Sciences - basic, applied, and data - as well as accelerating collaborative innovation by Industry and Agri Universities."

Jaywant Arakeri
Professor, Indian Institute of Science (IISc) and Indian Institute of Technology (IIT) Jodhpur

"Government enabled, and sustained collaborative effort by agriculture universities and laboratories, technical institutes, and industry is needed to overcome the unique challenges faced by Indian agriculture – small land holdings, low productivity, resource stressed, and climate change related uncertainty."

1. Executive Summary

Developing products and solutions for the benefit of citizens across the spectrum of society entails an integrated and collaborative process. The CII National Forum on Industry Academia Partnership for Research and Development and Innovation Compendium, comprising 40+ case studies outlines the merits of a fruitful collaboration between the industry and academia.

According to the United Nations Population Fund, India will continue to have one of the youngest populations in the world till 2030.[1] While this augurs well for the nation, Mettl's India Graduate Skill Index report 2023 indicates that only 45% of India's graduates are employable and ready to meet the industry's demands. It comes as no surprise therefore that the country's worker-to-population ratio has declined from 38.6% in 2011-12 to 37.3% in 2022-23.

In the absence of gainful employment opportunities, the Indian youth especially those from rural areas and Tier 2 and Tier 3 cities run the risk of getting caught in the low-income group and remaining there, which can turn the young demographic dividend into a demographic liability. Therefore, impactful collaboration between industry and academia is imperative to leverage India's demographic dividend.

The Graduate Skill Index report 2023 further states that while India ranks third in the world for research, it ranks 40 in innovation. These statistics underscore the urgent need for academia to continually work with the industry not only for research and innovation, but also to align the learning objectives and pedagogy of the courses offered so that the educated youth are more employable.

This Compendium of 40+ case studies and the corresponding Policy Communiqué highlight the rewards and challenges of collaborative research and development, and innovation. The document aims to inspire further research and innovation which can stimulate the economy and improve the lives of people across the country.

The case studies cover seven tracks - key drivers, mobility, robotics and AI, healthcare, semiconductors, energy transition and AgriTech. From programming robots by demonstration for industrial and warehouse automation to building a humanoid caregiving robot, from a biomarker test kit for TB treatment monitoring to hands-on training programs on semiconductor process engineering to enable workforce development for India's semiconductor mission, the case studies underscore the importance of research and development, and innovation in anticipating market trends, meeting customer demands, and addressing climate change, among other objectives.

Detailed insights into problem statements, actions taken, technologies used, results, project impacts, challenges, and learnings provide an in-depth understanding of the areas which needs attention and areas which have potential to enhance India's ranking in the sphere of innovation. The recommendations offered in each track are accompanied by policy actions that, if implemented, could contribute to India's goal of becoming Viksit Bharat with a USD 35 trillion economy by 2047.

Several academic institutions such as IIT Bombay, IIT Madras, IIT Delhi, IIT Hyderabad, IIT Kanpur, IIT Roorkee, IIT Palakkad, IIIT Hyderabad, Palam Carnegie Mellon University, Society for Innovation and Development, Indian Institute of Science (IISc), ARTPARK, IISc, TWI Training and Examination UK, Narayana Nethralaya, BITS Pilani Hyderabad, National Chemical Laboratory Pune, IIHR, ICAR-NBAIR and JNCASR joined hands with those from the industry including Continental's Technical Centre India (TCI), Tata Consultancy Services, Agilent Technologies, Cummins, Shell, Infosys, FL Smidth, Aditya Birla Group, Baker Hughes, Chevron, CPCL, Mathworks ICN, IHFC, Hi-Tech Robotic Systemz and Global Oil Company to gauge the impact of actions undertaken for a target audience, understand the challenges and document the learnings.

One of the projects on drone pollination, for instance, showed how drone pollination is poised to transform the agricultural landscape, making crop production more resilient and sustainable. This innovative project has advanced to Technology Readiness Level 5 (TRL 5) and a MoU has been signed with Thanos Technologies for commercialization.

1. https://india.unfpa.org/en/topics/adolescents-and-youth-8#:~:text=India%20has%20its%20largest%20ever,that%20will%20last%20till%202025.

Another case study focused on the development of a continuous real-time discharge monitoring system for small open channels and closed conduits using ultrasonic tomography. The outcome of this project is *Dhaara* , a system for monitoring and managing water resources in municipal, agricultural and industrial sectors. The flowmeter developed in the project offers unique features to the Indian market which were hitherto not available and has now become a commercial success.

The industry-academia collaboration helped deep dive into areas of study ranging from achieving Industry 4.0 in biopharmaceutical manufacturing to the development of algorithms for industrial and warehouse automation and deliver tangible outcomes.

The establishment of the Institute for Continuing Medical Education (ICME) National Hub at IIT Kanpur, for instance, was meant to carry out advanced research on ICME based materials and technology and build a sustainable ecosystem comprising researchers and research groups in the country from academia and national laboratories and the industry. This was an important area of national significance and of immense value to the industry. One of the significant results of this project was the INH sponsored summer fellowships to five interns of the Students Undergraduate Research Graduate Excellence (SURGE) program.

In another instance, the strategic partnership between industry and academia resulted in the submission of an Indian patent for IP creation and a manuscript communication to a scientific journal IP creation. In yet another instance, it culminated in the commercialization of products and the development of solutions such as a robotic bin-picking solution or an automated conveyor sorting solution.

Therefore, these collaborations highlight the need for adopting a proactive participation of researchers, sectoral subject matter experts and other relevant stakeholders to move the needle on innovation.

02 Key Drivers

1. Continuous Discharge Measurement in Small Open Channels and Closed Conduits Using Ultrasonic Tomography
2. Fabrication of New Generation Self-resorbing Implants and Devices from Bioactive and Biodegradable Materials for Orthopedic Applications
3. Programming Robots by Demonstration for Industrial and Warehouse Automation
4. ICME National Hub at IIT Kanpur
5. Asha: A Humanoid Caregiving Robot

Case Study 1

Continuous Discharge Measurement in Small Open Channels and Closed Conduits Using Ultrasonic Tomography

Background:

The project aimed to develop a continuous real-time discharge monitoring system for small open channels and closed conduits by tomographic reconstruction of ultrasonic transit-time measurements. The academic research partners were involved in conceptualizing, prototyping, and lab testing. The industry partner was involved in conceptualizing, field testing, developing telemetry setups and commercialization.

Task and Technology Used:

The ultrasonic transit-time technology was used in the project. There are many avenues where this technology can be used for monitoring water resources. The long-term goal of the collaboration is to develop technologies for efficient monitoring and management of water resources in the country.

Actions Undertaken:

A literature review was conducted to decide the technology and design the flowmeter. An experimental setup was developed in the lab to calibrate and test different designs. Prototypes fabricated based on lab tests were tested in field conditions. The optimized flowmeters received ISO certification. A large-scale manufacturing plant was set-up by the industry partner for commercial production.

Results:

The outcome of the project is *Dhaara*, a system for monitoring and managing water resources in municipal, agricultural and industrial sectors.

Project Impact:

The flowmeter developed in the project offered some unique features to the Indian market that were hitherto not available, and therefore it has been a commercial success.

Challenges:

Interruptions in receiving funds due to changes in financial rules amidst the project.

Learning:

Industry partners, particularly start-ups, may not have funds for upfront investments in collaborative projects, however they can make non-monetary contributions. Provisions should be available to facilitate such collaborations as well. Incentives should be designed to encourage research students to participate in industry-academia research projects.

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Start Year: 2017

Target Audience: Water resource managers in municipal, agricultural and industrial sectors.

Project Sponsor (Industry Partner): Department of Scientific and Industrial Research; Industry Partner: Kritsnam Technologies

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Sujata Chaklanobis, Head (PACE), Department of Scientific and Industrial Research; priya@nic.in
K Sri Harsha, Founder-CEO, Kritsnam Technologies; harsha@kritsnam.com

Academic Research Partner: IIT Kanpur

Country of Academic Research Partner: India

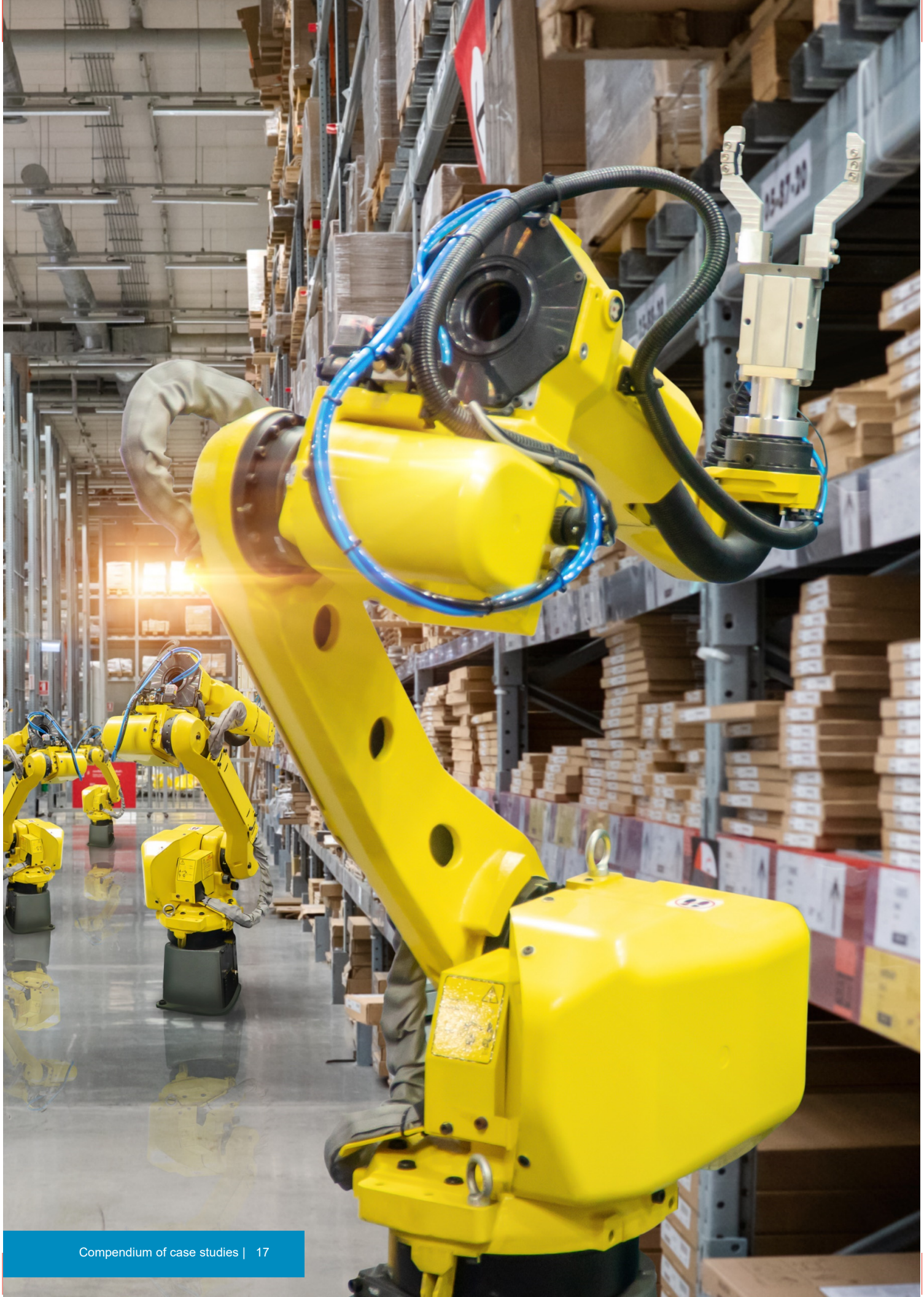
Key Members from Research Faculty/ Scholar: Shivam Tripathi (shiva@iitk.ac.in), Naren Naik (nnaik@iitk.ac.in) and Prabhat Munshi (pmunshi@iitk.ac.in)

Overall Cost: INR 1.15 crores

TRL : 9

Current Status of the Project: Delivered

Type of Partnership: Technology Research Project



Case Study 2

Fabrication of New Generation Self-resorbing Implants and Devices from Bioactive and Biodegradable Materials for Orthopedic Applications (1/2)

Background:

The invention relates to the development/fabrication of pure magnesium and pure magnesium based biodegradable bioactive alloys for temporary orthopedic implant applications. This process discloses magnesium purification via repeated casting method, and its alloying with materials like apatite to produce magnesium alloys that can be used as safe orthopedic implants. Alloying of purified magnesium has performed with indigenously synthesized stoichiometric and non-stoichiometric bone like apatite in a single step. The fabricated alloys have shown controlled degradation rate with mechanical properties mimicking to human cortical bone, as well as biocompatibility for bone implant applications.

Task and Technology Used:

The present research promotes innovation in the field of the orthopedic implant industry. The market for this industry at present stands at about 13 billion US dollars worldwide and about 5-10% of that is in India itself. ORPL is specifically focused on innovation in the field of orthopedic implants in particular degradable orthopedic implants. All the proposed objectives have been accomplished fully. Overall, the goal and the proposed outcome have been achieved. Related to the last objective regarding commercialization we have provided the know-how to the industry partners (ORPL) post patent filing for clinical trials.

Actions Undertaken:

The product has been well characterized for its physicochemical properties. Its biocompatibility has been tested with different cell lines that showed its potential to sustain their growth over an extended period of time. The product has also been tested in preclinical studies in small animal models and has shown promising results in terms of bone stabilization capacities in critical-sized bone defects. The technologies developed under this project have been provided to industry partners (ORPL) which need clinical evolution. Also, we are in consultation with the ICMR-Medical Devices and Diagnostics Product Development program for clinical evaluation.

Results:

The product has enormous potential to act as a biodegradable temporary bone support in bone defects due to its controlled resorption rate and optimal bone regeneration. Further, its biodegradable nature, and osteoconductive potential, make it a versatile product for orthopedic sectors.

Project Impact:

The product will fit into the high demand for reliable and affordable bone implants. The demand is very high, as per projection reports ranging between 3 to 5% compound annual growth rate. The product is in high demand in India as well as abroad as there is an increase in trauma cases in hospitals which require a bone implant to provide support to fractured bones. Altogether, this product has a demand in the global market in healthcare sectors and can help in improving the quality of patient's life.

Challenges:

Most of the products that are currently used in orthopedic applications are either titanium, stainless steel, or ceramics which are not bioactive and biodegradable and possess problems such as stress shielding, fatigue, non-resorbable, and require secondary surgery for removal. Secondly, most of the materials that are commercially available in the Indian market are directly imported from companies such as Zimmer, Stryker, and Bone Support, and have high costs to be available to the Indian population. This invention specifies the development of new generation of materials that are bioresorbable, bioactive, and have properties similar to bone and allow natural bone formation at the defect site thus improving healing.

Learning:

The fabrication process of magnesium alloying and purification is standardized. As the raw materials are easy to procure and the fabrication process is easy to replicate. It provides a good opportunity for interested parties to extend their support and enhance the progress of the product towards clinical testing and marketing thereafter.

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Fabrication of New Generation Self-resorbing Implants and Devices from Bioactive and Biodegradable Materials for Orthopedic Applications (2/2)

Start Year: 2018

Target Audience: In the healthcare sector and pharmaceutical industry with a promising market in India, the product is of very high use to orthopedic surgeons in hospitals/trauma centers for tackling emergency or routine cases of bone injuries. Hence, this product will be beneficial for clinical applications to be used as temporary bone support in fractures and also enhance the osteointegration of bone implants

Project Sponsor (Industry Partner): Ortho Regenics Private Limited

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Dr. Gopal Pande (Ph.D.) & Dr. K. Sudhir Reddy (MBBS, MS, FRCS) Email: orthoregenics@gmail.com

Academic Research Partner: IIT Kanpur

Country of Academic Research Partner: India

Key members from research faculty/ scholar: Prof. Ashok Kumar, Professor of Bioengineering, Dept. of Biological Sciences and Bioengineering, Centre for Environmental Science and Engineering

Email: ashokkum@iitk.ac.in

Overall Cost: INR 7 crores

TRL: 5

Type of Partnership: Technology Research

Current Status of the Project: Ongoing

Case Study 3

Programming Robots by Demonstration for Industrial and Warehouse Automation

Background:

A state-of-the-art bin-picking solution is developed that is reliable and efficient and can pick unknown objects from dense clutter. The method is tested with an industrial robotic arm (i.e. UR10) in a real-world challenging scenario. Additionally, the conveyor sorting solution is under development.

Task and Technology Used:

A robotic bin-picking and object-rearrangement solution and an automated conveyor sorting solution.

Results:

- A robust bin-picking solution
- Publications at various reputed international conferences and journals.

Project Impact:

Developed algorithms can be used on robotic manipulator for warehouse automation. Industrial POC/demo for ISRO picking object completed, patents filed, and manpower trained both industrial and academia sides, equipment (i.e. Robotic arm, conveyor belt, sensors), and contingency

Challenges:

Disruption during Covid-19 pandemic due to limited manpower and equipment procurement.

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Start Year: 2019

Target Audience: Industries, warehouses and large grocery stores

Project Sponsor (Industry Partner): Tata Consultancy Services

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: global.marketing@tcs.com

Academic Research Partner: IIT Kanpur

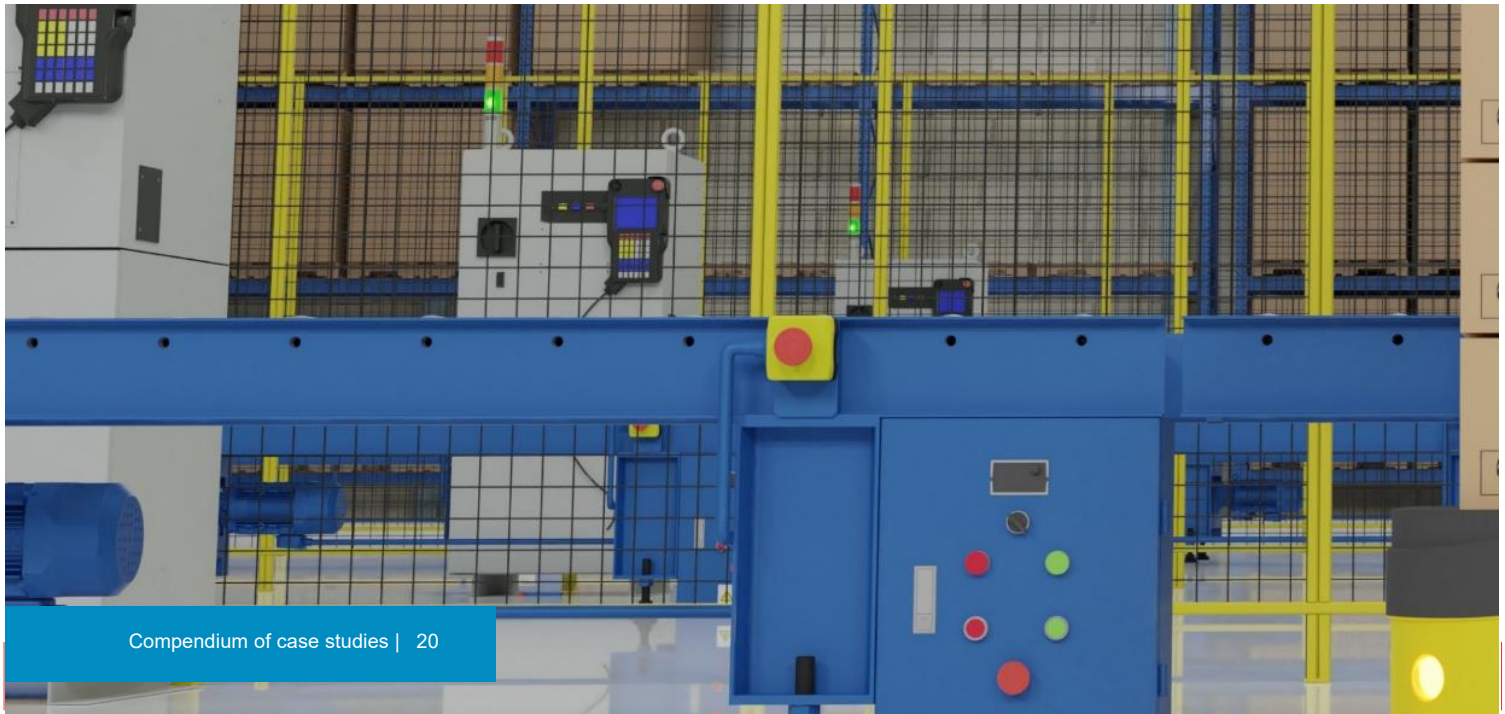
Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. Tushar Sandhan (sandhan@iitk.ac.in)

Overall Cost: INR 1.92 crores

TRL: 4

Current Status of the Project: Ongoing



Case Study 4

ICME National Hub at IIT Kanpur (1/2)

Background:

The objective of the project is to carry out cutting edge research on ICME based materials and technology, development of national importance, identification of priority research areas in the field of ICME, build an eco-system consisting of interested researchers and research groups in the country from academia, national laboratories and the industry and thus strengthen the professional community on a sustained basis.

Task and Technology Used:

ICME National Hub (INH) will be carrying out projects under TCS-IITK research MoU and TCS-PREMΛP will be needed for the project execution and/or integration of the research outcome with the platform. The National Hub will act as a nodal point for national academia/laboratories and will collaborate with national/international academic institutions and will seek active collaboration with industries (steel, aluminum, automotive, aerospace, glass, etc.) and government sector (defense, space, atomic energy, railways, etc.). The National Hub will leverage other opportunities to get additional funding from Government sources and other agencies.

Actions undertaken:

A space of 120 sqm was allotted to the INH by IIT-K. This space has been utilized for creating the following research facilities of the INH:

- office/meeting room
- data center
- computer lab
- high-throughput lab.

Results:

- Whole space renovated
- Data center with 2 server racks, 1 UPS + Battery system and second installment of INH HPC Cluster installed.
- Computer lab with 32 cubicle workstations completed and procurement of 34 Desktop PCs under process
- For the burgeoning demand for ICME related applications, the INH has planned to set up an HPC facility of its own – first and second installments completed.
- INH is under the process of procurement of a total of 34 2 desktop PC systems.
- The website of the INH has been given a face-lift and updated with latest information.
- A brand-new logo has been designed for the INH.
- The INH sponsored Summer Fellowships to five interns of the Students-Undergraduate Research Graduate Excellence (SURGE) program in the summer, 2020.

Project Impact:

Human resource development - creation and training of world class professionals in this emerging field through development of ICME related courses at all levels of maturity - undergraduate, graduate, and undertaking innovative research projects at M. Tech. and PhDs levels. Developing open-source tools for facilitating ICME based development of materials, processes and products for teaching and research. The National Hub will act as a nodal point for national academia/ laboratories and will collaborate with national/international academic institutions and will seek active collaboration with industries (steel, aluminum, automotive, aerospace, glass, etc.) and government sector (defense, space, atomic energy, railways, etc.). The National Hub will leverage other opportunities to get additional funding from Government sources and other agencies.

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ICME National Hub at IIT Kanpur (2/2)

Target Audience: The National Hub will act as a nodal point for national academia/ laboratories and will collaborate with national/international academic institutions and will seek active collaboration with industries (steel, aluminum, automotive, aerospace, glass, etc.) and government sector (defense, space, atomic energy, railways, etc.).

Project Sponsor (Industry Partner):
Tata Consultancy Services

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization:
Dr. B P Gautham bp.gautham@tcs.com

Academic Research Partner: IIT Kanpur

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:
Prof. Amarendra Kumar Singh amarendra@iitk.ac.in

TRL:

Overall cost: INR 1.65 crores

Case Study 5

Asha: A Humanoid Caregiving Robot

Background:

The project was developed as an outcome of the COVID-19 pandemic/ social distancing in caregiving environments—where human proximity is necessary to diagnose ailments, show empathy, treat patients, and provide care. The mechanisms of using masks, gloves and sanitizers are not always foolproof to ensure safety in caregiving environments that teleoperated humanoid robots powered by artificial intelligence (AI) technology can transform industries.

Task and Technology Used:

The humanoid has two sides—the robot at the front end and a human operator at the backend. The physical robot acts as an interface between two human beings, one of which is the operator.

TCS Research devised solutions encompassing AI and ML, and the platform, to ensure Asha moves around in a controlled environment.

Hanson Robotics built the head and the torso with sophisticated technologies, including high-speed cameras that help mimic human vision.

IISc designed the teleoperation in a way that the remote operator uses virtual-reality goggles to see through Asha's eyes.

The operator controls the robot through a remote console that serves to steer Asha, helping her move across a space in varied directions. Multiple sensors ensure she listens to commands, acts accordingly, and stays out of danger. The operator wears a sensor equipped glove that helps capture and convey actions to Asha. A pair of foot pedals helps her within indoor spaces. Asha also has an emergency stop feature that immediately disables operations, if needed.

Asha is equipped with a speech-to-text conversion capability, speech-driven synchronized lip movements, and emotion rendering. She has been programmed to differentiate between commands and voice responses. Furthermore, she is engineered with application programming interface (API) calls to implement simple commands.

Despite being humanly controlled, Asha has semi-autonomy marked by some level of freedom.

Actions undertaken:

TCS Research, along with a team of over 20 innovators comprising academicians, technology professionals, and students, have developed this AI entity.

The team, Aham Avatar—is a collaboration of individuals from TCS Research, Indian Institute of Science (IISc), and Hanson Robotics. While Hanson Robotics built the socially intelligent humanoid platform, TCS Research and IISc integrated its mobility and immersive teleoperation capabilities.

The Asha prototype was conceived as an entry into the global four-year ANA Avatar XPRIZE robotic competition.

Result:

A humanoid robot nurse who can see, perceive, hear, touch, and interact like human beings and is sensor-equipped dexterous with fingers which can pick, hold, move, and hand over objects.

Project Impact:

The robot remains a work in progress with new functionalities continually being tested and added. Ultimately, team Aham Avatar aims to make Asha a viable 'human' caregiving solution for environments where humans are at the risk of contact exposure to communicable diseases.

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Start Year: 2020

Target Audience: Healthcare/caregiving industry

Project Sponsor (Industry Partner): TCS, Hanson Robotics

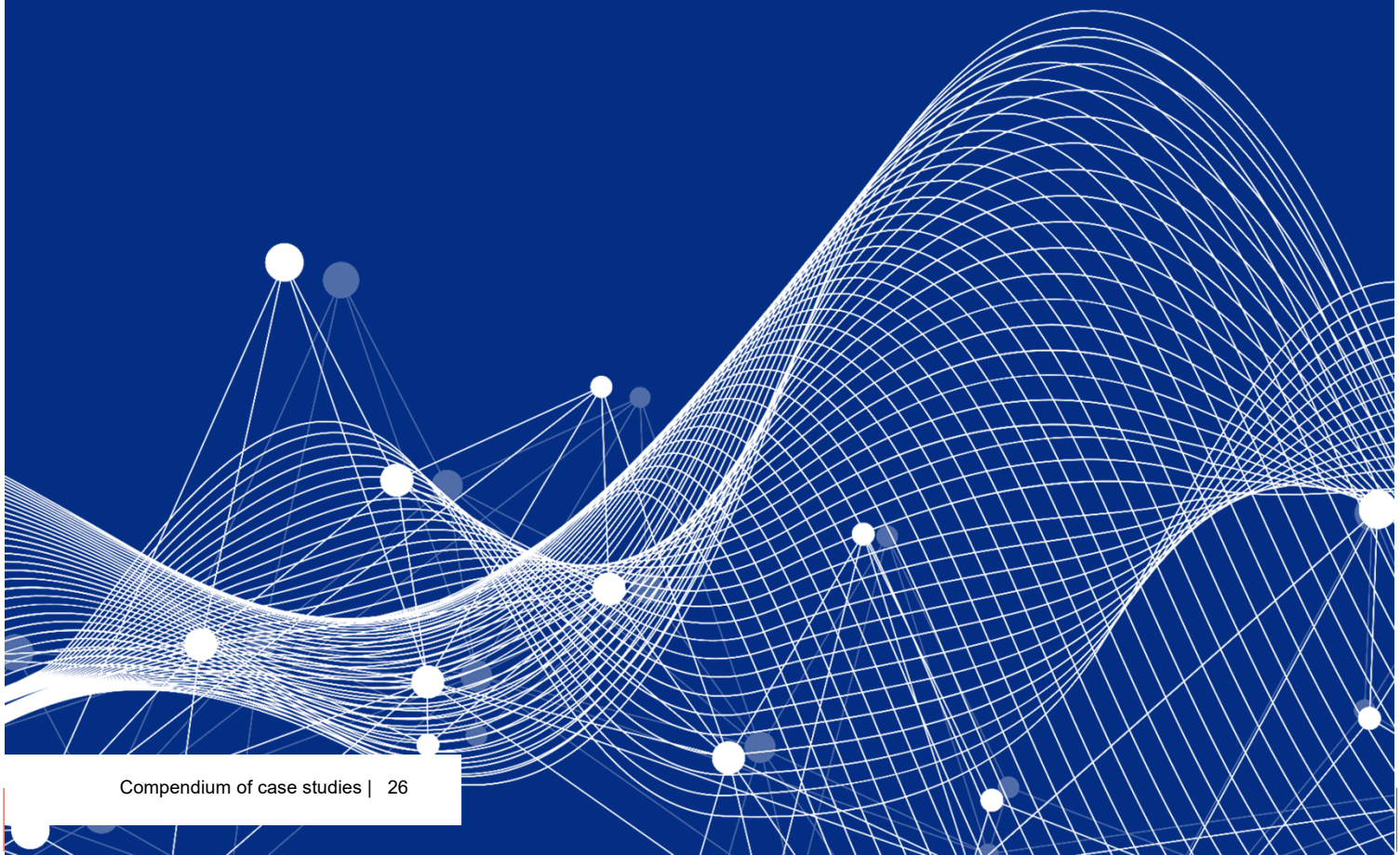
Country of Operation of Sponsor: India

Academic Research Partner: ArtPark@IISc

Country of Academic Research Partner: India

Type of Partnership: Technology Research

Current Status of the Project: Shelved



03 Mobility

1. TUTEM: Technologies for Urban Transit to Enhance Mobility and Safe Accessibility
2. Development of Advanced Nanocomposite Proton Exchange Membrane-based Fuel Cells Suitable for Automobile Applications
3. Design and Development of an Intelligent Unmanned Aerial Vehicle Applied to Open Cast Minefield Surveillance for Real-time Monitoring, Hazards, and Vulnerability Assessment
4. Identify, Quantity, and Isolate Rotor Interturn Faults in Large Synchronous Motors (ABB AMS and AMZ type)
5. Research in Autonomous Driving Technologies, Connected Mobility, and Advanced Safety Solutions
6. Accelerating Software Driven Vehicles and Advanced Driver Assistance Systems
7. Enabling Energy Transformation to a Low Carbon Future through a Global Academia-Industry-Government Collaboration
8. MTA – IITM – Online M.Tech in Automotive Technology
9. MTA – SRMIST – (P)GET Technical Training
10. Centre for Innovation in Mobility

Case Study 1

TUTEM: Technologies for Urban Transit to Enhance Mobility and Safe Accessibility

Background:

Public transport users in India are declining due to poor access infrastructure, leading to security concerns, especially for women. The Technologies for Urban Transit to Enhance Mobility and Safe Accessibility; (TUTEM) project, funded by the Asian Development Bank, addresses these issues in Chennai, aiming to enhance last-mile security and safety for transit passengers.

Task and Technology Used:

The TUTEM project focuses on developing a security index, a decision-making tool, and implementing a proof of concept for enhancing last-mile security. Technological interventions include a safety rating system for urban transit transfer points (UTTPs), secure route recommendations through SMS and mobile applications, and a distress passenger support system.

Actions Undertaken:

Key actions involve collaboration between academic institutions (IIT Bombay, BITS Pilani, IIT Kharagpur) and LocationMind Inc. to develop and implement technological solutions. The project coordinators manage financials, while researchers focus on security ratings, route recommendations, and distress support. Collaborations with local entities are essential.

Results:

1. Development of security index and decision-making tool.
2. Implementation of proof of concept for last-mile security.
3. Collaborative efforts with local partners and stakeholders.
4. Enhancing the perception of security and safety for transit users.

Project Impact:

The project aims to improve public transport ridership in Chennai, particularly for women and senior citizens. It seeks to reduce security concerns, enhance environmental sustainability, and contribute to the economic well-being of the society.

Challenges:

Addressing the decline in the use of public transport, ensuring the safety of transit users, and overcoming security concerns at the last mile.

Learning:

1. Collaborative efforts with local authorities and law enforcement are crucial.
2. Technological interventions can play a significant role in enhancing last-mile security.

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Start Year: 2023

Target Audience: Mass transit

Project Sponsor (Industry Partner): Asian Development Bank (ADB)

Country of Operation of Sponsor: Asia-Pacific region-Manila (Headquarter)

Academic Research Partner: Project Coordinator and Principal Investigator-Avijit Maji from the Indian Institute of Technology Bombay (IITB), Joint Principal Investigator- Prasanta Sahu from Birla Institute of Technology and Science Pilani (BITS), Joint Principal Investigator- Arkopal Goswami from the Indian Institute of Technology Kharagpur (IITKgp), Co-Principal Investigator- Ryosuke Shibasaki from LocationMind Inc.

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prasanta Kumar Sahu-prasanta.sahu@hyderabad.bits-pilani.ac.in

Overall Cost: USD 473,550

TRL: Early stages of development

Current Status of the Project: Ongoing

Case Study 2

Development of Advanced Nanocomposite Proton Exchange Membrane-based Fuel Cells Suitable for Automobile Applications

Background:

The primary objective of the project is to develop advanced nanocomposite proton exchange membranes (PEMs) for fuel cells, specifically tailored for automobile applications. The focus will be on enhancing the performance, durability, and efficiency of the PEM-based fuel cells, with a particular emphasis on addressing challenges related to automotive environments.

Task and Technology Used:

The project is expected to yield advanced nanocomposite proton exchange membranes (PEMs) that significantly enhance the performance, durability, and efficiency of fuel cells for automobile applications. The outcome will include high-performance PEMs with superior proton conductivity, increased durability to withstand automotive conditions, and improved energy conversion efficiency for enhanced fuel economy.

Actions Undertaken:

The project is ongoing.

Results:

Results are yet to be achieved.

Project Impact:

High-performance PEMs with superior proton conductivity, increased durability will lead improved energy conversion efficiency for enhanced fuel economy.

Learning:

1. Policies like Production Linked Incentives(PLI) scheme for encouraging research and adoption of fuel cells, alternate fuels and their applications in automotive industry.
2. Guidelines or standards around the production, storage, and transportation of the hydrogen.

****

Start Year: 2022

Target Audience: Battery applications in cars

Project Sponsor (Industry Partner): Schaeffler India Limited, Maharashtra

Country of Operation of Sponsor: India

Academic Research Partner: IIT Roorkee

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Mr. Akshay Dvivedi (dsric@iitr.ac.in)

Overall Cost: INR 73.85 lakhs

TRL: 5

Type of Partnership: Technology Research

Current Status of the Project: Ongoing

Case Study 3

Design and Development of an Intelligent Unmanned Aerial Vehicle Applied to Open Cast Minefield Surveillance for Real-time Monitoring, Hazards, and Vulnerability Assessment

Background:

Devising solutions for identified challenges in the field of open-cast mining using drone technology. The focus of the project is on achieving accurate measurements for both dump analysis and coal stock assessments. Actively engaged in the precise delineation of boundaries within the open cast mining area and closely monitoring vegetation growth in the region.

Task and Technology Used:

1. Enhanced safety protocols through real-time monitoring of dump slopes, landslide detection, blast activities, and overall health and safety at mining sites.
2. Efficient resource management achieved by using drones for boundary mapping, stockpile volume measurement, and haul road width analysis, and optimizing the extraction processes.
3. Environmental responsibility upheld through plantation growth measurement, vegetation cover mapping, and air quality monitoring, and complying with the regulations.
4. Improved surveying accuracy and planning with drones facilitating digital terrain model generation, aiding precise mapping in construction and mining projects.
5. Swift disaster response enabled by drones providing real-time data for surveillance, thermal mapping, and effective disaster management strategies.

Actions Undertaken: In Progress

Results: In Progress

Project Impact:

Enhanced safety protocols through real-time monitoring, improved surveying accuracy, swift disaster response

Learning:

1. Create multiple industry accelerators (catapult network) across the country to promote the research in UAV, VOLT applications in real life scenarios such as aerial taxis, goods mobility, logistics solutions, and surveying, and mentor, aid, provide testing and infrastructure support on proof of concept, concept to product journey to the upcoming startups and innovators.
2. Create specialized centers which functions as single window for support from government on prototyping, testing infrastructure, hardware, security clearances for real life application testing and manufacturing. (Especially for heavy grade, higher weights, higher payload (100-300 kg for human mobility, 50-150 kg for goods mobility.)
3. Policy or guidelines establishing standards, technical requirements, certifications, and other requirements.

****

Start Year: 2023

Target Audience: Military, Rescue operations, etc.

Project Sponsor (Industry Partner): I-Hub Foundation for COBOTICS (Technology Innovation Hub of IIT Delhi, Government of India)

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Roorkee

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Mr. Akshay Dvivedi (dsric@iitr.ac.in)

Overall Cost: INR 1.64 crores

TRL: 7

Type of Partnership: R&D partnership

Current Status of the Project: Ongoing

Case Study 4

Identify, Quantity, and Isolate Rotor Interturn Faults in Large Synchronous Motors (ABB AMS and AMZ type)

Background:

The project involves a literature review to understand interturn faults, the predominant rotor faults in synchronous machines, with a focus on their progression over time. Subsequently, a prototype will be developed for diagnosing rotor turn faults in synchronous machines, requiring dedicated hardware test beds.

Task and Technology Used:

The research aims to create a physics of failure model by identifying parameters defining fault levels and insulation degradation for rotor faults. The project will also collect data for various fault levels and loads, utilizing the hardware test bed, and use this information to develop machine learning models for the fast and accurate diagnosis of rotor faults in synchronous motors.

Actions Undertaken:

Developing and utilizing hardware test bed

Results:

The expected outcomes include an enhanced understanding of rotor faults, a functional hardware prototype, a physics-based model, and machine learning tools for efficient rotor fault diagnosis in synchronous machines.

Project Impact:

Improvement in motor performance

Challenges:

No major challenges faced.

Learning:

Need for accelerators/catapult centers that can be used for the development of prototypes or small-scale production.

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Start Year: 2023

Target Audience: Applications of large Synchronous DC motors

Project Sponsor (Industry Partner): ABB Global Industries and Services Private Limited (ABB GISPL)

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology Roorkee

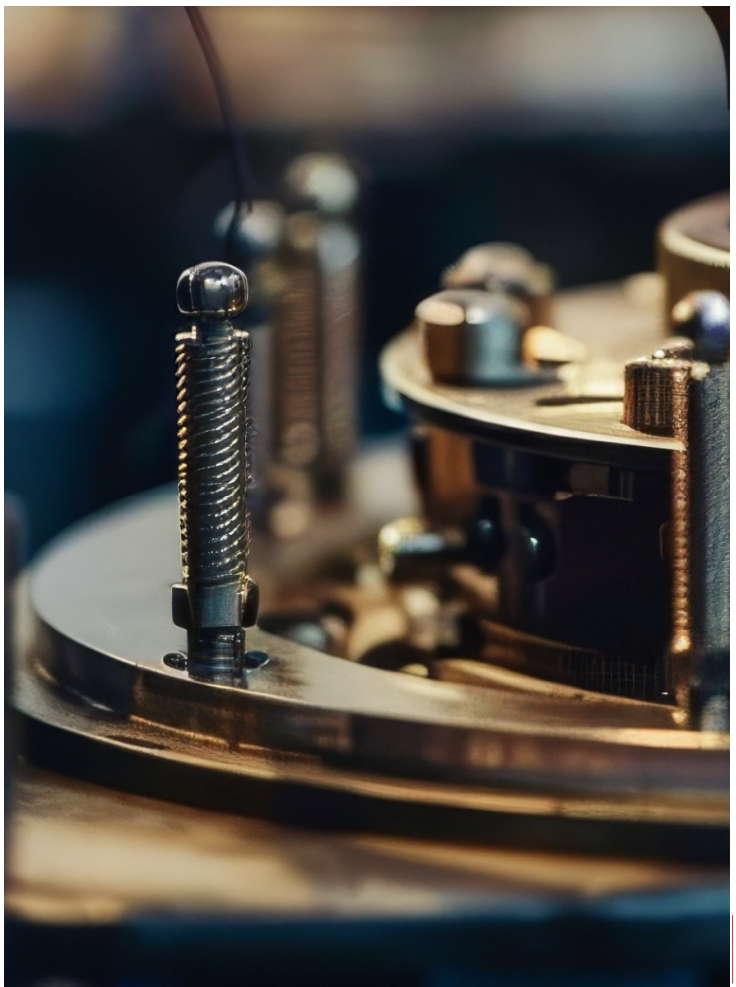
Country of Academic Research Partner: India

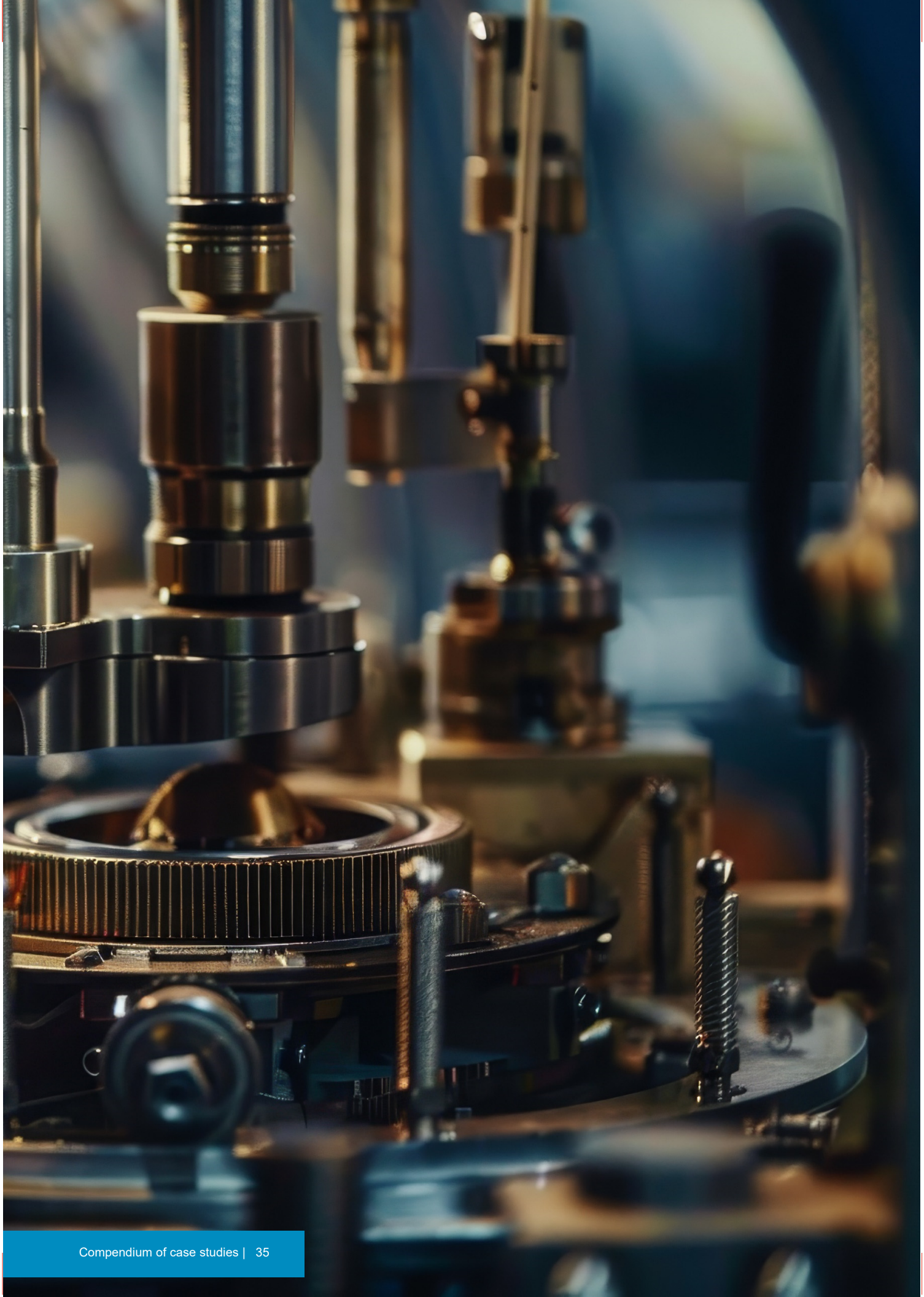
Key Members from Research Faculty/ Scholar: Mr. Akshay Dvivedi (dsric@iitr.ac.in)

Overall Cost: INR 75 lakhs

Type of Partnership: Technology Research

Current Status of the Project: Ongoing





Case Study 5

Research in Autonomous Driving Technologies, Connected Mobility, and Advanced Safety Solutions

Background:

The MoU will facilitate a collaboration between the technical expertise available at Continental and the academic and research excellence of IIT–Palakkad in the fields of autonomous driving technologies, connected mobility, and advanced safety solutions. Continental will also offer internship opportunities and co-design inputs for course offered at IIT-Palakkad, to keep students up to date with current and upcoming industry trends.

Task and Technology Used:

The program fosters R&D in areas like optimizing high-performance computing, simulation models for image and video processing chain for autonomous driving, autonomous mobility safety features based on human vision features, and advanced safety solutions for an intelligent battery sensing module.

Actions Undertaken:

Niche skills of both Continental and IIT Palakkad that the collaborative program will foster through R&D include areas like optimizing high-performance computing, simulation models for image and video processing chain for autonomous driving, autonomous mobility safety features based on human vision features, and advanced safety solutions for an intelligent battery sensing module. With a key focus on horning the IITians at Palakkad into highly competitive industry-ready talent, the salient features of the project include internships for students to work alongside Continental's topic experts, and interactive and insightful hackathons and competitive challenges to inspire students to prove their mettle.

Results:

The program will have a strong emphasis on joint research projects complements automotive megatrends. This will mutually benefit Continental and IIT-Palakkad in terms of acquiring technology competence and academic excellence. It will provide opportunities to the students in the form of internships and specially designed course work that will help bridge the gap between industry and academia.

Project Impact:

Internships for students to work alongside Continental's topic experts, and interactive and insightful hackathons and competitive challenges to inspire students to prove their mettle.

Learning:

Tax rebate based on the amount invested by the industry players in the research collaborations with the institutes on novel technologies. Data Sharing Protocol - Encourage collaboration between industry players and academic researchers to analyze and learn from real-world data, improving the overall safety and reliability of autonomous systems.

****

Start Year: 2022

Target Audience: Automotive companies

Project Sponsor (Industry Partner): Continental's Technical Centre India (TCI)

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Latha Chembrakalam, Head of Technical Centre India (TCI)

Academic Research Partner: IIT- Palakkad

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Dr. Santhakumar Mohan, Dean, Industry Collaboration & Sponsored Research, IIT- Palakkad

Overall Cost: INR 78 lakhs

TRL: 5

Type of Partnership: Technology Research

Current Status of the Project: Ongoing

Case Study 6

Accelerating Software Driven Vehicles and Advanced Driver Assistance Systems

Background:

As automotive companies strive to develop SDVs with autonomous technologies, they look for innovative solutions and accelerators that help them reduce technology incubation time and cost.
Tata Technologies and TiHAN will collaborate towards solutions that address these specific challenges being faced by companies in developing SDVs that incorporate the latest technologies.

Task and Technology Used:

Leverage the collective expertise and resources to explore use cases for SDV by adopting modern System on Chip (SoCs), Artificial Intelligence (AI), Machine Learning (ML), Over the Air (OTA) frameworks, and Connected technologies within the realm of Software Defined Vehicles.

Actions Undertaken:

TiHAN at IITH has been established to focus on the research and development of autonomous and intelligent navigation systems.

Results:

The collaboration will specifically focus on development of platforms and proofs of concept that optimize product development timelines, enabling upskilling and hands-on training for Tata Technologies engineers at TiHAN in new technology areas.

Project Impact:

Enhancing car's capabilities

Learning:

Policy or guidelines establishing standards, technical requirements, certifications. Tax break based on the amount invested by the industry players in the research collaborations with the institutes on novel technologies.

****

Start Year: 2023

Target Audience: Automotive Companies in the areas of safety and software

Project Sponsor (Industry Partner): Tata Technologies

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Sriram Lakshminarayanan, President & Chief Technical Officer of Tata Technologies

Academic Research Partner: IIT Hyderabad

Country of Academic Research Partner: India

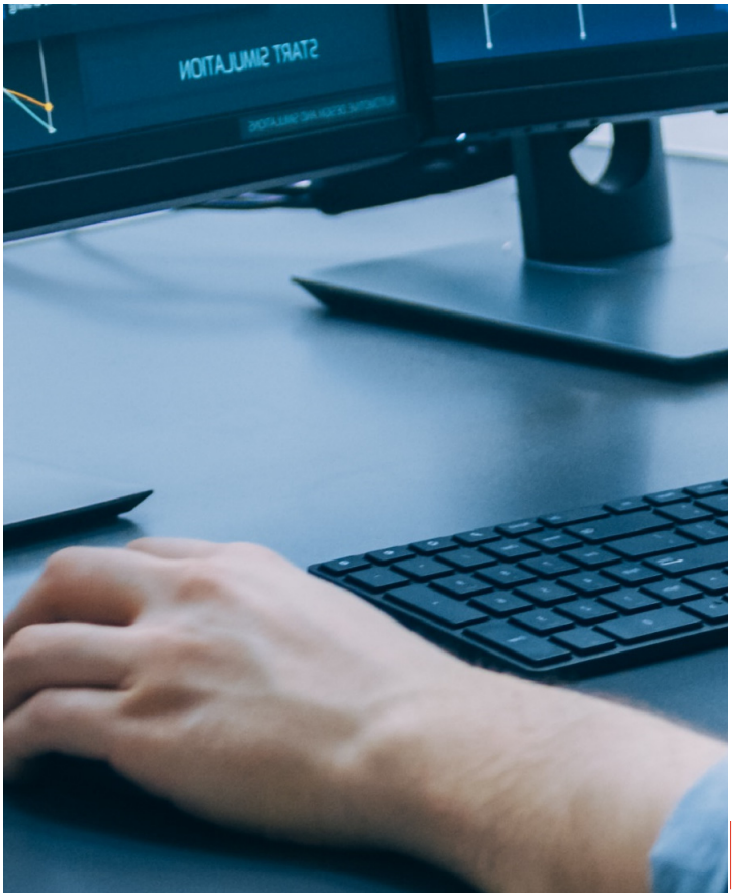
Key Members from Research Faculty/ Scholar: B. S. Murty, Director, IITH

Overall Cost: Undisclosed

TRL: 5

Type of Partnership: R&D partnership

Current Status of the Project: Ongoing



Case Study 7

Enabling Energy Transformation to a Low Carbon Future through a Global Academia-Industry-Government Collaboration

Background:

The Energy Consortium is an umbrella initiative at IIT Madras that spans the whole spectrum of research in energy generation, storage, conversion, and distribution.

Task and Technology Used:

The core expertise areas at the consortium include carbon capture and storage, gas hydrates, coal and biomass conversion to useful chemicals, renewable energy systems including applications in electrolyzer technologies for CO2 conversion and green hydrogen, energy storage technologies both lithium and beyond, and distributed energy management including for resilient AC and DC microgrids.

Actions Undertaken: Ongoing activity

Results:

The IIT Madras Energy Consortium has been formed to leverage IIT Madras's expertise to accelerate decarbonization of Indian industry's energy systems.

Key Outcomes:

- Early outcomes to research
- Mutually selected R&D Projects
- Participation in Summits
- Impact KPIs defined and measured for each project.

Project Impact:

- Environmental improvement

Learning:

Guidelines or standards around the production, storage, and transportation of the hydrogen.

****

Start Year: 2023

Target Audience: Energy companies and automotive companies

Project Sponsor (Industry Partner): Multiple - including Cummins, Shell, Infosys, FL Smidth, Aditya Birla Group, Baker Hughes, Chevron, CPCL, among others.

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Subramanian Chidambaran <subramanian.chidambaran@cummins.com>

Academic Research Partner: Indian Institute of Technology Madras

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:

Overall Cost: Undisclosed

Type of Partnership: Technology Research

Current Status of the Project: Ongoing

Case Study 8

MTA – IITM – Online M.Tech in Automotive technology

Background:

The engineers at Mahindra Research Valley are on a technical career path where many opportunities to upskill themselves are given. There is a dedicated organization – the Mahindra Technical Academy (MTA) that is focused on building technical competencies for engineers at all levels. Many of the working professionals (practicing engineers) in the company want to pursue their higher studies in premier institutions. The company also wants to promote this culture to enable the young engineers to have the culture of continuous learning and hone deeper technical skills. At the same time, the company wants the employees to work on important projects and can't afford to release them for regular master's program for a long duration like two years. This inspired to look at the problem from a different angle.

Actions Undertaken:

IIT Madras (IITM) being a premier institute in the close vicinity of MTA, we wanted to work closely with IITM and come up with a solution for this. This led to the solution of web-enabled M.Tech in Automotive Technology (WEMAT) wherein the employees sponsored by the company can attend the class from MTA and the Professor teaches from IITM and it is a live class. This enabled live classroom experience to students without compromising on the academic rigor. The classes were scheduled from 5 pm to 7 pm for 3 days a week so that the employees can complete their daily work and attend the class at the end of office hours. This is a win-win solution for both the company and the employee. Since the employee has to focus on both work and study, the number of subjects per semester was reduced to 2 and the course duration was extended to 3 years instead of 2 years

Project Impact

This led to the successful enrolment of our engineers for the course and as of now 3 batches have successfully completed the course and earned their M.Tech degree. The fourth batch is in progress. With the success of this course, IITM has introduced M.Tech many new specializations like Mechanical Design, E-mobility, Microelectronics etc., Employees sponsored for this course had a longer retention period with the company and they were able to apply effectively their technical expertise in the new projects. These trained employees developed innovative features in the new products and also created valuable intellectual property (IP).

****

Start Year: 2017

Project Sponsor (Industry Partner): Mahindra & Mahindra

Country of Operation of Sponsor: India

Contact Details of Project Sponsor: Dr. Venugopal Shankar

Academic Research Partner: India Institute of Technology, Madras

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar: Dr. Shankar Ram

TRL Level: 5-7

Current Status of the Research Project: Ongoing

Case Study 9

MTA – SRMIST – (P)GET Technical Training

Background:

One of the primary objective of Mahindra Technical Academy (MTA) is to provide the Technical training the GETs and PGETs who join at Mahindra Research Valley (MRV) and quickly deploy them to the various product design (PD) departments. So far, the training batch size has been of 50-200 engineers. Due to a sudden surge in new product initiatives with the emergence of EV technology, about 625 GETs and PGETs were inducted in a single batch and trained all the 625 in a single batch to meet the business requirement. The facility could not handle a large batch of 625 members and were thinking of alternative ideas to overcome the problem.

Actions Undertaken:

The problem was solved in a different way by exploring the possibility of partnering with one of the premier engineering university - SRM Institute of Science and Technology (SRMIST) who is also situated very close to our campus. SRMIST being a university campus they had bigger size halls which can easily accommodate our 625 members. They also had multiple computer halls and labs to provide online and practical training sessions. This led to new collaboration with SRIMST for training our GETs and PGETs and utilizing their facility for training. Since their facility is very close to MRV we could easily bring our experts for training session according to the time slots. We could also leverage SRMIST faculty expertise to teach many topics to our fresh engineers.

Project Impact

We could successfully complete 2 months of technical training for our GETs & PGETs for a large batch of 625 members in a hassle-free manner and could deploy them to role as per the business requirement. The learnings from this gave us the confidence to handle bigger batches in future. Early deployment of these trained engineers on new product development programs greatly helped us to meet the business goals.

****

Start Year: 2022

Project Sponsor (Industry Partner): Mahindra & Mahindra

Country of Operation of Sponsor: India

Contact Details of Project Sponsor: Dr. Venugopal Shankar

Academic Research Partner: SRM Institute of Science and Technology (SRMIST)

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar: Dr Baskara Sethupathi

TRL Level: 5-7

Current Status of the Research Project: Ongoing

Case Study 10

Center for Innovation in Mobility

Background:

Centre is constituted to work closely with academic institutions and automotive industry to provide advanced technical support and focus on developing application technologies for current and future mobility industries such as Automotive, Railways and Hyperloop.

Task and Technology Used:

The project can be broadly classified as following:

- To play a key role in India's mobility sector.
- To develop application technologies for current and future mobility platforms such as automotive, railways and hyperloop.
- To host facilities for Computer Aided Design and Engineering (CAD/CAE), Experimental Roll Forming, Dynamic Dent test system, AR/VR experience center and full-scale facilities for vehicle benchmarking.
- To help the mobility industry with design and engineering, material selection, prototyping and testing

Results:

Closer engagement with Academia and customers for futuristic mobility solutions.

Actions Undertaken:

- 5 Member researchers' team has already started working at the centre. TSL will further expand the team size.
- Tata Steel and TuTr Hyperloop signed a Memorandum of Agreement at IIT Madras, to jointly work on development and deployment of Hyperloop technology at scale.
- MoU in progress for long term internship for MTech Students

Project Impact:

The center provides Tata Steel proximity to IIT Madras, and several other collaborators located in IITM research park. The center facilitates connecting and bridging gaps among automotive customers while supporting TSL in expanding is innovation reach across India. Due to its strategic location, the Centre will be pivotal in harnessing diverse talent and bolstering Tata Steel's R&D efforts.

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Project Sponsor (Industry Partner): Tata Steel

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Madras

Country of Academic Research Partner: India

Overall cost: ~ INR 8 crores

04 Robotics and AI

1. Solutions to the Mahindra Autonomous Driving Challenge
2. Drone-based Aerial Manipulation with Human-in-the-Loop
3. Adversarial Unsupervised Domain Adaptation for ADAS
4. Computational Toolkit Design for Gas Separation Molecular Sieve Membranes
5. Robotic ARM Integration for Industrial and Agriculture Use
6. A-PATH: Affordable, Preventive and Adaptive Technologies for Healthcare

Case Study 1

Solutions to the Mahindra Autonomous Driving Challenge (1/2)

Background:

In 2014 IIIT Hyderabad and Uurmi Systems (later acquired by Mathworks in 2017) decided to participate in the Mahindra Autonomous Driving Challenge together. While Mathworks provided the engineers deployed the solutions and did extensive testing, IIIT Hyderabad's Researchers developed research based solutions for the Challenge Deliverables. There were constant interaction between the two parties at various levels of hierarchy, as often Mathworks Engineers worked with the IIIT Hyderabad Team at the IIIT Hyderabad campus site, IIIT Hyderabad's Students and Research Associates worked at the Mathworks office for long hours together. Both the Teams met for a weekly review meeting once a week, typically Fridays stretching over 4 hours where the respective Team Leads, Dr Shanti Medasani (Mathworks) and Prof K Madhava Krishna (IIIT Hyderabad) went through the weekly progress, analyzed the results and suggested next steps

Task and Technology Used:

Development of Autonomous Driving Algorithms spanning Perception, State Estimation, Navigation and Control. Extensive Modeling and Simulation Frameworks, Rigorous Testing in Simulators and Prototype Vehicle.

Actions Undertaken:

1. MoU signed in 2014 between IIIT Hyderabad and Uurmi Systems for the start of the Research Collaboration and in 2017 between IIIT Hyderabad and Mathworks for Continuation of the Research Collaboration.

2. Several algorithms relating to perception, navigation, cross sensor calibration,

3. planning and control were developed by the Teams and tested on the Mahindra's E2O the Self Driving Testbed

Results:

1. Perception, Localization (State Estimation), Navigation and Control Algorithms for Autonomous Driving

2. Extensive Dataset Collection

3. Extensive Testing of Algorithms on the E2O Self Driving Platform in On Road Scenes

4. Release of the Autonomous Scenario Generation and Collision Avoidance as part of the Mathworks' AD Toolbox available for all Mathworks Users who Procured the Toolbox

Project Impact:

This was the first such effort on Self Driving Technologies taken up in the timeframe 2014-2017 and further continued until 2020. This lead to deeper understanding of the perception and navigation stack by both the organizations, lead to an ecosystem of collaborative research and joint testing. Lead to the release of the Mathworks' Autonomous Scenario Generation framework available as part of the Mathworks' AD Toolbox.

Challenges:

IIIT Hyderabad had to manage a constantly changing set of research interns,

project staff, grad students throughout the 6 years of this effort. While several IIIT students joined Mathworks and continued the development cycle there, maintaining continuity on several modules posed a significant challenge.

Learning:

1. There must be a clear intent, will at all levels between the two teams (from project leads, to engineers, to grad students and research associates).

2. Both the teams should be committed to the deliverables, need to cut out the noise around IP, code and data sharing etc and work as a single team cutting organizational boundaries

3. Processes and systems should be in place to cushion the impact when critical team members leave the organization.

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Solutions to the Mahindra Autonomous Driving Challenge (2/2)

Target Audience: IIIT Hyderabad, Mathworks

Project Sponsor (Industry Partner): Mathworks Inc

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization:
Shanti Medasani, smedasan@mathworks.com

Academic Research Partner: IIIT Hyderabad

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:
K Madhava Krishna, mkrishna@iiit.ac.in

TRL: 5-6

Case Study 2

Drone-based Aerial Manipulation with Human-in-the-Loop

Background:

This project presents a solution to the increasing challenges faced in agriculture, such as labor shortages and the decline of bee populations, by providing consistent, controllable, and efficient pollination. Drone pollination is poised to transform the agricultural landscape, making crop production more resilient and sustainable. Our innovative drone pollination project has now advanced to Technology Readiness Level 5 (TRL 5). We have signed MOU with Thanos Technologies for commercialization.

Task and Technology Used:

New drone-based pollination mechanism, advanced adaptive control algorithm.

Actions Undertaken:

Our innovative drone pollination project has now advanced to Technology Readiness Level 5 (TRL 5). This milestone was achieved following a successful basic field test that validated the proof of concept for the drone pollination mechanism in an operational environment. This test laid the groundwork for further refinement of the technology, proving its potential for practical application in paddy crop farming.

Results:

Modular pollination mechanism

Project Impact:

With the successful completion of a basic field test, drone pollination technology is proving to be a game-changer in the agricultural sector. As we move towards the critical field test for yield assessment, the promise of this technology in enhancing productivity, reducing costs, and promoting environmental sustainability becomes ever more tangible. The upcoming tests will be instrumental in establishing drone pollination as a reliable and superior alternative to traditional methods, setting the stage for widespread adoption and revolutionizing paddy crop farming.

Challenges:

Fund shortages and cost escalation

Learning:

It is difficult for an academician to market technologies. Industry should appoint personnel among academia with technical knowhow, who can be a part of the project from the beginning and better coordinate among industry and academia.

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Target Audience: Farmers

Project Sponsor (Industry Partner): IHFC, Technology Innovation Hub IIT Delhi

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization:
Asutosh Sharma (CEO, IHFC),
email: asutosh@ihfc.co.in

Academic Research Partner: IIIT Hyderabad

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:
Dr. Spandan Roy,
email: spandan.roy@iiit.ac.in

Overall Cost: INR 1.3 crore

TRL: 5

Case Study 3

Adversarial Unsupervised Domain Adaptation for ADAS

Background:

The objective of the project was to explore one possible approach in which synthetic data can be used for training models along with relevant data set for real target environment. Hi Tech Robotic Systems entered into an Educational Project Agreement with Carnegie Mellon University to work on this research problem – identified as a capstone project.

Task and Technology Used:

1. Asses the state-of-the-art transfer learning, domain adaption and generative techniques
2. Implement proposed approach most relevant to driving problem
3. Evaluate standard data set and recommend one possible approach

Actions Undertaken:

1. Existing synthetic data set was used to tests performances on KITTI, data set for real street images.
2. Tensor Flow – machine learning library, Faster R CNN for base data set and CORAL tools were used by research scholars.

Results:

Identified the optimized approach in which synthetic data can be used for training models for real target environment.

Project Impact:

1. Indigenously developed patented technology, Novus Drive product feature development, performance validation and reliability has improved owing to this research.
2. The research has helped us improve patent technology product.

Challenges:

1. Remote Collaboration: Coordinating across different time zones and working remotely posed logistical challenges for both teams.
2. Intellectual Property Rights (IPR): Negotiating IPR ownership was a significant hurdle, particularly considering past experiences where Indian institutions typically insist on shared rights.

Learning:

1. IPR Ownership: Encourage policies that facilitate IPR ownership by collaborating entities, fostering a more favorable environment for research partnerships.
2. Remote Collaboration Support: Provide resources and support for remote collaboration, including funding for communication tools and flexible working arrangements.
3. Learning from Global Counterparts: Promote knowledge exchange with global partners to enhance indigenous research capabilities.

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Target Audience: ADAS Business

Project Sponsor (Industry Partner): Hi-Tech Robotic Systemz

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Anuj Kapuria

Academic Research Partner: Carnegie Mellon University (CMU)

Country of Academic Research Partner: USA

Key Members from Research Faculty/ Scholar:

1. Linda Duffy
2. Daniel Ron - dron@andrew.cmu.edu
3. Zhaoting Ye - zhaotiny@andrew.cmu.edu

Overall Cost: USD 30,000

Case Study 4

Computational Toolkit Design for Gas Separation Molecular Sieve Membranes (1/2)

Background:

Carbon molecular sieve (CMS) membranes have been studied for many years as a promising material for energy-efficient gas separation and sorption/storage technologies. The separation or storage efficiency of the CMS membranes depends on its small pore structure and chemical selectivity. Details of such a resolution cannot be resolved by current experimental analytical tools. This project focuses on atomistic-level simulations for tuning the molecular level chemistry and small pore size.

Task and Technology Used:

1. Stitch together various fragments from pyrolysis to form a membrane structure or rely on mostly chemical intuition and various advanced energy sampling techniques to build the possible geometry.
2. Utilize reaxFF and genetic algorithm with the input from NMR data to construct the working model of the membrane.

Actions Undertaken:

The research collaboration project was done under a multi-project research framework agreement consisting of separate SoW agreement under the framework for each project which spells out various deliverables, timelines, pre-existing IPs, foreground IPS between SID-IISc and global oil major.

Results:

1. Engagement is going strong now with more than 10+ research projects completed framework agreements extended beyond 10 years
2. Adjunct faculty from the global major inducted in IISc.
3. Various global business units of the companies now getting into engagement, with a strategic partner relationship management structure also coming in, with Program managers on each side to ensure various project engagements with their respective SPOCs do not face hurdles in the execution.
4. Numerous publications, conference presentations, and patents have resulted from various projects.

Project Impact:

1. IISc has been able to get repeat research projects and register continued growth. The organization has been able to do more research with less R&D expense compared to US-EU research universities.
2. Students are seamlessly being hired for the workforce, having direct industrial experience.
3. The faculty has been able to get more funding for research and their students, and insight/collaborations on industrial challenges.

Challenges:

1. The framework agreement took 18 months-24 months to finalize with US, EU legal teams involved from with company side with their business leader SPOC for the research engagement from their side and senior leadership involved from SID-IISc side as well to make legal sides converge, given the business leaders' commitment for the long-term strategic relationship.
2. Multiple stakeholder visits from client-side leadership to drive the message home was key.
3. Ensuring that the faculty expectations and industry SPOC expectations are synergized a-priori, beyond just deliverables listed, but with respect to methodology, approaches, variations, timelines, student related availability, continuity, IP confidentiality.

Learning:

1. Institutional collaboration: establishing long-term research collaborations under multi-project frameworks with industry majors promotes sustained engagement and facilitates resource sharing and knowledge transfer.
2. Structured agreements: develop comprehensive Statements of Work (SoW) agreements under the framework to outline deliverables, milestones, costs, and IP arrangements. This ensures clarity and alignment between stakeholders.
3. Strategic partner relationship management: Implement a structured relationship management approach with designated program managers to streamline project execution and address any challenges promptly

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Computational Toolkit Design for Gas Separation Molecular Sieve Membranes (2/2)

Target Audience: Global Oil Company

Project Sponsor (Industry Partner): Global Oil Company

Country of Operation of Sponsor: Worldwide

Key Member from the Sponsor Organization:

Academic Research Partner: SID, IISc

Country of Academic Research Partner: India

Key members from Research Faculty/ Scholar:

Overall Cost: USD 150,000

TRL: 4

Case Study 5

Robotic ARM Integration for Industrial and Agriculture Use (1/2)

Background:

The market size of robotic and autonomous systems is increasing rapidly in India and global markets for various domains, including industrial, and agricultural etc., With support from MHI, ARTPARK, has set up an accelerator to create companies that sell products like and help develop such companies to beat the global competition.

Task and Technology Used:

1. The problem is indeed a very challenging problem with slew of advanced technologies, not limited to actuation, communication, sensors and integration, ML, complex mechanical design and realization, in an integrated fashion with various levels of testing and certifications involved for the desired application.
2. Twara Robotics the pre-venture-cum-startup-company at ARTPARK is building two robotic ARMS for an agricultural client, ATHON-TSS for arecanut plantation fruit plucking and sapling sowing. They also have prototype orders to supply actuators, as a component to other ARM manufacturers in India.

Actions Undertaken:

1. Conceived as a research translation project with the deliverable as a marketable product with a global quality benchmark and competing with global competition which is in the US, EU, Japan and China.
2. Realized through a ‘research+ pre-venture company’ creation project rather than a pure research relationship, resulting in the end with a start-up company, which will eventually sell the products to target customers globally.

Results:

1. Engagement is going strong with clients and besides these two ARMs, three other product variants are coming out, one being for the agriculture client and the other two for industrial markets.
2. Pre-venture converted to a company with ARTPARK-IISc holding 15% equity on behalf of academia and the funding agencies, bound by various IP agreements, which are extremely flexible.
3. Nation creating an indigenous capability and an entire supply chain for such a product market, which is an extremely fast-growing business.
4. Numerous patents have to be filed from the project.

Project Impact:

1. Financial: Twara Robotics' emergence and success reduce India's reliance on imports, saving foreign exchange reserves while promising significant income from global markets. The growth in robotics fosters job creation and economic development.
2. Environmental: Automation in agriculture curbs manual labor, potentially reducing emissions and enhancing sustainability. Precision farming minimizes resource wastage, lessening environmental impact.
3. Research Capability: Collaboration between ARTPARK and academic institutions like IISc elevates research in robotics and related fields, fostering innovation and entrepreneurship. This strengthens academia-industry ties and promotes technology commercialization.
4. Industrial Growth: Twara Robotics' products propel the nation's robotics industry forward, catering to diverse markets and establishing India as a global player. The indigenous supply chain enhances competitiveness and industrial capabilities.

Challenges:

1. Building confidence in client and funding agency that it can be done in 3 years while global teams took 9 to 20 years to come up.
2. Budgets
3. IP agreements, licensing mechanism in future, right kind of pre-venture team members and faculty members who have similar mind set.

Robotic ARM Integration for Industrial and Agriculture Use (2/2)

Learning:

1. Establish supportive policies incentivizing collaboration between industry and academia.
2. Provide dedicated funding mechanisms for joint research initiatives.
3. Implement flexible IP agreements to facilitate technology transfer.
4. Invest in skill development programs for collaborative teams.
5. Ensure access to advanced research facilities and infrastructure.

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Target Audience: Manufacturing industry and other robotic applications in agriculture

Project Sponsor (Industry Partner): TSS + MHI

Country of Operation of Sponsor: India

Academic Research Partner: ARTPARK, IISc

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:

Overall Cost: USD 3 Million

TRL: 7

Case Study 6

A-PATH: Affordable, Preventive and Adaptive Technologies for Healthcare

Background:

The project consortium consisted of four partners from the United Kingdom and India: InnoTecUK and TWI from the United Kingdom, and AdvanceTech and IIT Ropar from India. The UK partners had successfully closed the project in 2019, after presented the outcomes to UK funding agency. Due to pandemic in 2020 and later 2021, the project status was kept on halt. A final extension had been received in mid-2021 for six months, i.e. June 2021- Nov 2021. This report gathers the complete work done in each work package, to be submitted for project closing proceedings.

Task and Technology Used:

The development of the prototype bio-sensing suit, the human intention module, and the assembly of the generated lower- and upper-body exoskeletons. Initial testing on prototypes have been done, and further information regarding operational evaluations are not included in this reporting due to pending patents.

Actions Undertaken:

Regular discussions with partners, and design and development of different modules - the bio-suit, upper limb and lower limb exoskeleton.

Results:

Bio-suit is tested for TRL-8 stage and successfully announced as completed task in DST-GITA reviews. The other two components are less effective, but good research work has been done for detailed design, and prototype for testing and evaluation.

Project Impact:

To cater to 'Make in India', Aatmanirbhar Bharat, it is important to progress through direct industrial issues.

Challenges:

Unless patented, there is always a fear of bigger partners utilizes the idea and may represent it in new projects.

Learning:

Industry-academia projects should be further encouraged, but there are limitations on industry involvement either due to constrains in fund sharing, or their less trust in academia. Both academia and industry partners may work out schemes for utilizing resources in a mutually beneficial way.

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Target Audience: Weak patients or Industrial workers for enhancing strength for daily tasks

Project Sponsor (Industry Partner): DST GITA: For Newton-Bhabha Research Grant

Country of Operation of Sponsor: India and UK

Key Member from the Sponsor Organization: DST-GITA office, leena.vardia@gita.org.in

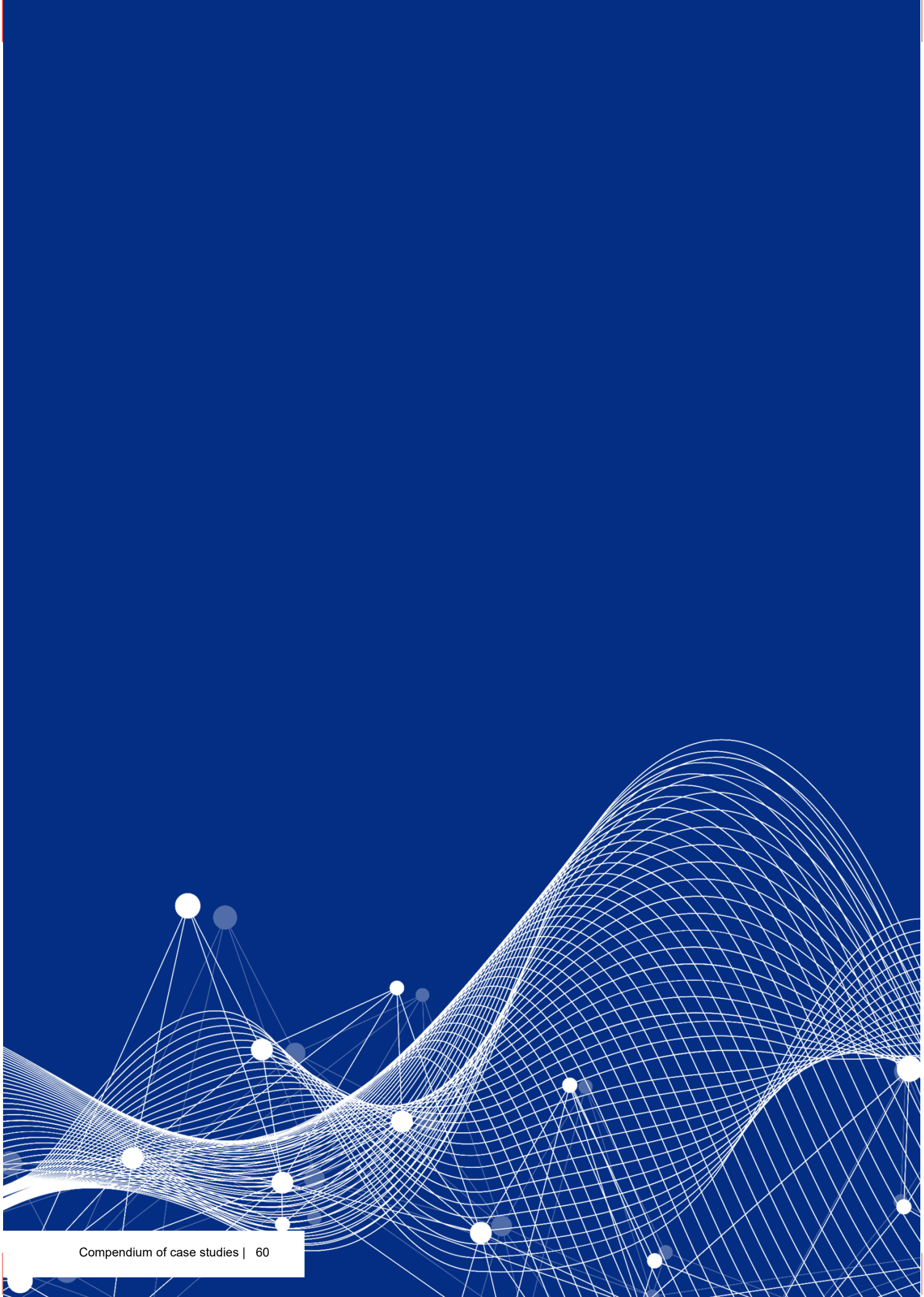
Academic Research Partner: TWI Training and Examination, UK

Country of Academic Research Partner: United Kingdom

Key Members from Research Faculty/ Scholar: Dr Ekta Singla, ekta@iitrpr.ac.in

Overall Cost: INR 1.25 crores

TRL: 7



05 Healthcare

1. Study of Molecular Mechanism of Progression of Retinoblastoma
2. Achieving Industry 4.0 in Biopharmaceutical Manufacturing: Automation and Digitalization of Continuous Manufacturing of Monoclonal Antibodies
3. A Comprehensive Framework for Treatment of Stroke of Upper Extremity by Combining Computational Modelling, Movement Behavior and Gaming
4. Biomarker Test Kit for TB Treatment Monitoring and Guiding Clinical Decisions
5. Single Lead Wearable ECG Devices with Disposable Gel Pads
6. Engineering and Production of an Acid Protease Enzyme Exhibiting High Thermal and Acid Tolerance Employing Synthetic Biology

Case Study 1

Study of Molecular Mechanism of Progression of Retinoblastoma

Background:

The objective was to identify specific progression markers and correlation of expression markers with disease mechanism of retinoblastoma, a pediatric eye cancer. The team envisioned that Agilent's multi-omics solutions can play a pivotal role in identification of key biomarkers that could help improve treatment and management of Retinoblastoma.

Task and Technology Used:

Team could map differentially accumulated metabolites and its corresponding genes to distinct pathways using different analytical technologies. It was made possible by integrating different types of technologies, which helped to identify the underlying disease mechanism and provided evidence for a new treatment modality in eye cancer. The identified markers and pathways specific of different cancer stages can be used for future drug development efforts and to tailor treatment modalities more accurately.

Actions Undertaken:

Agilent helped to conduct the research, by providing its broad range of solutions like microarray, LCMS, GCMS, Cell analysis platform, software and database libraries. Patient tissue and tear samples were provided by Narayana Nethralaya. The institute also validated the findings using biochemical assays and in different animal models.

Awareness of the disease was undertaken at various levels by publishing peer reviewed papers, presenting the findings at various national and international conferences.

Results:

The identified markers will be critical to guide future diagnostic and therapeutic development leading to treatment of the disease with greater precision.

Project Impact:

The identified markers and pathways specific of different cancer stages can be used for future drug development efforts and to tailor treatment modalities more accurately, an unmet clinical need.

Challenges:

Justification of business priorities as research outcome doesn't corroborate with overall business strategies, lack of expertise at academic level to analyze the data and handle high end instruments.

Learning:

Increase research funding for procurement of high-end solutions by academia, allocate separate funding for training of researchers on novel technologies, incentivize industry to provide skill development without imposing any unjustifiable conditions.

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Start Year: 2014

Target Audience: Cancer researchers/ Scientists working on multi-omics

Project Sponsor (Industry Partner):
Agilent Technologies

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization:
Dr. Nilanjan Guha (nilanjan_guha@agilent.com)

Academic Research Partner: Narayana Nethralaya

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:
Dr. Arkashubhra Ghosh
(arkasubhra@narayananethralaya.com)

Overall Cost: INR 2.5 crores

Current Status of the Project: Delivered

Case Study 2

Achieving Industry 4.0 in Biopharmaceutical Manufacturing: Automation and Digitalization of Continuous Manufacturing of Monoclonal Antibodies (1/2)

Background:

With an explosion of artificial intelligence (AI) and industrial internet of things (IOT) applications in all areas of life, the biopharmaceutical industry has an opportunity to implement Industry 4.0. This involves creation of end-to-end connected bioprocess, acquiring data from the various process and analytical equipment, and communicating to the process equipment over IOT to run and control the bioprocess.

Role of TCS – Integrating process and analytical equipment's for data acquisition on a common platform and seamless communication between them.

Role of IITD – Developing digital twins and model-based control to monitor, predict CPP/CQA, run and control an integrated bioprocess in dynamic environment.

Task and Technology Used:

The project focused on the development of a continuous manufacturing operation integrating upstream and downstream unit operations, enabling bioprocessing 4.0. To do so, hybrid intelligence concepts were leveraged along with data-driven AI-ML approaches such as deep neural networks and multivariate process evolution models. The scope of the study encompassed both process development and control system design aspects for the continuous biomanufacturing operation.

Actions Undertaken:

1. Development of integrated upstream and downstream bioprocessing operation using different algorithms for process modelling and online process monitoring for enabling real time measurements
2. Design of model-based control strategy for automatic process control of different unit operation along with the development of multivariate process control and data analysis techniques for monitoring and fault identification of an integrated continuous biomanufacturing. Data analysis helped in analyzing the variation of PAT in-process measurements.
3. Progress tracking
4. Continuous monitoring
5. Valuable Insights
6. Insightful experimentations

Results:

Development of hybrid intelligent models for the different unit operations, design of model-based control strategy for each unit operation with real time implementation and development of integrated continuous platform to produce monoclonal antibody. Also, advanced control strategies involving machine learning techniques were implemented for the monitoring, control and fault detection purpose. A set of guidelines are formulated characterizing the interplay between novel instrumentation, monitoring tools and control strategies required to ensure smooth continuous operation.

Project Impact:

With the successful implementation of the project at lab scale, the presented methodology has opened an opportunity for the companies to participate in the Industry 4.0. By leveraging the methodologies proposed batch process can be transitioned into continuous processing. This transition can offer the promise of higher productivity (10-20X), lower cost of manufacturing (30-75%), and most importantly more consistent product quality.

Challenges:

The major challenge in developing an automated platform for continuous manufacturing is hardware-software interfacing and designing a flexible control that can handle various processes and its variability. The rapid improvements in upstream processing in terms of processability and higher titres, led to the downstream process becoming the bottleneck as the clarified harvest from the bioreactor should be loaded continuously onto the chromatography columns, requiring high capacity throughout the downstream setup.

Learning:

Emerging approaches that can be implemented orthogonally with individual unit operation-level controls, leveraging computational techniques such as machine learning and artificial intelligence for a global picture of the entire process is presented.

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Achieving Industry 4.0 in Biopharmaceutical Manufacturing: Automation and Digitalization of Continuous Manufacturing of Monoclonal Antibodies (2/2)

Start Year: 2018

Target Audience: Biopharmaceutical Industry

Project Sponsor (Industry Partner): Tata Consultancy Services India

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Venkataramana Runkana. TCS Research, Pune.

Academic Research Partner: Indian Institute of Technology, Delhi

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Professor Anurag S Rathore, asrathore@biotechcmz.com

Overall Cost: INR 4 crores

TRL: 9

Type of Partnership: Technology Research

Current Status of the Project: Delivered

Case Study 3

A Comprehensive Framework for Treatment of Stroke of Upper Extremity by combining Computational Modelling, Movement Behavior and Gaming (1/2)

Background:

Funded by TCS and Ministry of Human Resources & Development (MHRD), Govt. of India, under the Uchhatar Avishkar Yojana (UAY)

Participating Institutes:

1. Indian Institute of Technology Madras - Main Academic partner (Brain modeling, VR game design)
2. Tata Consultancy Services - Industry Partner (Arm modelings)
3. Indian Institute of Information Technology (IIIT), Hyderabad - MRI and fMRI analysis
4. National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru - Clinical partner (Recruitment, assessment and data collection from stroke patients)
5. Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram - Clinical partner (Recruitment, assessment and data collection from stroke patients)

Executive summary:

Stroke is considered the second greatest killer after coronary heart disease. Current treatments like drugs, physiotherapy and brain stimulation are highly empirical and are therefore associated with uncertain outcome. Computational neuroscience models have the potential to bring quantitative rigor in the existing therapies and render the outcome more accurate and predictable. Inter-patient variability is the hallmark of the presentation of stroke as well as the treatment outcomes. This calls for patient-specific predictive models as well as designing of customized treatment protocols.

The project propose to create a comprehensive methodology for personalization of rehabilitation therapy for stroke that has a computational neuroscience model as its backbone, and provides a framework that can integrate physiotherapy, clinical assessment, brain stimulation and neuroimaging in a streamlined fashion.

A novel aspect of the proposed work is use of virtual reality based games for physiotherapy and effect of gaming technology on brain can be studied from the computational model. Use of gaming technologies appropriately adapted to the patient, have been found to increase the motivation levels of the patient, enabling the patient to meet the rigors of the physiotherapy required for significant recovery from stroke.

Task and Technology Used:

1. Virtual Reality games
2. Brain modeling
3. Arm modeling
4. Analysis of MRI and fMRI data
5. Clinical assessment scales

Actions Undertaken:

The project started in mid 2018. Till now around 60 patients are recruited.

Results:

Patents:

- “Hand Reach Exercise Ranker For Personalized Neuro Motor Rehabilitation Therapy Using Musculoskeletal” – Indian Provision Patent Application - TEMP/E-1/33804/2020-MUM
- “Investigating the efficacy of Exploration as a Stroke Rehabilitation Paradigm in a Bilateral Network” – Filing in process.

Publications:

- A preliminary computational model of the cortico-basal ganglia system to generate bimanual reaching movements. This work has recently been published in the journal Scientific Reports [https://www.nature.com/articles/s41598-019-49670-4].
- Narayanamurthy, Rukhmani, Samyukta Jayakumar, Sundari Elango, Vignesh Muralidharan, and V. Srinivasa Chakravarthy. "A Cortico-Basal Ganglia Model for choosing an optimal rehabilitation strategy in Hemiparetic Stroke." Scientific reports 9, no. 1 (2019): 1-14.

A Comprehensive Framework for Treatment of Stroke of Upper Extremity by combining Computational Modelling, Movement Behavior and Gaming(2/2)

- Oishee Mazumder, Ayush Rai, Aniruddha Sinha. “Muscle Synergy Control During Hand Reach Task on Varying Shoulder Configuration.” In In 42nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 4839-4843. IEEE, 2020.
- Elango, Sundari, Amal Jude Ashwin Francis, and V. Srinivasa Chakravarthy. "Interaction of network and rehabilitation therapy parameters in defining recovery after stroke in a Bilateral Neural Network." Journal of NeuroEngineering and Rehabilitation 19, no. 1 (2022): 142.
- Rinta Paul, MSc; Sundari Elango, BE; V. Srinivasa Chakravarthy, PhD; Aniruddha Sinha, PhD; PR Srijithesh, MD, DM; Bapi Raju, PhD; PS Sarma, PhD; Shabeera Hafsath, ME; Amal Jude Ashwin Francis, B. Tech; Divya Darshini, B. Tech. "Feasibility and Efficacy of Virtual Reality for Upper Extremity Impairment due to Ischemic Stroke: A Randomized Controlled Trial Protocol" Submitted in Journal of Stroke and Cerebrovascular Diseases.

Project Impact:

In future, the findings of the project can be used to design personalized rehabilitation plan and quantify the improvement due to usage of VR games. Moreover, wearable based assessment of the finger and hand movement would be more suitable for assessment of natural daily living tasks rather than in the controlled environment in front of a camera. The wearable can further be designed as assistive devices with bio-feedback to enable closed loop adaptive assistance and personalized rehabilitation.

Challenges:

Agreement on IPR clauses, On time funds from Govt., COVID scenario.

Learning:

Yearly review by MHRD/ICMR along with all the partners, Ontime release of funds, Roadmap for next steps after the project is over.

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Start Year: 2018

Target Audience: Stroke patients, Hospitals.

Project Sponsor (Industry Partner): TCS.

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Aniruddha Sinha, aniruddha.s@tcs.com

Academic Research Partner: Indian Institute of Technology, Madras

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. Srinivasa Chakravarthy, schakra@ee.iitm.ac.in

Overall Cost: INR 3.12 crores [75% funded by MHRD+ICMR and 25% by TCS].

TRL: 3

Current Status of the Project: Ongoing

Case Study 4

Biomarker Test Kit for TB Treatment Monitoring and Guiding Clinical Decisions (1/2)

Background:

The development of a blood test for TB diagnosis and treatment monitoring, especially involving drug resistance was felt to be extremely useful, instead of just using sputum tests. The development test was based on the work of Prof. Nagasuma Chandra in IISc which involved research into a host response to TB and led to the research papers and the development of a blood-based biomarker. IHF provided support and funding to carry out the development of assays and clinical trials to Healthseq Precision Medicine incubated in IISc and based on the IISc developed technology. The clinical trials and assay development have worked successfully, and the project is nearing completion.

Task and Technology Used:

The primary task was the development of an RNA blood-based biomarker blood test such that it can be used in tertiary settings using the RT-PCR technology now available widely after the COVID pandemic. This included development of assays, workflows, and protocols for collecting blood samples, RNA extraction, use of assays and development of a set of scores for TB identification. The collaboration with IISc was towards use of the research in biomarker development and testing. The expected outcome is in deployment of the test widely in primary care centers for diagnosis and treatment monitoring of TB.

Actions undertaken:

The organization developed a multiplexed assay based on the research at IISc, indigenization, design and execution of clinical trials including comparison with gold standard tests, development of workflows and scores, evaluation of the test for diagnosis and treatment monitoring, including drug sensitive and drug-resistant cases. The blood samples were collected at five hospitals leading to over 500 patient samples being collected for testing.

Result:

The project is nearing completion and results presently acquired are showing great promise. The assay developed for diagnosis and treatment monitoring is showing very good results. The next step is to apply for regulatory approval and deploy the tests in diagnostic centres, hospitals and primary care centres. The plan is to approach the Government institutions to evaluate the tests such that it can be integrated into the National TB programs.

Project Impact:

The test is a blood-based biomarker unlike the present sputum tests and when deployed should lead to better treatment monitoring for both drug sensitive and drug resistance patients. Change of treatments, second line therapies can be quickly adopted. This will ensure curing of TB at a faster rate, contributing and supporting the eradication of TB in the country, which in turn will reduce the burden on the healthcare infrastructure and lead to improved economic conditions for individuals and reduction in healthcare spend of the Government for TB.

Challenges:

There were no challenges in terms of collaboration in terms of industry-academia as the company was a IISc incubated startup. The challenges were in recruiting patients and follow up after diagnosis. Further challenges lie in getting regulatory approval, manufacturing and market development and ensuring that the test will be a part of the protocols of the national TB eradication programs.

Learning:

The interaction between academia, startups and industry was vital in this project and such activity should be supported. The incubation centers/science parks in institutions like IISc have led to translation of research into technology that can be transferred to the industry. Providing incentives, tax rebates and financing could help stabilize the startups in academic institutions leading to new innovations. Support for patenting, manufacturing and regulatory approvals would also help.

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Start Year: 2022

Target Audience: Hospitals, Primary care centers in rural and urban settings, Diagnostic centers, Government (Central and state) TB care institutions

Project Sponsor (Industry Partner):
India Health Fund

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization:
Archita Chaudhury, archita@indiahealthfund.org

Academic Research Partner: Indian Institute of Science (IISc)

Biomarker Test Kit for TB Treatment Monitoring and Guiding Clinical Decisions (2/2)

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:
Prof. Nagasuma Chandra, nchandra@iisc.ac.in

TRL: 6

Overall Cost: INR 1.82 crores

Type of Partnership: Technology Research

Current Status of the Project: Ongoing

Case Study 5

Single Lead Wearable ECG Devices with Disposable Gel Pads

Background:

The funding is aimed at developing affordable and improved wearable ECG pads to be used with the company's existing technology. The work is also aimed at improving the existing single-lead ECG hardware & software in terms of breath rate estimation, ergonomics, and power consumption for long-term usage. The industry partner sets out the optimal conditions to be met and we as academia partners attempt to provide optimal solutions after our R&D.

Task and Technology Used:

Task: Development of affordable and ergonomic Gel Pads

Technology Used: Laser-induced graphene gel electrodes on polyimide and reduced graphene oxide on laser-ablated paper substrates-based gel electrodes.

Task: Improved Bbreathing rate estimation

Technology Used: Digital signal processing algorithms for improved accuracy with minimal computational power consumption.

Actions undertaken:

1. Prototype development
2. Performance evaluation for developed gel pads
3. Comparison with standard gel pads across performance parameters
4. Improving breathing rate estimation techniques

Result:

1. Affordable gel pads are developed in two types - paper substrate-based for short-term use and polyimide substrate-based for long-term use.
2. Algorithm for improved breathing rate estimation developed.

Project Impact:

The outcomes improve the know how in the ECG sensor development and lays foundation for indigenization of relevant technologies leading to a possible boost in local production in near future.

Challenges:

International shipments often pose an issue in terms of possible levy of custom duties for samples and equipment which often lead to a delay. Also, availability of Raw material (such as gel used) are dependent on international supply - local availability is scare or non-existent.

Learning:

An improvised customs exemption policy may be developed for industrial R&D (at least for prototyping parts). Policy to foster manufacturing of medical devices raw materials may be considered.

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Start Year: 2022

Target Audience: Patients & Atheletes

Project Sponsor (Industry Partner): VitalProbe Inc.

Country of Operation of Sponsor: USA, UAE, India, Japan

Academic Research Partner: BITS Pilani Hyderabad Campus

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. Sanket Goel, sgoel@hyderabad.bits-pilani.ac.in

TRL: 3

Overall Cost: INR 13.5 lakhs

Type of Partnership: Technology Research

Current Status of the Project: Ongoing


Demographics
CO2
Et
mmHg
34
50
25
Fi
mmHg
0
4
Pressure
PEAK
cmH2O
17
40
4
PLAT
cmH2O
17
PEEP
cmH2O
3
Volume
Vt
ml
501
1000
5
MV
L/min
6.0
10.0
2.0
Rate
bpm
12
40
2
PS
Manual

Case Study 6

Engineering and Production of an Acid Protease Enzyme Exhibiting High Thermal and Acid Tolerance Employing Synthetic Biology (1/2)

Background:

Acid proteases are extensively used in industrial applications. The enzyme, despite of being in high demand, are mostly imported; secondly the stability of the enzyme is of concern. Tata Chemicals was interested in developing an indigenous technology for production of a stable acid protease enzyme. CSIR-National Chemical Laboratory, Pune was approached to leverage their computational biology, in silico protein engineering and overexpression skills. This collaboration led to successful completion of in silico gene sequence optimization using tools of synthetic biology and overexpression in a microbial host. Further trials are planned on process scale up and optimization to enhance the overall yield.

Task and Technology Used:

The sequence and structure analysis of existing proteases from microbial species showed a scope of improvement in activity and thermo-stability. To achieve this, sequence and structural analysis of acid proteases was done, and hotspots were identified for mutagenesis. Mutants were designed in silico using protein engineering and overexpressed using recombinant DNA technology.

Actions Undertaken:

In silico designing of the gene and lab scale optimization has been completed. The synthetic gene was synthesized in vitro and cloned into a microbial host for overexpression. The overall process was optimized to obtain the desired enzyme expressed by the microbial host at lab scale. Further optimization at fermenter level and at pilot scale will be done to optimize the yield and stability of the product.

Result:

1. Successfully designed the putative gene for a thermo-stable acid protease
2. Cloned and overexpressed the gene in a microbial host
3. Development of a proof of concept at lab scale

Project Impact:

Develop a research capability in synthetic biology that will aid in development of products having higher efficacy and stability at significantly lower cost. Using this technology and precision fermentation, the microbes can be engineered to produce value added products at a large scale using cheap raw materials thereby making the process significantly economical.

Challenges:

Understanding and accurately predicting the sequence to attain the desired stability of a protein is important. Also, overexpressing the desired protein in a microbial host, purifying, and maintaining the stability of the active enzyme is the key challenge.

Learning:

Rigorous brainstorming to identify the projects of high potential Utilizing latest technology to develop new products Clearly defining the scope and responsibility of the proposed work Risk assessment and mitigation plans needs to be addressed Industrial partner should drive scale-up, application development and seed product in the market.

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Start Year: 2021

Target Audience: The acid protease enzyme is widely used in feed, food, beverage, and pharma industries. The feed industry is the major market for acid protease. In animals, it supplements the deficiency of endogenous protease, increase the protein digestibility, and improve animal well being. In food and beverage industries, the enzyme is employed in cheese manufacturing, clearing of fruit juices and alcoholic liquors, and modifying wheat gluten in bread by proteolysis. In the pharma sector, these enzymes are being used in the treatment of inflammation, digestive disorders, respiratory tract disorders, cardiovascular disease and cancer.

Project Sponsor (Industry partner): Tata Chemicals Limited

Country of operation of Sponsor: India

Key Member from the sponsor organization:
Dr. Richard Lobo; rlobo@tatachemicals.com

Engineering and Production of an Acid Protease Enzyme Exhibiting High Thermal and Acid Tolerance Employing Synthetic Biology (2/2)

Academic Research Partner: National Chemical Laboratory, Pune

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:

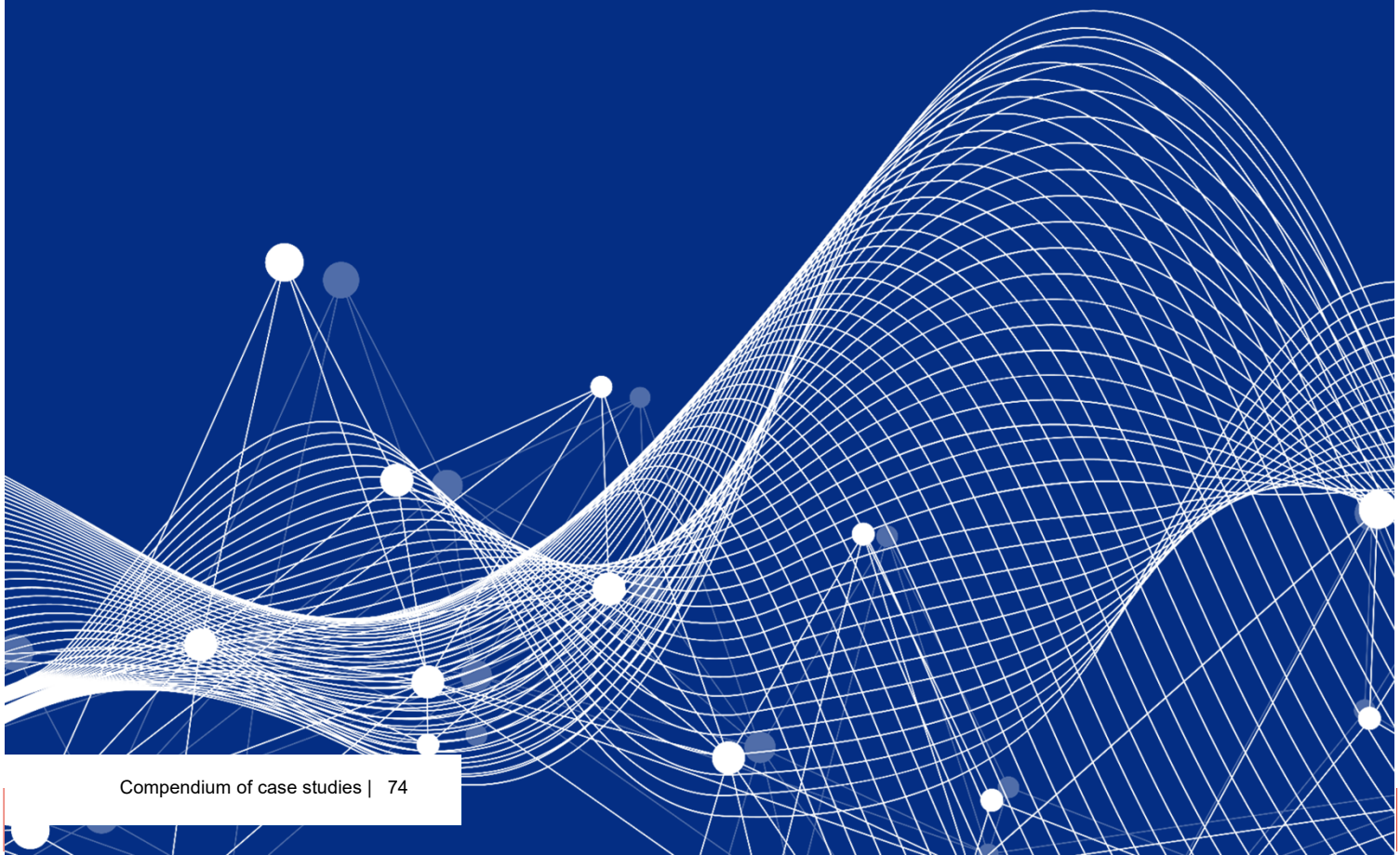
1. Dr. Ashok Giri (ap.giri@ncl.res.in)
2. Dr. Rakesh Joshi (rs.joshi@ncl.res.in)

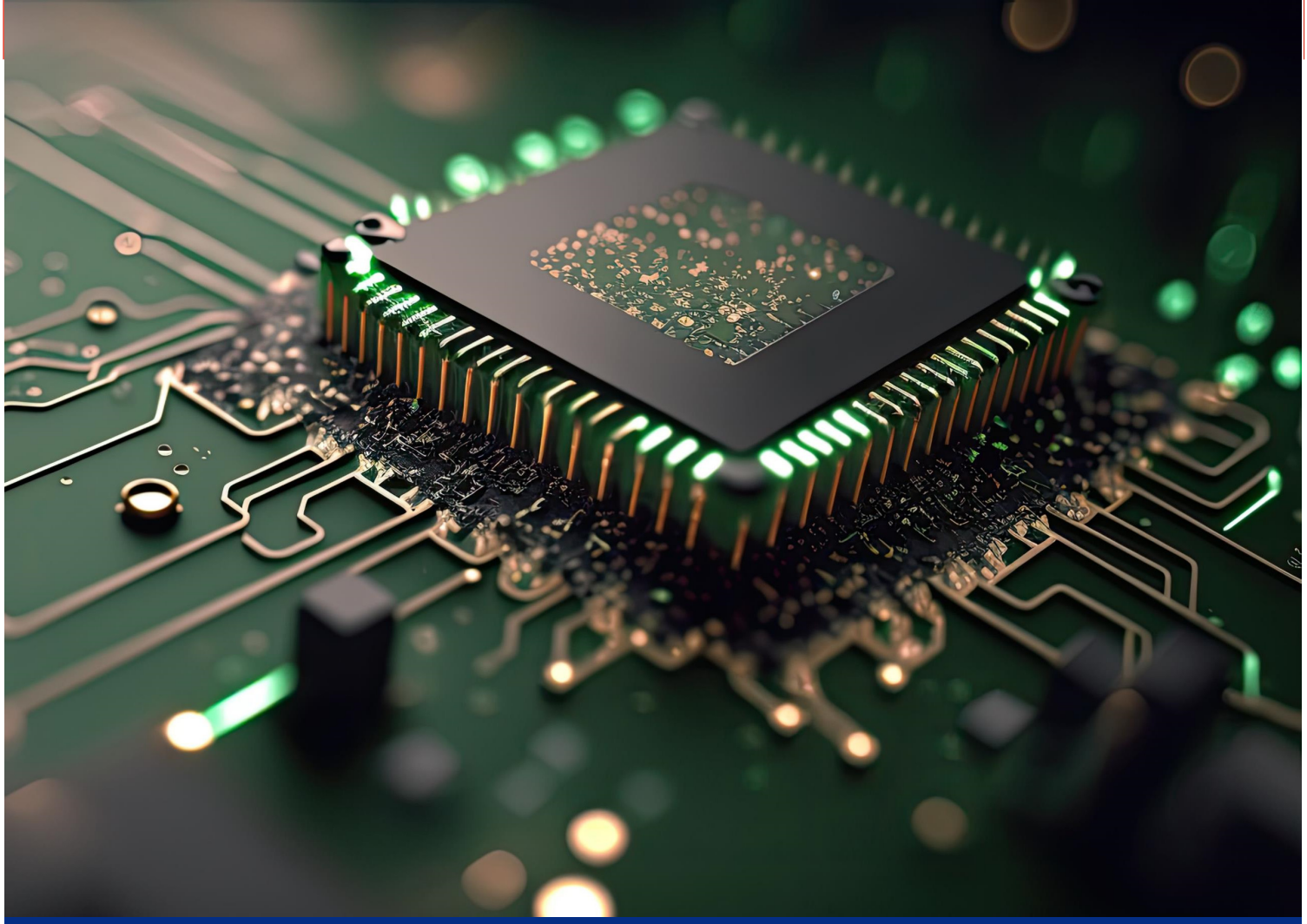
TRL: 4

Overall Cost: Confidential

Type of Partnership: Technology Research

Current Status of the Project: Delivered





06 Semiconductors

1. Laser Induced Graphenized Material on Shellac Supported Flexible devices
2. IIT Bhubaneswar-Marquee Semiconductor Inc. Collaboration
3. Hands-on Training Program on Semiconductor Process Engineering Enabling Workforce Development for India Semiconductor Mission
4. SiC power MOSFETs – Research Partnership between IIT Madras and GE (USA)
5. Nanoscale MOSFETs – Research Partnership between IIT Madras and IBM (USA)

Case Study 1

Laser Induced Graphenized Material on Shellac Supported Flexible devices

Background:

A gap existed in the literature for the one-step production of reduced graphene oxide(rGO) on affordable, flexible, and disposable substrates with improved conductivities. BITS Pilani took up the challenge to develop the process and achieved success in obtaining conductive traces of rGO in a single step. These traces can be used as a semiconductor material. Financial support was provided by Tata Steel, who also encouraged the development of multiple applications.

Task and Technology Used:

The research objective was to develop reduced graphene oxide (rGO) patterns on flexible substrates to produce cost-effective sensors. Simple 450 nm Laser and disposable flexible (paper/cloth) samples were used to obtain the graphenized material.

Actions Undertaken:

The following actions were undertaken to achieve the desired objectives:

1. Progress tracking
2. Continuous monitoring
3. Valuable insights
4. Insightful experimentations

Results:

This collaboration led to the submission of an Indian patent and a manuscript communication to a scientific journal.

The methodology was validated through various interesting applications, including energy harvesting (fuel cell and supercapacitor), series-parallel circuits, and electrocardiography sensors.

Project Impact:

The project led to the development of:

1. A clean and efficient way to produce disposable graphenized sensors (ecofriendly process)
2. Ultrafast process saving production time and resources leading to the industrial profitability.

Learning:

Identifying the problems faced by the industries and trying to solve these challenge in academia could make a meaningful impact in industry-academia collaborations.

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Start Year: 2023

Target Audience: Materials Engineering, Sensor domains, Semiconductor Industries, Researchers

Project Sponsor (Industry Partner): Tata Steel Jamshedpur (Graphene Division)

Country of Operation of Sponsor: India

Key Member from the sponsor organization: Dr. Chandrani Pramanik

Academic Research Partner: BITS Pilani, Hyderabad Campus

Country of Academic Research Partner: India

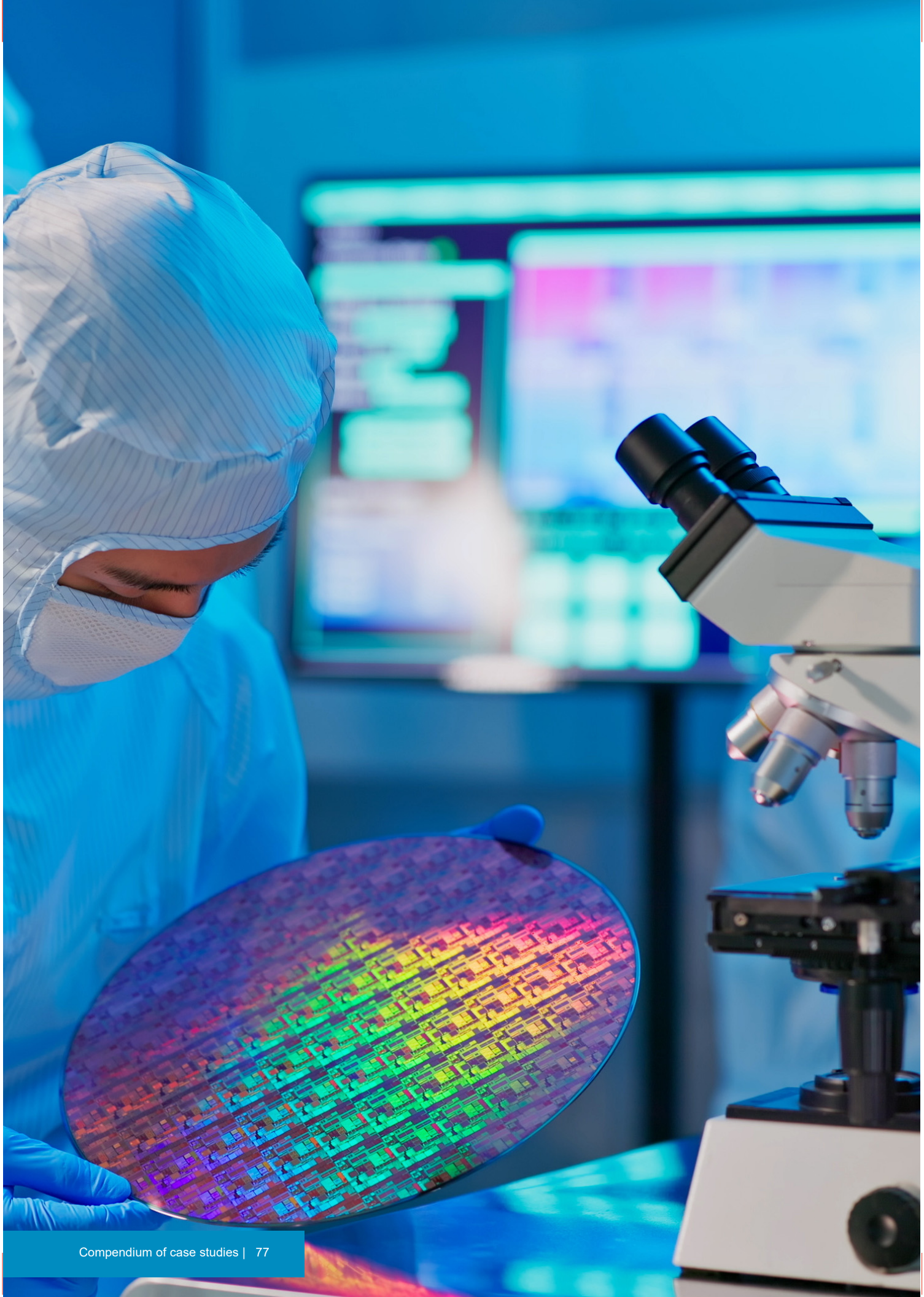
Key Members from Research Faculty/ Scholar: Prof. Sanket Goel (sgoel@hyderabad.bits-pilani.ac.in); Mr. Pavar Sai Kumar (p20200440@hyderabad.bits-pilani.ac.in)

Overall Cost: INR 7.5 lakhs

TRL: 4 -5

Type of Partnership: Technology research and new business model

Current Status of the Project: Delivered



Case Study 2

IIT Bhubaneswar-Marquee Semiconductor Inc. Collaboration

Background:

IIT Bhubaneswar and Marquee Semiconductor came together to establish a Marqueesemi Chair Professor position and Centre for Excellence (CoE) in System-on-Chip (SoC) through an MoU. The designs and technologies developed at CoE are commercialized by Marqueesemi.

System-on-Chip (SoC) Design Research Lab at the School of Electrical Sciences, Indian Institute of Technology Bhubaneswar is actively involved in IC design, fabrication, packaging, test, and measurement with the active involvement of the semiconductor industry. Some of the technologies developed here are actively commercialized by the semiconductor industry, especially through the industry partner, Marquee Semiconductor Inc.

Marquee Semiconductor which is headquartered in Silicon Valley - USA, brings a distinct perspective and unique capability to semiconductor design services. With its engineering sites around the world – India, Philippines, Singapore, Malaysia, and the USA, Marquee has developed a strong background in connectivity, both within modern Systems-on-Chip (SoCs) as well as between chips, and Marquee leverages those skills for the benefit of their customers.

Task and Technology Used:

The semiconductor chips are fabricated in 1P9M TSMC 1.2 V, 65-nm CMOS technology for target applications including:

1. IEEE 802.15.4 IoT Applications
2. Die-to-Die communication (Chip-to-Chip Communications)
3. IEEE 802.11 ac-WiFi

Actions Undertaken:

The semiconductor chips were designed, fabricated, tested and delivered for commercialization through Marquee Semiconductor Inc.

Results:

The partnership resulted in IP and commercialization of product.

Designs are protected as an IP and Marquee Semiconductor Inc. identified customers and now, they are tailor-made to meet the specific deployments.

Project Impact:

The commercialization aspect led to further projects from worldwide customers to the project industry partner. It also led the support from industry partner in financially supporting technology development through in cash and in-kind.

Learning:

Special innovation funds can be created to encourage patenting and IP transfer, to generously fund this activity.

****

Start Year: 2023

Target Audience: Semiconductor industry

Project Sponsor (Industry Partner): Marquee Semiconductor Inc

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Mr. Mukesh Sukla

Academic Research Partner: Indian Institute of Technology, Bhubaneswar

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. Vijay Shankar Pasupureddi; email: vijay@iitbbs.ac.in

Overall cost: INR 47.5 lakhs - sponsored by the industry partner, INR 1.46 crores - sponsored by govt. agencies.

TRL: 7

Type of Partnership: Chair professorship

Current Status of the Project: Ongoing

Case Study 3

Hands-on Training Program on Semiconductor Process Engineering Enabling Workforce Development for India Semiconductor Mission (1/3)

Background:

Until the early 2000s, there were several challenges in building a semiconductor ecosystem in India, in terms of inadequate infrastructure for research and development facilities, and limited local supply chain for components, equipment, and raw materials. Besides this, there was no major high-volume semiconductor manufacturing facility in the country. Another major challenge for the industry was the talent shortage and skill gap with expertise in semiconductor design, fabrication, testing, and packaging. Additionally, funding and incentives for research, financial assistance to set up infrastructure, and manufacturing facilities were limited.

Addressing these challenges required a multi-stakeholder approach involving collaboration among industry, academic institutions, and government. Strategic investments, policy support, skill development initiatives, infrastructure development, and a conducive business environment were key to overcoming these challenges and building a successful semiconductor ecosystem in India.

During 2012-2014, Applied Materials India and IIT Bombay jointly developed a course to train workforce to provide a theoretical and practical understanding of technologies and concepts in semiconductor manufacturing.

The partnership between Applied Materials India and IIT Bombay aimed to address the growing demand for advanced materials and semiconductor technologies by leveraging the strengths of both industry and academia. Applied Materials brings its industry-leading expertise, cutting-edge technologies, and market insights, while IIT Bombay contributes its renowned research capabilities, academic excellence, and a vibrant ecosystem of researchers and students.

Applied Materials India and IIT Bombay developed a training program that aimed to provide a comprehensive understanding of semiconductor manufacturing processes and technologies. The program included theoretical lectures, hands-on training sessions, and panel discussions on relevant topics. Applied Materials hired new engineers with a diverse skill set in materials and science but knowledge in semiconductor process engineering was pivotal. The course designed for the new hires offered extensive training on semiconductor process technologies and metrology techniques.

Task and Technology Used:

To address the challenges in the semiconductor ecosystem in India in the domain of infrastructure development and skill gap in semiconductor process engineering, for workforce development a short-term training program has been developed to provide a fundamental understanding of current technologies and advanced concepts in semiconductor manufacturing along with hands-on experience on equipment and processes used in IC fabrication worldwide.

The program was conducted by faculty members from IIT Bombay and industry experts from Applied Materials. They provided in-depth knowledge various aspects of semiconductor manufacturing including process steps, equipment, materials, and characterization techniques.

Actions Undertaken:

The program included theoretical lectures, hands-on training sessions, and panel discussions on relevant topics.

Additionally, in 2023, Applied Materials India announced a partnership with the Centre for Semiconductor Technologies (SemiX) at IIT Bombay through the Industry Affiliate Program, to develop a strong engagement with the semiconductor talent and innovation engines of the two entities.

A short-term course was conducted by SemiX in association with Applied Materials India on semiconductor manufacturing.

The program was attended by academia, students, working professionals from semiconductor industries, research scientists, and technical staff of various government labs, the session successfully engaged the audience through hands-on trainings and insightful panel discussions.

In January 2024, SemiX conducted its first new college graduate (NCG) program with Applied Materials India. This course was specially designed for new hires at Applied Materials which offered extensive hands-on training on semiconductor process and characterization along with lectures delivered by faculty members from IIT Bombay.

Hands-on Training Program on Semiconductor Process Engineering Enabling Workforce Development for India Semiconductor Mission (2/3)

Results:

By successfully completing the NCG program, the new hires at Applied Materials India gained a solid foundation in semiconductor processes and equipment and were armed with the necessary skills to contribute effectively to the company's growth and development.

The program not only enhanced their technical knowledge but also fostered a deeper understanding of the industry and its prospects. These NCGs will be posted in various manufacturing locations within the partner company where these skills will be utilized.

Project Impact:

A total number of 188 participants are trained under project.

The impact of a training program on semiconductor technology can have significant implications for a nation/organization that will address the gaps in semiconductor manufacturing in the ecosystem in India:

1. Financial Impact: A well-trained workforce in semiconductor technology can contribute to the growth and development of the semiconductor industry in the country. Skilled professionals can also attract investments and foster innovation, leading to the development of a robust and competitive semiconductor sector. This, in turn, can contribute to the overall economic growth of the nation.
2. Environmental Impact: Advances in semiconductor technology have led to the creation of more energy-efficient and environmentally friendly electronic devices. A training program that focuses on semiconductor manufacturing processes can play a vital role in promoting sustainable practices within the industry.
   By incorporating these practices into their work, trained professionals can contribute to reducing the environmental impact of the semiconductor industry.
3. Research Capabilities: A training program that emphasizes research-driven learning can enhance the research capabilities of participants and contribute to the overall research ecosystem of the nation. By being exposed to cutting-edge technologies and research methodologies, participants can develop a deeper understanding of the field and contribute to advancements in semiconductor technology leading to the generation of new knowledge, patents, and innovative solutions,

Challenges:

While industry-academia collaboration offers numerous benefits, it also presents various challenges that need to be addressed for successful partnerships. Some of the key challenges include:

1. Differences in Goals and Timelines: Industry and academia often have different objectives and timelines. Academia focuses on long-term research and knowledge creation, while industry prioritizes short-term commercial outcomes. Managing these divergent goals and timelines can be a challenge when collaborating on projects. Aligning expectations and finding a common ground can require effective communication and negotiation.
2. Intellectual Property (IP) Concerns: Balancing the protection of IP rights can be a complex issue in collaborations. Industry partners may be reluctant to share proprietary information, limiting the scope of research or publication. Academic researchers may feel apprehensive about disclosing their findings or signing restrictive agreements. Resolving IP concerns and establishing clear agreements on the ownership and use of research outputs is crucial in establishing trust and collaboration. This is one of the most important challenges for research and product development, while for training and upskilling this can be easily resolved.
3. Funding and Resource Limitations: Both industry and academia may face funding and resource limitations that can impact collaborative efforts. Industry partners may prioritize resources towards immediate commercial goals, while academic institutions may have limited funding for collaborative projects. Identifying and securing adequate funding and resources, as well as establishing fair distribution mechanisms, is crucial for sustained collaborations.
4. Addressing these challenges necessitates proactive efforts from both industry and academia. Building trust, open communication, clearly defined goals, joint decision-making, and mutually beneficial agreements can foster successful and impactful collaborations. Additionally, bridging the gap through joint workshops, exchange programs, and collaborative research centers can facilitate better understanding and collaboration between the two sectors.
5. Government through its Anusandhan National Research Funding (NRF) can enable larger collaborations on all the gaps for the success of ISM.

Hands-on Training Program on Semiconductor Process Engineering Enabling Workforce Development for India Semiconductor Mission (3/3)

Learning:

To foster industry-academia collaboration in research and innovation, following are the key learnings:

Policies and regulations need to be developed that promote and facilitate collaboration between industry and academia.

This includes creating incentives for both sectors to collaborate, such as tax benefits, grants, and funding mechanisms specifically designed for collaborative projects.

Policy makers should support initiatives that encourage the transfer of knowledge and technologies between industry and academia. This can be facilitated through collaborative platforms, technology transfer offices, and entrepreneurship programs that facilitate the commercialization of research outputs.

Research centers, joint innovation labs, and industry consortia can provide a framework for long-term collaborations, encourage resource sharing, and foster a culture of collaboration.

Skill development and training programs should be prioritized that bridge the gap between industry and academia. This can involve initiatives that provide industry exposure to academic researchers and vice versa, as well as programs that equip researchers with entrepreneurial and commercialization skills.

The collaboration of Applied Materials with IIT Bombay and Indian Institute of Science (IISc) can be replicated by policy makers and make the pool of engineers getting trained larger for the benefit and align with the goals of India Semiconductor Mission (ISM). Training and upskilling of new graduates should be the first area that needs to be on priority. Theory and process exposure is key for the success of ISM and put India in global semiconductor roadmap.

Interdisciplinary research, faculty-industry exchanges, and recognizing collaborative achievements should be promoted to creating a collaborative culture within both industry and academia. By considering these key learnings, policy makers can create an enabling environment that encourages and supports industry-academia collaboration in research and innovation, fostering economic growth, technological advancement, and societal impact.

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Start Year: 2012

Target Audience: Working professionals, Research scientists, technical staff, Academics.

Project Sponsor (Industry Partner): Applied Materials India Pvt. Ltd.

Country of Operation of Sponsor: India

Key Member from the Sponsor Organization: Mr. Suraj Rengarajan

Academic Research Partner: Indian Institute of Technology Bombay (IIT- Bombay)

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar:

1. Udayan Ganguly (udayan@ee.iitb.ac.in)
2. Saurabh Lodha (slodha@ee.iitb.ac.in)

Overall Cost: INR 1 crore

Type of Partnership: Technology Training Program

Current Status of the Project: Ongoing

Case Study 4

SiC power MOSFETs – Research Partnership between IIT Madras and GE (USA)

Background:

GE personnel approached the IIT Madras faculty for study of Silicon Carbide (SiC) Power MOSFETs

Task and Technology Used:

Technology Computer Aided Design tools and analytical modeling were used to simulate conventional and super-junction SiC power MOSFETs.

Actions Undertaken:

2 PhD students worked on simulation and modeling of power MOSFETs.

Results:

Simulation and analytical modeling of conventional and super-junction power MOSFETs

Project Impact:

Development of research manpower in the area of simulation of power MOSFETs

Work published as 7 reputed journal & several conference papers.

Challenges:

Not available as the industry could not provide experimental data.

Learning:

Apart from providing monetary support, industry should also consider sharing experimental data.

****

Start Year: 2008

Target Audience: Power devices research community

Project Sponsor (Industry Partner): GE (USA)

Country of Operation of Sponsor: USA

Key Member from the Sponsor Organization: R. Ramakrishna Rao

Academic Research Partner: IIT Madras

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. Shreepad Karmalkar (karmal@iitbbs.ac.in)

Overall Cost: USD 20,000 (~INR 16.7 lakhs)

Type of Partnership: Technology Research based Industrial Consultancy

Current Status of the Project: Delivered

Case Study 5

Nanoscale MOSFETs – Research Partnership between IIT Madras and IBM (USA)

Background:

IBM personnel approached the IIT Madras faculty for study of nanoscale devices.

Task and Technology Used:

Technology Computer Aided Design tools and analytical modeling were used to simulate nanoscale junctions and MOSFETs.

Actions Undertaken:

3 PhD students and 1 MS students supported on simulation and modeling of nanoscale MOSFETs.

Results:

Simulation and analytical modeling of nanoscale junctions and MOSFETs

Project Impact:

Development of research manpower in the area of simulation of Nanoscale devices

Work published as 12 reputed journal & several conference papers.

Challenges:

The industry could not supply experimental data.

Learning:

Apart from providing monetary support, industry should also consider sharing experimental data.

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Start Year: 2007

Target Audience: Nanoscale MOSFET research community

Project Sponsor (Industry Partner): IBM (USA)

Country of Operation of Sponsor: USA

Key Member from the Sponsor Organization: Dr. Basanth

Academic Research Partner: IIT Madras

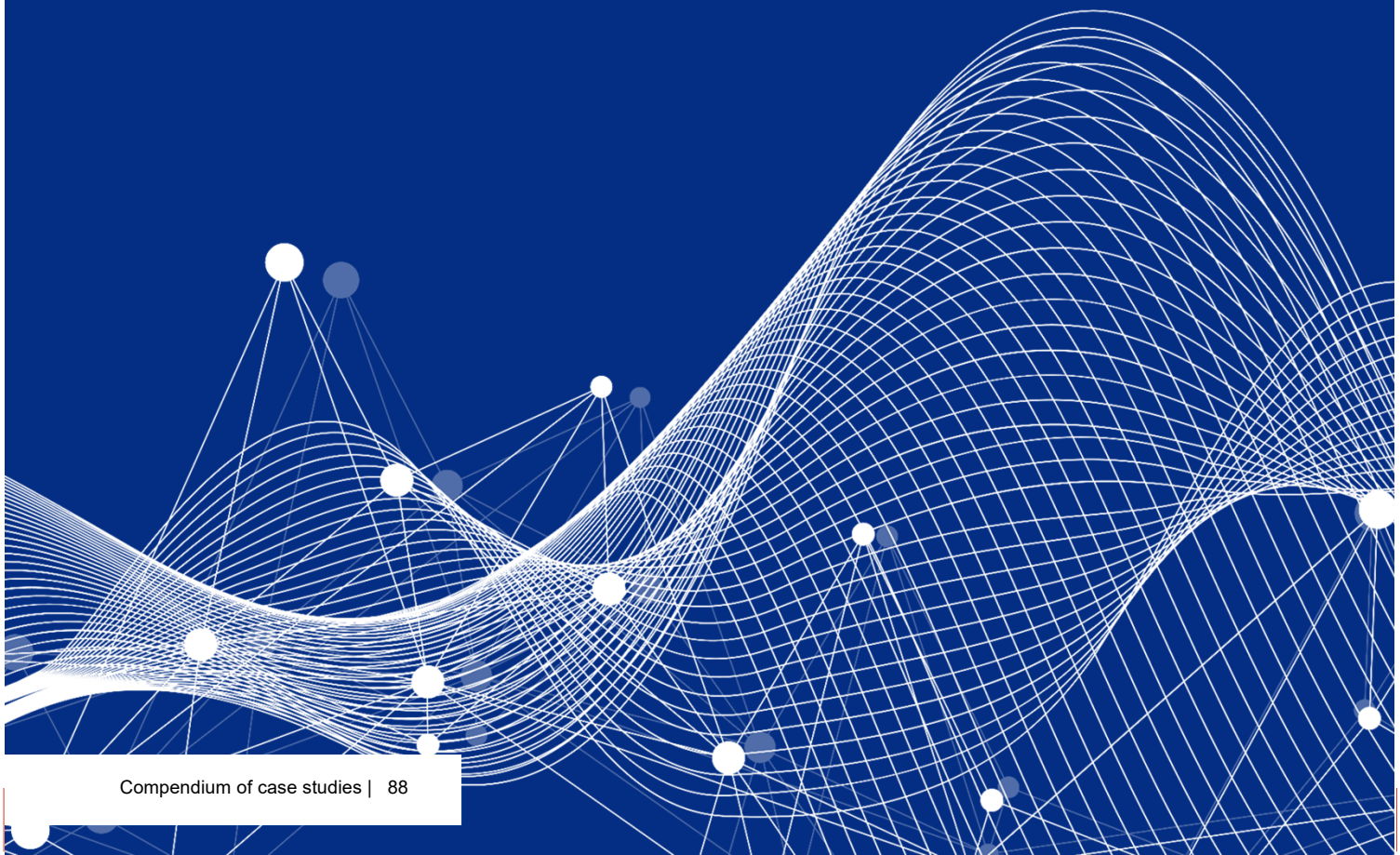
Country of Academic Research Partner: India

Key Members from research Faculty/ Scholar: Prof. Shreepad Karmalkar (karmal@iitbbs.ac.in)

Overall Cost: USD 10,000 (~INR 8.35 lakhs)

Type of Partnership: Technology Research

Current Status of the Project: Delivered



07 Energy Transition

1. Conversion of Indian High Ash Coal to Methanol
2. PowerAnser Labs
3. Supercritical CO2 Turbomachinery Development
4. Design and Development of Biomass Solar Electricity and Cooling Solutions for Rural India
5. Coal Tar Derived Hard/Soft Carbon Anodes for Power Li-ion Batteries
6. Coating Composition for IR Shielding/Heat-seal Effect/Cooling effect

Case Study 1

Conversion of Indian High Ash Coal to Methanol

Background:

Thermax, a prominent player in the energy, environment, and water sector, initiated a groundbreaking project to develop indigenous coal gasification technology tailored for India's high ash coal. With India emerging as a major global economy, its rising GDP underscores the critical role of the energy sector in sustaining growth. However, the country's heavy reliance on imported liquid and gaseous fuels poses a significant threat to its energy security, with 80% of these fuels currently being sourced from overseas.

In response to this challenge, the Government of India has set ambitious targets for coal gasification, aiming for 100 million metric tons (MMT) by 2030. To support this goal, the Ministry of Science and Technology has been actively promoting indigenous technology development under the Make in India mission.

Task and Technology Used:

The Department of Science and Technology (DST) awarded a development project to Thermax and IIT Delhi to demonstrate a pilot-scale plant for converting coal to methanol. Discussions are underway to enhance the technology further by adding a Carbon Capture and Utilization (CCU) block, aiming to bridge the gap towards achieving net-zero emissions.

Actions Undertaken:

The envisioned business model involves partnerships between refineries, Oil Marketing Companies (OMCs), and coal-to-methanol plants to utilize methanol as a fuel blend derived from India's high ash coal.

Results:

Thermax and IITD have successfully demonstrated Indian high ash coal conversion to methanol technology at a 1 TPD scale. Critical technical and design inputs from IITD's lab experimentation were important for particulate removal, water gas shift, CO2 capture, and catalytic conversion to methanol. All these inputs ensured the successful demonstration.

Project Impact:

The collaboration between Thermax, IIT Delhi, and policy makers underscores the importance of indigenous technology development and policy support in achieving India's energy security goals while mitigating environmental impact.

Challenges:

The overall success of utilization of Indian coal through indigenously developed technology as a liquid / gaseous fuel input requires considerable support from the policy makers. Many of these are in the pipeline.

1. Support for a commercial level demo project at a 100 to 300 TPD methanol production scale
2. Promoting blending of methanol in fuel
3. Coal cost control
4. Promoting green hydrogen and renewable economy (for CCU)

Learning:

This is a great example of successful collaboration between Indian academia and industry.

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Start Year: 2018

Project Sponsor (Industry Partner): Thermax

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Delhi

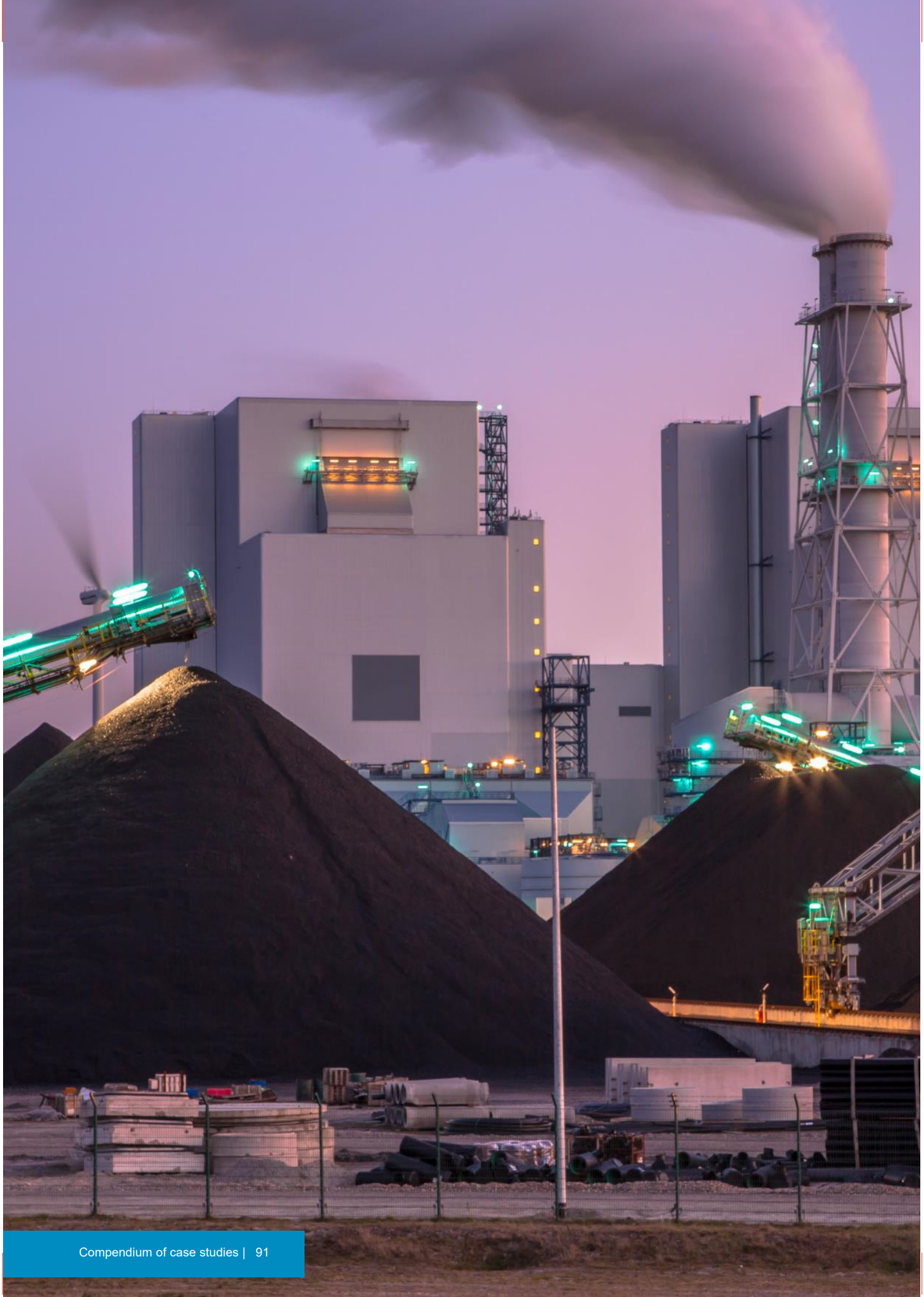
Country of Academic Research Partner: India

Overall Cost: INR 38 crores (funded by Department of Science & Technology)

TRL: 6

Type of Partnership: Technology Research

Current Status of the Project: Completed



Case Study 2

PowerAnser Labs

Background:

In late 2000s, when renewable energy penetration was increasing in power grids across the globe, it was widely recognized that information technology driven solutions will have a major, if not critical, role to play in reliably operating a greener grid. It was then Tata Consultancy Services (TCS), Tata Consulting Engineers (TCE), and IIT-Bombay came together to create the Power Analysis Services (PowerAnser) Labs (PAL) in 2009. The lab brought together the research expertise of IIT-Bombay, information technology expertise of TCS, and project/domain expertise of TCE.

Task and Technology Used:

The idea behind establishing PAL was to leverage technology platforms to offer advanced power system analytics to the utility industry. As a result of this collaboration, for the first time in Indian power sector, power system analytics solutions was offered to the utilities through software as a service (SaaS) model. A unique SaaS platform called "webDNA" (web-based delivery of network applications)" was built.

Actions Undertaken:

As a part of webDNA, software solutions for several critical power systems problems were developed and offered to Indian utilities. These include short term load forecasting, transmission network cost and loss allocation, load flow analysis, and cable sizing. The lab has also developed solutions for the new age grid such as wide area monitoring systems (WAMS) solutions based on the phasor measurement unit (PMU) data and market clearing software for electricity markets.

Results:

The solutions developed by the lab are being used by several state and private utility companies, such as those form Gujarat, Tamil Nadu and Maharashtra. The WAMS solutions and the associated analytics have been deployed in National and Regional load dispatch centers in India. The market clearing software is being used by the Power Exchange India Limited (PXIL).

Project Impact:

The solution to the transmission network cost and loss allocation has contributed a lot to the Indian power sector by providing guidance to the Central Regulatory Authority to define new regulations, which has resulted in a novel and fair methodology to allocate transmission cost and loss to the beneficiaries in the Indian transmission system. Further, this solution has been adopted by the Grid Controller of India to implement new regulations.

Challenges:

Some important considerations in a collaboration between academia and industry are:

1. a mature framework to engage in go-to-market strategies is needed,
2. guidelines / agreements protecting mutual interests, objectives and IP.
3. need for all the parties to come out of their comfort zones and act, as well as to interact closely with the end customers and regularly get their feedback.

Learning:

1. It is important to understand the start-up culture while respecting the priorities of individual parties.
2. It is Important to present jointly in external forums and workgroups,
3. Knowledge-sharing sessions, and creating awareness in customer facing roles in the industrial partners are vital,
4. Robust governance strategies and plans for product / solution roll-out is a must.

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Project Title: PowerAnser Labs.

Start Year: 2009

Target Audience: Power sector companies - state electricity boards, retailers, grid operators, power exchanges

Project Sponsor (Industry Partner): Tata Consultancy Services, Tata Consulting Engineers

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Bombay

Country of Academic Research Partner: India

Key Members from Research Faculty/ Scholar: Prof. S A Soman

TRL: 6 - 7

Type of Partnership: Technology Research

Current Status of the Project: Delivered

Case Study 3

Supercritical CO2 Turbomachinery Development

Background:

Globally super critical CO2(sCO2) turbomachinery is recognized as critical piece in future energy transition. To locally develop this new technology product, there is a need of close industry academia collaboration. By harnessing the potential of sCO2 technology, this initiative aims to contribute significantly to the advancement of clean and efficient energy solutions, showcasing India's capability in developing cutting-edge technologies for sustainable energy production.

Task and Technology Used:

Triveni Turbine Limited, in collaboration with the Indian Institute of Science (IISc), embarked on a pioneering project focused on developing natural products in a niche technology domain. The project ventured into sCO2 technology, which involves generating power through the design and development of turbomachinery based on supercritical carbon dioxide.

Actions Undertaken:

The primary objective of this collaborative effort is to successfully create and demonstrate indigenous turbomachinery capable of producing 100 kilowatts (kW) of power using sCO2. By harnessing the potential of sCO2 technology, the initiative aims to significantly advance clean and efficient energy solutions. It serves as a testament to India's prowess in developing cutting-edge technologies for sustainable energy production.

The Indian Institute of Science (IISc) plays a pivotal role in the project, leading the design and testing phases of the turbo machinery. Their involvement ensures that the machinery is both effective and reliable.

Results:

TTL and IISc have showcased this prototype turbine at a G20 event in Goa, in Jul'23.

Triveni's new technology group and ICER of IISc tied up to develop 100 KW technology demonstration model.

Project Impact:

The technology offers versatile applications in next-generation nuclear plants, industrial waste heat recovery in cement/steel plants, and marine ships. It enhances energy efficiency, safety, and sustainability across these sectors, reducing emissions, optimizing processes, and supporting auxiliary power generation. This versatile technology addresses diverse energy challenges, promising sustainable and efficient energy utilization.

Challenges:

1. Availability of critical research information on cutting edge technology in Indian universities.
2. Sustaining long industry – academia partnership to progress on TRL.
3. Overcoming industrialization challenges of research products.
4. Manufacturing challenges of high-speed compact turbomachinery.

Learning:

This product is a great example of successful collaboration between Indian academia and industry.

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Target Audience: Government Sector and Private Sector (Energy Intensive)

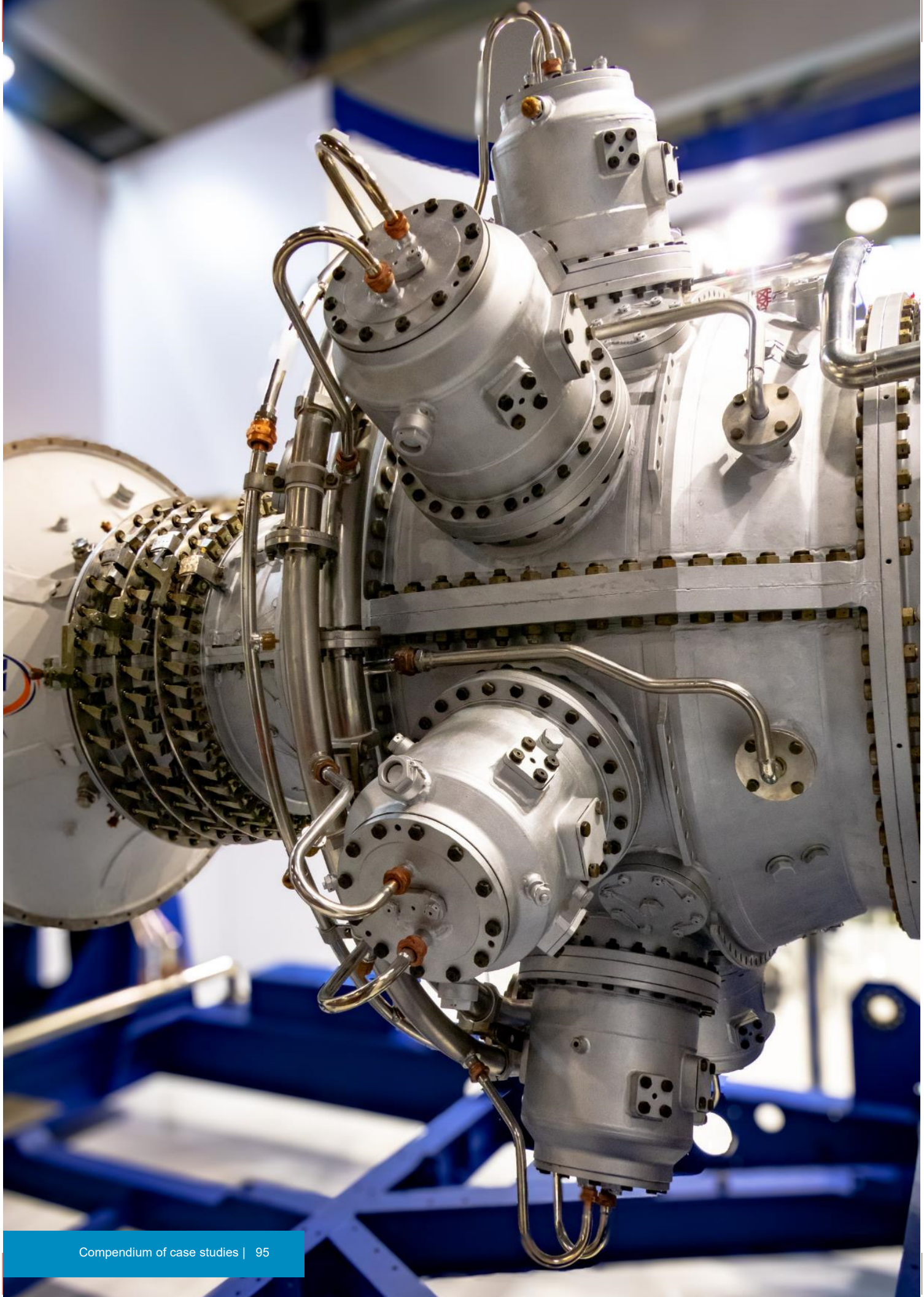
Project Sponsor (Industry Partner): Triveni Turbine Limited (TTL)

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Science Bengaluru (IISc)

Country of Academic Research Partner: India

Type of Partnership: Technology Research



Case Study 4

Design and Development of Biomass Solar Electricity and Cooling Solutions for Rural India

Background:

In India, 2.4% of the total population still has limited access to electricity. The main reason could be their remote location or poor connectivity from the Grid. The Government is taking initiatives to provide electricity services to such locations by either connecting them to nearby substations or developing a multi-energy system-based microgrid. One such innovation challenge has been addressed in work titled “Design and Development of Biomass Solar Electricity and Cooling Solutions for Rural India.”

Task and Technology Used:

The project aims towards the development of a holistic system integrating renewable energy sources and locally produced energy, e.g., a biomass gasifier for catering to the electrical and thermal loads of a remote location.

The project can be broadly classified as following objectives:

1. Control algorithms for seamless control of voltage source converters from voltage control to current control modes.
2. Demonstrate a green chill cold storage system using waste heat from a two-stage gasifier power plant.
3. Demonstration of the PV-biomass gasifier and battery-based microgrid with the integrated cooling solution in two villages in Odisha.
4. Explore the possibility of integrating woman empowerment, livelihood improvement, human resource development, and local entrepreneur needs during implementation.

The work integrates a multi-energy system comprising a solar PV system, 2-stage Biomass gasifier, Green Chill, and Battery Energy Storage. It produces electrical energy from Solar PV and the gasifier's alternator, and thermal energy from an Exhaust heat-based adsorption system and Green Chill for the Cold Room. An electrical vapor compression system (VCS) is added for cold room operation from electrical energy, with a VFD-based controller for efficient Solar PV-Battery System operation.

Actions Undertaken:

The presence of multiple energy sources and various load types creates the necessity for optimal sizing, planning, and energy management for the uninterrupted operation of the system. It is noteworthy that the combined energy management strategy for thermal and electrical systems leads to the maximum utilization of resources, minimizing the cost of operation and fuel. The algorithm was prepared after performing a baseline study on the needs of villagers and the availability of generation and load. The obtained survey data helped to estimate the sizing and number of operating hours so that the algorithm is robust.

Results:

The combined energy management strategy for thermal and electrical systems maximizes resource utilization, minimizing operational costs and fuel usage.

Project Impact:

These systems are very useful in places that are still not connected to the electrical grid or face intermittent power supply on a regular basis; hence the developed solution can be extended to such locations in the future as well.

This will benefit them in the socio-economic development of the village. The commissioned system was finally handed over to SPREAD NGO and Village Mahila Mandal for usage and operation.

Learning:

This product is a great example of successful collaboration between Indian academia and industry.

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Target Audience: Government Sector and Private Sector (energy Intensive)

Project Sponsor (Industry Partner): TERI

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Delhi

Country of Academic Research Partner: India

Type of Partnership: Technology Research

Case Study 5

Coal Tar Derived Hard/Soft Carbon Anodes for Power Li-ion Batteries

Background:

Soft carbonaceous materials, showing both graphitic and non-graphitic structure, represent an interesting class of compounds, since they can store more lithium than pure graphite. Coal tar pitch and low ash clean coal are the potential sources for the preparation of soft carbon anode materials. In this project, synthetic anode materials such as soft/hard carbon are prepared by pyrolysis of conditioned pitch and tested in a lithium-ion battery with a specific capacitance of 350mAh g-1 and good cycle performance.

Task and Technology Used:

The project can be broadly classified as following:

- Detailed characterization of the coal-tar pitch derived hard carbons/soft carbon materials
- Preparing electrodes via conventional tape-cast route using hard/soft carbon material
- Conducting Li and Na ion shuttlecock electrochemical cycles to check various properties
- Fabricating full cells and study the long-term cycling performance at different current rates
- Characterizing porous carbon materials derived from coal-tar which is an industrial by-product from Tata Steel.
- Demonstrating lab-scale Li and Na ion full cell configurations using commercial positive electrodes
- Optimizing silicon amount in composite anode and further demonstration of battery pack in 2W

Results:

Anode material with >372mAh/gram specific capacity was prepared and demonstrated to power a two-wheeler.

Project Impact:

A battery pack was designed using coal tar derived hard/soft carbon anode and commercially available cathode. The battery pack was showcased, demonstrating its ability to power a scooter. Soft carbonaceous materials, showing both graphitic and non-graphitic structure, represent an interesting class of compounds, since they can store more lithium than pure graphite. Coal tar pitch and low ash clean coal are the potential sources for the preparation of soft carbon anode materials. The work is ongoing to increase capacity and keeping voltage profile as flat as possible. Silicon addition to existing anode material to from Si-Synthetic anode composite can help in increasing the material capacity. Combining carbon anodes stability and silicon's specific capacity can be beneficial for development of superior hybrid synthetic anode.

Challenges:

- Poor initial coulombic efficiency, energy density, and charge-discharge performance
- Chargeability of soft/hard carbon at a reasonable rate without deteriorating. A fast charge can induce severe underpotential, resulting in hazardous Li plating and the subsequent deterioration of cell performance.

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Project Sponsor (Industry Partner): Tata Steel

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Bhubaneshwar

Country of Academic Research Partner: India

Overall cost: ~INR 50 lakhs + 2 FTEs from Tata Steel

Case Study 6

Coating Composition for IR Shielding/Heat-seal Effect/Cooling Effect

Background:

Due to the climate change, temperature of cities is increasing rapidly. This will result in the increased demand for the air conditioning and refrigeration, which demands a significant portion of energy supply. Reducing this energy demand and increasing sustainability requires proper design and construction materials. In the present study, a smart material was developed to respond to the temperature rise and deliver a sustainable cooling effect when used in a coating on steel. The project was targeted to develop a coating composition comprising modified hollow air-filled micron-sized spherical particles [HMS] optionally along with nano metal oxide (MO). The modified hollow air-filled HMS with inorganic shell material and nano metal oxide (MO) provides a cooling effect without the use of any powder pigments.

Task and Technology Used:

The project can be broadly classified as following:

- To develop a multifunctional coating system using hollow nano-/micro- spheres and nanometal oxides.
- To test the effect of the processing steps and filler contents on the performance of the coating
- To quantitatively evaluate the thermal shielding effect of the HMS-MO coating system.
- To quantitatively evaluate the corrosion resistance characteristics of the coatings and the effect of the HMS and MO on these properties
- To modify the filler particles and study their multifunctional capabilities in improving the performance characteristics of coatings

Results:

Novel Coating material provides a temperature reduction greater than 12 degree Celsius along with excellent mechanical and corrosion resistance properties

Project Impact:

The developed coating when applied in the thickness range of about 60 - 100 µm provides 60-75% screening of temperature from an IR source. A novel dual mechanism of cooling is incorporated in the design of the smart material to generate maximized cooling effect which provides a temperature reduction greater than 12 degree Celsius along with excellent mechanical and corrosion resistance properties.

The coating has been tested at lab scale (mild steel and galvanized steel panels of size 3 inches x 6 inches of 1 mm thickness) and now TSL is planning to take a trial using larger steel substrate.

Challenges:

- Mechanical properties strongly influence the coating performance when exposed to the outdoors.
- Adhesion and corrosion properties.

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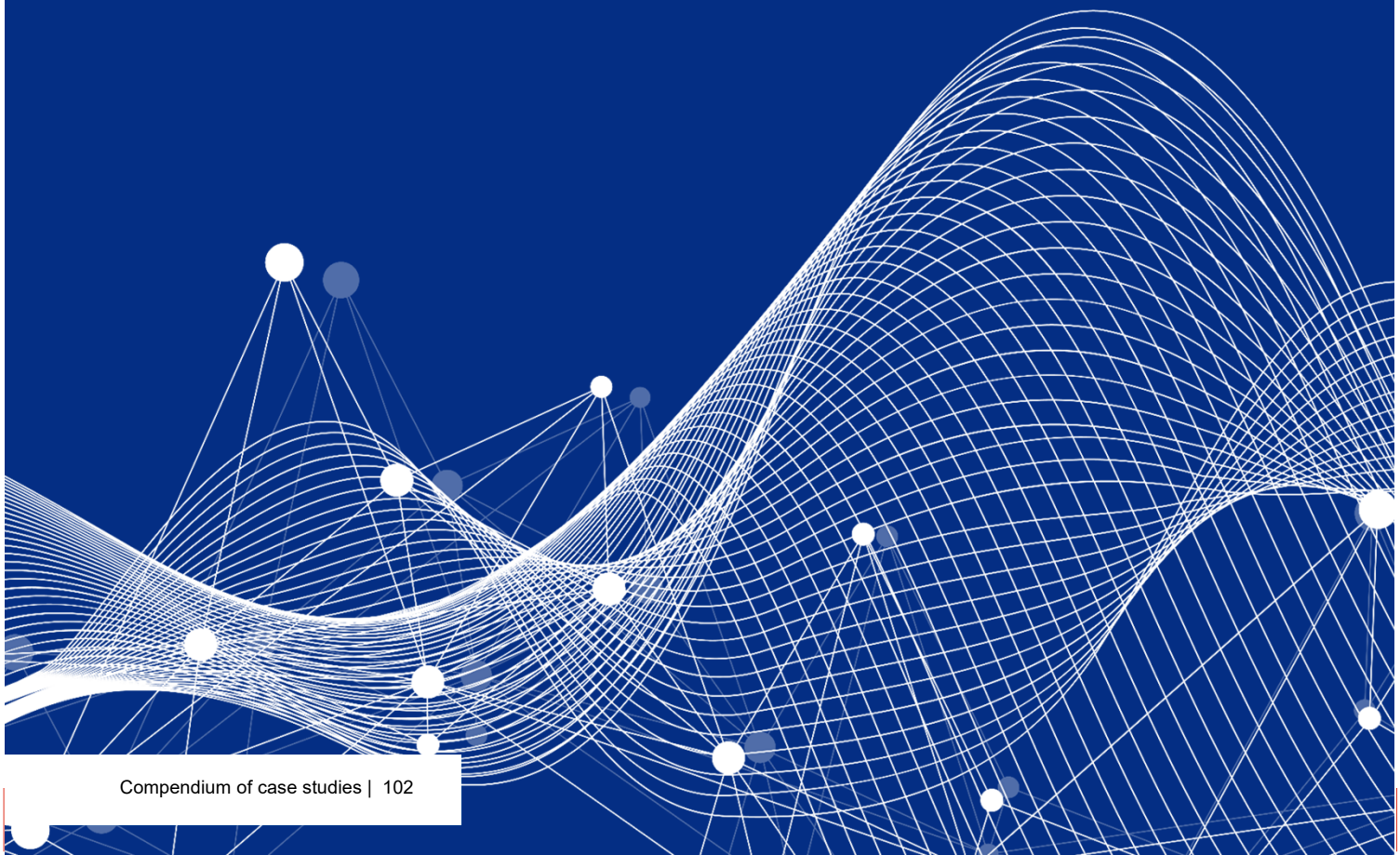
Project Sponsor (Industry Partner): Tata Steel

Country of Operation of Sponsor: India

Academic Research Partner: Indian Institute of Technology, Bombay

Country of Academic Research Partner: India

Overall cost: ~INR 40 lakhs + 1 FTE from Tata Steel



08 AgriTech

1. High-speed Grader for Non-invasive Mango Grading by Size, Weight, Ripeness, Sweetness and Internal Quality

2. Polyhouse Design for Indian Conditions Using Solar Chimney

3. Controlled-release Dispenser for Delivery of Pheromones to Rice Stem Borers (Scirpophaga incertulas) and Citrus Leaf Miners (Phyllocnistis citrella)

4. MTA – Virginia Tech India – Skilling Farm Product Design Engineers in AI and Data Science

Case Study 1

High-speed Grader for Non-invasive Mango Grading by Size, Weight, Ripeness, Sweetness and Internal Quality

Background:

The agricultural sector, particularly the mango industry in India, encounters challenges that inhibit its export potential. Many importing countries require pre-treatments for Indian mangoes that compromise their quality. There is also an issue of mangoes looking appealing externally while being damaged internally, which has led to consumer dissatisfaction. This highlights the need for a solution that can non-invasively ascertain the internal quality and sweetness of mangoes.

To tackle these challenges, a collaborative initiative was formed between the Indian Institute of Horticultural Research (IIHR), known for its expertise in fruit ripening and internal defects, and Zentron Labs Private Limited, a pioneer in developing indigenous grading solutions for fruits using advanced sensors, AI and ML technologies. Along with the Karnataka State Mango Development and Marketing Board (KSMDMC), which facilitated the identification of suitable farms and stakeholders, this partnership aimed to develop a high-speed grading solution for mangoes. This initiative had an overall investment of INR 4 crores.

The collaboration resulted in a groundbreaking grading system that evaluates mangoes based on size, weight, ripeness, sweetness and internal quality at high speeds, revolutionizing mango quality assessment and aiming to enhance export potential and consumer satisfaction.

Project Impact

1. Reduced rejections during exports and encouraged stakeholder investment in packhouse infrastructure.
2. Enhanced satisfaction through improved quality assessment of mangoes.
3. Utilized advanced technologies like Hyperspectral, Multi-spectral and X-ray for fruit quality assessment.

Key Learnings

1. Administrative flexibility is crucial for the success of such innovative projects.
2. Funding models need to consider workforce costs.
3. The right partnerships can lead to remarkable advancements and solutions.
4. Close cooperation between research institutions and industry is essential to translate research findings into practical benefits for farmers and the broader community.

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Project Sponsor: IIHR, KSMDMC, Zentron Labs Private Limited

Country of Operation of Sponsor: India

Contact Details of Sponsor: Jagadeesh Sunkad (jagadeeshs@zentronlabs.com)

Academic Research Partner: IIHR, Hesaraghatta, Bengaluru

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar: Dr Sudhakar D V Rao (sudhakarrao.dv@icar.gov.in), Dr C K Narayana (narayana.ck@icar.gov.in)

TRL : 7

Current Status of the Research Project: Completed

Case Study 2

Polyhouse Design for Indian Conditions Using Solar Chimney

Background:

In the realm of agriculture, optimizing input use efficiency represents a challenge that directly impacts both productivity and environmental sustainability. Recognizing this, a collaborative project emerged, aiming to leverage technological innovations to enhance the efficiency of resources utilized in agriculture. This necessity for innovation brought together an interdisciplinary team of mechanical engineering experts, crop physiologists and agriculturalists, marking an effort to integrate technological interventions within the agricultural sector.

The project, sponsored by the Robert Bosch Centre for Cyber Physical Systems-Indian Institute of Science (IISc), Bengaluru, engaged academic research partners, including IISc, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) and University of Agricultural Sciences (UAS), Bengaluru. Targeted at progressive farmers, seed companies and cultivators working in protected environments, the initiative aimed to develop a suite of technologies for precision agriculture. With an overall investment of approximately INR 3 crores, the project set out to create practical solutions that could improve the agricultural sector's input use efficiency.

The collaboration resulted in the development of several groundbreaking technologies, including solar chimney-based polyhouses that maintain a nearly ambient temperature even during Bengaluru's hot summers, which is a stark contrast to existing designs that lead to a temperature increase of 6-8°C above ambient. Other innovations include mini-lysimeters, low-pressure drip irrigation systems and a modular aeroponic chamber with precise control over temperature, humidity and light.

Project Impact

1. Established precision agriculture as a key vertical within the Bengaluru Science and Technology Cluster.
2. Attracted more institutions and industries to collaborate, thus broadening the scope and impact of precision agriculture in the region.

Key Learnings

- The transition from Technology Readiness Levels (TRL) 4 or 5 to market readiness is identified as a critical phase requiring investment and collaboration to adapt technologies to market needs.

2. The combination of mechanical engineering, crop physiology and agricultural expertise can be effective in tackling complex agricultural challenges.

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Project Sponsor: Robert Bosch Centre for Cyber Physical Systems, IISc Bengaluru

Country of Operation of Sponsor: India

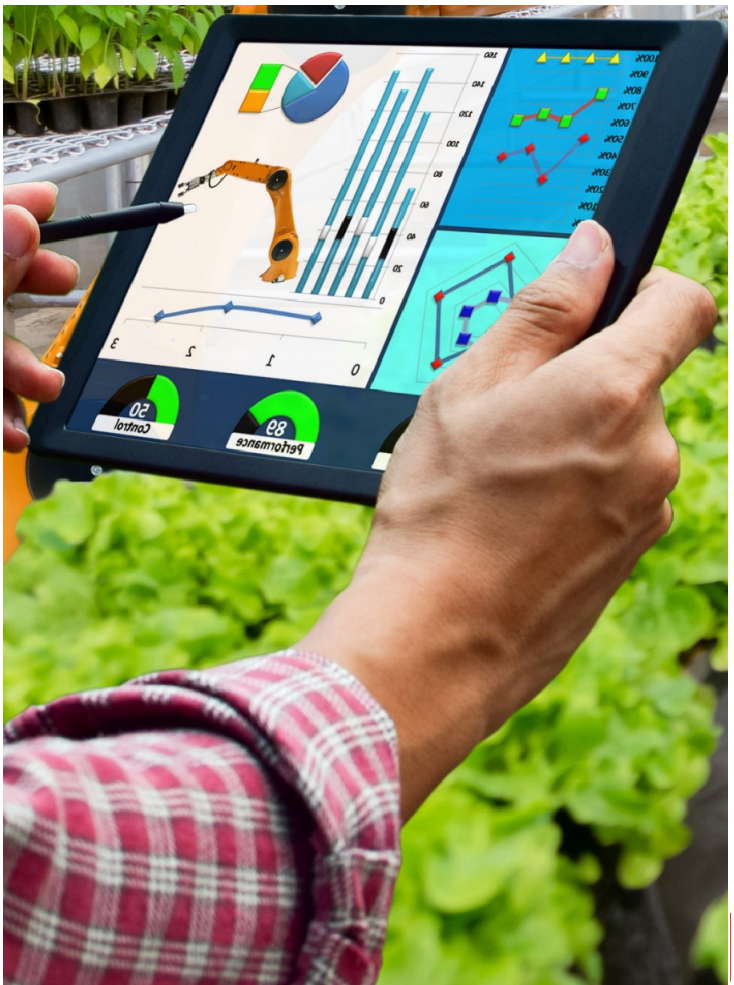
Academic Research Partner: IISc, JNCASR, UAS, Bengaluru

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar:
Prof M S Bobji (bobji@iisc.ac.in)

TRL : 4-5

Current Status of the Research Project: The project is continuing with additional funding



Case Study 3

Controlled-release Dispenser for Delivery of Pheromones to Rice Stem Borers (*Scirpophaga incertulas*) and Citrus Leaf Miners (*Phyllocnistis citrella*)

Background:

To address the challenge of pest management in agriculture, a collaboration was established between the Technical Research Centre (TRC) at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, and the Indian Council of Agricultural Research-National Bureau of Agricultural Insect Resources (NBAIR). This initiative, primarily targeted at farmers and focused on developing a novel pest control method, was funded at an overall cost of INR 1.5 crores and yielded financial benefits of INR 5 lakhs.

The project's main objective was to synthesize and characterize nanomaterials loaded with pheromones for an effective pest attractant and trapping system. This led to the creation of a nanomatrix designed for optimal pheromone delivery, utilizing advanced nanotechnology for improved spatial and temporal release mechanisms.

Project Impact

1. Created an innovative nanomatrix for pest management.
2. Offered a cost-effective alternative to traditional methods, saving money for farmers.
3. Reduced reliance on chemical pesticides.
4. Boosted research in nanotechnology and agricultural sciences.

Key Learnings

1. A multidisciplinary approach is essential for developing innovative solutions to agricultural challenges.
2. Industry-academia collaboration is important for bringing advanced research to practical application.
3. Integrating nanotechnology, chemistry and agricultural sciences through research is crucial for creating sustainable solutions.

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Project Sponsor: TRC, JNCASR

Country of Operation of Sponsor: India

Academic Research Partner: ICAR-NBAIR and JNCASR

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar: Prof M E Swaramoorthy (eswar@jncasr@ac.in), Dr Kesvana Subaharan (kesavan.subaharan@icar.gov.in)

TRL : 6

Current Status of the Research Project: Completed

Case Study 4

MTA – Virginia Tech India – Skilling Farm Product Design Engineers in AI and Data Science

Background:

Mahindra Research Valley (MRV) is the new product development (NPD) hub of Mahindra and all the new products in automotive and farm sector are designed and tested here. This leads to generation of huge amount of data from our test vehicles. The engineers want to extract meaningful insights from the collected data and want to extrapolate and predict using the available data for future projects thus reducing the development and validation timeline. We wanted to build in-house technical capability in data science to address this need. However, we were unable to find courses for our engineers that are application oriented with examples relevant to automotive domain. Most of the available courses were focused on business analytics.

Actions Undertaken:

Virginia Tech India (VTI) is one of the premier institute offering courses in this domain. MTA partnered with VTI to offer data science course for automotive engineers. MTA identified the members to be trained in data science domain and conducted inhouse training program at MTA on basics of data science so that they are familiar with the data science concepts. Engineers who have successfully completed this course were identified and sponsored for VTI data science course. The engineers are required to take up a capstone project which is a day-to-day problem that has to be solved and enroll for the course. They learn the concepts in the course and apply it in their work. The classes are also conducted in the online mode on Saturdays and Sundays so that the employees can attend the course without affecting their work. One of our MTA team members (Dr Srinivas) became an adjunct faculty at VTI and used automotive case studies to teach the cohorts to apply data analytics to solve real world automotive problems

Project Impact

Employees have enrolled for this course in about five batches and have successfully completed the course. Learnings from their capstone project were implemented in the live projects and we have also seen an increase in the demand for the course from the HoD's to create more of data science experts in their function. One of these projects won the first prize in the "Create the Future" innovation contest organized by Mahindra.

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Start Year: 2019

Project Sponsor (Industry Partner): Mahindra & Mahindra

Country of Operation of Sponsor: India

Contact Details of Project Sponsor:
Dr. Venugopal Shankar

Academic Research Partner: Virginia Tech India

Country of Academic Research Partner: India

Contact Details of Research Faculty/Scholar:
Dr Padmanabhan

TRL Level: 5-7

Current Status of the Research Project: Ongoing


FOOD
DELIVERY
AUTONOMOUS
ROBOT

9. Way Forward

By addressing pressing issues such as healthcare, energy transition, agriculture, and climate change and aligning their efforts, industry and academia can develop innovative solutions, technologies, and policies to minimize human intervention, reduce costs and optimize efficiency to improve the quality of life and productivity of the target audience. The key learnings from the challenges faced in these case studies could pave the way for the adoption of some of the best practices that could contribute to India's overall economic growth and development.

Such transfer of knowledge, technology, and skills between industry and academia can lead to the development and commercialization of new products, services, and processes, thereby benefiting concerned stakeholders, advancing technology and societal impact.

The encouraging results obtained through collaborations between academic institutes and industry leaders across different fields indicate that these symbiotic relationships can prove instrumental in accelerating technological advancements that are both sustainable and implementable.

Researchers could take up challenges issued by industries, be it for software defined vehicles (SDVs) or for a humanoid caregiver that eliminates the risk of contagion. Firms, on their part, could reap the benefits of academic research, while helping academics become industry-ready, gain exposure to the latest technologies, and have their innovations properly patented and marketed.

In the field of healthcare, collaboration between industries and academic institutes is beneficial for the masses. Combining theory and practical applications helps the development of innovative and patient-specific solutions, such as the use of computational neuroscience models to drive accurate and predictable outcomes in case of strokes. Humanoid caregivers and pure-magnesium-based bioactive orthopedic implants that are biodegradable could improve the entire course of healthcare in the country.

AgriTech too has the potential to cut costs, and workforce effort and improve yields in agriculture. Technology can help with efficient farming, minimizing human intervention. Smart tools could also be used for grading produce and reducing rejections (based on quality) during exports. Studies of soil, climate and crop can help with pest control, as smart solutions detect patterns and prevent harvest spoilage.

Another pertinent point that needs to be addressed is reducing India’s dependency on imports. India, which currently imports a large amount of fuel, could invest in more research to produce renewable energy and sustainable fuels by leveraging indigenous technology to help bring down the import dependency and contribute to the country’s net-zero goals.

While the Government has created PLI schemes encouraging research, companies must also set aside resources for R&D activities. A cloud-based national-level platform accessible by students and researchers across the country could also be built to advertise industry-academia pilot and commercial initiatives and crowdsource ideas for execution.

Strategic partnership between industry and academia have the potential to drive innovation, economic growth, and societal development. By forging strong collaborations, these two segments can leverage their respective strengths and resources to achieve tangible outcomes and accelerate India’s journey towards becoming a global economic powerhouse.

Notes

Notes

Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with around 9,000 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 294 national and regional sectoral industry bodies.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2024-25, CII has identified "Globally Competitive India: Partnerships for Sustainable and Inclusive Growth" as its Theme, prioritizing 5 key pillars. During the year, it would align its initiatives and activities to facilitate strategic actions for driving India's global competitiveness and growth through a robust and resilient Indian industry.

With 70 offices, including 12 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 300 counterpart organizations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

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Confederation of Indian Industry
The Mantosh Sondhi Centre
23, Institutional Area, Lodi Road, New Delhi – 110 003 (India)
T: 91 11 45771000
E: info@cii.in • W: www.cii.in

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