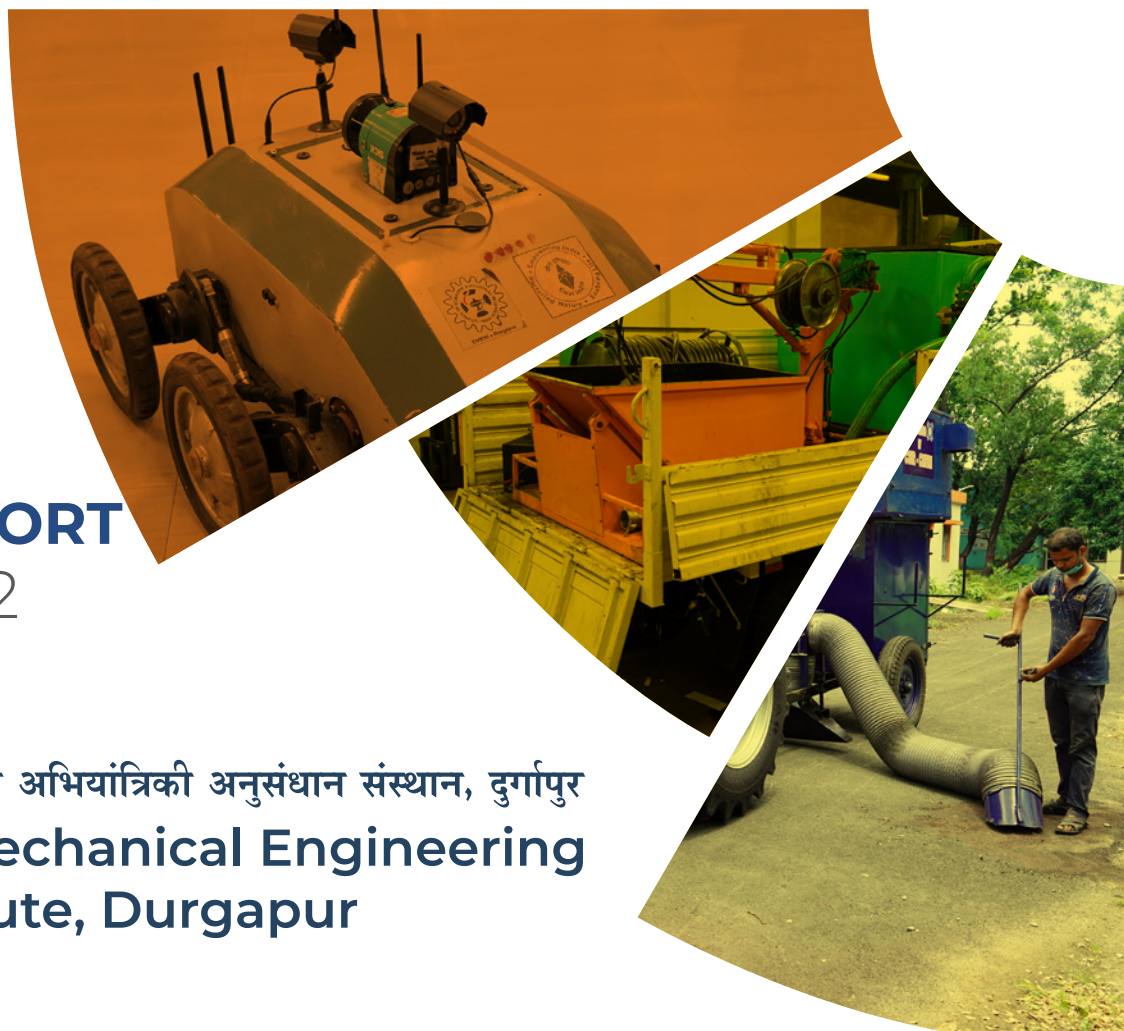




## ANNUAL REPORT 2021-2022

सीएसआईआर-केंद्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान, दुर्गापुर  
CSIR-Central Mechanical Engineering  
Research Institute, Durgapur





# OVERVIEW

In India, mechanical engineering technology has accounted for nearly half of the total technology imported. In terms of products, nearly one third of the value of total imports is for mechanical engineering equipment. In order to develop indigenously mechanical engineering technology for the industries so that R&D can play a key role in self-reliance, the Central Mechanical Engineering Research Institute at Durgapur, West Bengal was established in February 1958 with the specific task of development of mechanical engineering technology.

The **Central Mechanical Engineering Research Institute (CMERI)** is the apex R&D institute for mechanical engineering under the aegis of the Council of Scientific and Industrial Research (**CSIR**). Being the only national level research institute in this field, CMERI’s mandate is to serve industry and develop mechanical engineering technology so that India’s dependence on foreign collaboration is substantially reduced in strategic and economy sectors. Besides, the institute is facilitating innovations and inventions for establishing the claims of Indian talent in international fields where Indian products shall ultimately compete.

In the new millennium, CMERI is poised to expand its horizon of research activities so as to steer the country forward in cutting-edge and sunrise feel

# अवलोकन

भारत में आयातित कुल प्रौद्योगिकियों का लगभग आधा हिस्सा मैकेनिकल इंजीनियरिंग की प्रौद्योगिकियाँ होती हैं। उत्पादों के मामले में कुल आयात के मूल्य का लगभग एक तिहाई हिस्सा मैकेनिकल इंजीनियरिंग उपकरणों के उत्पाद का आयात होता है। उद्योगों के लिए स्वदेशी रूप से यांत्रिक इंजीनियरिंग प्रौद्योगिकी विकसित करने के उद्देश्य से मैकेनिकल इंजीनियरिंग प्रौद्योगिकी के विशिष्ट विकास कार्यों हेतु दुर्गापुर, पश्चिम बंगाल में केंद्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान की स्थापना फरवरी 1958 में की गई थी ताकि देश के आत्मनिर्भरता के मामले में अनुसंधान और विकास कार्य अपनी महत्वपूर्ण भूमिका निभा सके।

केंद्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान (सीएमईआरआई) वैज्ञानिक और औद्योगिक अनुसंधान परिषद (सीएसआईआर) के तत्वावधान में मैकेनिकल इंजीनियरिंग हेतु कार्य करने के लिए एक शीर्ष अनुसंधान और विकास संस्थान है। इस क्षेत्र विशेष में एकमात्र राष्ट्रीय स्तर का शोध संस्थान होने के नाते सीएसआईआर-सीएमईआरआई का कार्य उद्योगों की सेवा करना और मैकेनिकल इंजीनियरिंग प्रौद्योगिकी विकसित करना है; ताकि सामरिक और आर्थिक क्षेत्रों में विदेशी सहयोग पर भारत की निर्भरता काफी हद तक कम किया जा सके। इसके अलावा यह संस्थान तकनीकी क्षेत्र के भारतीय प्रतिभा के दावों को अंतरराष्ट्रीय क्षेत्रों में स्थापित करने के लिए नवाचारों और आविष्कारों की सुविधा प्रदान कर रहा है जहां पर भारतीय उत्पाद अंततः प्रतिस्पर्धा किया करेंगे।

नई सहस्राब्दी में सीएसआईआर-सीएमईआरआई अपने अनुसंधान गतिविधियों के क्षितिज का विस्तार करने के लिए तैयार रहता है ताकि देश को अत्याधुनिक बनाने और अभ्यूद्य का अहसास दिलाने हेतु उन्नति पथ पर आगे बढ़ाया जा सके।





## VISION

- To be a global R&D institute having confidence of industries and visibility to society in mechanical engineering sciences and technologies.

## MISSION

- To research and develop cost effective and value added technologies in mechanical engineering and allied domains.
- Contribute significantly to national skill development initiatives for sustainable empowerment.

## MANDATE

- Carrying out research and development in relevant areas of national priority as evolved by bodies concerned with the overall planning for science and technology in the country.
- Undertaking R&D sponsored by public/ private sector industries in consonance with national priorities.
- Undertaking R&D directed towards continuous improvement of indigenous technology.
- Undertaking R&D for evolving new technologies relevant to the country's social, economic and industrial needs in keeping with national objective of self-reliance.
- Undertaking R&D on appropriate and alternate technologies, with emphasis on the use of local resources.
- Ensuring continuous flow of finance and resources through extension of R&D services for fostering basic research at the institutional level.
- Undertaking activities focused towards fast translation of laboratory level technologies to commercial entities through proper nurturing and marketing.
- Undertaking on a routine basis effort for identification of R&D requirements of industries for rapid intervention through the extension of R&D services.

## दूरदर्शिता (विजन)

- मैकेनिकल इंजीनियरिंग विज्ञान और प्रौद्योगिकियों में उद्योगों का विश्वास और समाज के लिए अपनी समुचित दृश्यता बनाए रखते हुए एक वैश्विक अनुसंधान एवं विकास संस्थान के रूप में उभरना।

## उद्देश्य

- मैकेनिकल इंजीनियरिंग और इससे संबद्ध शोध क्षेत्रों में लागत प्रभावी और मूल्य वर्धित प्रौद्योगिकियों का अनुसंधान और विकास करना।
- सतत सशक्तिकरण के लिए राष्ट्रीय कौशल विकास पहल में महत्वपूर्ण योगदान देना।

## अधिदेश

- देश में विज्ञान और प्रौद्योगिकी के लिए समग्र योजना से संबंधित निकायों द्वारा विकसित राष्ट्रीय प्राथमिकता से संबद्ध क्षेत्रों में अनुसंधान और विकास कार्य करना।
- राष्ट्रीय प्राथमिकताओं के अनुरूप सार्वजनिक/निजी क्षेत्र के उद्योगों द्वारा प्रायोजित अनुसंधान एवं विकास उपक्रम।
- स्वदेशी प्रौद्योगिकी के निरंतर सुधार की दिशा में अनुसंधान एवं विकास का उपक्रम करना।
- आत्मनिर्भरता के राष्ट्रीय उद्देश्य को ध्यान में रखते हुए देश की सामाजिक, आर्थिक और औद्योगिक जरूरतों के लिए प्रासंगिक नई प्रौद्योगिकियों को विकसित करने के लिए अनुसंधान एवं विकास करना।
- स्थानीय संसाधनों के उपयोग पर जोर देते हुए उपयुक्त और वैकल्पिक प्रौद्योगिकियों पर अनुसंधान एवं विकास करना।
- संस्थागत स्तर पर बुनियादी अनुसंधान को बढ़ावा देने के लिए अनुसंधान एवं विकास सेवाओं के विस्तार के माध्यम से वित्त और संसाधनों का निरंतर प्रवाह सुनिश्चित करना।
- उचित पोषण और विपणन के माध्यम से प्रयोगशाला स्तर की प्रौद्योगिकियों का व्यावसायिक संस्थाओं को तीव्र हस्तांतरण करने के मद्देनजर उपक्रम गतिविधियां जारी रखना।
- अनुसंधान एवं विकास सेवाओं का विस्तार करते हुए उद्योगों की अनुसंधान एवं विकास आवश्यकताओं की पहचान हेतु तेजी से हस्तक्षेप करने के लिए एक नियमित प्रयास का पहल करना।





## Director's Message

It gives me great pleasure in presenting the CSIR-CMERI Annual report for the period 2021-22. CSIR-CMERI being the apex R&D Institute in India in the domain of Mechanical Engineering and allied fields, is the Frontline Organisation for addressing Industrial and Social concerns through apt and time-bound technology interventions. This Institution has had a glorious past as it has contributed tremendously towards the ushering in of the Green Revolution in India, by dedicating the indigenously developed Swaraj Tractor to the Nation. Subsequently, over the years CSIR-CMERI has evolved to be a State-of-the-Art Premier Research Laboratory in the domain of Mechanical Engineering and allied areas. The "Suri-Transmission" is a breakthrough in the domain of Engineering, has been a phenomenal and indispensable contribution of CSIR-CMERI. In the year 2021-22, CSIR-CMERI has contributed a lot to solve the burning problems of the industry as well as society.

The development of mechanized drain cleaning system is an important initiative has been taken to replace the manual scavenging involved in drainage cleaning. Taking another step towards creating a greener and pollution-free nation, CSIR-CMERI developed Solar PV energy based electric cooking system which can reduce the consumption of imported LPG, and significantly contribute to reducing carbon emissions. As a societal special contribution to tackle Covid-19 pandemic, CSIR-CMERI developed an Oxygen Enrichment Unit which is capable of providing normal as well as nasal high flow oxygen therapies. This technology has the capability to enrich blood-oxygen levels by extracting it from atmospheric air. CSIR-CMERI developed tele-operated mining robot for underground

coal mine applications. The robotic system is able to remotely monitor the environment of a hazardous mine tunnel from the mine manager's desk before starting any extraction. Apart from these, CSIR-CMERI was involved in developing various technologies which are beneficial to our society such as tractor operated iron ore dust collecting machine, tractor mounted sprayer for reduction of air pollution & system integration for spraying applications using multi-copter. On the applied research side, other significant activities are the development of a Mob Control Vehicle which is an important step towards mitigating the problems faced by CRPF, para-military forces of our country in handling large unruly gatherings.

During the period April 2021 – March 2022, around 107 SCI publications were made in peer-reviewed journals, 16 patents were filed and 4 patents granted in India. Five scientists were awarded PhD degrees from various institutions. As many as 25 skill development programmes and 14 online/webinar based training programmes in different domains were successfully organized. New linkages with academia and industry have been established through signing of a number of MOU and NDA. CSIR-CMERI achieved the Guinness World Record of designing and establishing World's Largest Solar Tree of capacity 53.6 kWp.

This Annual report summarizes in all aspects, the achievements and progress of the institute during the past one year. I take this opportunity to acknowledge the contributions made by our scientists, administrative and support staffs, students and project fellow, councils and stakeholders.

Dr. Naresh Chandra Murmu



## निदेशक का संदेश

मुझे सीएसआईआर-सीएमआईआरआई के वर्ष 2021-22 की अवधि का वार्षिक रिपोर्ट प्रस्तुत करते हुए अत्यंत प्रसन्नता हो रही है। सीएसआईआर-सीएमआईआरआई भारत में मैकेनिकल इंजीनियरिंग कार्य क्षेत्र और इससे संबद्ध अन्य क्षेत्रों में एक शीर्ष अनुसंधान व विकास संस्थान होने के नाते उपयुक्त और समयबद्ध प्रौद्योगिकी हस्तक्षेपों के माध्यम से औद्योगिक और सामाजिक सरोकारों व मामलों को निपटाने वाला एक फ्रंटलाइन संगठन है। इस संस्था का एक गौरवशाली अतीत रहा है क्योंकि इसने राष्ट्र को स्वदेशी रूप से विकसित स्वराज ट्रैक्टर समर्पित करके भारत में हरित क्रांति की शुरुआत करने की दिशा में जबरदस्त योगदान दिया है। इसके बाद पिछले कुछ वर्षों में सीएसआईआर-सीएमआईआरआई मैकेनिकल इंजीनियरिंग और संबद्ध क्षेत्रों के कार्यक्षेत्र में एक अत्याधुनिक प्रीमियर अनुसंधान प्रयोगशाला के रूप में विकसित हुआ है। इंजीनियरिंग के क्षेत्र में "सूरी-ट्रांसमिशन" एक महत्वपूर्ण सफलता है और इसके जरिए सीएसआईआर-सीएमआईआरआई ने इंजीनियरिंग के क्षेत्र में अभूतपूर्व एवं अति आवश्यक योगदान दिया है। वर्ष 2021-22 में सीएसआईआर-सीएमआईआरआई ने उद्योग के साथ-साथ समाज की ज्वलंत समस्याओं को हल करने में बहुत योगदान दिया है।

जल निकास नालियों की सफाई में हाथ से गंदगी हटाने की प्रथा को बदलने के लिए मैकेनाइज्ड ड्रेन क्लीनिंग सिस्टम का विकास एक महत्वपूर्ण पहल है। हरित और प्रदूषण मुक्त राष्ट्र बनाने की दिशा में एक और कदम उठाते हुए सीएसआईआर-सीएमआईआरआई ने सोलर पीवी ऊर्जा आधारित इलेक्ट्रिक कुकिंग सिस्टम विकसित किया है जो आयातित एलपीजी की खपत को कम कर सकता है और कार्बन उत्सर्जन को कम करने में महत्वपूर्ण योगदान दे सकता है। कोविड-19 महामारी से निपटने के लिए एक विशेष सामाजिक योगदान के रूप में सीएसआईआर-सीएमआईआरआई ने एक ऑक्सीजन संवर्धन इकाई विकसित की है जो सामान्य पद्धति के अलावा नाक के जरिए उच्च प्रवाह ऑक्सीजन पद्धति के माध्यम से उपचार प्रदान करने में सक्षम है। इस तकनीक में वायुमंडलीय हवा से ऑक्सीजन छानकर रक्त-ऑक्सीजन के स्तर को समृद्ध करने की क्षमता है। सीएसआईआर-

सीएमआईआरआई ने भूमिगत कोयला खदान में अनुप्रयोगों के लिए टेली-ओपरेटेड माइनिंग रोबोट विकसित किया है। कोई भी निकासी कार्य शुरू करने से पहले खदान प्रबंधक के डेस्क से एक खतरनाक खदान सुरंग के पर्यावरण की निगरानी दूर से ही करने में रोबोटिक सिस्टम सक्षम रहा है। इनके अलावा सीएसआईआर-सीएमआईआरआई कुछ ऐसे विभिन्न तकनीकों को विकसित करने में शामिल हुआ है जो हमारे समाज के लिए फायदेमंद रहे हैं, जैसे ट्रैक्टर संचालित लोह अयस्क धूल संग्रह मशीन, वायु प्रदूषण को कम करने के लिए ट्रैक्टर माउंटेड स्प्रेयर और मल्टी-कॉप्टर के उपयोग से छिड़काव अनुप्रयोगों के लिए सिस्टम इंटीग्रेशन। अनुप्रयुक्त अनुसंधान पक्ष की अन्य महत्वपूर्ण गतिविधियों के अंतर्गत एक भीड़ नियंत्रण वाहन का विकास किया गया है जो अनियंत्रित बड़ी सभाओं को संभालने में हमारे देश के सीआरपीएफ, अर्ध-सैन्य बलों द्वारा सामना की जाने वाली समस्याओं को कम करने की दिशा में एक महत्वपूर्ण कदम है।

अप्रैल 2021 - मार्च 2022 की अवधि के दौरान सहकर्मि-समीक्षित पत्रिकाओं में लगभग 107 एससीआई प्रकाशित किए गए, 16 पेटेंट दायर किए गए और भारत में 4 पेटेंट प्रदान किए गए। विभिन्न संस्थानों द्वारा पांच वैज्ञानिकों को पीएचडी की उपाधि से सम्मानित किया गया। विभिन्न क्षेत्रों में 25 कौशल विकास कार्यक्रम और 14 ऑनलाइन/वेबिनार आधारित प्रशिक्षण कार्यक्रम सफलतापूर्वक आयोजित किए गए। कई एमओयू और एनडीए पर हस्ताक्षर करके शिक्षा और उद्योग के क्षेत्र में नए संबंध स्थापित किए गए हैं। सीएसआईआर-सीएमआईआरआई ने 53.6 kWp क्षमता वाले विश्व के सबसे बड़े सौर वृक्ष को डिजाइन करने और स्थापित करने का गिनीज वर्ल्ड रिकॉर्ड हासिल किया।

यह वार्षिक रिपोर्ट सभी पहलुओं, संस्थान के पिछले एक वर्ष की उपलब्धियों और प्रगति का सार प्रस्तुत करती है। मैं इस अवसर पर अपने वैज्ञानिकों, प्रशासनिक और सहायक कर्मचारियों, छात्रों व प्रोजेक्ट फेलो, परिषदों और हितधारकों द्वारा किए गए योगदान को स्वीकार करता हूँ।

डॉ नरेश चन्द्र मुर्मू



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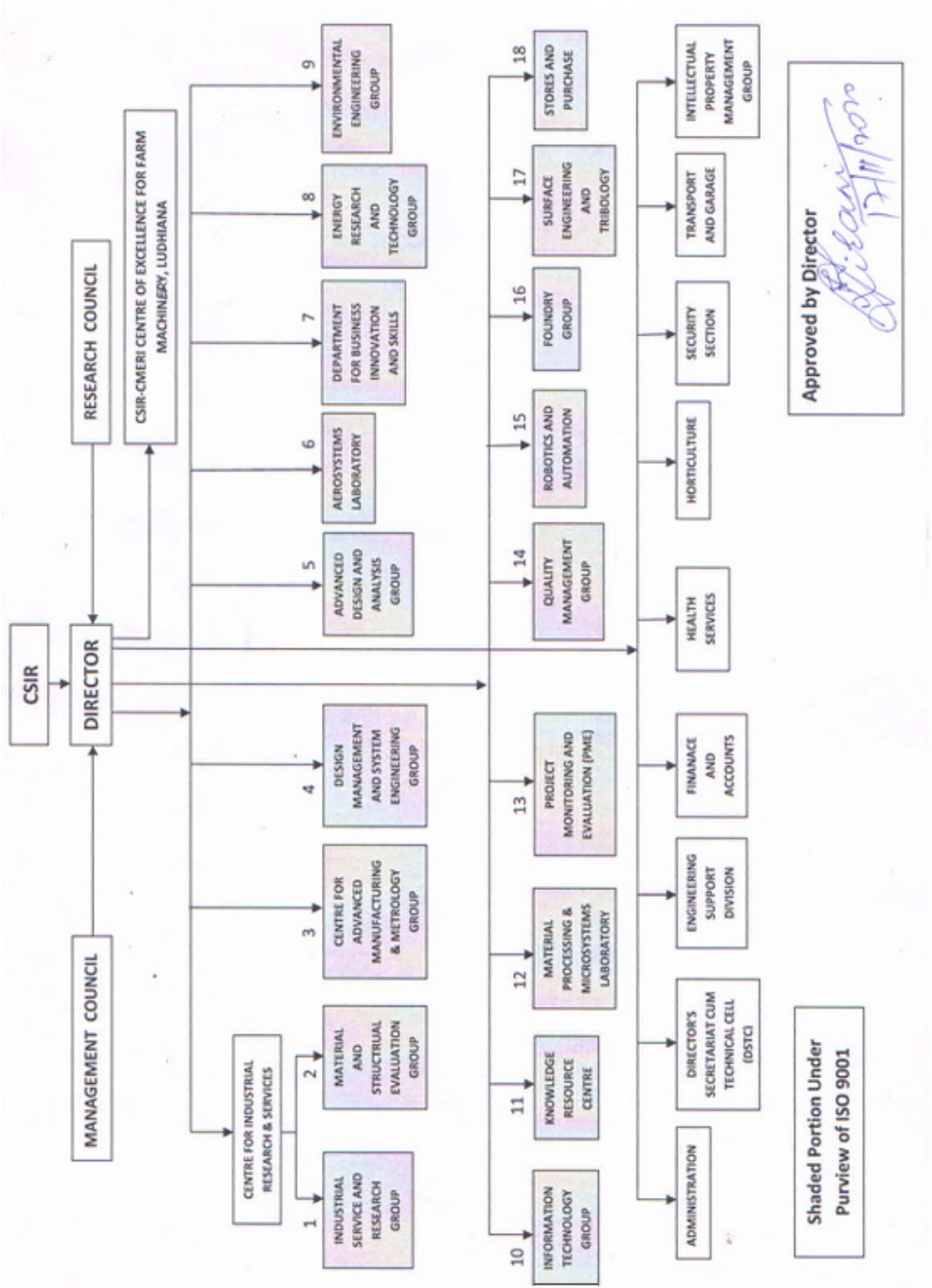
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Organization Chart (संगठन चार्ट)

CSIR-CMERI ORGANIZATION CHART





## Research Council (As on 31.03.2022)

	अध्यक्ष Chairman	<b>प्रो. एम एस उन्नीकृष्णन</b> थर्मैक्स/भारतीय प्रौद्योगिकी संस्थान पवई, मुंबई	<b>Prof. M S Unnikrishnan</b> Thermax/Indian Institute of Technology Powai, Mumbai
	सीएसआईआर मुख्यालय आमंत्रित CSIR Hqrs. Invitee	<b>श्री अनोज कुमार चदर</b> प्रधान वैज्ञानिक महानिदेशक कार्यपालक निदेशालय वैज्ञानिक और औद्योगिक अनुसंधान परिषद रफी मार्ग, नई दिल्ली - 110001	<b>Shri Anoj Kumar Chadar</b> Principal Scientist Director General Executive Directorate Council of Scientific and Industrial Research Rafi Marg, New Delhi – 110001
	सदस्य Member	प्रो. बी के मिश्रा निदेशक भारतीय प्रौद्योगिकी संस्थान फार्मगुडी, पोंडा- 403401, गोवा	<b>Prof. B K Mishra</b> Director Indian Institute of Technology Farmgudi, Ponda- 403401, Goa
	सदस्य Member	प्रो. अविनाश अग्रवाल यांत्रिक इंजीनियरिंग विभाग भारतीय प्रौद्योगिकी संस्थान, कल्याणपुर कानपुर- 208016	<b>Prof. Avinash Agarwal</b> Department of Mechanical Engineering Indian Institute of Technology, Kalyanpur Kanpur- 208016
	सदस्य Member	डॉ. सुमन चक्रवर्ती यांत्रिक इंजीनियरिंग विभाग भारतीय प्रौद्योगिकी संस्थान खड़गपुर- 721302	<b>Dr. Suman Chakraborty</b> Department of Mechanical Engineering Indian Institute of Technology Kharagpur- 721302
	सदस्य Member	डॉ. श्रीनिवासन दुरईस्वामी उपाध्यक्ष, प्रमुख, नई प्रौद्योगिकी व्यवसाय विकास रिलायंस कॉर्पोरेट, पार्क बिल्डिंग नंबर - 8, ए विंग, पहली मंजिल, सीए -35 ठाणे बेलापुर रोड, घनसोली, नवी मुंबई - 400701	<b>Dr. Srinivasan Duraiswamy</b> Vice- President, Head New Technology Business Development Reliance Corporate, Park Building No – 8, A wing, 1st Floor CA-35 Thane Belapur Road, Ghansoli, Navi Mumbai – 400701

	सदस्य Member	डॉ. लिपिका डे प्रधान वैज्ञानिक टाटा कंसल्टेंसी सर्विसेज नई दिल्ली	<b>Dr. Lipika Dey</b> Principal Scientist Tata Consultancy Services New Delhi
	एजेंसी प्रतिनिधि Agency Representative	डॉ. देबासिस चक्रवर्ती निदेशक प्रणोदन प्रौद्योगिकी केंद्र (DRDO) भारतीय प्रौद्योगिकी संस्थान मुंबई मुंबई	<b>Dr. Debasis Chakraborty</b> Director Centre of Propulsion Technology (DRDO) IITB, Mumbai
	महानिदेशक की नामिती DG's Nominee	डॉ. लीना वछानि सह - आचार्य सिस्टम और नियंत्रण इंजीनियरिंग विभाग भारतीय प्रौद्योगिकी संस्थान बॉम्बे पवई, मुंबई - 400076	<b>Dr. Leena Vachhani</b> Associate Professor Department of Systems and Control Engineering Indian Institute of Technology Bombay Powai, Mumbai – 400076
	सिस्टर प्रयोगशाला Sister Laboratory	डॉ. एन. कलाइसेल्वी निदेशक सीएसआईआर-केंद्रीय विदुत रासायनिक अनुसंधान संस्थान, सीईसीआरआई कराईकुडी - 623006	<b>Dr. N. Kalaiselvi</b> Director CSIR-Central Electrochemical Research Institute, CECRI Karaikudi – 623006
	सदस्य Member	डॉ. सुमन कुमारी मिश्रा निदेशक सीएसआईआर-केंद्रीय यांत्रिक इंजीनियरिंग अनुसंधान संस्थान महात्मा गांधी एवेन्यू दुर्गापुर - 713209	<b>Dr. Suman Kumari Mishra</b> Director CSIR-Central Mechanical Engineering Research Institute Mahatma Gandhi Avenue Durgapur – 713209
	सचिव Secretary	डॉ. एस.आर. देबबर्मा सीएसआईआर-सीएमईआरआई, दुर्गापुर	<b>Dr. S.R. Debbarma</b> CSIR-CMERI, Durgapur



# CSIR-CMERI

## Management Council

(As on 31.03.2022)

<b>Chairman</b> Prof. (Dr.) Suman Kumari Mishra, Director, CSIR-CMERI, Durgapur	<b>अध्यक्ष</b> प्रो. (डॉ.) सुमन कुमारी मिश्रा, निदेशक, सीएसआईआर-सीएमईआरआई, दुर्गापुर
<b>Member</b> Dr. Anjali Chatterjee, Chief Scientist, Business Innovation & Skills Dr. Biswajit Ruj, Chief Scientist Dr. Arpita Mukherjee, Principal Scientist Dr. Binod Kumar Saha, Principal Scientist Dr. Ishita Sarkar, Scientist Shri Pranabendu Saha, Sr. Technical Officer (3) Mr. Parag Patar, Controller of Finance & Accounts	<b>सदस्य</b> डॉ. अंजलि चटर्जी, मुख्य वैज्ञानिक, व्यवसाय नवाचार और कौशल डॉ. विश्वजीत रुज, मुख्य वैज्ञानिक डॉ अर्पिता मुखर्जी, प्रधान वैज्ञानिक डॉ. बिनोद कुमार साहा, प्रधान वैज्ञानिक डॉ. इशिता सरकार, वैज्ञानिक श्री प्रणबेंदु साहा, वरिष्ठ तकनीकी अधिकारी (3) श्री पराग पातर, वित्त और लेखा नियंत्रक
<b>Member-Secretary</b> Mr. Vinod Kumar, Controller of Administration	<b>सदस्य सचिव</b> श्री विनोद कुमार, प्रशासन नियंत्रक

## Year at a Glance

a.	PhD Awarded	: 05
b.	Patent Filed and granted	: 20
c.	SCI Publications	: 107
d.	External Project Initiated	: 19
e.	Major Events Organized	: 39
f.	External Cash Flow (Rs. in Crores)	: 16.11 (approx.)
g.	Human Resources (As on 31.03.2022)	: 333

## संपूर्ण वर्ष पर एक नजर

क.	पीएचडी से सम्मानित	: 05
ख.	पेटेंट फाइल किया गया और प्रदान किया गया	: 20
ग.	एससीआई प्रकाशन	: 107
घ.	शुरू की हुई बाहरी परियोजनाएँ	: 19
ङ	आयोजित प्रमुख कार्यक्रम	: 39
च.	वाह्य कैश फ्लो (करोड़ रुपये में)	: 16.11 (लगभग)
छ.	मानव संसाधन (31.03.2022 तक)	: 333

## R&D Profile

The R&D profile of CSIR-CMERI is spread across thirteen interconnected research groups.

a.	Advanced Design and Analysis Group
b.	Aerosystems Laboratory
c.	Centre for Advanced Manufacturing and Metrology Group
d.	Centre for Industrial Research & Services
e.	CMERI Centre of Excellance for Farm Machinery
f.	Design Management and System Engineering Group
g.	Energy Research and Technology Group
h.	Environmental Engineering Group
i.	Foundry Group
j.	Information Technology
k.	Materials Processing and Microsystems Laboratory
l.	Robotics and Automation
m.	Surface Engineering and Tribology

## अनुसंधान एवं विकास प्रोफाइल

सीएसआईआर-सीएमईआरआई का अनुसंधान एवं विकास प्रोफाइल तेरह परस्पर जुड़े अनुसंधान समूहों में विस्तृत किया गया है।

क.	उन्नत डिजाइन और विश्लेषण समूह
ख.	एरोसिस्टम्स प्रयोगशाला
ग.	उन्नत विनिर्माण एवं मेट्रोलॉजी समूह केंद्र
घ.	औद्योगिक अनुसंधान और सेवा केंद्र
च.	सीएसआईआर-सीएमईआरआई फार्म मशीनरी उत्कृष्टता केंद्र
छ.	डिजाइन प्रबंधन एवं सिस्टम इंजीनियरिंग समूह
ज.	ऊर्जा अनुसंधान एवं प्रौद्योगिकी समूह
झ.	पर्यावरण इंजीनियरिंग समूह
ट.	फाउंड्री ग्रुप
ठ.	सूचना प्रौद्योगिकी
ड.	सामग्री प्रसंस्करण और माइक्रोसिस्टम्स प्रयोगशाला
ढ.	रोबोटिक्स एवं स्वचालन
त.	सतह इंजीनियरिंग और ट्राइबोलॉजी



## उन्नत डिजाइन और विश्लेषण समूह

## Advanced Design and Analysis Group

## Introduction:

The 'Advanced Design and Analysis Group (ADAG)' at CSIR-CMERI is involved in the areas of Design and Analysis that integrate science, to the understanding of mechanical systems and the design process, including the development of applications meeting industrial, societal and strategic needs. The capabilities and experience of the group include but are not limited to: Aerospace, Automotive, Biomedical and Bioengineering, Mechanical and Agriculture, Manufacturing, Chemical and Renewable Energy. The group has extensive experience in a wide range of industrial and research projects and has worked with several National and International R&D organizations, Academic and Industrial partners to deliver successful results as per the mission and mandate of the Laboratory.

The group has significant exposure to Engineering Design, Computer-Aided Design (CAD), Multibody Dynamics, Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA). The team has successfully completed several

sponsored and industrial projects in recent past in the specified areas.

The Group has the following recent activities:

- ▶ Design of Beam Stoppers for Super-FRS in FAIR project
- ▶ Design and Analysis of 60 & 81 mm light weight advanced mortar system,
- ▶ Design and development of force reflecting hand exoskeleton (haptic device) for application in remote handling in defence,
- ▶ Development of actuated exoskeleton-based rehabilitation device for hand function impairment (AEROH),
- ▶ Integration of Multi-copter with Mine Protected Vehicle (MPV) for geo-terrain mapping operations,
- ▶ CSIR-MIDI (Metal Industry Development Institute, Ethiopia) Twinning Program

## Activities in Detail:

### 1. Design of Beam Stoppers for FAIR Project [Project No: GAP 098212, Sponsored by: BI-IFCC, Kolkata, DST-DAE, Status: Ongoing]

The Facility for Antiproton and Ion Research (FAIR) international particle accelerator is being built at GSI (Helmholtzzentrum für Schwerionenforschung), Darmstadt (Hesse), Germany and is set to be one of the largest research facilities for basic research in physics worldwide. On October 4, 2010 the FAIR GmbH was founded by an international treaty with overall project cost estimated in the order of 1,357 million Euros (price level of 2005) by participating countries (<http://www.fair-center.eu>) which will be realized in stages. The Republic of India also signed the treaty, being the third largest shareholder in this international mega science project with Bose Institute (BI) as the shareholding institute in India. India's contribution to the FAIR construction to be 36 million Euro (in-kind). Since the programme has got global multi-institutional character, immense magnitude, multi-agency funding, international obligations involving multitude of tasks, an MOU was signed between CSIR-CMERI and Indo-FAIR Coordination Center (IFCC) on 22nd July 2014 for Design of Beam Stoppers as one of the critical in-kind contribution from India [<http://www.fair-center.eu/partners/in-india.html>].

Beam Stoppers (synonymously used for beam dumps or beam catchers in this context) are primarily energy intercepting and dissipating devices. They are widely used for intercepting beams of various energy levels, starting from laser to very high energy accelerators beams like electron/positron beam, proton/antiproton beam, ion beam etc. In high energy heavy-ion accelerators, the beam energy is of the order of GeV (1000 million electron volts). When this high energy beam is stopped in beam-dumps, a thermal shock wave is created in a very short time ( $\approx 10^{-12}$  sec). This shock wave may explode the beam stoppers, if heat is not quickly dissipated within the short time span. The primary technological challenges are to distribute the huge thermal gradient compounded by thermal shockwaves and material irradiation damage. In addition to that, downstream ion-optical systems are protected from radiation damage.

#### Current status:

The CSIR-CMERI project team worked in close coordination with Super-FRS Group at GSI, Darmstadt, Germany in the

Design of Beam Stoppers for Super-FRS in FAIR project. Two important milestone in the Design Phase of the project, namely, (I) Conceptual Design Review (CDR) and (II) Final Design Review (FDR) of the Beam stoppers BC1, BC2 and BC3 has been successfully completed and approved by FAIR. Currently, manufacturing of such high-power beam stoppers in India with suitable Institute-Industry collaboration has been initiated by BI-IFCC (Bose Institute- Indo Fair Coordination

Center, Kolkata) to achieve this very challenging activity in the project. Some of the Indian manufacturers have shown keen interest in this technology. Once the manufacturers get empowered and confident with this technology, they can compete with global manufacturers in this field to cater the requirements of high-power beam dumps for Global Mega Science projects funded by several countries.

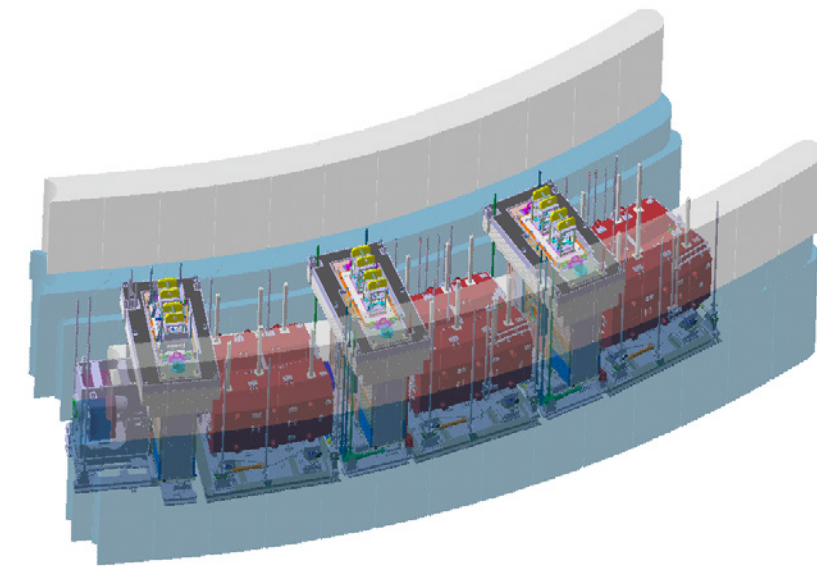


Fig. Designed Position of Beam Stoppers (BC1, BC2 and BC3) in Super- FRS Tunnel at FAIR (status as on May 2022)

### 2. Design and development of force reflecting hand exoskeleton (haptic device) for application in remote handling in defence [Project No: GAP 225512, Sponsored by: JCBCAT-DRDO, Kolkata, Status: Ongoing]

**Objective:** Development of technology for a wearable hand exoskeleton with force feedback (haptic master device) and motion sensing for application in force feedback aided dexterous remote handling to assist soldiers.

**Deliverable:** Experimental prototype of a wearable hand exoskeleton (haptic master device) with motion sensing and force feedback.

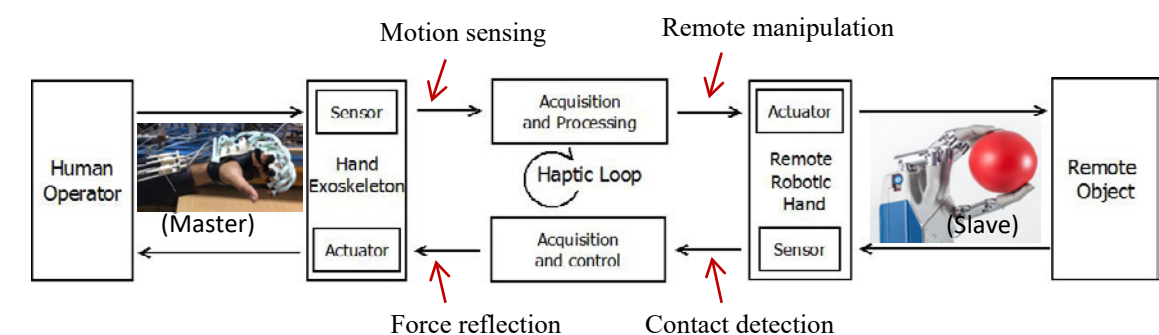


Fig. Proposed Scheme: Force feedback loop in remote handling



The project deals with design and development of an actuator assisted hand exoskeleton with force feedback for application in remote handling through master-slave interaction. The user uses a master device (a dexterous force reflecting device, an exoskeleton with motion sensing and actuation) connected through a data link with remote/slave manipulator (a remote manipulation device, e.g. a robotic hand with sensors and actuators) which interacts directly with remote objects. The proposed methodology is as follows:

- ▶ **Development of hand exoskeleton (Master)**
  - ▶ Modelling of finger kinematics and dynamics in grasping
  - ▶ Redundant degrees of freedom for varying joint stiffness's
- ▶ **Motion sensing and transfer of motion on remote robotic hand (Slave)**
  - ▶ Incorporating hand motion sensing in the exoskeleton
  - ▶ Transfer of motion on remote robotic hand (Slave) with feedback

3. Development of actuated exoskeleton-based rehabilitation device for hand function impairment (AEROH) [Project No: HCP 026, CSIR Mission Mode Project on “Medical Instruments & Devices”, Status: Ongoing]

**Objective:** Design and development of wearable exoskeleton based therapeutic device for rehabilitation of functional impairments in human hand.

**Deliverable:** Working prototype of actuated, wearable hand exoskeleton-based hand rehabilitation device.

Loss of hand motor function is a major source of disability in stroke survivors which may become permanent if rehabilitation is not successfully completed. The current trend of rehabilitation therapy is conventional which include highly repetitive motion exercises by the patient, performed or assisted by physiotherapists. This is monotonic and cumbersome. Further, in such methods of therapy the key recovery parameters such as active and passive range of motion of fingers, residual strength etc. are not quantitatively measured and recorded. Additionally, conditions such as flexor hypertonia cause inability to open the hand to grasp and release the objects which is a major hiatus in its performing repetitive, task-oriented exercises. The present prototype can

- ▶ **Contact detection and force sensing at remote robotic hand manipulator during grasping**
  - ▶ Incorporating motion/force sensors at robotic hand to detect contact with objects during grasping
- ▶ **Force Reflection on hand exoskeleton**
  - ▶ Developing smart actuation module for hand exoskeleton (Master) with Force Reflection.

Current Status:

The detail design and subsequent experimental prototype development of the wearable hand exoskeleton and the actuator module has been completed. Also, hand motion sensing and integration with exoskeleton has been done. The testing of the actuator module, sensor data analysis and control module development, procurement of slave hand are in progress

assist to overcome such issues whose salient features are as follows:

- ▶ Quantitative measurement of active and passive Range of Motion & voluntary force exertion capacity of each of the fingers.
- ▶ Logging of measured data to show the progress in recovery.
- ▶ Bio-Feedback through real-time graphical display of finger motion data.
- ▶ Finger motion assistance using actuators to perform assisted motion cum resistance strengthening exercises.
- ▶ Independent actuation of each finger.
- ▶ Reduced level of involvement from physiotherapists.
- ▶ Quantitative data to enable physiotherapists to perform scientific scrutiny of recovery.

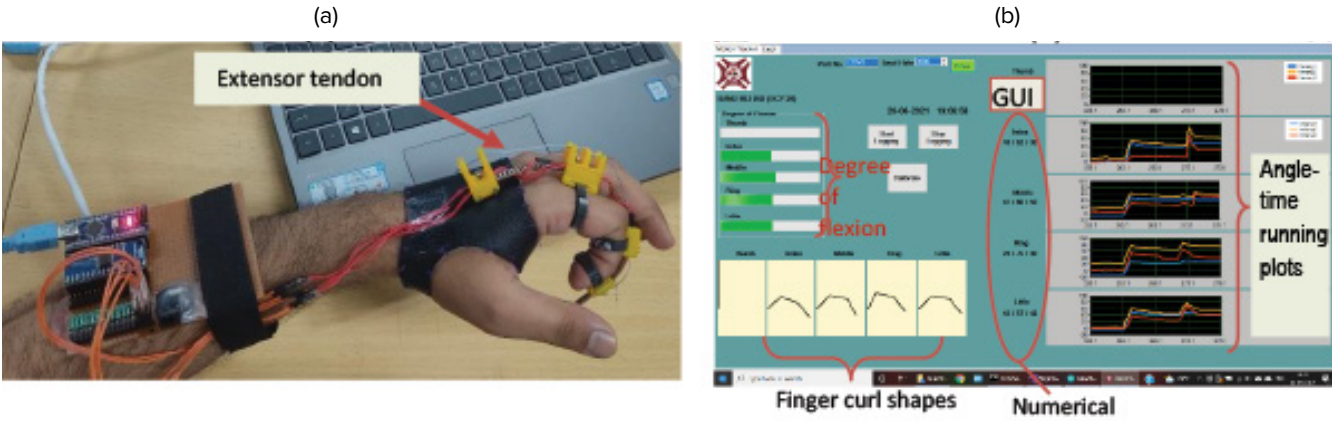


Fig. In house developed (a) finger motion sensing mechanism and (b) real time graphical display of finger motion

**Current Status:** Design and development of hand exoskeleton for real-time motion sensing has been completed while force sensing is in progress. Actuator module and controller development are also in progress

4. Analysis of the interior ballistic processes and external aerodynamics of a guided projectile system [Project No: GAP 23532, Sponsored by Science and Engineering Research Board, DST, Status: Ongoing]

**Objective:** This project aims to develop a three dimensional comprehensive computational model to simulate the transient interior ballistic processes and the external aerodynamics of a guided projectile system.

The projectile system consists of several parts including an ignition cartridge with a primer and a flash tube, propellant charge increments, the projectile body, and the guide tube (barrel). The present work will address the flame spreading and combustion processes along with pressurization process, and wave propagation in some parts of the projectile system. The modeling and simulation of the interior ballistic processes

involve an empirical flash tube sub-model, a mobile granular bed combustion sub-model, a sub-model to determine flame spreading rate instantaneous gas-phase and condense-phase properties along the granular bed inside the tail boom, including pressure, temperature, density, velocity, propellant burn rate, propellant surface temperature, intragranular stress, etc., a 3D combustion sub-model and a projectile dynamics sub-model. Finally, an integration of the above sub models will perform to obtain a complete 3D projectile model. The analysis and the modeling will help in design modifications and improvement of the system performance.

5. Project Title&No: Integration of Multi-copter with Mine Protected Vehicle (MPV) for Geo-Terrain Mapping Operations [Project No: SSP 229112, Sponsored by Ordnance Factory, Medak (OFMK), Status: Completed]

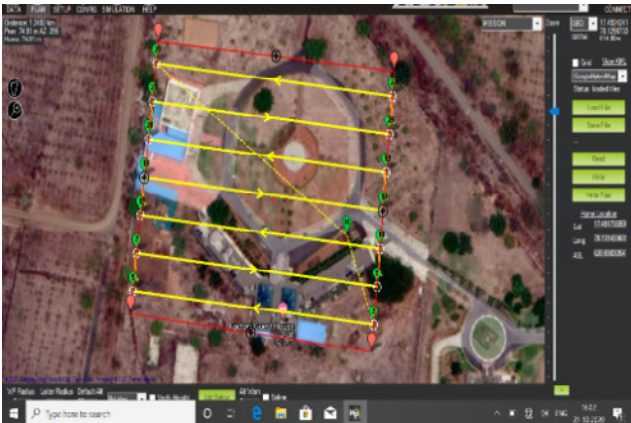
**Objective:** Integration of one multi-copter with Mine Protected Vehicle (MPV) for Geo-Terrain Mapping Applications as proof of the concept demonstration at Defense Expo scheduled on Feb-2020.

Deliverables achieved:

1. Multi-copter equipped with necessary sensor and other accessory materials on returnable basis for demonstration at Defense Expo, 2020
2. One rugged Tablet with installed Geo Terrain mapping and other software procured from equipment Head of the

- project is handed over to OFMK on non-returnable basis
3. Integration of the multi-copter with MPV at OFMK
  4. Demonstration of Mission Planning and execution of the same at OFMK
  5. Demonstration of multi-copter take-off from MPV and landing on the ground in clear LOS of the pilot from within the MPV at OFMK
  6. Imagery and 3D terrain map generation
  7. Two weeks training at OFMK on development of multi-copter flying skills





Mission Planning at OFMK FTH Guest House



Ortho-mosaic Image of the OFMK FTH Guest House



Demonstration at Defense-Expo 2020



Training on multi-copter flying skill at OFMK

6. Project Title: Design and Development working prototype of small oil free air compressor for portable oxygen concentrator [Project No: GAP 237712, Sponsored by Science and Engineering Research Board, DST, Status: Ongoing]

**Objective:** The indigenous design of the oil free compressor for the medical application.

The medical application of compressed air needs to be oil free. The oil free pressurized air is indispensable for generation of concentrated oxygen. The concentrated oxygen from the oxygen concentrator has a huge usage in the

hospitals specially for treating respiratory problem patients. The central equipment of the oxygen concentrator is the small oil free reciprocating compressor. The oil-free air compressor for medical application is very critical because of design and development of sliding components of the reciprocating compressor considering the wear of the components.

7. Project Title: Design and Analysis of Advanced Mortar System

WP-1: Design and Analysis of a 60 mm Lightweight Advanced Mortar System [Project No: SSP 233112, Sponsored by Gun & Shell Factory, Cossipore, Kolkata-700002, Status: Ongoing]

**Objective:** Design of a 60 mm commando version (lightweight infantry mortars designed for maximum portability and rapid deployment) mortar system as per the 2nd draft GSQR of DG of Infantry dated 5th April, 2019.

It is related to design and analysis of a compact and light weight 60 mm Mortar system, which is a high angle fire weapon with desired effect on target used for close-in-support of Special Forces troop. The mortar desired is a commando version for

use of Special Forces operatives. The system design should comply the specification and requirement laid out in the 2nd draft GSQR of DG of Infantry dated 5th April, 2019. The system design is divided mainly into two major tasks - Analysis and design optimization of 60mm mortar bomb and Design and analysis of the 60 mm mortar system including the mortar barrel, breech block, firing mechanism, terrain based base plate etc.

WP-2: Design and Analysis of Long range version of 81 mm Advanced Mortar System [Project No: SSP 235612, Sponsored by Gun & Shell Factory, Cossipore, Kolkata-700002, Status: Ongoing]

**Objective:** Design and Analysis of Long Range version of 81 mm Advanced Mortar system” as per the Letter no. 86759/81 mm Mor/ Inf-10 dated 01.01.2021 from the OO DG of Infantry

Presently 81 mm Mortar System is in production at GSF, having range of 5000 m and weight of 40 Kg. Now, DG Infantry requires, as per the Letter no. 86759/81 mm Mor/ Inf-10 dated 01.01.2021, a 81 mm mortar system with extended range

upto 8000 m but having reduced weight. There are some reported 81 mm advanced Mortar systems, developed by the organisations at the Foreign Countries, like Hirtenberger UK, BAE Systems, USA, Elbit Systems, Israel etc. The main purpose of present activity is import substitution and mandate of CSIR-CMERI is R&D directed towards indigenous technology development. The main assigned responsibility to CSIR-CMERI is Design, Analysis and optimization

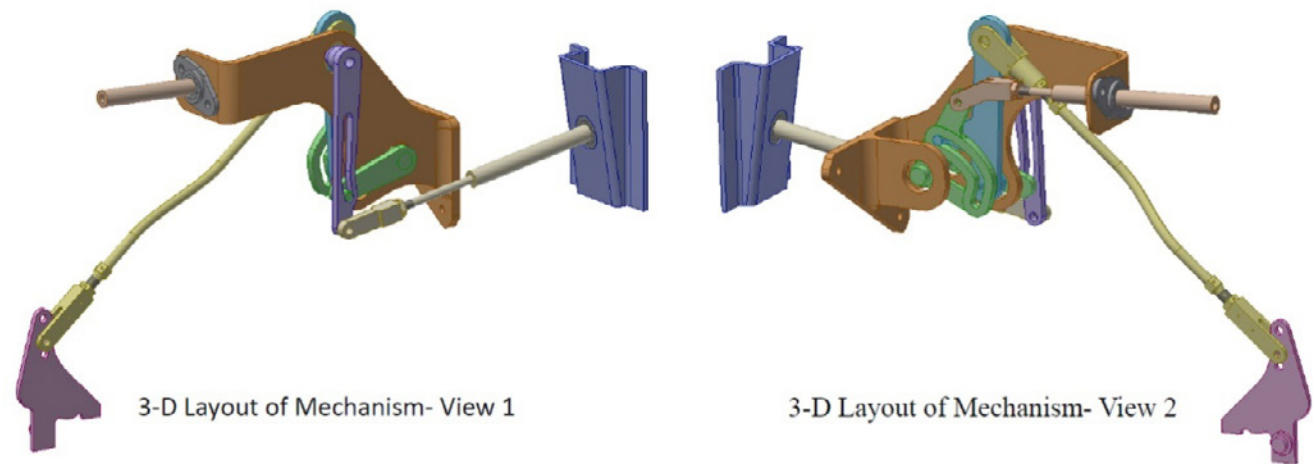




Aerosystems Laboratory (ASL) Group is actively involved in interdisciplinary research and development activities in products development such as valves, gear trains, power transmission and control sub-systems for aircraft and road vehicles, electrical motors, and controllers for Electric Vehicles (EV) besides technical support to a wide variety of industries and strategic sectors. It has expertise in pneumatic and hydraulic systems design, heat transfer enhancement from systems, Analysis of mechanical components & systems through CFD and experiment, and analytical methods, non-linear transient dynamic analysis of structures, high and low cycle fatigue, vibration analysis of structural components,

system engineering, vehicle integration and dynamics, vehicle system design (CVT, Gearbox, etc.), oxygen generation through pressure swing adsorption, modal-based dynamic analysis of structures, fluid-structure interaction (FSI), vortex-induced vibration, the aerodynamics of bluff bodies, drag reduction, experimental aerodynamics, turbulence, shock/blast wave attenuation, and mitigation, aeroacoustics, design of power converter and robust control, electromagnetics modelling of traction motors, design, modelling, and controls of power converters, process automation, and control, algorithm development, hardware design of robotic systems, system interfacing, DAC system development, etc.

Proposed Design of Two Lever Mechanism: Iteration no:3



- This proposed two lever mechanism is designed with sufficient clearance from all the geometric envelopes
- Overhang in the mounting bracket is reduced by 14mm
- Intermediate lever and box cam lever is merged to single component for compactness
- FCL coupler link is redesigned to avoid interference with fuel bleed line
- As earlier, cam profile has been made smooth, having single radius of curvature, for entire FCU lever movement and also a slotted link mechanism transfers motion to CSU lever from the same intermediate lever
- Four discrete positions of CSU lever have been achieved with the help of above single linear slotted link mechanism.

Fig. 1: Proposed design of two lever mechanism

A team from ASL has taken up a challenge from CSIR-NAL for the Design, Development, and Supply of Two Lever Throttle Quadrant Box and associated linkage mechanism for SARAS MK II aircraft (Fig. 1). A complete 3D model with detailed engineering drawings has to be prepared for the developed mechanism and tested through various analytical, numerical and experimental techniques. CSIR-CMERI will be responsible for complete design and analysis, development of mock-up, PDR, CDR, Test Plan, Fabrication of prototype using airworthy material, and ground testing. The design of the linkage mechanism has reached the final stage and the engine test is also completed successfully at CSIR-NAL.

The ASL group has designed, developed, and tested an Anti-Pilfer Self-Closing Valve (APSCV) by modifying the existing Self-Closing-Valve (SCV) with a 25.6 mm outlet collar diameter and fitted in LPG Cylinders. The SCV in circulation under the public distribution system of the Government Oil Companies has a drawback which allows the removal of fuel in liquid form when the cylinder is tilted upside-down. This creates non-uniform fuel weight distribution to customers by

either accidental leakage or theft. M/s. Hindustan Petroleum Company Ltd, Mumbai has approached CSIR-CMERI for designing/modifying the existing valve to prevent the removal of fuel in liquid form and it should operate with all existing current hardware systems for filling/emptying within a stipulated time.

It is a challenging task as the added component has to be designed in such a way that it should not affect the filling time in the plant, should totally support functioning of the domestic pressure regulator (DPR) with standard rated LPG vapour outflow, should prevent liquid outflow from the cylinder in all orientations such as inclined, horizontal & inverted with the valve in open condition, shall allow unrestricted withdrawal of vapour when the spindle pin is pressed under the normal operating conditions of filling and evacuation process at bottling plants, shall pass all the test requirements given in IS 8737, shall fit in the existing location on the cylinder, etc. (Fig. 2a). It is fabricated and tested to the satisfaction of HPCL and patenting is under progress.

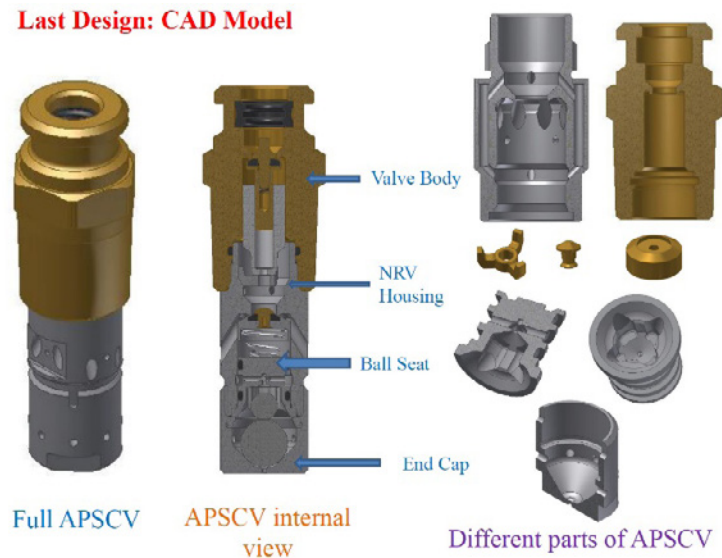


Fig. 2(a): Designed APSCV and its components (b) oxygen enrichment unit

The ASL group was actively involved in the development of various components and systems necessary to fight COVID19. Though mechanical ventilator was attempted initially to some degree of success, later the focus was shifted towards the development of oxygen concentrator. The studies on COVID-19 patients started revealing that most of the patients may be cured through Oxygen Therapy alone without needing ventilation. CSIR-CMERI tuned its research towards developing an Oxygen Enrichment Unit, which is capable of providing

Normal as well as Nasal High Flow (NHF) Oxygen Therapies. The majority of hospitals do not have an oxygen plant and relied on oxygen cylinders which were often unavailable. This innovation has the capability to enrich oxygen levels in atmospheric air. The size and weight of this innovation are such that multiple units can easily be transported to remote areas, providing healthcare to people who may not have an option to access it without traveling to faraway cities. This technology was transferred to 13 companies across India.



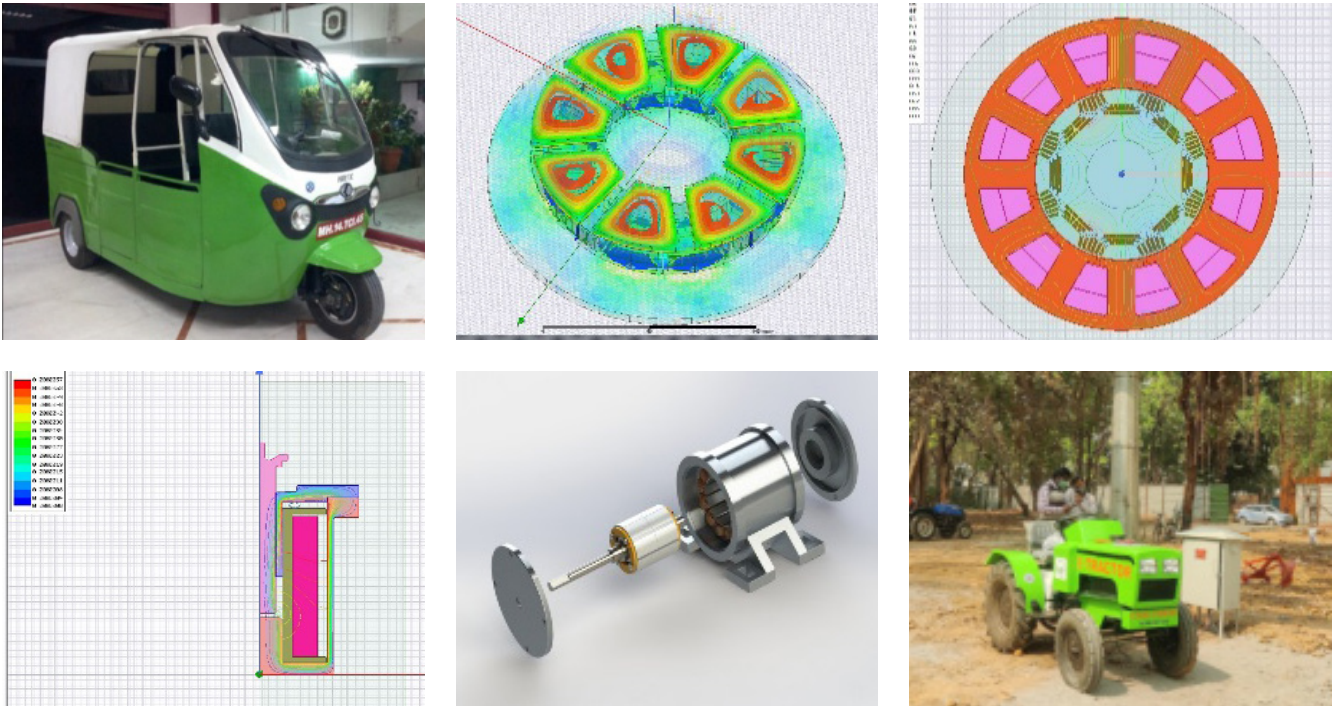


Fig. 3(a) Scaled down model of FGD plant (b) Collection of samples for measuring gypsum concentration in the slurry.

Besides R & D, it is also providing technical services to industries, and strategic sectors. The Honourable Supreme Court directed the Central Pollution Control Board (CPCB) to fix environmental norms for NO<sub>x</sub> and SO<sub>x</sub> emissions for coal-fired thermal power plants. L&T Power Vadodara fetched orders from NTPC & DVC to install FGD plants to limit the emission of SO<sub>x</sub>. As the cost for constructing each plant would be in the order of a few billion, L & T power was interested to test the performance of the FGD plants through a few scaled-down models. ASL fabricated different scaled-down models and examined their performance through measurements of vertical velocities at different stations (using particle image velocimetry), gypsum slurry concentration, and the angular velocity of agitators, and torque applied on the absorber tank (torque sensor). We have tested the performance of 7 FGD models and Fig. 3 shows a scaled-down model of one FGD system.

Recently, the ASL group is working on the Indigenous Design, Fabrication, and Demonstration of Type-IV Hydrogen Storage Tank, Safety Valves, and Leak detectors for the rated

pressure varying from 350 bar to 700 bar. The test rig will also be developed for testing the hydrogen safety valve. It is also working on sponsored projects from ARDB India on the aerodynamics characteristics of different variants of grid fins through wind tunnel testing. A team in ASL is also actively involved in the development of electric motor-based power trains for automotive applications. Furthermore, the team is also exploring the advanced driver assistance system (ADAS) techniques for Level-2 or more autonomous electric vehicles. This team has recently developed a 250W, radial flux, and axial flux BLDC motor for low-speed three-wheeler applications. The inclusion of permanent-magnet in the motor has several advantages viz-a-viz high power density, lower inertia, reduced rotor losses, fast dynamic response and improves efficiency. The design and analysis of the electric motor are carried out in the ANSYS MAXWELL platform. Manufacturing and fabrication of the motor, windings and sensor placement are being carried out in-house in CSIR-CMERI. The 250W BLDC motor drives are also designed and developed followed by its speed control algorithm implementation.



The team is also exploring the non-magnet motor technology i.e. Switched reluctance motor (SRM) which is attracting attention in the research community because of its various advantages. The six-phase asymmetrical bridge topology for SRM drives is developed and sensor-based control algorithms such as torque sharing function are being implemented on the MATLAB dSPACE platform. Small farmers comprise over 80% of cultivators in India. In the national market, there is no electric tractor available at low power of 10 to 12 HP. Indian market e-tractor charging demand electricity is indirectly dependent

on fossil fuels. Also, many areas of rural India are not having electricity lines, which becomes the major bottleneck for the deployment of e-tractor in that areas. Hence a renewable solar PV-based charging ecosystem along with the improved transmission system equipped e- tractor is being proposed for the small and marginal small farmers of India. The prototype of the above-mentioned ecosystem is being developed at CSIR CMERI, wherein the electric motor, drives selection, and implementation are carried out in CSIR-CMERI.





CSIR-CMERI

उन्नत विनिर्माण एवं मेट्रोलॉजी समूह केंद्र

Centre for Advanced Manufacturing and Metrology Group

Annual Report 2021-22

Activities/overview of department:

The department is central hub for manufacturing, Prototyping, and Metrology to serve all the scientists in various departments of CMERI.

CAMM is working on various R&D projects and technical support projects for Government bodies like DRDO, OFB,

S&T Departments, and Private Industries, majorly in Wire Arc Additive Manufacturing, Product Development, Die design & development, manufacturing of Critical Machining components, and Metrology.

Also, the NABL accredited Metrology lab is involved in various skill development programs and Instrumentation certification works for various Industry and Government bodies.

Prototype Development	Industrial Incubation service Center	Wire Arc Additive Manufacturing and 3D Printing	Metrology
<ul style="list-style-type: none"><li>• R &amp;D in Drive train application.</li><li>• Vehicle integrated system design and development</li><li>• Machine health diagnosis and prognosis through ML.</li><li>• Machine tool designs.</li><li>• Computational fluid dynamics of screw extrusion system.</li><li>• Agronomics and human factors in man machine Interaction.</li><li>• Electronic and computer application in farm machineries design.</li></ul> <ul style="list-style-type: none"><li>• Scientists - 5</li><li>• T.O. - 7</li><li>• Technician – 16</li></ul>	<ul style="list-style-type: none"><li>• Cater in-house R &amp;D Projects.</li><li>• Support to the Industry Incubations.</li><li>• CNC machining of complex geometry.</li><li>• Support to the Scientists of other Department for Prototype Design and Development .</li></ul> <ul style="list-style-type: none"><li>• Scientists - Nil</li><li>• T.O. - 4</li><li>• Technician – 3</li></ul>	<ul style="list-style-type: none"><li>• Metal additive manufacturing using Wire Arc Additive manufacturing technology (WAAM).</li><li>• Medium to large scale WAAM components of MILD steel, Stainless steel, Aluminium, Inconel, Titanium and other alloys.</li><li>• Refurbishment of existing parts for service life enhancement.</li></ul> <ul style="list-style-type: none"><li>• Scientists - 02</li><li>• T.O. - 01</li><li>• Technician – Nil</li></ul>	<ul style="list-style-type: none"><li>• Dimensioning of Critical and Miniature Components.</li><li>• Performance Evaluation of CNC Machines by Laser Interferometer</li><li>• Calibration of</li><li>• Measuring Equipment and Gauges</li><li>• Knowledge dissemination through on job training</li></ul> <ul style="list-style-type: none"><li>• Scientists - Nil</li><li>• T.O. - 03</li><li>• Technician – 01</li></ul>

Objectives of department:

Projects: The major projects

In the FY 2021-22 CAMM involved in the following major projects:

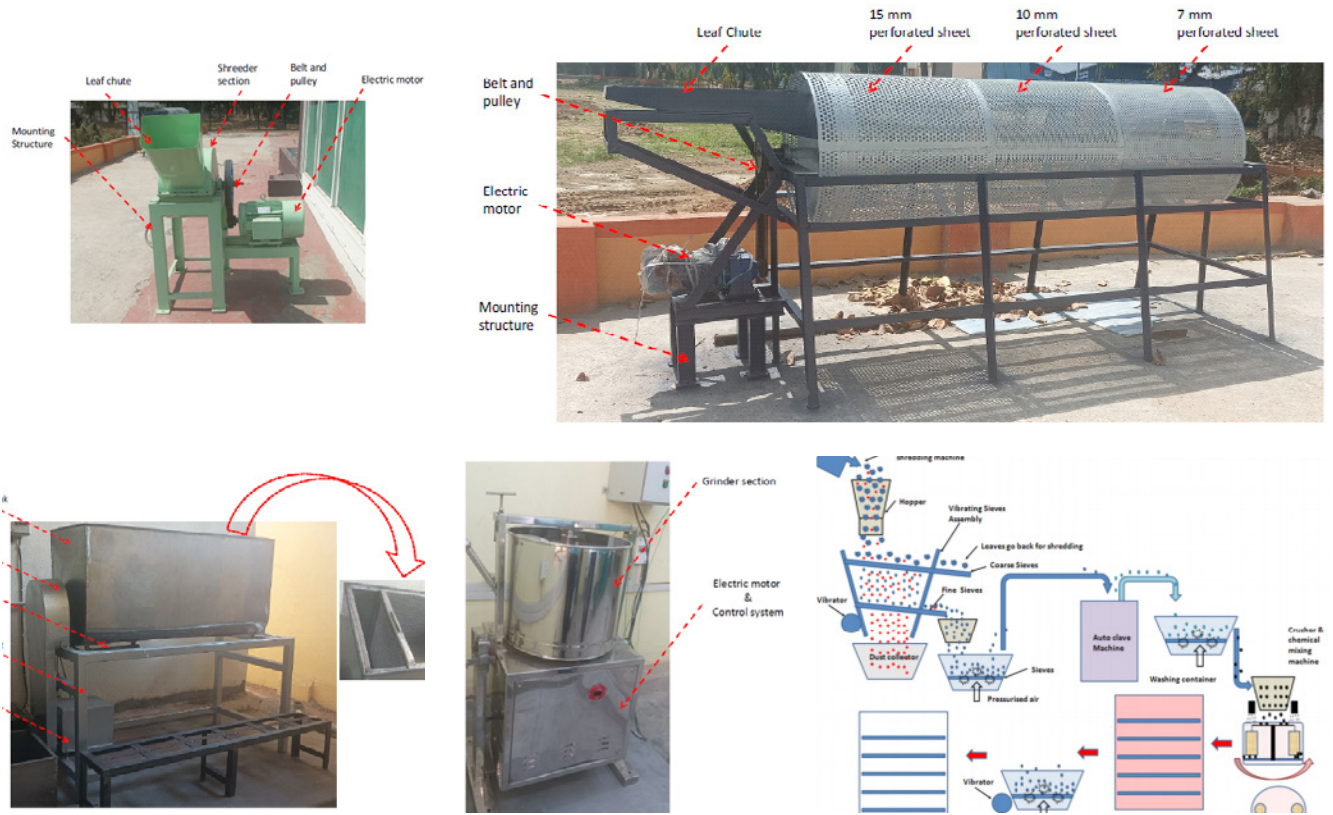
- ▶ **Design & Development of Mechanized Sewage Cleaning System** [Project No: MLP 232212]
- Objective: Prototype development
- Deliverables achieved:
  - ▶ Development of three modules of drain cleaning machine.
  - ▶ The Technology was demonstrated to DG.
  - ▶ Two Technology has been transferred to the top OEM of the domain

CSIR-CMERI

Annual Report 2021-22



- ▶ **Batch Scale Production of High-quality Activated Carbon from Biomass Wastes for Wastewater Treatment – an initiative towards Waste to Wealth** [Project No: MLP 230012]
- Objective: To design and develop the process plant
- Deliverables:
  - ▶ Design and development process plant.
  - ▶ Field testing and result evaluation.




- ▶ **Development of Multi-robotic Wire Arc Additive Manufacturing Platform** [Project No: OLP 231912]
- Objective:
  - ▶ To develop direct metal deposition process and data base of Inconel 625/718 and Ti-6Al-4V for different industrial and strategic applications.
  - ▶ To assess and understand the metallurgical and mechanical behaviour of the deposited layers.
  - ▶ To find out the optimum process conditions for improved quality of different deposited metals.
  - ▶ Development of algorithm for CAD Slicing > RAPID code generation.



- ▶ To develop feedback control mechanism for real time monitoring and control. Three parameter monitoring (such as temperature, travel speed and wire feed speed) system may be established initially.
- ▶ To initiate the development of actual components (like wave guide brackets (Ti-6Al-4V/Inconel 625) for aerospace, bearing support structure (Ti-6Al-4V/718) and turbine exit casing (625/718) with the optimized process variables.
- ▶ SCI/SCIE publications and patents.

Deliverables:

- ▶ New insight into material database applicable for WAAM will be established using design of experiment method.
- ▶ First step will be started to develop new algorithm for the WAAM system.
- ▶ To identify metallurgical and mechanical behaviour of the layered structure for common alloys.
- ▶ The identification of optimized process parameters for common alloys shall be carried out.
- ▶ Fully functional WAAM setup for further R&D work will be available. Furthermore, the facility will be open for enthusiastic industrial and academic partners.



**Development of clutch plate housing**  
Material : ER70S-6  
Total Layer : 70  
Deposition Time : ~3 hrs 56 min  
Machining Time: ~4 hrs 55 min  
YS – 15% higher.  
UTS – 13% higher.  
Material save – 60%



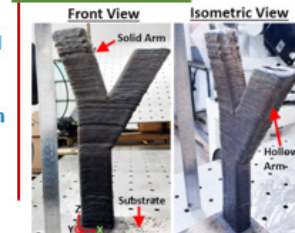
**Valve body**  
Material : ER70S-6  
Total Layer : 62  
Deposition Time : 3 hrs 50 min  
Machining Time : 4 hrs 45 min  
Material save : 61%



**Pressure Reducing and Shut-off Valve body**  
Material : SS – 316L  
Total Layer : 42  
Deposition Time : 2 hrs 45 min  
Machining Time : 2 hrs 30 min  
Material save : 56%



**Circular inverse conical overhang structure**  
Material : SS 308L stainless steel  
Dimension: Max. dia. – 170 mm  
Min. dia. – 30 mm  
Max. height – 110 mm  
Total Layer : 67  
Total Time : 4 hrs 15 min  
YS – 35% higher.  
UTS – 20% higher.



**Y-shape hybrid frame**  
Material : SS 316L stainless steel  
Dimension: Max. length – 180 mm  
Min. width – 20 mm  
Max. height – 250 mm  
Total Layer : 126  
Total Time : 9 hrs 40 min  
YS - 30% higher.  
UTS – 25% higher.

Proc. IMechE, Part C: Journal of Mechanical Engineering Science, October 2021. (doi: 10.1177/09544062211045489).  
Materials Today: Proceedings. 2021, 44 (6), 4342-4348. DOI: 10.1016/j.matpr.2020.10.355.

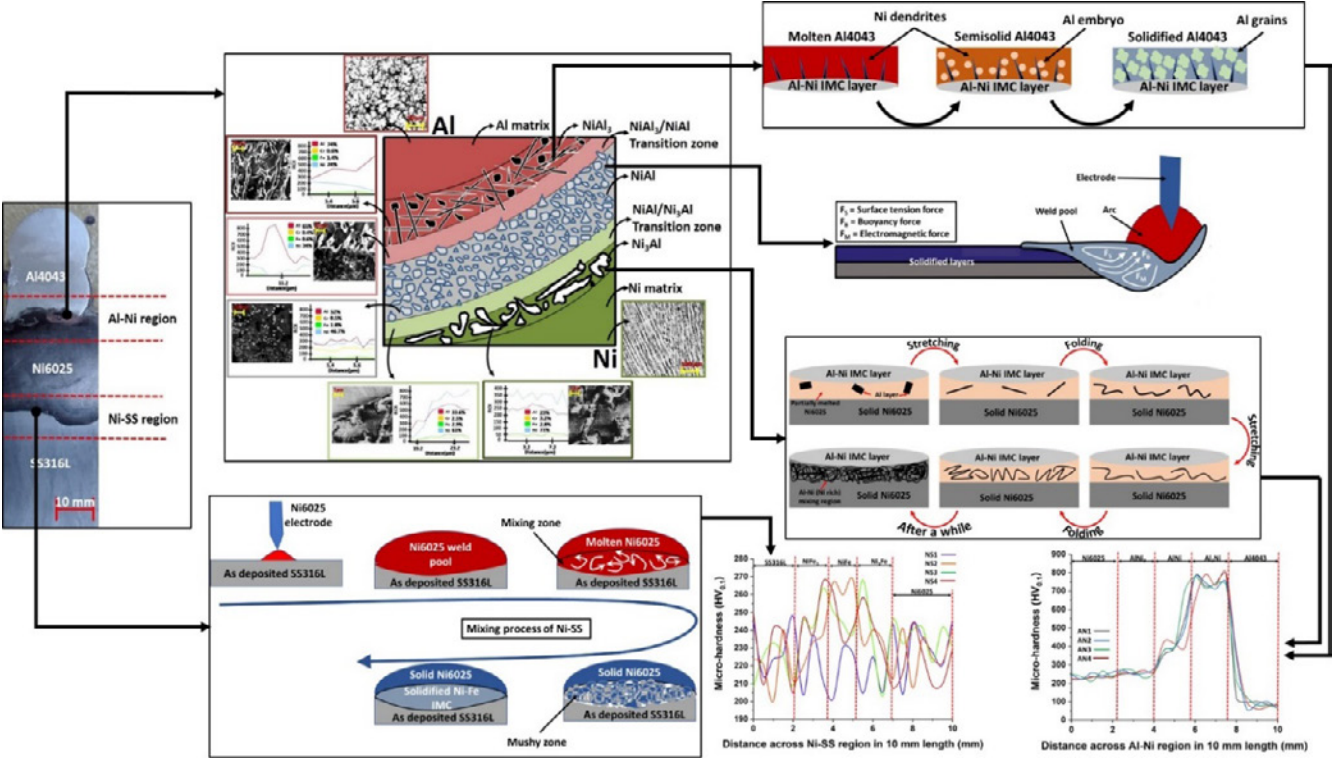
- ▶ *Analysis of Interface Characteristics to develop Dissimilar Wire and Arc-based Additive Manufacturing Components for Industrial Applications* [Project No: GAP 226812]

Objective:

- ▶ To develop dissimilar metal deposited components of Ni-base alloys to SS, Al to SS and Al to SS with buffer layers.
- ▶ To analyse the effect of welding parameters (welding speed (W), Peak current (I), Peak time (T), Voltage (V), pulse frequency (f) and Thermal pulse frequency (f)) on the performance of the dissimilar metal interface.
- ▶ To assess the metallurgical behaviour of the dissimilar metal interface in terms of grain morphology, grain orientation, formation intermetallic phases, phase fraction etc.
- ▶ To analyse the mechanical (such as tensile, fatigue, toughness, hardness etc.), behaviour of the dissimilar metal interface.
- ▶ To find out the optimum process conditions for improved quality of dissimilar metal deposited components.

Deliverables:

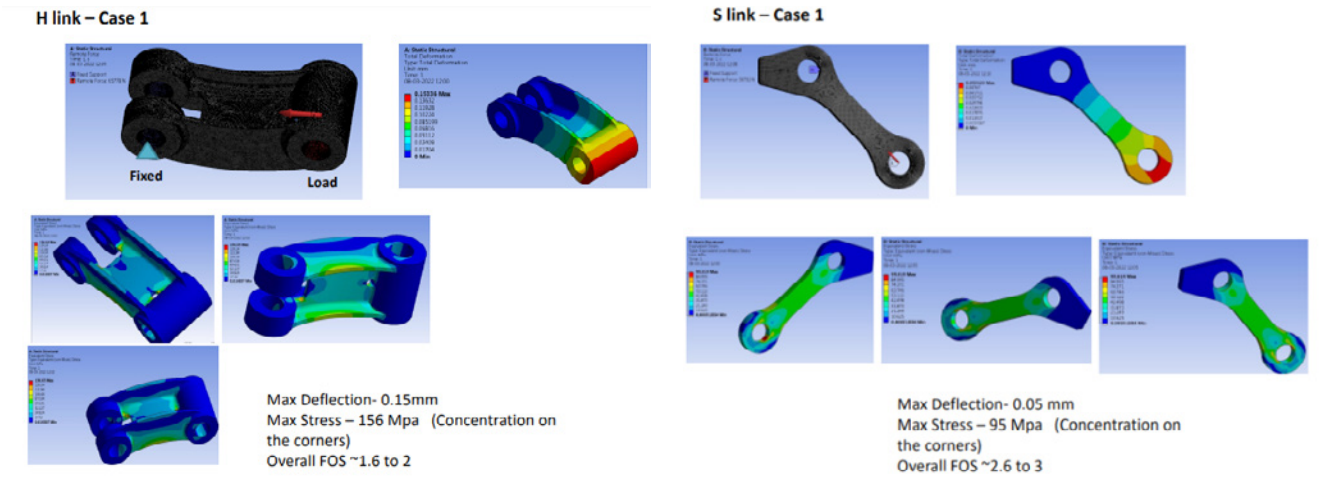
- ▶ Development of dissimilar Al-SS interfaces with different buffer layers.
- ▶ Dissimilar wall structures.
- ▶ PhD and Publications



- ▶ *Design, Analysis and Development of Rheo Gravity Die Cast Al-15Mg2Si-4.5Si Composite based Light Weight Bucket links for Mining Excavators* [Project No: GAP 236012]

Objective:

- ▶ Bench mark study and Analysis of the excavator backhoe system and to propose the new design for the RGDC Material.



- ▶ *Upgradation of in-house CNC Machines (MiKron, DMG morie &Maho)* [Project No: OLP233312 & OLP233512]



Objective: Retro fitment of the 4-axis MAHO Universal milling machine.

Deliverable:

- ▶ Retro fitment of the 4 axis MAHO Universal milling machine. The objective is achieved and the machine is now functional.



Images showing the retrofitted CNC MAHO 500C milling machine post installation and Commissioning

- ▶ **Maintenance of CNC Machining Centers (1. MIKRON-VCP710 2.DMG MORI-CMX70U) and diesel gen set (250KVA) [Project No: OLP 233312]**

Objective:

- ▶ To make the assets/facilities functional towards utilization in its full capacity to develop prototype, provide R&D support as well as skill development activities.

Deliverable:

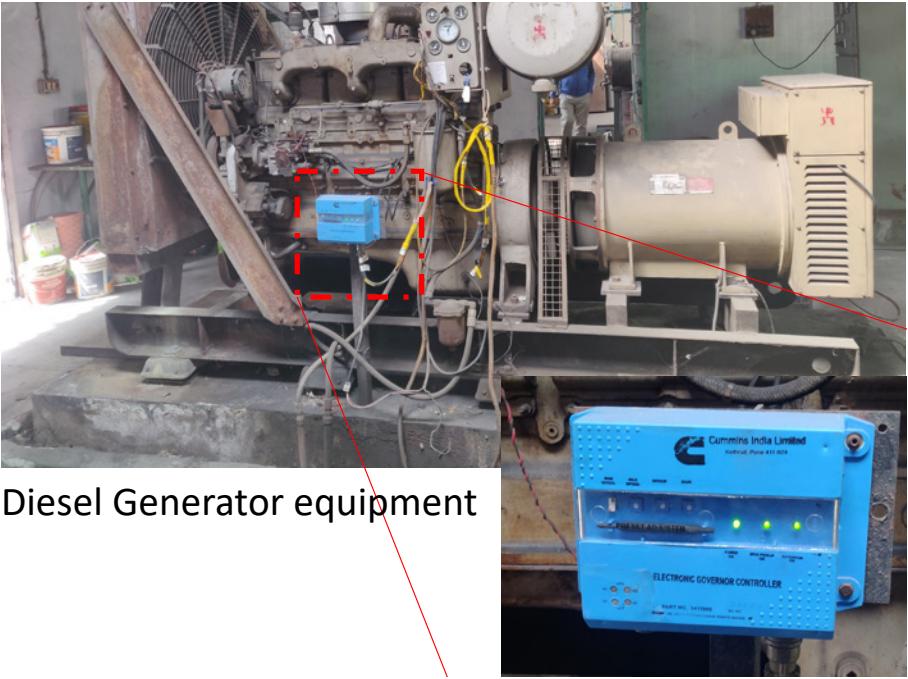
- ▶ The MIKRON-VCP710, DMGMORI-CMX70U and diesel genset (250 kVA) is functional and are now used for its intended purpose.



Linear Scale of DMGMORI- CMX 70U



Figure showing the replaced linear scale of DMGMORI- CMX 70U, (b) showing the MIKRON 3-axis milling machine post maintenance.



Diesel Generator equipment

Images showing the Diesel Generator equipment and the changed electronic Governor.

Project in services mode:

The workshop was involved in the following project as a service mode:

- ▶ Design & development of compliance actuators (Project No: GAP 219112)
- ▶ Design & development of unmanned ground vehicle (Project No: GAP 232212)
- ▶ Development of stir cast heat Sink components (Project No: GAP 224712)
- ▶ Extrusion based additive manufacturing (Project No: GAP 236212)
- ▶ GTRE gearbox manufacturing (Project No: SSP 236112)
- ▶ Design and development of suit of sensors and their characterization for perimeter surveillance (Project No: GAP 2298112)
- ▶ Development of subsea thruster (Project No: OLP 231012)



The Industrial Service and Research Group of CSIR- CMERI has the creditability and considerable experience in the field of damage assessment, component integrity and in service failure studies of the power and process plant components. These activities directly contribute to significant improvement in useful life of the individual components of the different thermal power and process plants. The studies are important in respect to the cost effective Renovation and Modernization programme of the aged thermal power station. Many of the power plants in India are old and require major renovation programme for future operation, which need in depth assessment of the present component damage.

Plant and machinery are expensive assets, designed to operate under very harsh conditions, where a failure can be catastrophic both in safety and economic aspects.

Two options may be considered in operating plant and machinery.

- Condition base maintenance: Failure anticipated and monitored continuously.
- Breakdown maintenance: Machines will run until they need attention.

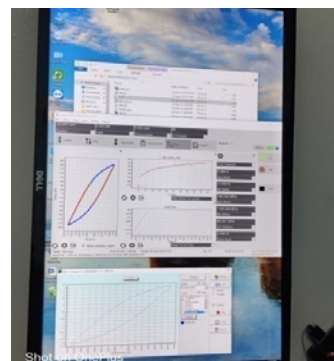
Both techniques have their applications, virtues and vices. ISR Group of CSIR-CMERI has provided its services to the industries in both ways. It offers its services in the form of measurement and analysis of vibration and in-situ dynamic balancing of various complicated and vital machinery of the plant, such as Turbo-Generator sets, High speed Compressors, Gear boxes, ID Fans, PA Fans, CW Pumps, ACW Pumps, Mine Ventilation Fans, Blowers, CT Fans, Boiler Feed Pumps etc.

The beneficiaries of the studies include several industries like, DVC, WBPDC, HZL, DSP(SAIL),CESC, BHEL, Hindustan Unilever, Haldia Petrochem and many other industries. Apart from these activities, this group is also engaged in various Sponsored Research Projects from GTRE, DRDO. Significant contribution has been made in the last few years providing in-depth analysis of Aero Engine components in terms of their assessment of Microstructural and mechanical behaviour.

The Group is well equipped with advanced characterization equipments such as 100kN UTM with High Temperature facilities, Electron Microscopy with In-situ testing facilities, Onsite Metallography and others.



100kN UTM with High Temperature facility



On-site Metallography



FESEM with attached EDS and Deformation stage



Dual Channel Vibration Analyzer



LASER Alignment System

The group has generated Rs. 87.35 Lakhs of External Cash Flow (ECF) through different technical services of life assessment and failure analysis activities during 2021-22 financial year. Apart from that the group has published 10 research papers in different SCI journals.

The group is also actively engaged in spreading awareness among college students/ working professionals about the importance of Life Assessment, Evaluation of Damage mechanics and Failure analysis. Quite often, workshops/ training programs are conducted to take initiative in this regard.

Core activities of ISR Group

- ▶ Component integrity, Life Assessment, Failure Analysis of Industrial Components
- ▶ Fracture and Fatigue Damage Evaluation
- ▶ Understanding damage mechanics in components
- ▶ Materials Characterization using Optical and Electron Microscopy.
- ▶ Vibration Analysis & Dynamic Balancing of Rotating Machinery
- ▶ Vibration Based Fault Diagnosis and Prognosis of Rotating Machinery Equipment
- ▶ Providing Training to Industry Professionals, College Students.
- ▶ Finite Element Analysis
- ▶ Natural frequency assessment of machine components and machines
- ▶ Signal processing and Data Analytics
- ▶ Alignment of industrial rotor
- ▶ Research in allied areas for Strategic Sectors.





## सीएसआईआर-सीएमईआरआई फार्म मशीनरी उत्कृष्टता केंद्र CSIR-CMERI Centre of Excellence for Farm Machinery

### 1. Department of Energy & Post Harvest Technology

#### Activities/ Overview of the Department:

Department of Energy & Post Harvest Technology is carrying out basic and applied research in the field of Bioenergy, especially the machinery development in the area of renewable energy. Having a multidisciplinary team of Scientists from Agricultural Engineering, Mechanical Engineering, Electrical Engineering, Electronics Engineering and Science background, the Department is dedicated for carrying out cutting edge research in the area of Biodiesel, Biogas, Briquetting, Bio Oil, Solar Energy etc. The department is constantly getting projects from Central & State Govt. Departments and Industries. As an outcome, quality publication, patent, technology transfer and Human Resource Development are coming out regularly.

### 2. Department of Design and Advanced Manufacturing

Department of Design and Advanced Manufacturing is carrying out the R&D in design and development of industrial and agricultural machines, prototype development, workshop services & extension of manufacturing support for internal requirements &

overall maintenance of institute machinery infrastructure. The department has the state of art machinery and infrastructure to cater the industries and technical services to the MSME Sector. Various projects are presently undertaken as follows

#### i) Design and Development of Inline Biomethane Enrichment and CO<sub>2</sub> Separation System [Project No: GAP 235812]

##### Objectives:

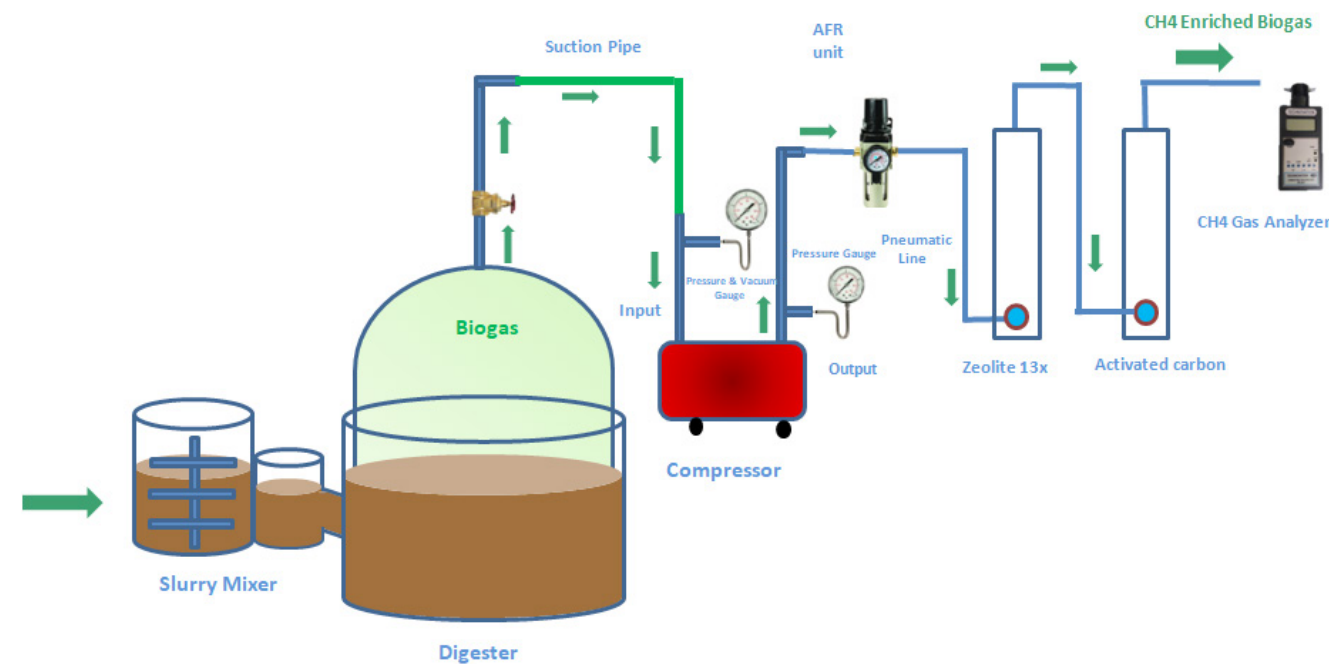
- ▶ Design and development of inline biomethane enrichment system
- ▶ Separation of CO<sub>2</sub> from biogas
- ▶ Desorption and purification of CO<sub>2</sub> for further utilization
- ▶ Analysis of the methane enrichment and CO<sub>2</sub> purification

##### Deliverable:

- ▶ Inline biomethane enrichment system

##### Salient research achievements during 2021-22

- ▶ Lab scale prototype of biomethane enrichment system has been developed



Schematic of lab scale biomethane enrichment system

#### ii) Production and Supply of 15000 litre Biodiesel to M/s. International Tractors Limited [Project NO: TSP 1002]

##### Objectives:

- ▶ Production and supply of 15000 litre biodiesel (B100) to M/s. ITL, Hoshiarpur

##### Deliverable:

- ▶ 6800 lit total has been supplied till date.

#### iii) Biofuel Value Chain from Karanja Seeds for Sustainable Energy Production [Project No: GAP 235812]

##### Objectives:

- ▶ Optimization of extraction of oil from karanja seed through mechanical expelling



#### iv) Development of 50kW Solar Tree

##### Objectives:

- ▶ Development of 50kW Solar tree
- ▶ Demonstration of integrated farming through solar renewable energy.

##### Deliverable:

- ▶ Solar tree Art effect of capacity 53.6kW with 160 solar panels of 335Wp on grid system.

- ▶ Optimization of production of biodiesel from karanja seed oil
- ▶ Utilization of de-oiled karanja cake for production of biogas and bio-manure
- ▶ Development and demonstration of 0.6 TPD Biofuel Value Chain at SFRI, Ladhawal, District Ludhiana

##### Deliverable:

- ▶ Biofuel Value Chain System to be installed at SFRI, Ladhawal

##### Salient research achievements during 2021-22

- ▶ Prototypes of Decorticator, Expeller and Biodiesel Plant designed and developed.





World's Largest Solar Tree 53.6kW Capacity



v) Battery Operated E-Power Tiller

Objectives:

- ▶ Developed Battery Operated E-Power Tiller for the purpose of performing ploughing and tilling applications
- ▶ Demonstrative unit for the E-charging through solar tree.

Deliverables:

- ▶ E-Power tiller for the small and marginal farmers for tilling purpose in the small fields and hilly areas.

- ▶ Demonstrative unit for e charging of the vehicles as well as power tiller through Solar tree.

Battery Operated E-Power Tiller: CSIR-CMERI-COEFM, Ludhiana developed Battery Operated E-Power Tiller for the purpose of performing ploughing and tilling applications. A battery operated E-Power Tiller is agriculture equipment with two traction wheels and a 600 mm wide rotary tiller for tilling of the small fields. The power tiller is powered by 48V, 100AH Battery Bank, which can be charged using conventional Single Phase AC charger or Solar Charger.



Battery Operated E-Power Tiller

vi) Tractor Based Mob Control Vehicle



Objectives:

- ▶ Development of Tractor based Mob control vehicle with following features as per MHA committee recommendations. Demonstration of integrated farming through solar renewable energy.
1. Iron/Steel Shield sheet to be replaced by good quality SS wire mesh.
  2. Shield should be foldable to extent that not to occupy space beyond base vehicle width to avoid mobility issue in by lanes.

3. Shield should have more sections to enable expansion as per available space.
4. Height of shield should be 10 ft.
5. Shield should be provided on one side only.
6. Smaller variant replacing Tractor may be explored.
7. Driver cabin should have structural protection against stone pelting preferably SS wire mesh on all sides.
8. All Hydraulic

**Tractor Based Mob Control Vehicle (MCV):** is designed for effective riot control and protection of law enforcing agencies (police, paramilitary etc.). It's aim is to control riots, to disperse or control very aggressive crowds, to maintain public order in order to protect people or property. The system is meant to implement for both protecting the law-enforcement units as defensive device and controlling the situation whenever peace maintenance is required as offensive device.

The Tractor Based MCV is built on a 90 HP category tractor with four wheeled drive chassis, mainly consisting of expandable and foldable multiple shield system at front, advanced PTZ camera vision system cum communication system. The MCV is undergoing field trials with 103Bn CRPF RAF at Wazirabad, New Delhi.



Design Management & Systems Engineering Group

I. OVERVIEW:

The major goal of the department is to provide sustainable, innovative solutions to Ministries, Societies, Strategic sectors and Industries through design, drawing, development of mechanical, electro-mechanical systems (including autonomous and intelligent one) and Industrial services. In this regard, a number of technical solutions have been/ is being provided in the form of projects/ technical services. Beneficiaries/ stake-holders include Ministry of Defence, Ministry of Coal, Ministry of Electronics & Information Technology, Ministry of Textiles (NJB), NTPC Ltd., Eastern Coalfields Limited etc. Presently the following projects are going on in the department.

II. R&D ACTIVITIES:

**Project Title:** Design and Development of Drop Test Facility for Pit Bottom Buffer, used in Underground Coal Mines [Project No: GAP 234712]

**Approved Budget:** Rs 248.61 lakh

**Project Duration:** 02 Years (10.02.2021-09.02.2023)

**Funding Agency:** Coal India Limited

Pit bottom buffers are safety devices which are required to be mounted at the base of an elevator shaft for avoid hard landing. As with any safety device Pit Bottom Buffers have to meet with a variety of stringent specifications but probably the most important of these is the manner in which the buffer must bring an impacting elevator cage to rest. In India, DGMS pointed out related norms in DGMS technical circular. However, no such mechanism is available at present capable of testing the functionality of Pit Bottom Buffer. Such nationwide capability will enable Indian coal mines to adhere to statutory safety norms. Development of state-of-the-art drop test facility will technologically empower Indian coal industries to achieve the goal of zero fatalities and injuries and indirectly enhance its productivity.

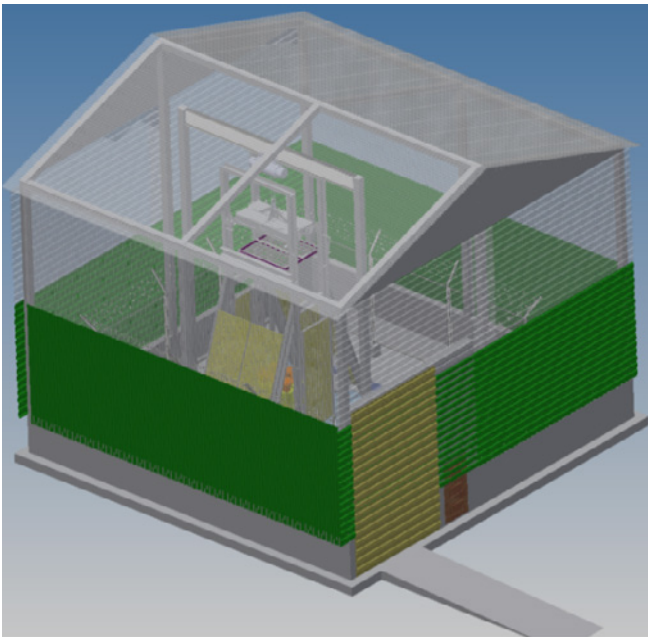


Fig: Concept Model of Drop Test Rig

Salient features:

- ▶ Mechanism for drop load adjustment (1 tonne – 10 tonne) and the drop height adjustment (0 – 3m) as per the requirement of the test.
- ▶ Equipped with sensors capable of measuring various test parameters.
- ▶ Equipped with remote load releasing mechanism.
- ▶ Advance safety mechanism for safe testing of buffers.
- ▶ Equipped with advanced data acquisition system for data collection and post-processing.

Socio-economic aspects:

- ▶ Help in minimizing the risk of fatal injury of mine workers by ensuring strict design parameters.
- ▶ Continuous LRF earning potential through testing of Pit

**Project No:** GAP 225312

**Project Title:** Development of Technology for Unmanned Ground Vehicle (UGV) for Multipurpose and Multirole Applications [Project No: GAP 225312]

**Approved Budget:** Rs 290.00 lakh

**Project Duration:** 04 Year (26.02.2019-25.02.2023)

**Funding Agency:** DRDO-JCBCAT, KOLKATA

The UGV technology can be considered as one of the elite technology which has multitude of applications. It can be used for various hazardous and dangerous applications where there are life threats to the human operators. Thus the major applications of UGV are for the defense or security and commercial sectors. In case of defense or security, UGV can either be sent ahead of the troops to examine the path and safeguard the troops or maintain front-line supplies (foods and ammunitions) to the troops. Apart, they can also be used for perimeter and border patrolling, detection and defusing of IEDs and bombs. The commercial applications of UGV include security and surveillance in large and unmanned home or industrial areas; inspection of plants, electric sub-stations and underground gas pipe lines etc. One major and important application of the UGV can be carrying wounded soldier or rescued persons to the nearby primary health unit or hospitals.

The present work aims to develop a six-wheeled UGV platform with variable ground clearance using indigenous BLDC/ Hub motors for Indian defence sector.

bottom buffers. (No. of winder shaft under CIL is 125, as per the winder data provided by UMD, CMPDI dated 20.07.2020)

- ▶ Indirectly improve the Output per man shift (OMS) of underground mines.

List of industries expressed their interest:

- ▶ Coal India Limited (CIL)
- ▶ Tata mines, Jharia division, Jamadoba, Dhanbad - 828112
- ▶ M/s Suman Engineering, Ranigang, Paschim Bardhaman 713358, W.B.
- ▶ M/s Diesel Pump Engineers, 131 Tagore Road, Durgamandir, Asansol – 713303
- ▶ M/s R. S. Engineering Works, Asansol - 713303
- ▶ M/s Shakticast Pvt. Limited, Dhanbad – 826001

**Project No:** GAP 225412

**Project Title:** Reconfigurable Tracked Flipper type Mobile Robot Technology with Autonomous Navigation in Indoor Environment [Project No: GAP 225412]

**Approved Budget:** Rs 179.00 lakh

**Project Duration:** 04 Year (27.02.2019-26.02.2023)

**Funding Agency:** DRDO-JCBCAT, KOLKATA

Mobile Robots have the huge potential for remote application in hazardous situations and in unapproachable/ constrained areas and they are best suited for applications that are totally unsafe for human beings, such as remote surveillance in disturbed/ naxalite areas, identification of stray objects and surveillance in post-disaster scenarios, post-disaster inspection of underground mines and surveillance in goaf areas.

Stair climber robot can be distinguished by wheeled, legged and tracked based on mobility. Tracked robot creates a large contact area with the ground, which provides better traction on natural as well as rough terrains than with wheels. Tracked robot increases the capability of obstacle negotiation and ground adaptability as in disaster mitigation, unmanned combat, military inspection & surveillance and other rescue operations.



III. TECHNICAL SERVICES

**Project Title:** Designing Estimation and Certification of PIT Bottom Buffer for 67 nos. of UG Pits of Different Collieries  
[Project No: TSP 1396]

**Approved Budget:** Rs 80.00 lakh

**Project Duration:** 01 Year (01.04.2022-31.03.2023)

**Funding Agency:** Eastern Coalfield Limited (ECL)

The cage which ferries man and material in a mine pit is the most essential component of the underground mining operation. The cage makes around 100-200 trips per shift in an average coal mine pit. The landing of the cage on the pit floor is a very important issue during man carrying. Landing the cage with high speed (hard landing) can cause severe damage to the occupants of the cage. Hence a project was proposed and subsequently approved by the ECL (**Design**

and Development of Drop Test Facility for Pit Bottom Buffer, used in Underground Coal Mines/ GAP234712) for decreasing the severity of the hard landing. In this project a setup is proposed to be erected for testing of hydraulic buffer cylinder which are to be installed at the pit bottom.

As an offshoot to this facility creation project another project was sanctioned (**Designing estimation and certification of PIT Bottom Buffer for 67 nos. of UG Pits of Different Collieries**) for inspection of the underground mine pits and propose a design for installation of the buffer cylinders. The duration of the project is 01 years, in which three months are allotted for inspection of the pits, collection of requisite data and providing designs for installation of buffers along with cost estimate. Thereafter the rest of the time will be spent on inspection of the installed buffers based on the provided design. The installation of pit bottom buffers is expected to decrease the accidents related to hard landing of the cages.



(a)



(b)



(c)



(d)

Fig 1. (a) the cage used in the UG mines for carrying man and material. (b), (c), (d) the existing condition of the pit bottom.

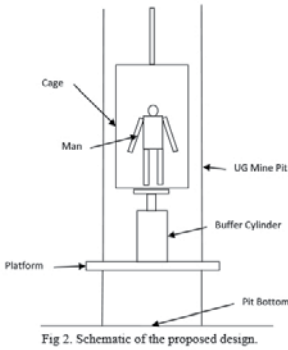


Fig 2. Schematic of the proposed design.

ऊर्जा अनुसंधान एवं प्रौद्योगिकी समूह  
Energy Research and Technology Group

**1. Activities / overview of department:** Scientists in Energy Research & Technology Group are involved in R&D activity in the field of Fluidized Bed Technology, Gasification/ Combustion/Pyrolysis, Clean Coal Technology, Biomass Energy, Municipal Solid Waste Management, Plasma Gasification of Solid Waste and Solar energy related technologies. We have also expertise in developing machinery for post-harvest processing of ginger/turmeric etc. We also provide service like Calibration of Thermal and Fluid Flow Measuring Instruments.

**2. Projects:**

► **Title: Solar Energy based Cooking System (Solar Chulha)**

[Funding agency: CSIR]

a) Design and development of solar PV energy based electric cooking system: The developed solar PV energy based electric cooking system consists of solar PV panel, charge controller, battery bank and cooking

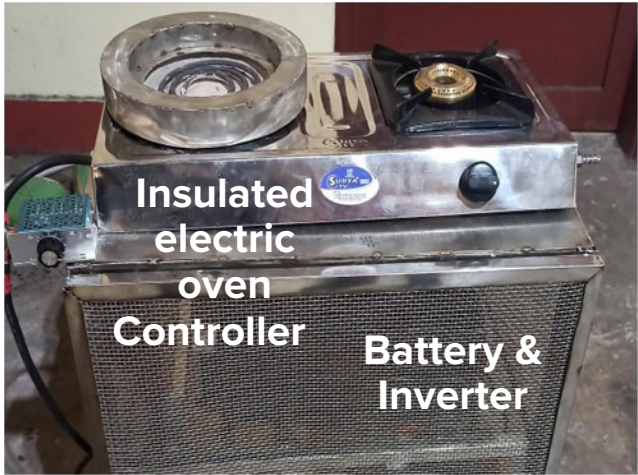
oven. Here, solar energy is converted to electricity using PV panels and stored in the batteries via solar charge controller. Electricity stored in the batteries can directly be used for heating the coil in the cooking oven. The excess electricity produced by the PV panels is stored in the batteries for using in the night.

**b) Design and development of hybrid solar PV e-cooking + biomass cooking system:**

In order to reduce the dependency on battery for energy storage, a hybrid solar PV electric and biogas cooking system is designed and developed. Here, total cooking load is shared by both the systems. The objective is to use mostly the solar PV system in the daytime and biogas system during night to reduce the battery storage requirement. Moreover, kitchen waste, generally thrown outside creating environmental pollution, can be used for generating biogas.

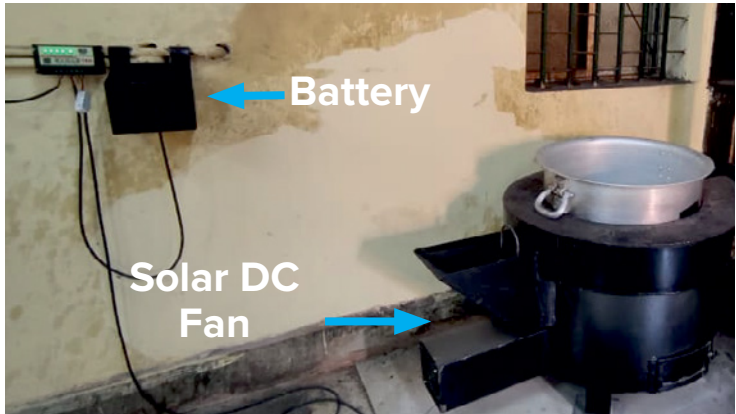






c) **Design and development of low cost solar-biomass cooking system:** It is observed that, till date, a significant portion of our country still use biomass as cooking fuel because biomass is available almost free of cost to them. But, majority of these biomass materials

are used inefficiently for cooking using traditional cook stoves which are very inefficient and also cause extensive air pollution. Therefore, a solar assisted improved biomass cook stove is also developed.

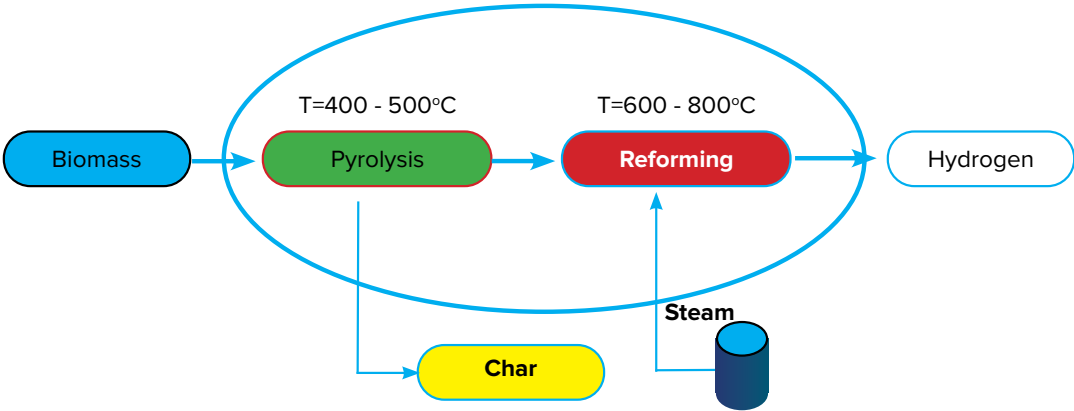


► **Title: Hydrogen Production from Biomass through Pyrolysis Process followed by Catalytic Steam Reforming of Volatiles**

[Funding agency: Department of Biotechnology (DBT)]

At present, most common H<sub>2</sub> production technologies available in the world are the reforming of natural gas and oil followed by coal gasification. Hence, there is a special focus to produce H<sub>2</sub> from biomass. Thermo-chemical conversions like pyrolysis and gasification are studied as alternative routes for H<sub>2</sub> production from biomass. But the main drawback of gasification is that the

syngas produces contains impurities particularly the tar which creates serious problem related to its downstream application. Pyrolysis of biomass is a recent technology where biomass is converted into liquid fuel called bio-oil and then H<sub>2</sub> is produced by reforming bio-oil. However, the main drawback here is that the bio-oil polymerized under storage causing an increase in viscosity and molecular weight. Therefore, it is proposed to develop an integrated biomass pyrolysis and reforming reactor where biomass will be pyrolyzed and the pyrolysis vapour will be reformed online to produce H<sub>2</sub>.



Process flow diagram of the proposed integrated pyrolysis–reforming system for hydrogen production from biomass

► **Title: Development of Plasma Torch for Efficient Disposal of Municipal Solid Waste**

[Funding agency: CPRI, Bangalore]

Plasma torch is widely used in industrial applications such as for plasma cutting, welding, melting, and many other processes. The modern trend of Plasma torch is also used in medical and health care for operation theatre, plasma surgery, and tumour treatment, due to its high-speed plume, high temperature, and high energy density. The present world is threatened due to its huge solid waste produced by the huge population and modern lifestyle. In this direction, efficient high-temperature thermal plasma torch highly demanded area for solid waste destruction, but only a few commercially available around the world. Despite the technology is already established but yet a number of issues still reaming to make an efficient, continuous flow high-temperature plasma torch. This project developed an economical high-temperature continuous flow efficient plasma torch. This project is reported a modified and economical high-temperature continuous flow efficient plasma torch and characterization for the optimum performance. In this project a non-transferred DC plasma torch has been designed, fabricated and experimented at laboratory to achieve the desirable objective

► **Title: Design and Development of Smart Wireless Sensor Network System for Structural Vibration Monitoring Application and Performance Evaluation on Different Structures**

[Funding agency: DST, New Delhi]

Structures like high rise buildings, dams, bridges are complex engineered systems that assure the nation's economic and technological development. Unfortunately, these structures are subject to extreme loading situations and severe environmental factors, which are not anticipated its structural deterioration causing severe harm, which results in

catastrophic accidents and fatalistic casualties.

Wireless sensor network is appropriate method for detecting vibration data for analyzing structural health. A significant number of damage detection methods have been implemented and developed during the past decade. In this project a low cost wireless sensor module has been designed and developed for data logging of various structural parameters such as vibration, acceleration, temperature humidity at various nodes. Among these important parameter is structural acceleration spectral analysis techniques to identify the model parameters. Modal parameter estimation in frequency domain techniques such as fourier spectrum analysis, power spectral analysis and cross power spectral analysis is to identify the structure's resonant frequency for the evolution the structural health.

► **Title : Design and Development of Self-sustainable Integrated Municipal Solid Waste Disposal System (i-MSWDS) for Bulk Waste Generator**

[Funding agency: CSIR]

The objective of the project is to develop an integrated Municipal Solid Waste Disposal system (i-MSWDS) for bulk waste generators. Bulk waste generators include hotels, businesses, marriage halls, hospitals, which generate more than 100 kg of waste on a daily basis. It also includes gated communities and institutions spread over an area of more than 5,000 square meters. Bulk generators contribute substantial amount of waste-nearly 30-40% of the daily waste. According to the Solid Waste Management Rules 2016, Bulk Waste Generators are responsible for managing their own waste. Suitable technology modules have been developed and implemented under this project for the processing and disposal of up to 500 kg/day Solid Waste relevant to the bulk waste generators. Special emphasis is given towards sustainable management of solid waste and establish circular economy model reducing waste to a minimum.





► **Title : Design of 2 TPD Rotary Kiln Gasification Pilot Plant with high CV Syngas Production**

[Funding agency: DST, New Delhi]

The objective of the project is to design, develop and implement a waste feed preparation sub-system for a Rotary Kiln Gasification Pilot Plant. The plant will process 2 TPD of non-biodegradable solid waste. The composite solid waste feed for the plant will have a minimum weighted average calorific value as 3000 kcal/kg and an initial moisture content as high

as 35%. The project is implemented in collaboration with Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu and is currently in execution phase.

**3. Technical services:**

► **Title: Design, detailed engineering, manufacturing and installation of 11.5 kWp solar artifact at Raja Narendra Lal Khan (RNLK) Women's college, Midnapore**

[Funding agency: Raja Narendra Lal Khan Women's College (Autonomous)]



► **Title: Development & Installation of Small Capacity Solar DC Cooking System**

[Funding agency: Asansol Braille Academy]

- Design and development of a small capacity (with 48V, 40 Ah battery backup).
- Installation of the developed system at Asansol Braille



Academy's kitchen.

► **Title: Design, Engineering, Installation & Commissioning of 20 nos. Solar Lighting Systems at various places under Paschim Bardhaman Zilla Parishad**

[Funding agency: Paschim Bardhaman Zilla Parishad, Govt. of West Bengal]

► **Title : Design and development of integrated Municipal Solid Waste Disposal System (i-MSWDS)**

[Funding agency: Central Reserve Police Force]

The project is related to field level implementation of the selected modules of the technology for integrated Municipal Solid Waste Disposal system (i-MSWDS) at CRPF Group Centre, Durgapur. The pilot plant will be capable of processing 1 TPD of Municipal Solid Waste within CRPF Campus and generate value added products out of the waste.

► **Title : Installation and commissioning of integrated Rural**



► **Title: Supply, installation and commissioning of plastic shredder, aggro-mixer at different districts of Manipur**

[Funding agency: Public Health Engineering Department, Govt. of Manipur]

**Solid Waste Disposal System (i-RSWDS) at Senapati, Bishnupur, Imphal East and Imphal West districts of Manipur**

[Funding agency: Public Health Engineering Department, Govt. of Manipur]

The project is related to field level implementation of the selected modules of the technology for integrated Municipal Solid Waste Disposal system (i-MSWDS) at the four districts of Manipur. The capacities of the plant are 1 TPD at Bishnupur, Imphal East and Imphal West districts & 2 TPD at Senapati district, respectively.



The project is related to field level implementation of the selected modules of the technology for integrated Municipal Solid Waste Disposal system (i-MSWDS) at all the sixteen districts of Manipur



I. Activities / overview of department

Scientists in Environmental Engineering Group are involved in R&D activity in the field of removal of contaminants like iron, fluoride, arsenic and other pollutants from groundwater, wastewater treatment, arsenic & fluoride sludge disposal, waste disposal (plastic, tyre, etc.) through pyrolysis and catalytic pyrolysis, functional tribomaterials, composite coatings etc. Different types of filter for removal of water bound contaminants have been developed and implemented at the different villages. Disposal of plastic waste and e-waste (plastic part) is also the focus areas of research of this Group. The in-house water testing facility is created (recognized by the West Bengal pollution control board) to render services to the industries, academic institutions etc. through water testing.

R&D Activities in the following areas:

- ▶ Water purification
- ▶ Sludge disposal
- ▶ Plastic waste & e-waste (plastic part) disposal & value added product recovery through pyrolysis /catalytic pyrolysis

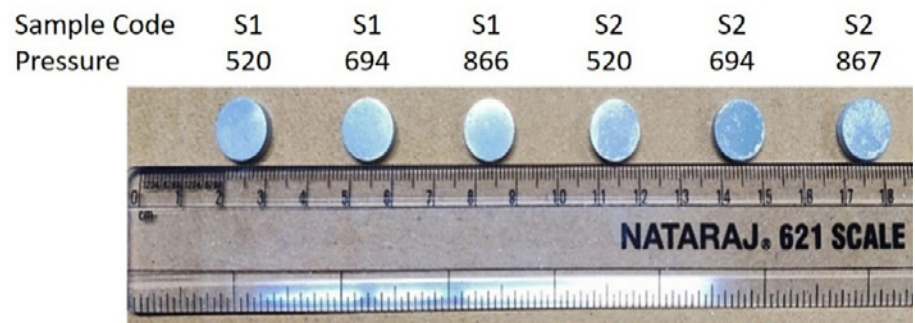
- ▶ Functional tribomaterials and composite coatings

II. Projects:

Title: Self-Lubricating Al-SiC-Graphene Composites for Advanced Tribological Applications

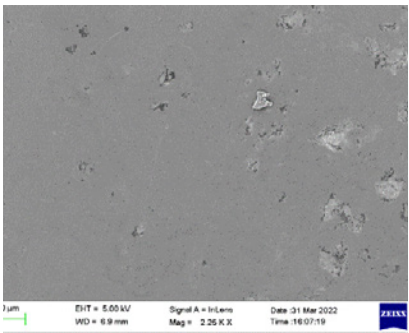
[Sponsor: SERB, New Delhi]

The requirement for lubrication in a metallic contact arises when tribological functions in a mechanical systems become critical and challenging to control friction and wear. Traditional lubrication with lubricant base oils are sometimes not adequate enough to assist advanced tribological applications. These limitations directed to the necessity of alternate lubricants in the form of solid lubricants for critical applications. However, there has always been a dispute over the benefits of using solid lubricants as a surface coating or as dispersed suspended particles in base oil. However, impregnation of these lubricant particles in a base matrix alloy in the form of a composite materials generates self-lubricating ability in that base material.



Cold pressed Sintered samples of Al, Al-SiC, composite Al-GO and Al-SiC-GO

The demand for Aluminum composites have increased over the years in production sector such as aerospace and automotive applications, due to its attractive properties such as light weight, corrosion resistance and superior ductility. Al composites have superb mechanical properties as well as corrosion resistance but associated with very poor wear resistance. SiC is one of the most used materials in industry due to its superior hardness, chemical inertness, corrosion resistance and superior mechanical properties. Graphene is also a promising reinforcing material in composite matrix because of its exceptional properties, such as high mechanical strength, modulus, thermal and electrical conductivity. Therefore, the composites prepared by combining a metal



SEM Topography of Al-SiC-GO

alloy such as Al with a second phase filler material such as ceramics in form of SiC and a lubricant particle in functionalized graphene oxide (f-GO), enhances the properties of the base Al metal. This facilitates to develop a new class of composite materials that is designed for a specific application need. Composites are structural bulk materials with improved desired properties, such as wear resistance, friction, corrosion resistance and others, yet keeping the bulk properties of the material unchanged.

Title: Deployment of Community Level Water Purification Plants for Removal of Iron from Groundwater in Iron Affected Rural/Tribal Villages for Supply of Safe Drinking Water

[Sponsor: DST, Govt. of West Bengal, Kolkata]

Project category: Replication efforts for successful models

Objective: Deployment of CMERI design iron removal plants (IRP) in rural areas to provide safe drinking water.

CSIR-CMERI designed and developed community level iron removal plant with a capacity of ~ 800 LPH. The USP of the CMERI design IRP is as follows:

- ▶ Naturally available geo-materials used for removal of iron

- ▶ No electric power requirement
- ▶ No chemicals requirement
- ▶ Attachable to the existing Submersible pump and Mark-II hand pump
- ▶ Backwashing facility provided
- ▶ IPR Status: Patent
- ▶ Winner of CSIR Technology Award-2017 (under innovation category)



IRP installed at Barjora Girls High School, Bankura



IRP installed at Kunchia High School, Purulia

After installation of 2 nos. of IRP, 1000 users (approx.) are being benefitted by getteing safe drinking water.

Title: Development and Deployment of Community Level Water Purification Plant for Removal of Fluoride from Groundwater.

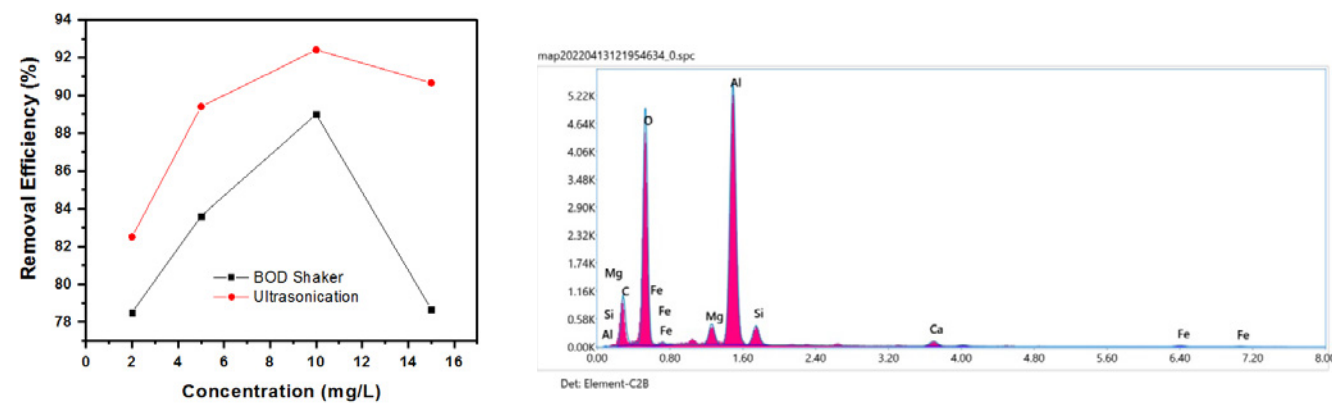
[Sponsor: DST, New Delhi]

Objective: To provide fluoride free safe drinking water

Fluoride contamination of groundwater is a serious problem in several states spread throughout the India as ingestion of excess fluoride. Most commonly, through drinking

contaminated groundwater causes fluorosis. Long term ingestion of fluoride in high doses can lead to severe skeletal fluorosis. To solve the fluoride problem, we are in a process of development of adsorption based technology for removal of fluoride for which low cost geo-material as adsorbent has been used. Batch type experiments have been done extensively with the variation of fluoride concentration, adsorbent dose, pH, time etc. and it is observed that the selected adsorbent shows encouraging results with respect to its high removal efficiency.





Title: Device Development for Testing of Groundwater Iron

[Sponsor: DST, New Delhi]

Objective: To develop a device for testing of groundwater iron & Prototype development-10 Numbers

Several techniques are available for the treatment of iron contamination in groundwater but the detection of the same at source have emerged as a challenging task. Presently, the kits available in the market for determination of iron in groundwater are mainly foreign-made and the testing per sample is highly expensive. To solve this problem, we have undertaken this project to develop a kit which can detect iron in groundwater at the field/site which is cost effective and affordable. We are in a process of development of the first prototype which is prepared based on the principle of oxidation followed by colorimetric analysis by providing semi quantitative estimation of iron concentration present in groundwater. Trial run given in the field/iron affected sites/villages and so far we are getting highly encouraging results and result is also comparing with

the Atomic Absorption Spectrometry (AAS) process.

III. Technical Services:

Project Title: Water testing for various industries

Objective: To provide services to various industries, academic institutes, R&D institutes, MSMEs through testing of water & wastewater.

Sponsor: Various industries, Academic institutes etc.

Drinking water parameters shall comply with the requirements prescribed by IS 10500:2012. The various water quality parameters have to remain with the permissible limits. Therefore, the water quality parameters are essential to test on a regular basis. With this background, Environmental Engg. Gr. has created water testing facility (recognized by the West Bengal Pollution Control Board) and rendering services to the various industries, academic institutions etc. During the year 2021-22, Env. Engg. Gr. has generated 122 nos. of water testing reports and out of which 57 nos. are external reports.



फाउंड्री ग्रुप  
Foundry Group

The 'Foundry Group' at CSIR-CMERI has specialised in different aspects of casting & manufacturing of ferrous and non-ferrous alloys. The capabilities and experience of the group include but are not limited to: Aerospace, Automotive, Mechanical and Agriculture, Manufacturing, Chemical and Renewable Energy. The group has extensive experience in a wide range of industrial and research projects and has worked with several National and International R&D organizations, academic and industrial partners to deliver successful results as per the mission and mandate of the Laboratory.

1. Development of aeronautical-standard, high strength, long endurance casting with Al-7Si-0.3Mg-0.05Mn-0.05Cu alloy for Aero Engine Power Transmission Box [Project No: SSP 236112- Ongoing]

Gas turbine engine for fighter aircraft has to operate at very high stress and temperature for long duration under adverse

environmental condition. Stress and temperature to which critical components in the engine are subjected, depends on the mission requirement. Engine power transmission box (TB) is one of the critical modules of the aero-engine which provides the drive for major engine and aircraft accessories like fuel booster, hydraulic and lubrication pump, generators etc. It is considered as class-1 critical part from design perspective as the failure of the component during mission could be catastrophic leading to loss of both man and aircraft [MILL- std 5007E]. Complete power transmission box assembly, including casing along with the accessories is subject to vibratory and manoeuvre loads, which makes this part structurally critical that demands minimum casting defects to withstand the operational loads within the flight envelope. The 3D model of transmission box is shown in Figure 1. The molten metal was poured at 700°C to smooth and complete filling of mold cavity. The trial casting is shown in figure 2.

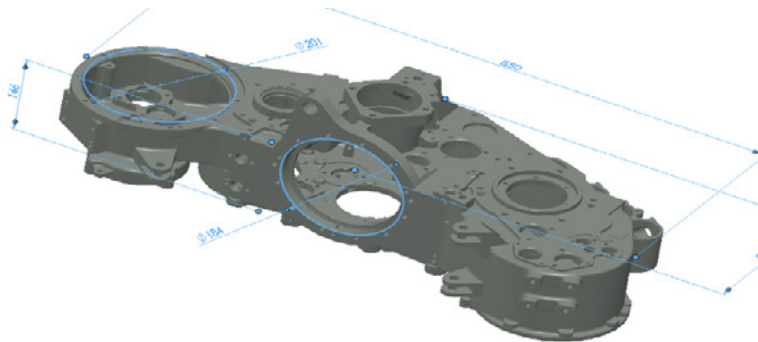


Figure 1: 3D model of Transmission Box



Figure 2. Trial prototype casting of transmission box



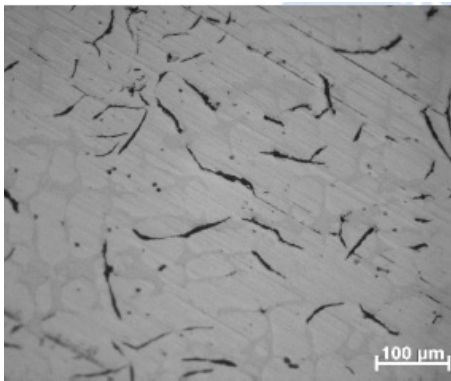
2. Development of process technology to Manufacture high phosphorus cast iron Brake Shoe [Project Title: TSP 1345, Completed]

The high phosphorus cast iron brake shoe was developed under collaboration with M/s. A K Ispat Udyog, Kolkata to be used by Indian Railways. The challenge in this project was to obtain the uniformly distributed Grade A graphite flakes

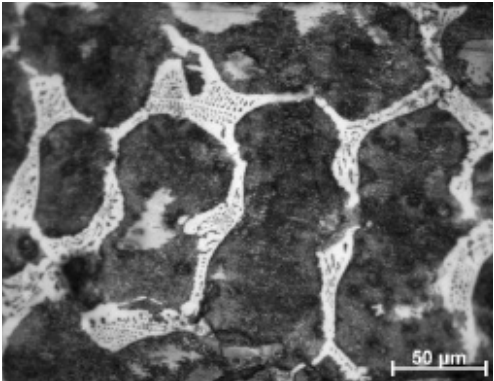
and homogenously distributed steadite phase. The melting temperature was maintained at 1250°C-1285°C to avoid unwanted melting losses for various elements as well as to scale up the process in Cupola for its commercial production. The liquid metal was poured in the green sand mold below 1250°C to avoid shrinkage defect in brake shoe casting. Presence of silicon and phosphorous increases the fluidity. Figure 3 shows the cast sample along with its microstructure.



As cast high phosphorus brake shoe



uniformly distributed random flakes



uniformly distributed steadite phase that conforms to form I, Type-A graphite, and pearlite in the matrix

3. Process Technology for Developing Cast Iron Foam from Ferrous Scrap [Project Title: OLP 237212, Completed]

Porous castings are avant-garde materials termed as cellular metals. It showcases attractive characteristics likened to their solid equivalents. Powder metallurgy has been long utilized to manufacture metallic foams using diverse chemicals to attain internal pores, however this method is not viable for hefty components. The proposed methodology in this investigation is capable to produce structured foam using space holders from ferrous scrap. Melting and casting of iron foam described to develop foam structure is inspired by TPMS cellular structure. TPMS lattice structures possess a virtuous amalgamation of high surface-to-volume ratio, pore connectivity and desired strengths through control of

connecting structures. An underlying challenge in deploying the TPMS based structure in the melt route is the flow ability of molten metal through the narrow interconnected regions. An unambiguous approach has to be performed to ensure the reduction of experimental trials. A Box-Behnken based simulation study is performed for various TPMS structures along with other significant parameters to identify the flow ability, defects and other casting parameters, Figure 4. Shows the gating system adopted in the simulation. Porosity of 62.4% is achieved through casting route with a compressive strength of 176.7 MPa, the cast sample is seen in Figure 5. Radiography tests shows that there are no significant defects and there is connectivity between pores. Thickness of as low as 1.5mm is cast with Cast Iron.

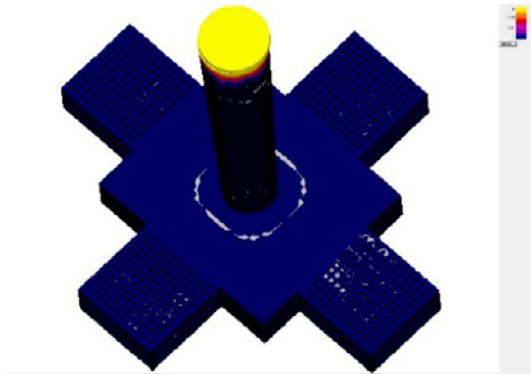


Figure 4: Simulation of gating system

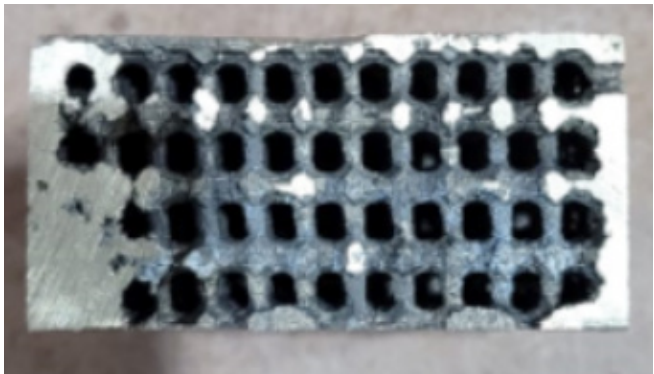


Figure 5: Casted Sample

4. Development of Screw Extruder based Additive Manufacturing System for Developing Ceramic Core to be used in Turbine Blade Casting [Project No: GAP 236212, Ongoing]

Design and development of a ceramic extrusion based additive manufacturing (CEAM) system with Feedstock preparation out of silica-based ceramic for the ceramic extrusion based additive manufacturing system. This work package includes Optimization of the additive manufacturing process parameters, De-binding process development, Optimization of sintering parameters and Development

of ceramic core (Aerofoil Shape). Ceramics are becoming increasingly important in the nowadays-industrial landscape and Final goal is to build tailored ceramic products with customized geometries. The cad model and developed is as shown in Figure 6 & Figure 7 Respectively. The proposed extruder will have a Working temperature range of build-up material head of 100-350 °C, working temperature range of support material head at Ambient Max. 80 °C with a Volume capacity and Deposition rate of 3.3 x 10<sup>6</sup> mm<sup>3</sup> and 5 mm/s to 30 mm/s respectively.

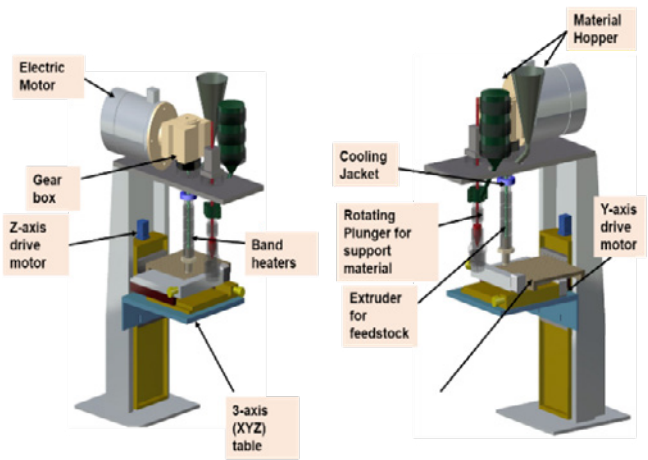


Figure 6: Cad model of Extruder design

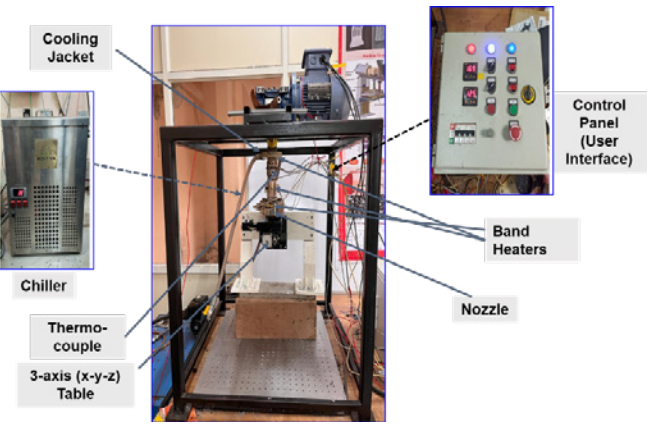


Figure 7: Developed Prototype





सूचना प्रौद्योगिकी  
Information Technology

I. Activities / overview of Department

- ▶ To design and develop an IoT based System and its industrial applications
- ▶ To build the capability in emerging area like IoT and AI etc

II. Projects:

Title: IoT Based Smart Irrigation for Precision Agriculture Applications

The farm activities are transforming from manual and static to intelligent systems in order to enhance the productivity of agricultural crops yielding efficient resource utilization through automation. In agriculture, the most important part is the utilization of water in efficient manners through irrigation where the traditional irrigation systems don't encounter

the use of excess water during irrigation. By using smart intervention through the Internet of Things (IoT), smart irrigation with sensing, control, and monitoring systems using cloud is developed. The web application is designed for appropriate action by the user during drip irrigation. This application provides the appropriate amount of water from the pump for gardening. IoT based smart irrigation, Soil sensing and surveillance systems has enabled the following features:

- ▶ Smart irrigation through automated pump system
- ▶ Analyze the soil condition through soil sensor
- ▶ Voice enable features in surveillance system
- ▶ Wireless communication through IoT Cloud platform
- ▶ Power transmit through solar system



Figure 1. Development of IoT based smart irrigation system

Title: Development of Pipeline Inspection Robot for Inspection of Pipelines

A pipeline inspection robot (PIR) for inspection of pipelines (diameter of 500-600 mm) is developed using a wall-press type mechanism. The major advantage of this mechanism is that it can adopt the changes inside the pipe. The major parts of this robot are body structure, scissor mechanism, foot mechanism, camera, gas sensors, and thickness measurement device, etc. In the body structure, the robot is

designed using three scissor mechanisms along with the foot mechanism at radial position (at 120 degrees). The scissor mechanism consists of two cross-links which help it to self-adjust the height of the robot when it passes through pipes with varying cross-sectional diameters. The foot mechanism consists of spring-loaded active wheels and terrain belts which can provide self-adjustment inside the pipelines. The capability of the robotic system is demonstrated for inspection of pipeline diameters ranging from 500-600 mm.



Figure 2. Development of pipeline Inspection robot for inspection of pipelines

Title: Fire Disaster Management using advances of IoT and AI

The disaster caused due to fire is still a serious problem and its occurrence is random moreover, the major characteristics of fire are it extends exponentially with time. Hence, timely detection of fire is critical for avoiding a major accident. Industry, home offices, hospitals etc. are very much vulnerable to fire that has the potential to cause harm to its occupants and severe damage to property. From social

implication, addressing the problem is important as proper fire management can save unparalleled human lives as well as prevent damages to safety critical civil infrastructure. To solve this problem, we propose an intelligent early fire detection and prediction, with real-time monitoring system that would not only detect the fire by using sensors but also notify the appropriate authorities including fire department, ambulance services, and local police station simultaneously to prompt extinguishing, protect valuable lives and properties

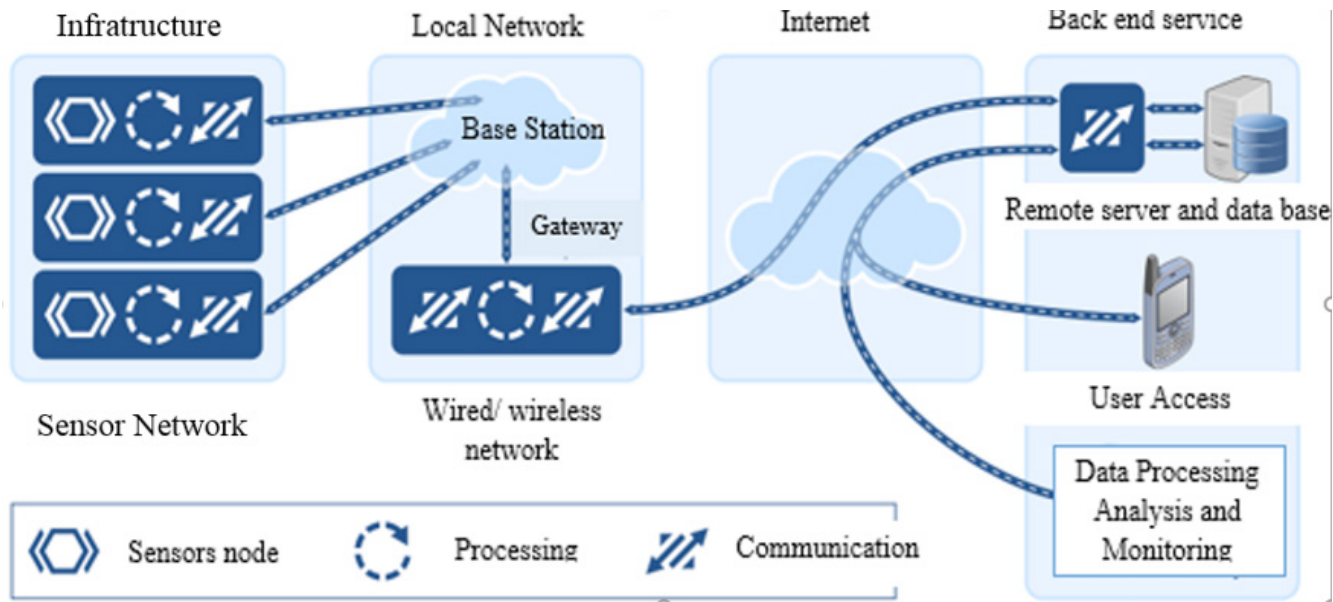


Figure 3. System Floor Plan



# Materials Processing & Microsystems Laboratory

**Materials Processing & Microsystems Laboratory (MPML)** addresses the challenges in basic as well as applied research in the field of Advanced Materials Processing and Microsystems towards development of Nano materials and Nano/Micro technology, Energy Conversion and Storage, Lab-on-chip/Sensor Devices, Light-weight Composites, Adsorbent for Water Purification, Laser Materials Processing through CSIR Funded Projects, Sponsored R&D Projects from various agencies, Technical Service Projects from different industries, User based Innovative Technology Development and finally Technology Transferred and Deployment for the benefit of industries as well as common people of society, Imparting Skill to Advanced Techniques of Materials.

MPML comprises of 7 Scientists, 2 Technical Staffs, 1 DST INSPIRE Faculty Fellow, 27 Ph.D students.

## Research Focus:

- ▶ Nano Materials and Nano/Micro Technology
- ▶ Energy Conversion and Storage
- ▶ Lab-on-chip/Sensor Devices
- ▶ Light-weight Composites
- ▶ Adsorbent for Water Purification
- ▶ Laser Materials Processing & Micro Machines

## Important R&D Projects

- ▶ Development of CNT- reinforced alumina composite for wear-resistant applications (DST-SERB)
- ▶ Development of Optically Transparent and Translucent Zirconia Ceramic Products for Advanced Technological Applications (DST-SERB)
- ▶ Laser forming of aluminium foam plate to produce curved surfaces (DST-SERB)
- ▶ 2nd sphere effects on the active site structure of synthetic Cytochrome P450nor and NorBC enzymes: characterization of intermediates towards Nitrogen Cycle (DST)
- ▶ 2D transition metal layered double Hydroxide: a cost effective catalyst for Hydrogen production by photo electro chemical water splitting (MES, DST)
- ▶ Development and Evaluation of Magnetically Controlled Novel Drug Delivery System for the Treatment of Lung Cancer (SERB-TARE)

- ▶ Laser additive manufacturing of tungsten carbide tool for friction stir welding of aluminum to steel (DST-SYST)
- ▶ Batch scale production of High quality activated carbon from biomass waste for waste water treatment – an initiative towards to wealth (CSIR)
- ▶ Design and development of printed solid-state oxygen gas sensors for medical ventilators and oxygen concentrator used in COVID 19 outbreak (DST)
- ▶ Development and deployment of hybrid manufacturing (additive-subtractive) micro machine for MSME industries and skill development (CSIR)
- ▶ Strategies for Green Hydrogen Generation by Seawater Electrocatalysis: CSIR H2 Mission (CSIR)
- ▶ Electrolyzation of Wastewater and Seawater as the Promising Future Strategies for Hydrogen Production: Challenges and Solutions (SERB-POWER)
- ▶ Nano-bioremediation of pesticides by immobilized microorganisms (SERB-CRG)
- ▶ Design, development and deployment of a smart watch with glucose sensor integrated with transdermal micro needle patch for stimuli responsive insulin delivery (SERB-Wearable Devices Special Call)

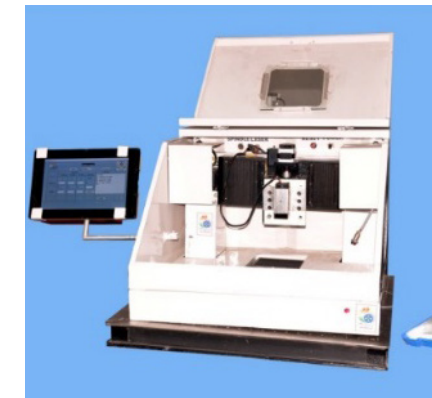
## Technology Developed, Transferred & Technical Service Projects:

This group has successfully developed the technology in association with other departments such as Community Level Arsenic Removal Filter (Model-II), High Flow Rate Iron Removal Filter, High Flow Rate Arsenic Removal Filter, Outdoor Air Purifier, CNC-based micro machining Technology on polymers, Facemask. Oxygen Enrichment Unit in recent years.

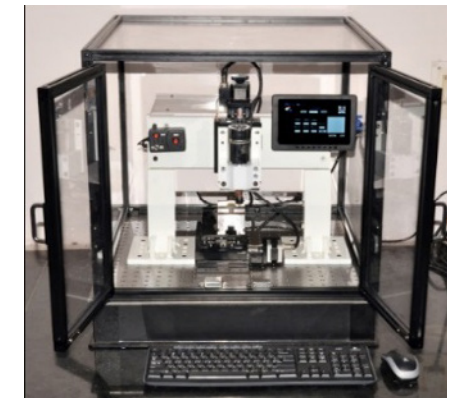
Total 49 numbers know-how/technology has been transferred to MSMEs/Industries. One of the success of the developed technology by deploying High Flow Rate Iron Removal Filter in many areas like Bihar, Maharashtra to provide safe drinking water to the people towards the fulfillment of Government of India's of Jal Jeevan Mission. Nano Lase and MultiFab was deployed to Industries and Colleges such as Tequity Engineering, Mumbai; Nag Enterprise, Birbhum; New Horizon Institute of Technology, Durgapur; Bankura Unnayanai Engineering College, Bankura, BITS Pilani.



High Flow Rate Iron Removal filter



Nano Lase



Multi Fab

In Technical service domain, a new area i.e. Measurement and Validation of UV-C (254 nm) Doses for Sterilization Application to Inactivate Microorganisms in recent Covid 19 pandemic situation has been initiated which also gets authorization from ICMR for certification. Different industries have been served for the purpose like Mattechs Solutions Pvt Ltd, Nash Industries (I) Pvt. Ltd etc.

With the expertise towards water purification domain, another new area has been adopted in our department towards testing of water filtration media and different water purification system of Industries. Unicare Technologies Pvt. Ltd. Has been one of the beneficiary of this area. Tractor Mounted Sprayer for Reduction of Air Pollution has been successfully developed and demonstrated to M/s. Gagan Ferrotech Ltd., Jamuria.

## R&D Facilities

This group has state-of-art experimental research facilities like X-ray Diffractometer, Atomic Force Microscope, UTM (50 kN Capacity), Fourier Transformation Infra-Red (FT-IR) Spectrophotometer, Thermal Analyzer, Ultraviolet-visible Spectrophotometer, High Speed Imaging System, Digital Phosphor Oscilloscope, High Temperature Tribometer, Hot Press Sintering Furnace etc.

## Glimpse of Few R&D Project Activities

**Title: Development of CNT-Reinforced Alumina Composite for Wear-Resistant Applications**

**Project No: GAP 225812**

**Project Cost: 43.04 Lacs**

**Sponsored Agency: SERB, New Delhi**

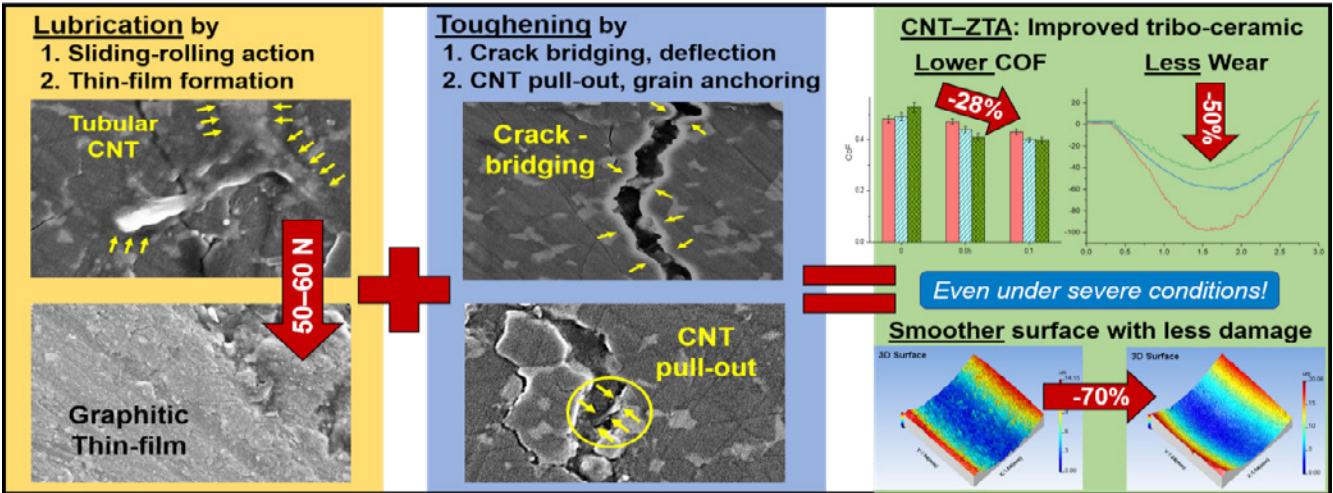
Alumina ceramic is well known for structural application due to its superior hardness, chemical inertness and electrical/

thermal insulation properties. However, brittle nature of alumina often restricts its industrial adaptation. Generally, high brittleness in alumina ceramics is resulted due to the evolution of pores and cracks during its preparation. However, development of structural devices/ tools using CNT/Al<sub>2</sub>O<sub>3</sub> composites overcome certain challenges which include

- Optimization of CNT incorporation to alumina ceramics
- Dispersion of CNTs in alumina matrix
- Compaction and sintering in controlled atmosphere

In view of the same, in the project, fabrication of ZTA-CNT nano composites using two different methods (Spark plasma sintering and hot-press) was quite successful. Various proportions of CNT (i.e. 0.02, 0.05, 0.1, 0.15, 0.20, 0.25, 0.30) wt% were incorporated into ZTA matrix without any agglomeration. The micro-hardness increased to a maximum of 2130.64±10.07 Hv (an increase of 3.74% over base matrix) for 0.15 wt% CNT addition to ZTA. The fracture toughness increased to a maximum of 5.8396 ± 0.8625 MPam<sup>1/2</sup> (an increase of 11.75% over base matrix) for 0.02 wt% CNT addition to ZTA. Additions beyond the 0.15 wt% of CNT are observed to have a detrimental effect in terms of mechanical properties. However, 0.10 wt% of CNT addition provided optimum mechanical properties. The same composition is sufficient to improve the friction coefficient and specific wear rate of zirconia-toughened alumina by up to 28.3% and 51% respectively. Dry sliding tests under normal loads of 40-60 N for a sliding distance of 1000 m reveal a load-dependent transition in the lubrication mechanism – CNTs retain their tubular morphology at low loads and reduce friction via a sliding-rolling response, whereas high sliding loads trigger the formation of a thin, lubricating film by the repeated crushing and smearing of exfoliated nanotubes





Therefore, ZTA matrix with 0.10 wt% CNT reinforcement has been chosen for fabrication of cutting inserts after considering the overall mechanical and tribological properties of the composites. The fabrication of one cutting inserts (SNGN 120408) has been done with the help of an industry. Apart from that, cost effective pressure-less sintering process is also initiated towards fabrication of CNT-ZTA composite as well as cutting inserts. The comparative study regarding the performance of the inserts will be carried out soon.

**Title: 2D Transition Metal Layered Double Hydroxides: A Cost- Effective Catalyst for Hydrogen Production by (Photo) Electrochemical Water Splitting**

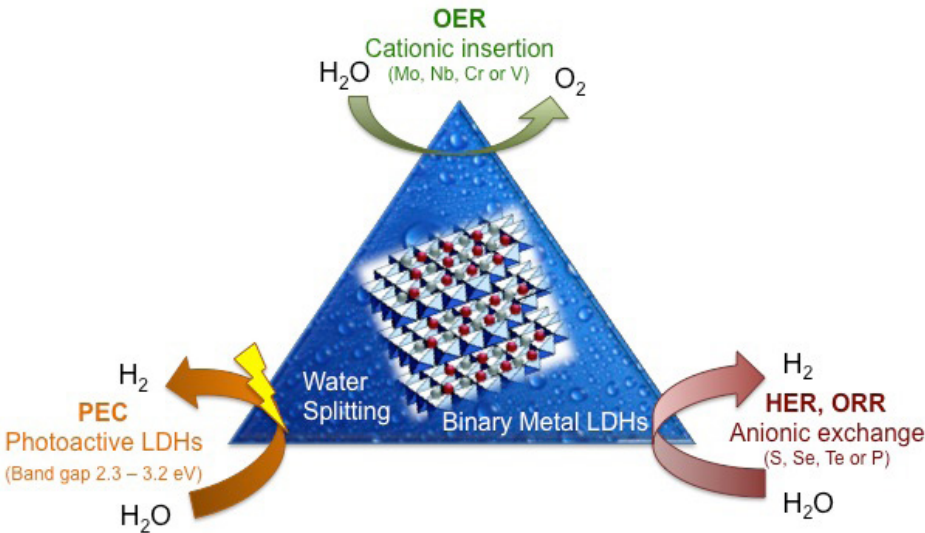
Project No. GAP228312

Project Cost: 96.43 lakhs

Collaborators: CSIR-CECRI, CSIR-IICT

Sponsored Agency: DST, India

The project has been devoted extensively on development as well as possible modifications of special layered double hydroxides to boost up various electrochemical as well as photoelectrical mechanisms involved in electrocatalytic as well as photoelectrocatalytic water splitting. Indeed, such materials have drawn much attention due to their special properties much applicable for efficient hydrogen production by water splitting.



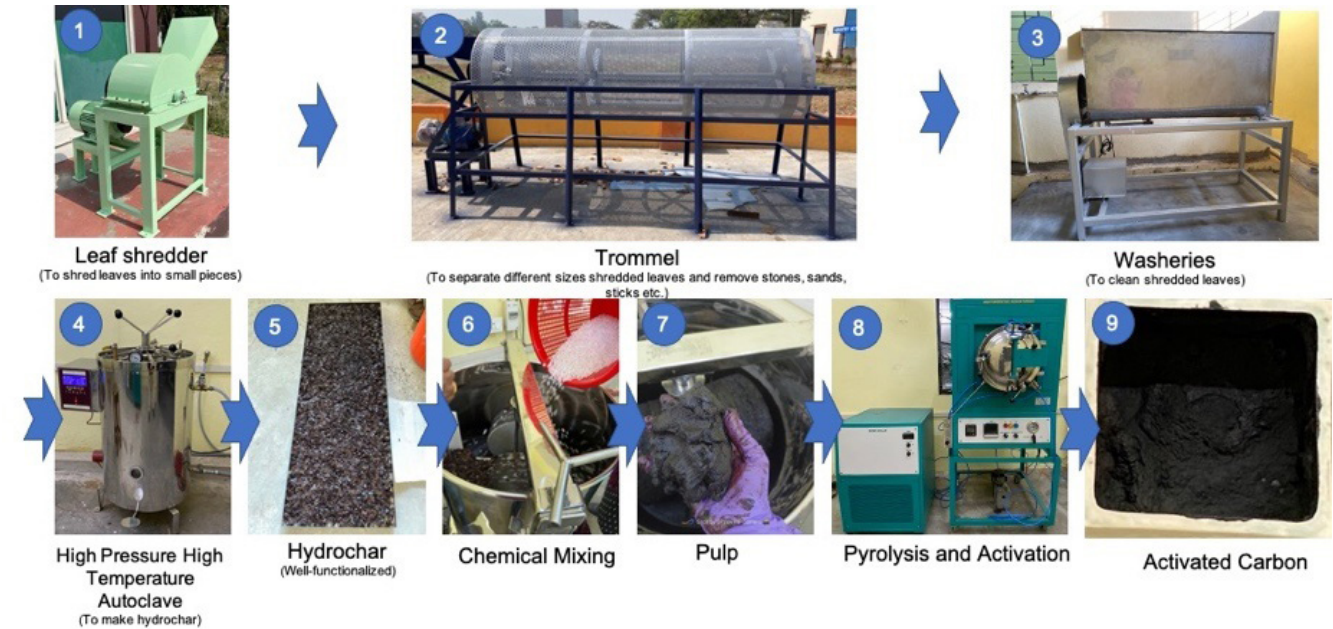
**Title: Batch Scale Production of High Quality Activated Carbon from Biomass Wastes for Waste Water Treatment – An Initiative towards Waste to Wealth**

Project No. MLP230012

Project Cost: 85.464 lakhs

Sponsored Agency: CSIR, India

The open burning of dry leaves and agro wastes is one of the major environmental threat now-a-days. Thereby safe disposal and the conversion of such bio wastes in to value-added product is much desired. The project emphasized the production process of porous carbon of high surface area from biomass waste by controlled carbonization as well as chemical treatment to achieve the material with desired properties.



**Title: Laser forming of aluminium foam plate to produce curved surfaces**

Project No: GAP224112,

Project Cost: ₹ 36.17 lakhs,

Sponsored Agency: SERB, India

Metal foams are emerging class of materials for diverse applications shown in Fig. 1. Aluminium foam/foam sandwich are most widely used. The problem of its limited formability under mechanical load is being overcome using laser forming. Experimental and numerical studies on laser forming of closed cell and open cell aluminium foams (Fig. 2-3) and aluminium foam sandwich under this project revealed robustness of laser forming being used to form aluminium foam/sandwich for Industrial applications.



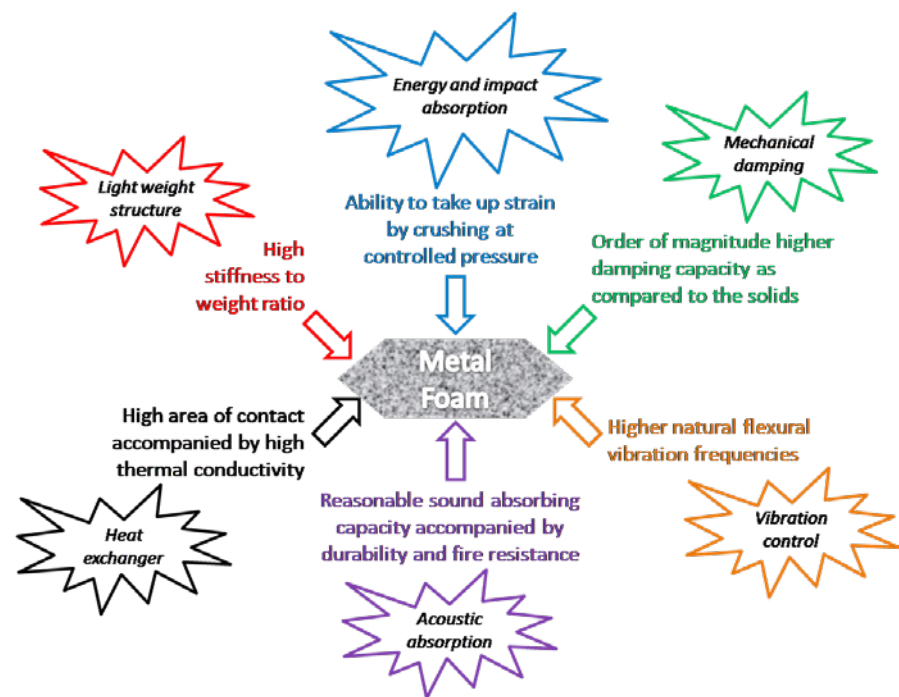


Fig 1. Diverse application potentials of metal foam.  
(<https://doi.org/10.1016/j.jmapro.2020.10.012>)



Fig. 2. Laser forming of closed cell

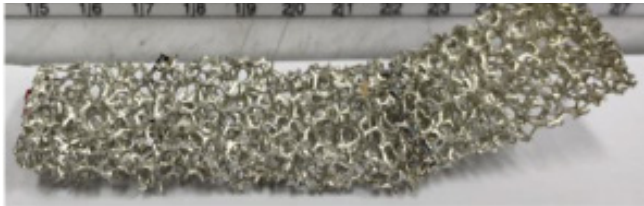
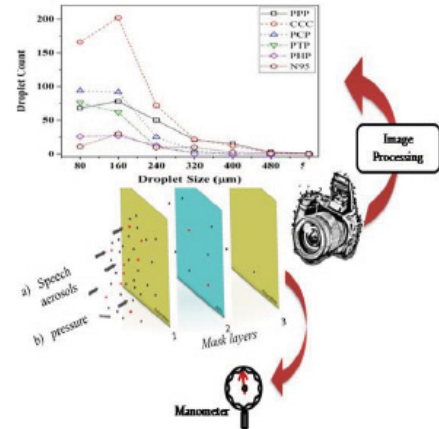


Fig. 3. Laser formed open cell Aluminium foam

FURTHER RESEARCH ON COVID-19

Effectiveness of Different Facemask Materials to Combat Transmission of Airborne Diseases

This investigation compares the effectiveness of five different 3-layered masks with N95 mask in terms of pressure drop and aerosol filtration capabilities. Different combinations of cotton, polypropylene fabric, tissue and high-efficiency particulate air (HEPA) were used as mask materials. In comparison to N95 mask, the result shows that the 3-layered cotton mask has much lesser pressure drop but least droplet filtration efficiency, while polypropylene-HEPA-polypropylene mask is seen as the best cost- effective alternative to N95 in terms of droplets filtration efficiency and breathability.



(<https://doi.org/10.1007/s12046-021-01634-z>)

रोबोटिक्स एवं स्वचालन  
Robotics and Automation

Introduction:

The ‘Robotics & Automation (R&A) Group’ at CSIR-CMERI is executing R&D projects to address requirements of civilian, industrial, strategic as well as societal sectors. The group’s multidisciplinary activities include development of various components and technologies in Industrial Robotics, Underwater and Terrestrial Robotics, robotics for Rehabilitation and Healthcare and Security and Surveillance. In FY 2021-2022, R&A Group carried out CSIR and various external agency (namely, DRDO, DST) funded projects, a few of which concluded and the rest are ongoing. Notably, R&A group executed projects with international collaboration, namely Indo-Korea Joint Network Centre on Robotics (IKJNC) under DST (India)–NRF (Korea) agreement and CMERI-LIRMM (CNRS) Indo-France collaboration through CEFIPRA funding.

The Group has the following recent activities:

- ▶ Development of Compliant Actuators with Mechanical Impedance Variability
- ▶ Design of a Smart Material based Soft Lower Limb Exoskeleton to Assist Soldier
- ▶ Design and Development of a Suite of Sensors and their Characterization for Perimeter Surveillance
- ▶ Human Intent Identification for ‘Motion and Impedance Control’ of Assistive Devices for physical Human Robot Interaction and Implementations
- ▶ Multi-agent collaboration- A human intent based mobile robotics framework for complex manipulation in the warehouse environment
- ▶ Development of Drone related Technologies for Society Oriented Applications: Development of Manipulator for Drone
- ▶ Human Guided Impedance Control of Cobotic Arm
- ▶ Design and Development of a 1kw subsea thruster with 1500m depth rating
- ▶ Indo-Korea Joint Network Centre on Robotics Node 3: “Endoscope for Medical Applications”
- ▶ Development on Multi Robotic Wire ARC Additive Manufacturing

- ▶ Development of actuated exoskeleton based rehabilitative device for human hand
- ▶ Design and Development of Force Reflecting Hand Exoskeleton (Haptic Device) for Application in Remote Handling in Defence
- ▶ Design, Development and Supply of Two Lever Throttle Quadrant Box- SARAS MK II
- ▶ Development of ultra –precision coordinate measuring machine (UCMM) with sub-micron range uncertainty
- ▶ Development of screw extruder based additive manufacturing system for developing ceramic core to be used in turbine blade casting

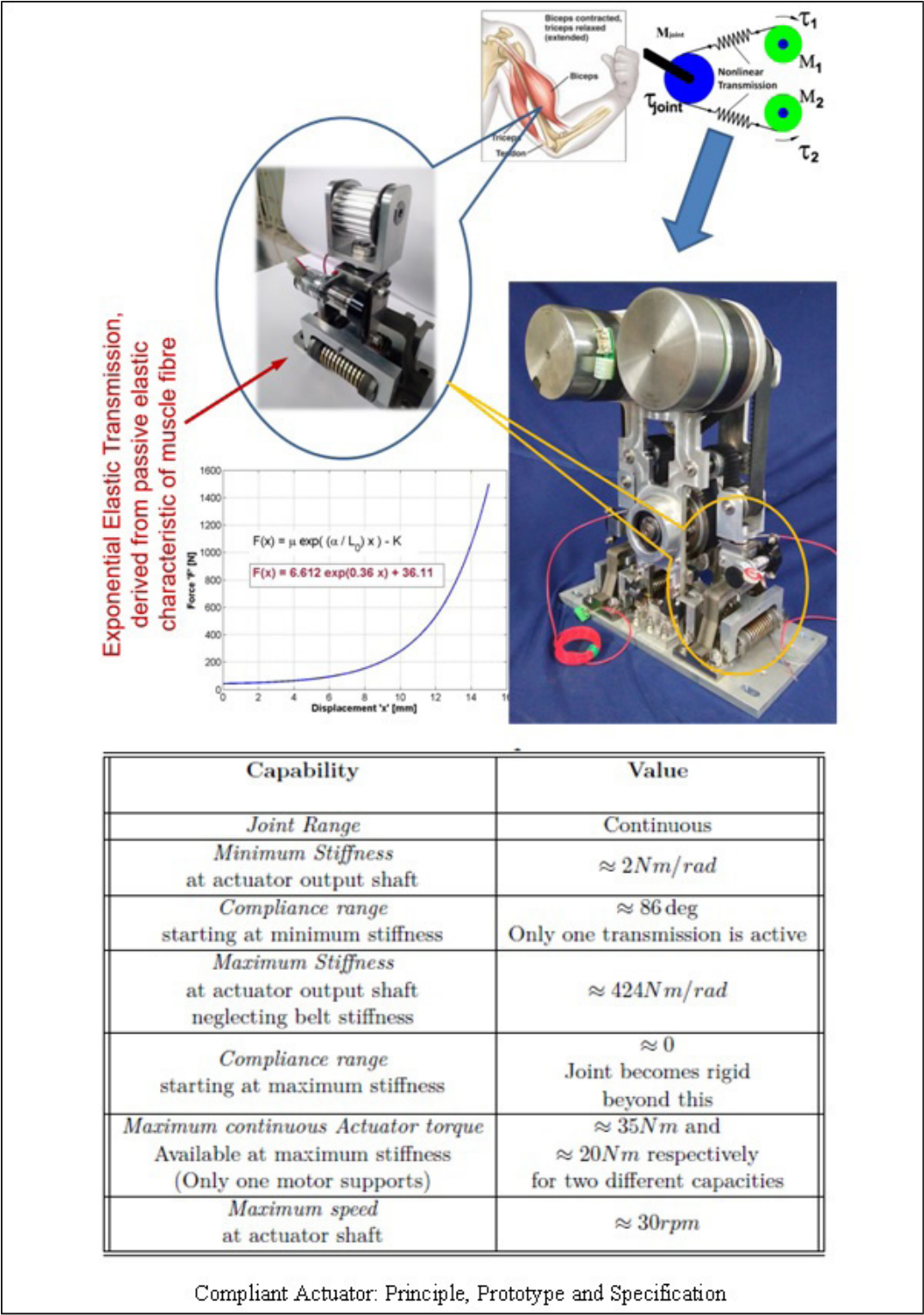
Activities in Detail:

I. Title: Development of Compliant Actuators with Mechanical Impedance Variability

The objective of the project is research on and design and development of actuators generating output motion with desired simultaneous variation of mechanical impedance, meant for physically interactive applications. Biological musculoskeletal actuation motivates the development. The objectives will be fulfilled through the following:

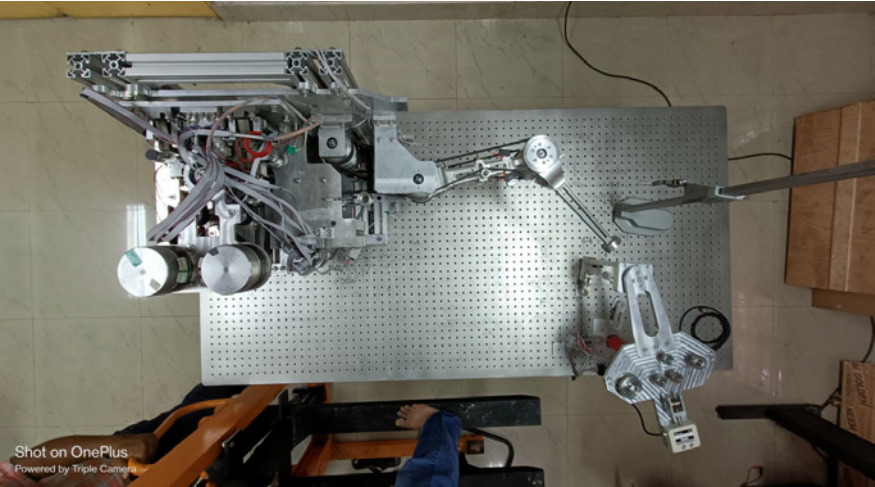
- I. Development of demonstrable prototypes of actuators
- II. Development of Planar 2-dof manipulator for proof-of-concept demonstration of compliance variability in robotic arm. The compliant actuators (see Figure) are developed with principles borrowed from biological musculoskeletal actuation system. Essentially, the actuators are driven by two Prime Movers (BLDC motors on harmonic drives) assembled in an Agonist-Antagonistic arrangement, having nonlinear elastic transmission interposed between the prime movers and the output power transmitting shaft. Stiffness variability is achieved antagonistically in a passive means, while, output motion is obtained through agonist action of the prime movers. The nonlinear transmission emulates the passive elastic characteristic of biological muscle fibres, eventually attaining an exponential behaviour (see Figure). The specification of the actuator is tabulated here.





To, demonstrate the effectiveness of the Variable Impedance Actuation, one planar Robotic Manipulator Arm, driven by the actuators above is also developed, where, the operational-space stiffness at the end-effector will be modulated as per

the task requirement, through simultaneous control of motion and stiffness variation. The Figure in the below shows the developed prototype of the manipulator.

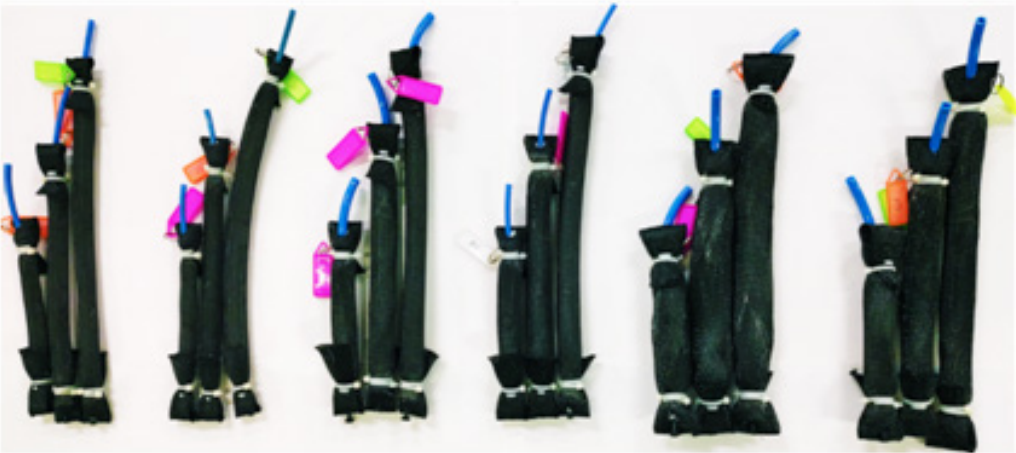


Prototype of Variable Impedance Arm

2. Title: Design of a Smart Material based Soft Lower Limb Exoskeleton to Assist Soldier [Project No: GAP 225912]

The main objective of the proposal is to design and develop a light weight soft exoskeleton suit that effectively improves soldier's walking efficiency during long walks with heavy packs and equipment without effecting natural walking gait. Pilot studies regarding the study and analysis of human walking gait has been completed in an indoor environment

on a motorized treadmill. Further, low pressure actuated pneumatic Artificial Muscle has been designed and developed in-house that gets actuated at an actuation pressure of sub 200 kPa and supporting an axial load up to 150N. The effect of various constructional as well as actuation parameters on the output of the actuator has been studies in detail. Complete behavioural modelling of the customized pneumatic actuator has been done using a metaheuristic algorithm tuned Artificial Neural Network method.



Title: Design and Development of a Suite of Sensors and their Characterization for Perimeter Surveillance

A laser based intrusion detection system is designed and developed for perimeter surveillance upto a range of 100 m. To accomplish intrusion detection over a range of 100 meters, a single pillar housing multiple laser beams pointing in various directions is designed and developed at CSIR-CMERI Durgapur. A communication interface transmits the data for all the range finders.

Salient Achievements

- Designed and developed master controllers for simultaneous monitoring of 9 lasers range finders for intrusion detection application.
- Development of IoT frame work for visualization of Intrusion activity
- Development of Solar charge controller for standalone deployment of surveillance tower in the remote area.
- Designed, developed, and installed a unique standalone surveillance tower prototype housing 9 LRFs, controllers, solar panel, and battery. Each tower can monitor 100 m range for any intrusion without blind spots.





**Title: Indo-Korea Joint Network Centre on Robotics: Node 3 activity “Endoscope for Medical A”**  
The collaboration is characterized by clear complementary contribution by development of concepts of mechanisms for

Steering of Endoscopy/ Colonoscopy head and sensor by CSIR-CMERI and concepts of mechanisms for *Locomotion* of Colonoscopy device by Korea Aerospace University (KAU). Please refer to Figures 1 and 2



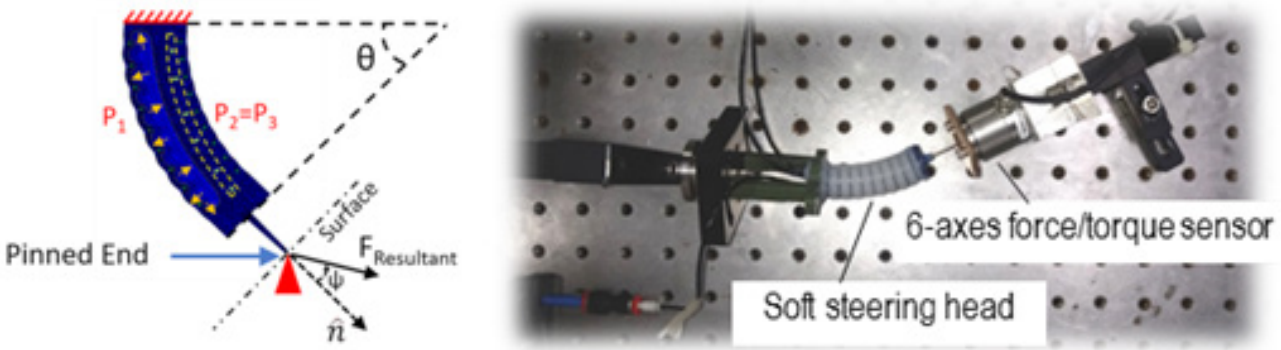
**Fig.1 Steering heads developed by CSIR-CMERI**



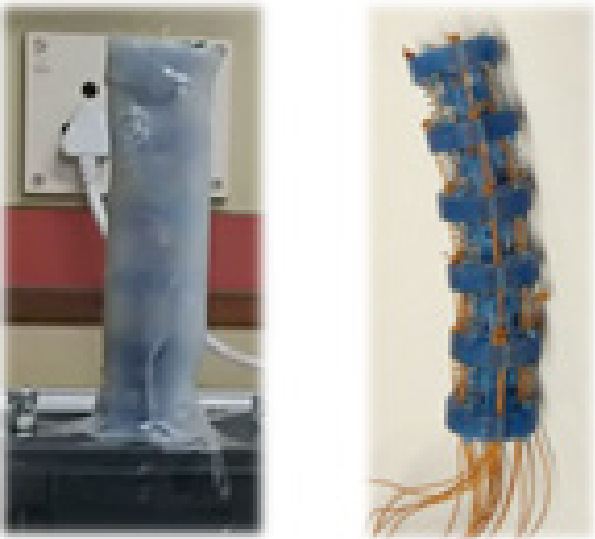
**Fig.2 Locomotion head developed by KAU**

CSIR-CMERI has come up with demonstration of two concepts of steering mechanism namely (i) Non-conventional steering mechanism developed upon biocompatible hyper elastic elastomer (silicone) based pneumatically driven soft actuator with embedded sensor, having force generation capability at the steering head (see Figure 3) and (ii) Hyper-redundant tendon driven manipulator based steering mechanism(see Figure 4).

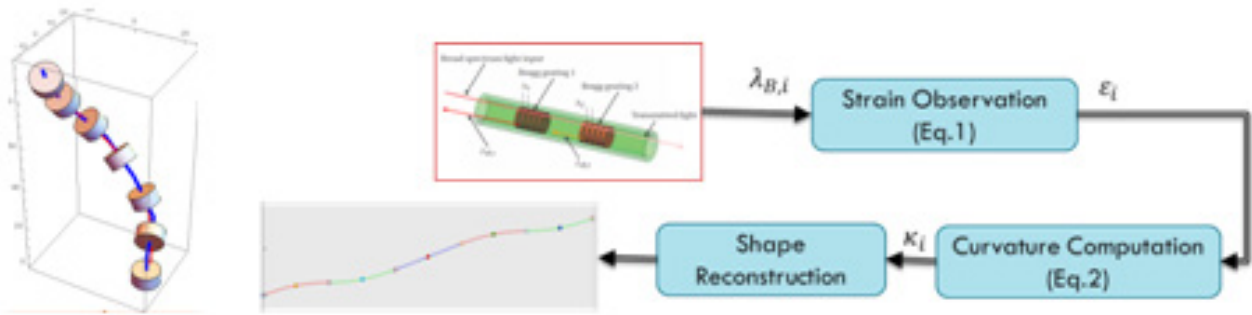
(iii) CSIR-CMERI has also developed *soft* force sensing element to be embedded on the silicone pneumatic actuator end, which has shown to be effective in sensing the contact force while executing some contact task such as needle aspiration (during biopsy etc.). (iv) CSIR-CMERI has initiated the development of multiplexed FBG (Fibre Bragg Grating) array based sensing system for estimation of instantaneous shape of the endoscopic device (see Figure 5).



**Fig.3 Ring-reinforced silicone based steering head with inbuilt needle having force exertion capability**



**Fig.4 Tendon-driven hyperredundant steering mechanism**



**Fig.5 Multiplexed FBG array based spatial shape estimation**



Based on the experience of the development of soft elastomeric actuators, CSIR-CMERI has also built and provided a 3-fingered Soft Gripper for the manipulator of a Quad-rotor UAV (drone), jointly developed by all the Indian participants (IITD, IITR, CSIR CMERI, NAL and CEERI) in the IKJNC integration project. The Soft gripper (see Figure 6) utilized single pneumatic channel driven reinforced fingers, actuated

by replaceable and rechargeable very lightweight pneumatic battery and a novel and simple pneumatic control that is highly suitable for aerial applications. The fingers, actuated at a pressure of 1.1 bar, could make possible a payload capacity of the gripper as high as 800gm with an endurance of 20 operation cycles.



**Fig. 6 Three-fingered Soft Gripper for UAV application**

A parallel activity carried out by CSIR-CMERI involved development of a low pressure Pneumatic Artificial Muscle (PAM), made up of hyperelastic silicone again (see Figure 7). Originally, miniature version of the PAM underwent feasibility study for development of steering head of the endoscopy/ colonoscopy devices. However, it was discarded due to difficulty in miniaturization. Nevertheless, the same PAM has been a candidate for the actuation system (agonist-

antagonistic) of the manipulator, envisaged for the UAV (drone) under development in the integration activity. Notwithstanding this, the manipulator for the final drone was designed to be actuated by electric servo motors only at IIT Delhi. Though it was not used in the present drone-manipulator system, it remains to be a viable option for manipulator actuation. The development of the PAM will be reported in the final project report of Node-3



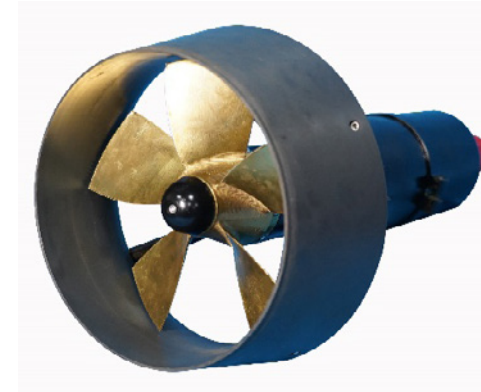
**Fig.7 Low pressure Pneumatic Artificial Muscle (PAM) developed by CSIR-CMERI using hyper elastic silicone, intended for actuation of UAV manipulator.**

## Title: Design and Development of a 1kw Subsea Thruster with 1500m Depth Rating

Subsea thruster is a device capable of generation of propulsive force through rotary motion of the propeller. Subsea thrusters are the primary propulsion devices for underwater vehicles. Imported thrusters are very costly due to its design complexity for underwater use. Very few companies worldwide (like Tecnadyne, USA; Sub-Seaeye, UK etc.) make thrusters having 1 kW power rating. Besides, thrusters for operation to depth greater than 1000 m are subjected to export restrictions of the respective foreign governments.

### Salient Achievements

- ▶ Designed and developed a radial magnetic coupling with 5.51 N.m pull-out torque for thruster application.
- ▶ Designed and development of a compact BLDC motor driver suitable for thruster application.
- ▶ A five bladed Ka 5-70 propeller, capable of producing 21 kg.f at 1200 RPM, is successfully designed and manufactured.
- ▶ Successfully integrated and tested the thruster prototype.

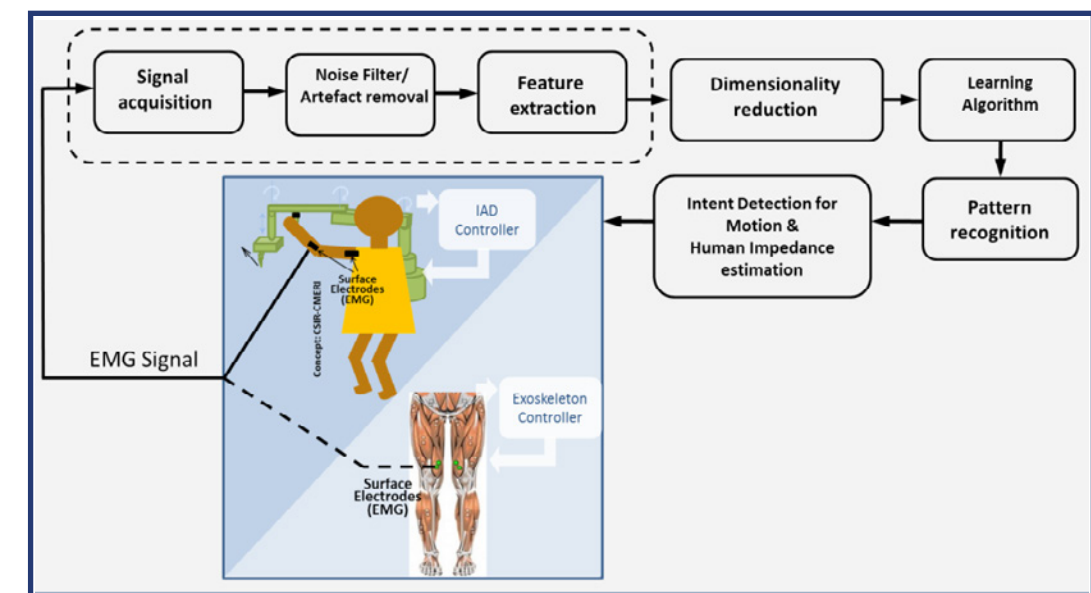


## Title: Human Intent Identification for 'Motion and Impedance Control' of Assistive Devices for physical Human Robot Interaction and Implementations

The project aims to imbibe the sense of motion and ability of impedance modulation of human in robotic assistive devices driven by compliant actuation for physically interactive tasks

The objective of the project is to develop human intent identification techniques, using motion, force and bio-signals, develop various compliant actuation systems and apply the same to control movement and impedance of the actuators. Specifically, the activities of the project include –

- Human intent (motion and impedance) identification and interpretation through trained model using signals, and sensed force & motion information
- Design, development of Compliant Actuators for assistive robotic devices
- Demonstration of intent and impedance identification through rendering on compliant actuators.



Signal flow in the concept of user intent identification: detection of motion intent and estimation of human impedance

## Title: Multi-agent collaboration- A human intent based mobile robotics framework for complex manipulation in the warehouse environment

The project is aimed to be an information hub that would remain in the forefront of human-machine intelligence. Warehouse management or shopfloor management involving a large area normally puts to use a fleet of mobile robots to accomplish the required tasks. Operating multiple robots coherently to accomplish time-constrained tasks is a challenge in itself, which involves coming together of multiple engineering disciplines. While at a lower-level control and path planning becomes a necessity, a robust fail-safe communication architecture is also required for the robots to inter-communicate amongst themselves. At a higher cognitive level the robots are expected to work in tandem with the human operators, capable of understanding gestures or facial expressions. For example, instead of typing up an instruction on the keyboard

for a fleet of mobile robots to go to a certain area, the human operator should be able to point to the destination and the robots should have the cognition to recognize the order and perform the required movement. Much of the same holds true for intelligent shopfloor management albeit with a different set of tasks to accomplish at a higher level, for example transporting jobs from one workbench to another.

### Title: Human Guided Impedance Control of Cobotic Arm

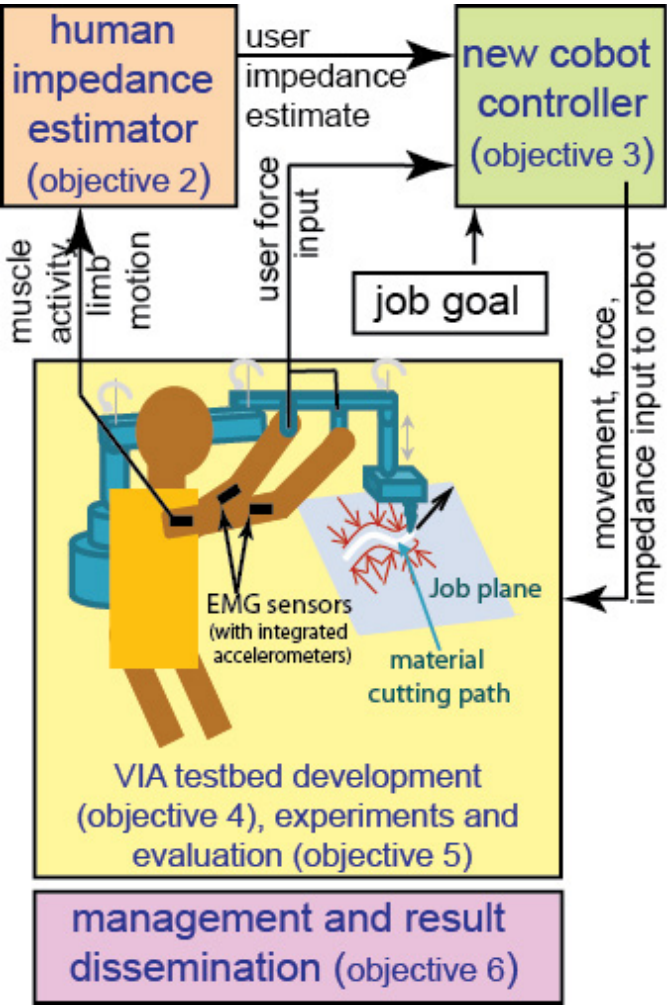
This is a project funded by Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA) being executed by CSIR-CMERI in collaboration with CNRS-LIRMM, Montpellier, France.

Present day robots still suffer from inadequacies in their perceptive and cognitive abilities. This constraints them from interacting with unstructured environments and humans. Collaborative robots (Cobots) offer a promising solution in this



regard, enabling the strength and precision offered by robots, to be complemented with the dexterity and cognitive abilities of a human. However, while current Cobots offer efficient human guided movements, they are still limited in their use in physical interaction tasks like contact tooling and physical interaction with humans. This is because, current cobots lack the ability to regulate impedance, which is fundamental for physical interaction tasks. On the other hand, again, humans are adept in the ability to implicitly vary mechanical impedance of limbs to control and stabilize interactions. Consequently, this project develops a human guided impedance controller for cobots. The project (1) estimates the impedance changes in a human cobot operator by utilizing electromyography (EMG), along with hand force and accelerometers, (2) develops a relevant impedance controller for a cobotic (a) active controlled manipulator, and (b) a manipulator driven by variable impedance compliant actuators, and (3) develops the test bed and experimentally evaluate our controller on an industrial jig saw cutting and hammering task. The new controller will greatly expand the applications for cobots, enabling them work in tasks requiring physical interaction,

such as contact tooling, and physical assistance of humans. There are significant challenges in the project that will be addressed as six objectives and are delineated (with timeline and deliverables) in the detailed proposal document. To summarize, the project makes an in-depth review of human impedance estimation techniques and cobot control. This will be used to develop a technique for real-time estimation of change in human impedance (qualitative) using user electromyography, force and movement information, activity led by CNRS-LIRMM. The impedance estimation will be integrated with the controller of a cobotic arm for impedance regulation and agin lead by CNRS-LIRMM. A variable impedance actuated (VIA) manipulator will be developed in parallel on the Indian side (CSIR-CMERI). The novel cobot controller will be implemented on a commercial manipulator for an experimental tooling task at CNRS-LIRMM and on the VIA manipulatorfor a chosen task at CSIR-CMERI. Test and evaluation will be performed on the cobotic manipulator test beds for the toolingtasks jointly. The below figure illustrates the overall activities of the project being carried out.



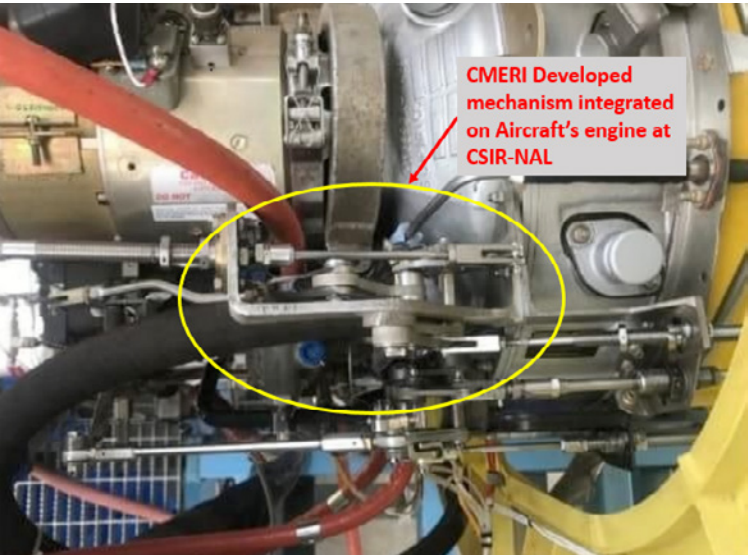
Schematic of experimental test bed and implementation of various objectives for an exemplar tooling task

**Title: Design, Development and Supply of Two Lever Throttle Quadrant Box for SARAS MK II**

A twin engine turbo propeller aircraft will have six levers, three for each engine, for controlling the engines' thrust, propeller RPM and fuel flow – cut-off, ground idle and flight idle. Reducing the number of control levers in the cockpit without affecting the overall functionality of the engines not only adds to the simplicity of the throttle quadrant box in the cockpit but also it reduces the pilot workload and ease of operation. The present work involves design and development of a two lever quadrant box, through combining functionality of fuel condition lever and constant speed unit lever, for SARAS MK-II aircraft.

**Salient Achievements**

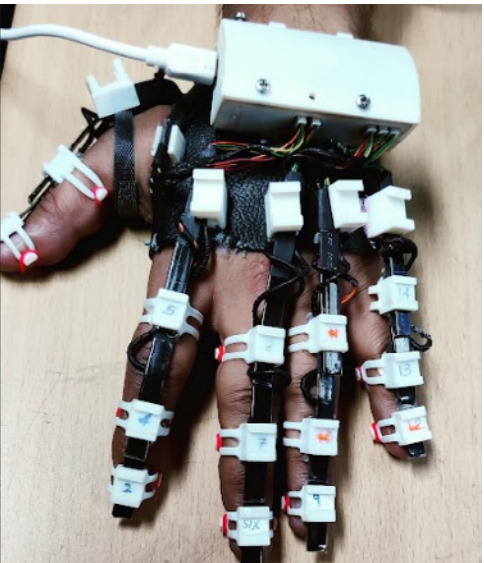
- Design and development of intermediate cam mechanism which generates output motion for fuel condition and constant speed units with single lever motion input from cockpit.
- Dynamic simulations studies have been carried out to confirm the functionality of the mechanism, to estimate the actuation force requirement, and to provide inputs for design iterations.
- Prototype of the mechanism is successfully integrated with the turboprop engine and tested.



**Title: Development of Actuated Exoskeleton based Rehabilitation Device for Human Hand HCP-26**

The objective of the work was to design and development of wearable exoskeleton based therapeutic device for

rehabilitation of functional impairments in human hand. An 18 DOF hand motion sensing system has been developed where, the undersigned was responsible for design, development and implementation of electronic circuitry for acquisition of signals from multiple flex sensors.

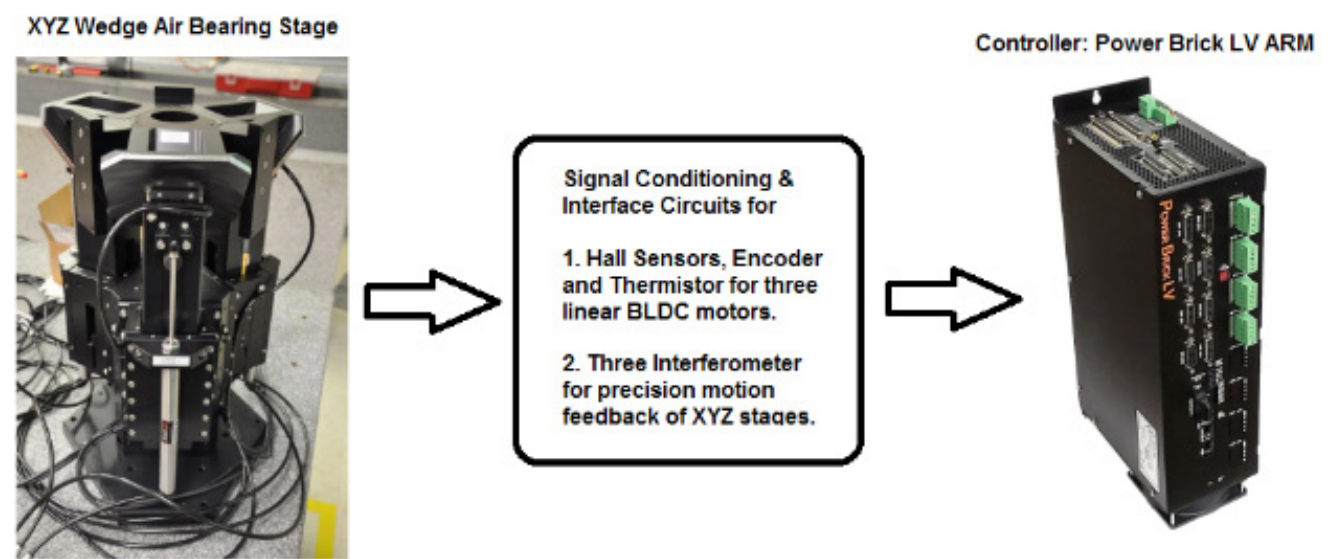




Title: Development of Ultra-precision Co-ordinate Measuring Machine (UCMM) with Sub-micron Range Uncertainty

Detailed study of subsystems of the “XYZ Wedge Air Bearing Stage” and the selected controller “Power Brick LV ARM” is done to finalize the requirements for signal conditioning & interface circuits for proper interconnection. Design of hardware circuit schematics with BoM and PCB layout design is carried out for two separate PCBs responsible for

(a) Interfacing of hall sensors, encoders and thermistors from three linear BLDC motors of XYZ stage to the controller, (b) Interfacing of three multi-beam interferometers for precision motion feedback of XYZ stage to the controller. Proper interfacing of these signals is essential for implementation of close loop servo control of the XYZ stage by means of the selected controller. Figure 1 shows the block diagram representation of signal flow for the complete system.



सतह इंजीनियरिंग और ट्राइबोलॉजी  
Surface Engineering and Tribology

I. Activities/ Overview of Department

The main goal at Surface Engineering and Tribology Group is to steer the development of technology from the advances in science and engineering research carried out through collaborative and innovative mode of research in science and engineering. The group is comprised of interdisciplinary team of Engineers & Scientists from having Mechanical Engineering, Electronics Engineering and Material/Chemical Science background. The efforts are still in nascent stages; however, some of the developed technologies have transferred to industry.

Currently we have 9 Scientists, 1 DST INSPIRE Faculty Fellow, 24 PhD Scholars and 5 Technical Staffs

This group provides a platform in emerging frontiers of Nanoscience and Engineering for masters' level students for carrying out research leading to PhD degree awarded by Academy of Scientific and Innovative Research (AcSIR), New Delhi.

Research Focus:

- ▶ Graphene based Ultracapacitor
- ▶ Foil and Gas bearings
- ▶ Nano-lubricants & composite coatings
- ▶ Micro / nano scale manufacturing systems
- ▶ Large scale graphene oxide production
- ▶ Synthesis of new molecules for sensors applications

These research activities are augmented by the state of art and well equipped experimental facilities, mostly designed and developed by CSIR-CMERI.

Testing Services

We also undertake different technical services based on the needs of industry including testing.

Some R&D Projects:

- ▶ Graphene Ultracapacitor Module to integrate with Electrical Power Supply for Hybrid Unmanned Ground Vehicle and other Pulse Applications (DRDO)
- ▶ Synthesis of Single Layer Graphene & Polymer Nano-Composite (DST)
- ▶ Design and Development of Multi Material Deposition (MMD) system (DST)
- ▶ Design and Development of Hollow Crankshaft for Automobile(Indo-German project)Low level Fluoride detection by cost effective chemosensor along with the mitigation of excess fluoride from different water resources by using naturally abundant indigenous adsorption material

- ▶ Design and development of electro hydrodynamic ink jet printing system(DST)
- ▶ Developing manufacturing technology of graphene based polymer composite for mechanically stable and thermally durable automotive components(DST)
- ▶ Developing an Optimum Thrust Pads, Bushes, and Shaft Design of a Multistage Submersible Water Pump for “SMART” Applications(DHI)
- ▶ Graphene based Aqueous lubricants(CSIR-FTT)

II. Projects:

Title: Finding the Correlation between Magnetic Field-enhanced OER Catalytic Activity and Spin-state of Fe-based materials [Project Cost: Rs. 25.09 Lakhs, Duration: 22/03/2022 to 21/03/2025, Project No: GAP 238212]

Objectives:

- ▶ Development of Fe-based electrocatalysts with varied spin-states
- ▶ Investigation of magnetic-field induced enhancement in OER catalytic activity of these electrocatalysts
- ▶ Formulation of a generalized correlation between the magnetic enhancement in catalytic activity and the spin-state of the electrocatalysts
- ▶ Correlate the extent of magnetic-field mediated enhancement in activity with the direction and magnitude of the field
- ▶ Optimization of the direction and magnitude of the electromagnetic field for achieving the highest efficacy
- ▶ Development of Fe-based OER electrocatalyst with highest improvement in activity owing to the application of external magnetic field

Deliverables:

- ▶ A generalized correlation would be obtained between the magnetic enhancement OER catalytic activity and the spin-state of an electrocatalyst which would lead further progress in this field of magneto-electrochemistry
- ▶ The effect of direction and magnitude of the applied field on the spin-state splitting in an electrocatalysts and its OER catalytic activity would be established
- ▶ These understanding would help in optimizing the electromagnetic setup to achieve the most efficiency in water electrolysis and the process could be performed at its thermodynamic minima i.e., 1.23 V
- ▶ Development of Fe-based electrocatalyst towards the magnetic-field-enhanced OER catalytic activity



- ▶ An electromagnet-mounted electrolyzer setup with superior performance could be constructed with the help of the obtained outputs
- ▶ The outputs obtained from this project will open up novel pathways towards the energy conversion and storage with the help of magneto-electrochemistry

Achievements:

Project started on March 22, 2022

**Title: Fabrication of High Energy Density Supercapacitor Pouch Cell using Chemically derived Meso-porous Graphene-based Composite Materials [Project Cost: Rs. 19.088 Lakhs, Duration: 18/03/2021 to 17/03/2024, Project No: GAP 234912]**

Objectives:

- ▶ Synthesis and characterization of graphene-metal oxide composite electrode for supercapacitor applications
- ▶ Evaluation of electrochemical performance of the graphene-metal oxide composite electrode
- ▶ Fabrication of 2 inch × 2-inch pouch cell supercapacitor with cell potential of 2.0-2.5 V and cell capacitance of 200-250 F
- ▶ Development of scaled down model of automobile parts using graphene-based composites.
- ▶ Performance evaluation and safety parameter investigation of the supercapacitors

Deliverables:

- ▶ 2 inch × 2-inch pouch cell supercapacitor with cell potential of 2.0-2.5 V, cell capacitance of 200-250 F and energy density of 15-20 Wh/kg

Achievements:

Incorporation of lanthanum in nickel-tin oxide/rGO composite crystal structure through one-step facile hydrothermal method. The overall electrochemical activity was enhanced by inducing defects created by doping of lanthanum. The optimized composite exhibited ~ 1238 F g<sup>-1</sup> specific capacitance at 3 A g<sup>-1</sup> current density using 6 M KOH as electrolyte.

**Title: Graphene Ultracapacitor Module to integrate with Electrical Power Supply for Hybrid Unmanned Ground Vehicle and other Pulse Applications [Project Cost: Rs. 472 Lakhs Duration: Nov, 2017 to May 2022, Project No: GAP219012]**

Objectives:

- ▶ Fabrication of cylinder type 18650 graphene ultracapacitor with rated voltage of 1.6-3.0 V, cell capacitance of 100-150 F and ESR < 1 ohm
- ▶ Development of ultracapacitor module for 24 V/20 A power bank

- ▶ Design and development of high efficiency power converters considering bidirectional power flow
- ▶ Implementation of power sharing strategies and control algorithms with an aim to cater the peak power demand from ultracapacitor, which in turn helps to reduce the peak power transfer stress of battery

Deliverables:

- ▶ 18650 graphene ultracapacitor with rated voltage of 1.6-3.0 V, cell capacitance of 100-150 F and ESR < 1 ohm
- ▶ Ultracapacitor module for 24 V/20 A power bank
- ▶ Power sharing strategies and control algorithms with an aim to cater the peak power demand from ultracapacitor, which in turn helps to reduce the peak power transfer stress of battery

Achievements:

- ▶ Fabricated Graphene ultracapacitor cell, Cell Capacitance: 56F, Voltage: 2.7V, ESR: 0.2 ohm
- ▶ 24V/20A power bank developed using Maxwell Ultracapacitor
- ▶ Developed 2 phase interleaved bidirectional power converter having 30A peak per channel
- ▶ Developed algorithm for peak power sharing from ultracapacitor and validated in hardware; battery life-cycle improvement is done in simulation

**Title: Rational Design of Binder-free Self-Supported Air Cathode for Rechargeable and Flexible Zinc Air Batteries: An Encouraging approach for Sustainable Energy [Project Cost: Rs. 35 Lakhs, Duration: 02/09/2021 to 01/09/2026, Project No: GAP237012]**

Objectives:

- ▶ Fabrication of robust air cathode for oxygen electrocatalysis to compete with the state-of-the-art electrocatalysts
- ▶ Design of binder-free electrodes using flexible substrates [carbon cloth, electrospun nanofiber (ENF) mats, stainless-steel mesh etc.] via chemical or electrochemical methods
- ▶ Rational design and development polymer gel electrolyte with stretchable and bendable property for flexible devices which will display a promising future with no electrolyte leakage and dendriteformation
- ▶ Fabrication of flexible Zn anode to cope-up with mechanical or electrical failure during continuous bending and stretching of the Zn anode

Deliverables:

- ▶ Flexible, foldable and stretchable Zn-air battery for wearable electronics such as smart watches and glasses, activity trackers, healthcare devices and so on
- ▶ Zn-air battery driven water-splitting device which can further be used for fuel cell applications

Achievements:

Bimetallic alloys have been designed which shows excellent trifunctional electrocatalytic rivalling to that of the commercially available electrocatalysts.

**Title: Establishment of Science Technology & Innovation Hub at Kanska Block, Paschim Bardhaman District, West Bengal [Project Cost: Rs. 62.85420 Lakhs, Duration: March, 2022 to March 2025]**

Objectives:

- ▶ Design and development of process technology for Sal butter from Sal seed
- ▶ Design and development of semi-automated system to mechanize the said process technology for enhancement of production and product-quality

Deliverable:

- ▶ Technologies for Sal seed butter– 1 no at pilot site and 1 no for R&D purpose

**Title: Development of Compressed Hydrogen Composite Storage Tank for Fuel Cell Electric Vehicles**

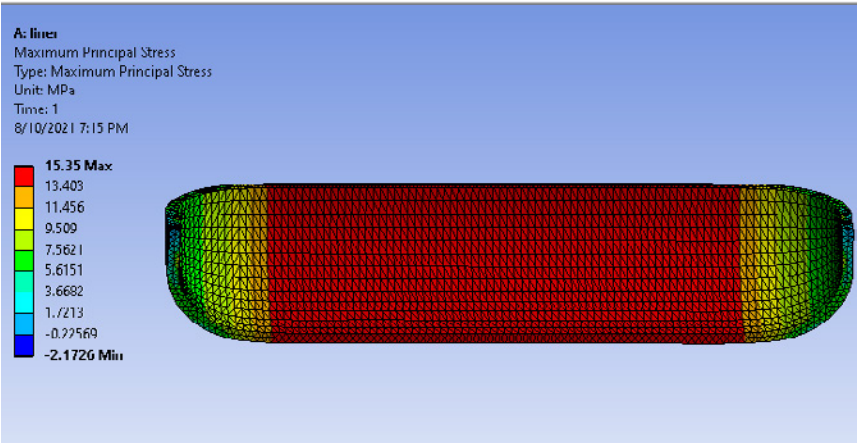


Figure 1: on liner of type IV tank of 12.5 mm thickness under 1.595 Mpa using maximum principal stress theory

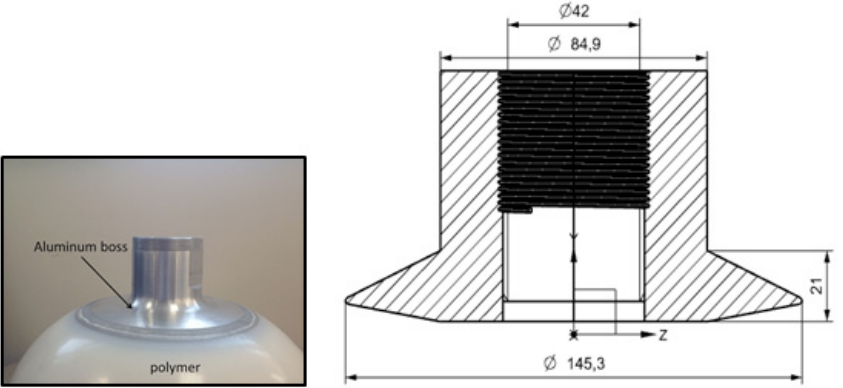


Figure 2: HDPE liner fitted with aluminum boss



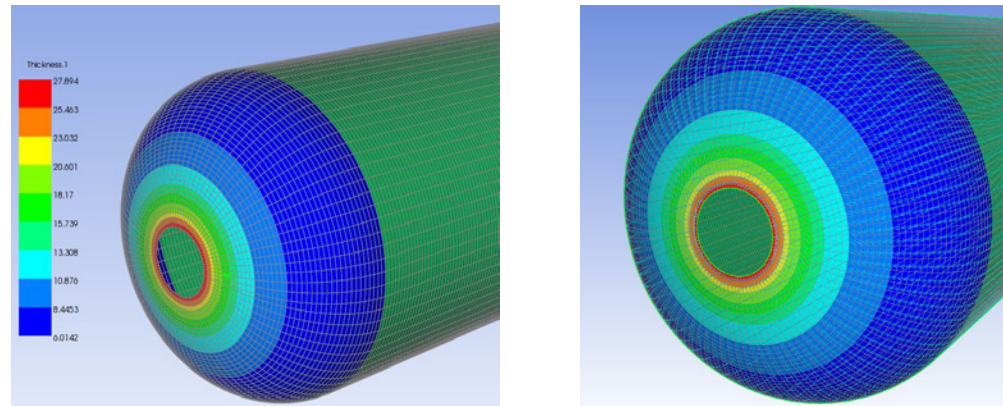


Figure 3: 3D model of composite layer using ANSYS ACP

- ▶ Epoxy matrix property enhancement using graphene reinforcement.

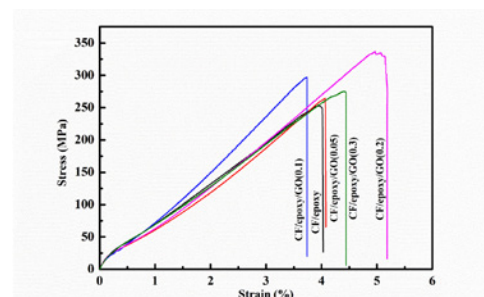


Figure 4: Stress-strain properties of the functionalized graphene/CF/epoxy composite

**Title: Design and Development of Graphene Reinforced Carbon Fiber/Epoxy Composite based Light Weight High Pressure Hydrogen Storage Cylinder for Vehicular Application**

**Objectives:**

- ▶ Improvement of mechanical strength and modulus by 30-40% of epoxy matrix by reinforcing graphene.
- ▶ Finite Element modeling of hybrid composite structure based on higher order shear deformation theory.
- ▶ Development of manufacturing technology for Type IV composite hydrogen storage cylinder with lower composite material usage, cost & higher efficiency.
- ▶ Fabrication of Experimental Prototype of light weight hydrogen storage tank with approx. dimension of 100-150 mm diameter and 300-400 mm length.

**Deliverables:**

- ▶ High strength and low weight composite material.
- ▶ Composite material with low-permeability and damage tolerance under static burst, fatigue and impact loading conditions.
- ▶ Finite element model of hybrid composite structure using

higher order shear deformation theory.

- ▶ Experimental Prototype of light weight hydrogen storage tank with approx. dimension of 100-150mm diameter and 300-400mm length which is capable of storing hydrogen at 700 bar pressure.

**Achievements:**

- ▶ The composites of Carbon Fiber/Epoxy/GO with various loadings of GO are prepared
- ▶ Preliminary design of the composite pressure vessel was carried out using netting analysis
- ▶ FEM analysis of composite pressure vessels.

### III. Technical Service:

**Title: Lubricant Testing and Analysis [Project No: TSP 1315]**

- Technical Service Project: Lubricant Testing and Analysis (TSP-1315)

**Objectives:**

- ▶ To test and analysis the lubricant from various companies

**Deliverable:**

- ▶ 10 Generation of test report

# Skill Development Programme



India is a young nation with more than 54% people below 25 years of age. Number of people joining the workforce each year is more than 1 crore. Percentage of skilled workers in India is still very low. The **Skill India** mission of the Central Government set up a formidable challenge of skilling over 40 crore Indians in different industry related jobs. CSIR-CMERI under **CSIR Integrated Skill Initiative** programme

has introduced a large number of Skill/ Training Programs at various levels to train students, MSME workers, unemployed youth and also small entrepreneurs. These skilling/training programmes, carefully designed considering the country's requirement of skilled workforce, are linked to employment generation including small scale techno-preneurship. All the skill development programmes are being organised with minimal training fees, without charging the manpower cost of the institute, keeping in view the institute's contribution towards the Scientific Social Responsibility.

In the FY 2021-22, Skill Development Programmes (SDP) have been organized in different domains, like solar and other renewable energy systems, waste utilization, water quality evaluation, agricultural machinery, CAD, design & analysis tools, manufacturing processes, robotics, metrology & calibration, non destructive testing & characterization of materials, micro controllers & embedded systems, mechatronics, IoT, estimation & quality assessment of civil works, and many more. In the year 2021-22, many skill development activities were organized also through web lecture, online workshops and webinars due to the COVID pandemic restrictions.

Glimpses of some of the activities are provided below; details of the SDPs carried out by CSIR-CMERI, Durgapur and CoEFM, Ludhiana in 2021-22 may be found in the appended table.

Skill Development Programmes	Duration	Participants from
Tractor category MCV training to RAF personnel June 14-18, 2021		103 Bn RAF, Wazirabad, New Delhi No. of Participants: 17
Sheet Metal Fabrication	July 27-30, 2021	MSME and Small Scale Industries No. of Participants: 15
CAD Packages & Analysis Tools	August 02-05, 2021	MSME and Small Scale Industries No. of Participants: 11
Industrial Training on CAD, CAM & CAE	August - September, 2021	B. Tech. Students No. of Participants: 10
Water Quality Assessment	Oct. 05-06, 2021	UG Science Students No. of Participants: 21
Water Quality Assessment	Oct. 28-29, 2021	UG Science Students No. of Participants: 31
Automation, Control & Maintenance of Electrical System	Nov. 15-19, 2021	UG Engg. Students No. of Participants: 14
Analytical Techniques and Instrumentation for Water Quality Assessment	Nov. 25-26, 2021	UG Science Students No. of Participants: 30
Mass, Volume and Density Measurement	Nov. 26, 2021	Industry Working Personnel No. of Participants: 03



Skill Development Programmes	Duration	Participants from
System Integration using 8051 and PIC Microcontroller Platforms and Basics of 'R'	Nov. 27-Dec. 05, 2021	Industry Professionals No. of Participants: 05
Integrated Rural Solid Waste Disposal System (Manipur)	Nov 26, 27, 29, & 30, 2021 - 4 nos.	PHE Officials of Manipur and local beneficiaries No. of Participants: 80
Renewable Energy Systems	Dec. 06-10, 2021	Diploma Engg. Students No. of Participants: 32
Dimension, Mass, Volume and Pressure Metrology	Dec. 20-21, 2021	Industry Working Personnel No. of Participants: 09
Analytical Techniques and Instrumentation for Water Quality Assessment	Dec. 23-24, 2021	UG Science Students No. of Participants: 30
Estimation, Billing and Quality Assessment of Civil Works;	Dec 20-24, 2021	Diploma Engg. Students No. of Participants: 30
Understanding and Preparation of 2D Manufacturing Drawing (including 3D), using AutoCAD Software & BIS norms.	Dec 20-24, 2021	Diploma Engg. Students No. of Participants: 27
Advanced Material Characterization	Dec 27-28, 2021	Science & Engineering students, PhD scholars No. of Participants: 44
Foundry Technology and Practice	February - March, 2022	Local MSME (Foundry) Artisans No. of Participants: 10
CAD Training and Sheet Metal Forming Fabrication	Mar 01-04, 2022	MSME Artisans No. of Participants: 10
Hands on training on Robot Building	Mar 07-11, 2022	UG Engg. Students No. of Participants: 18
Hands on training for Sensors and Actuators in Robotics & Automation Applications	Mar 13-16, & 22, 2022	Engg. Students and Research Scholars No. of Participants: 10
CNC Machining and Programming	Mar 21-25, 2022	Diploma Engg. Students No. of Participants: 35
Analytical Techniques and Instrumentation for Water Quality Assessment	Mar 22-23, 2022	UG Science Students No. of Participants: 31
Renewable Energy Systems and CFD Application	March 28-30, 2022	Engg. Students and Research Scholars
Pit Bottom Buffer Installation Norms and its Safety Aspects (in-situ training)	Mar 28-30, 2022	MSME workers No. of Participants: 05





List of Online / Webinar based Training

Online Summer Internship	June - August 2021	B. Tech Students from institutions across India No. of Participants: 101
Summer Research Fellowship for Science Academy students	June - August 2021	Indian Science Academy Summer Research Fellows No. of Participants: 8
Micro Nano and Additive Manufacturing Technologies	September 01-13, 2021	B.Tech. students from Dr. B. C. Roy Engg. College, Durgapur No. of Participants: 64
Internet of Thing (IOT) and Embedded Systems	September 01-14, 2021	B.Tech. students from Dr. B. C. Roy Engg. College, Durgapur No. of Participants: 62
CAD Modelling, Engg. Drawing and Manufacturing	September 03-13, 2021	B.Tech. students from Dr. B. C. Roy Engg. College, Durgapur No. of Participants: 40
Advanced Robotics	Oct. 18-29, 2021	UG Engg. Students No. of Participants: 25
Wire Arc Additive Manufacturing and Rapid Prototyping	Nov. 15-19, 2021	UG and PG Engg. Students No. of Participants: 09
Internet of Things	Dec 20-24, 2021	UG Engg. Students No. of Participants: 20
CAD Modelling, Engineering Drawing and Manufacturing	Dec 20-24, 2021	UG Engg. Students No. of Participants: 11
Collaborative short-term skill development programme on Industry oriented Internet of Things by CSIR-CMERI and NIT, Durgapur;	Feb 8-12, 2022	UG Engg. Students No. of Participants: 17
Agricultural Machinery: Design, Development & Testing	Feb 28- Mar 04, 2022	Students, PhD scholars from Agricultural Universities No. of Participants: 30
Wire Arc Additive Manufacturing and Rapid Prototyping	Feb 28- Mar 04, 2022	UG Engg. Students No. of Participants: 21
Basic Finite Element Analysis and CFD Analysis of mechanical components	Mar 02-04, 2022	UG and PG Engg. Students No. of Participants: 16
CAD and GD&T Techniques (Phase-II)	Mar 19-20, 2022	MSME workers No. of Participants: 10

# Human Resource Development (PhDs, AcSIR Activities, Student Affairs, Internship)

## PhD Awarded

Ongoing PhD programme is one of the key Human Resource activities of the Institute to create trans-disciplinary human resources at doctoral level. During April, 2021 to Match 2022, 05 individuals received PhD degree affiliated across 3 academic institutions.

## Ph.D Awardees



**Ekta Chaturvedi**  
*IIT (ISM), Dhanbad*  
Comprehensive studies on reservoir aspects of gas hydrates and thermodynamics & kinetics of hydrate formation and dissociation in the presence of different additives



**Man Singh Azad**  
*NIT, Durgapur*  
Performance of solar air heater having absorber roughened by chamferedsquare elements



**Ved Prakash**  
*IIT (ISM), Dhanbad*  
Electrical discharge processing of exotic materials for novel applications



**Manikandan Muthu**  
*Karpagama Academy of Higher Education, Coimbatore, Tamil Nadu*  
Investigation on producing grinding spindles using EN24, EN353 & EN41B alloy steels through cylindrical grinding process



**Virendra Kumar**  
*NIT, Durgapur*  
Dynamics, trajectory planning and design of underwater manipulator: an approach using empirical hydrodynamics



AcSIR Activities

Established in 2011 as an “Institution of National Importance”, the Academy of Scientific and Innovative Research (AcSIR) has adopted the mandate to create and train some of the best of tomorrow’s Science & Technology leaders through a combination of innovative and novel curricula, pedagogy and evaluation. Being ranked 22 in 2021-22 (in Research Category), the Academy has more than two thousand faculty members from CSIR Laboratories and around 5000 students enrolled in various programmes.

During the period of April 2021 to March 2022, 01 students was awarded PhD degree and 51 new students enrolled at CSIR-CMERI under AcSIR. Out of these 51 students, 13 students joined in PhD (Science) programme, 31 in PhD (Engineering) while 7 in Integrated Dual Degree Programme (IDDP). In other two programmes, MTech (“Mechatronics”, “Design of Machinery and Equipment”, “Farm Machinery and Power Engineering”) and PGDAMT (Post Graduate Diploma in Advanced Manufacturing Technology) 3 and 5 students are joined, respectively.

AcSIR Ph.D Awardees



**Mousumi Khanra**  
Enrolment No. 20EE17J12001  
Optimal Driving based Trip Planning  
of Electric Vehicles using Evolutionary  
Algorithms: A Driver Assistance  
System

Internship

Internship	No of Students
UG Project work	25
PG project work	13
BOPT (Joined)	15
Online Summer Internship	101
Science Academy Summer Research Fellows	7

Administration and Staff News (as on 31.03.2022)

During the period of 1st April 2021 to 31st March 2022, 5 personnel had superannuated, 5 people were transferred to CSIR-CMERI, Durgapur, 1 was transferred out of the Institute.

8 new employees joined the institute. Unfortunately, tragic demise of 2 employees had also been seen during this period.

Overall Staff Strength

Category	Number (as on 31.03.2022)
Scientists	118
Technical Officers /Assistants	78
Technicians	55
Administrative	55
Others	27

Superannuation

Name	Designation	Date of Superannuation
Dr Partha Sarathi Banerjee	Chief Scientist	30/06/2021
Shri Raju Pundi	MTS	30/06/2021
Shri Abhijeet Singh	Senior Technician (3)	28/02/2022
Shri Saket Bihari Singh	Administrative Officer	28/02/2022
Shri Amitava Mitra	Senior Technical Officer (2)	31/03/2022

New Joining

Name	Designation	Date of Joining
Shri Bappa Pan	Technician -1	25/01/2021
Shri Vijay Kumar Patel	Technician -1	27/01/2021
Shri Imran Khan	Technician -1	01/02/2021
Shri Prasanta Dey	Technician -1	02/02/2021
Shri Anirban Kundu	Technician -1	04/03/2021
Shri Brijesh Kumar	Technician -1	18/03/2021
Shri Rahul Prajapati	Technician -1	18/03/2021
Shri Nikhil Shashikant Dawande	Technician -1	18/03/2021

Transfer to CSIR-CMERI

Name	Designation	From	Date
Dr Sarita Ghosh	Principal Scientist	CSIR, Hqrs.	25/02/2021
Shri Ratan Bage	Store & Purchase Officer	CSIR-IICB, Kolkata	17/08/2021
Smt Sanhita Ganguly	Section Officer (G)	CSIR-CGCRI, Kolkata	17/08/2021
Shri Kamal Kujur	Section Officer (G)	CSIR-CIMFR, Dhanbad	19/08/2021
Shri Ravi Shanker Choudhary	Store & Purchase	CSIR-NBRI, Lucknow	23/08/2021

Leaving from CSIR-CMERI

Name	Designation	To	Date
Shri Arijit Chowdhury	Technical Officer	CSIR-IICB, Kolkata	08/10/2021

Demise

- Shri Ranjit Kumar Sil, MTS of General Section left for his heavenly abode on 2nd May 2021. All the staff members of the institute deeply mourn at his untimely demise.
- Dr. Tapas Gangopadhyay, Sr. Pr. Scientist and Head, Aerosystems Laboratory left for his heavenly abode on 3rd May 2022. All the scientists and staff members of the institute deeply mourn at his unfortunate demise.



# Major Events and Activities

## Important Scientific Events

### ❖ WORLD'S LARGEST SOLAR TREE

Non-Disclosure Agreement signed on 15.11.2021 with Guinness World Record Ltd., London on design of 53.6 kWp Solar Tree (World's Largest Solar Tree).



## CSIR FOUNDATION DAY LECTURE

80th CSIR Foundation Day was celebrated at CSIR-CMERI, Durgapur on September 26, 2021. On the eve of CSIR Foundation Day, Dr. Shekhar C. Mande, DG-CSIR addressed the entire CSIR family on 24th September, 2021. Prof. Dr. Harish Hirani, Director, CSIR-CMERI address all the employees and project staffs/ fellows of CMERI on the occasion of CSIR Foundation Day on 26th September 2021.



## VISIT OF DR JAYANTA KUMAR ROY

❖ Dr. Jayanta Kumar Roy, Hon'ble MP, Jalpaiguri, Member, Standing Committee on Science & Technology, Environment & Forests, Govt. of India & Member, Consultative Committee, Ministry of Health & Family Welfare, Govt. of India, visited CSIR-CMERI on 12th December 2021 and disclosed his willingness to utilise CSIR-CMERI Technologies in Siliguri, Jalpaiguri,

Mekhliganj, Malbazaar areas in North Bengal. Regional Media Houses, Prominent Regional Dailies, The Press Information Bureau covered the event.



## Institute Internal Seminar Series

- 1) National Conference cum Industry Meet on Foundry 4.0 – Opportunities and Challenges was organized by CSIR-CMERI, Durgapur in association with IIF Eastern Region during February 24-25, 2022. The conference inaugural programme was graced by Mr. Dibyendu Maiti, CEO (Mig Complex), Hal as Chief Guest.



- 2) CSIR-Industry Meet (On Virtual Platform)

Future of Additive Manufacturing in India - Grand Challenges, An event organized under the aegis of CIE & 4M Themes of CSIR was organized on 8 February 2022 .



Future of Additive Manufacturing in India( On virtual Platform)

- 3) Seminar on Aatma Nirbhar Bharat

One day Seminar on "Aatma Nirbhar Bharat" was held on March 25, 2021 in the institute Auditorium. The seminar was graced by Shri Jayant Shasrabudhi, the national organizing secretary of Vijnana Bharat (VIBHA).



## Open PhD Colloquium

- a) Debeshi Dutta, a PhD student (AcSIR) presented a talk on her PhD thesis entitled "Assessment of Grasp Ability of stroke survivors: a machine learning based approach" in an open colloquium on July 29, 2021.

- b) Manilal Murmu, a PhD student (AcSIR) presented a talk his PhD thesis entitled "Design, synthesis and characterization of organic molecules for corrosion inhibition of metals: Application of anti-corrosive additives and coating materials" on July 30, 2021.
- c) Preeti Singh a PhD student (AcSIR) presented a talk her PhD thesis entitled "Metal-reduced graphene oxide based nanocomposites: synthesis, characterization and sensing applications" on September 21, 2021.
- d) Nivedita Priyadarshni, a PhD student (AcSIR) presented a talk on her PhD thesis entitled "Synthesis and characterization of Functionalized metallic nanoparticles for the detection and removal of toxic ions" in an open colloquium on September 24, 2021.
- e) Debanjan Dey, a PhD student (AcSIR) presented a talk on his PhD thesis entitled "Development of Schiff base based organic frameworks/polymers as sorbent materials for water immiscible oil and toxic organic solvent clean up and small molecules for detection of water miscible toxins" in an open colloquium on October 07, 2021.
- f) Suparna Paul, a PhD student (AcSIR) presented a talk on her PhD thesis entitled "Development of sensory probes for expeditious chromo-fluorogenic detection of heavy, toxic cationic contaminants and lethal anions: Detailed characterization and application" in an open colloquium on October 25, 2021.
- g) Subhasis Shit, a PhD student (AcSIR) presented a talk on his PhD thesis entitled "Development of noble-metal-free efficient bifunctional electrocatalysts for overall water splitting in alkaline medium" in an open colloquium on November 01, 2021.
- h) Sourav Bej, a PhD student (AcSIR) presented a talk on his PhD thesis entitled "Design and synthesis of supramolecular assembly as sensory receptor for detection of neutral and lethal anionic contaminants" in an open colloquium on February 02, 2022.
- i) Puja Mitra, a PhD student (AcSIR) presented a talk on her PhD thesis entitled "Study of size-based isolation and detection of circulating tumour cells (cancer cells) using microfluidics and image processing" in an open colloquium on March 02, 2022.



Other institutional events



1.

West Bengal Senior State Ranking Badminton Tournament and Veteran's Invitational Badminton Tournament (VIBT 2022) during 5-10 March, 2022
2.

CSIR-CMERI Foundation Day celebration, 2021
3.

44th Meeting of Management Council (07/03/2022)
4.

Vigilance Awareness Pledge 2021
5.

Flag Hoisting by Director CSIR-CMERI on 73rd Republic Day 2022
6.

Celebration of Samvidhan Diwas (Constitution Day) 2022
7.

Invited lecture by Prof. Surjya Kanta Pal, Professor, IIT Kharagpur on 04/10/2021
8.

Observance of Swachhata Abhiyan 2021
9.

43th Meeting of Management Council
10.

Prof. S.K. Joshi Memorial football Invitational Cup (SKJMFIC-2021) during 25-26 Sept 2021
11.

Visit of Dr. Subhas Sarkar, Hon'ble Minister of State (Education) to CSIR-CMERI on 28 October, 2021
12.

Observance of Sadbhavana Diwas 2021 on 20/8/2021



13.

59th Meeting of Research Council
14.

Prof. S K Joshi Memorial Football Tournament (SKJMFT -2021) on 16.09.2021
15.

Inauguration of Fitness Club by Director CSIR-CMERI in CMERI Staff Club premises on 8/08/2021
16.

Observance of Rashtriya Ekta Diwas (National Unity Day) on 31.10.2021
17.

Independent India @75: Self Reliance with Integrity Pledge 2021
18.

Flag Hoisting by Director CSIR-CMERI on Independence Day 2021
19.

58th Meeting of Research Council



Information on Finance

External cash flow	Rs. in crores
Govt. Deptt. / PSUs	13,96,60,463.00
Private agencies	2,14,39,990.22
Foreign govt / agencies	NIL
Total ECF	16,11,00,453.22

Key Performance Indices

Awards and Accomplishment

- Dr. Priyabrata Banerjee has been inducted as Editor on Advances in Materials and Processing Technologies Published by Taylor & Francis.
- A paper titled “Correlation between Microstructure and Mechanical Properties of YSZ/Al<sub>2</sub>O<sub>3</sub> Ceramics and Its Effect on High Speed Machining of Steel” authored by Bipin Kumar Singh, Kunal Ghosh, Shibendu Shekhar Roy, Biswanath Mondal and Nilrudra Mandal — published in the Trans. Ind. Ceram. Soc., **77(4), 219-225 (2018)** has been selected for “**Malaviya Award – 2021**” by The Council of “**Indian Ceramic Society**”.
- Dr. Rajesh P Barnwal received INSA Visiting Scientist Fellowship Award-2022-23.
- Dr. Rajesh P Barnwal was elected as a IEEE Senior Member Grade - 2022
- Dr. Shitanshu Sekhar Chakraborty received the Best paper

MoU, NDA signed (April 2021 to March 2022)

Academic Linkages

Sl. No.	Name of Partners	Date of Sign	Signed for (Brief details)
01	Thapar Institute of Engineering & Technology (PIET), Thapar Technology Campus, Patiala-147004, Punjab	31/07/2021	MoU signed on Intellectual Co-operation, Scholarly Exchange and Development of National Partnership
02	Punjab Mandi Board (PMB) Mohali, Punjab	31/7/2021	MoU signed on Project : Sustainable Fruit & Vegetable Waste Management in APMC Mandis costing Rs.22,42,000/-
03	Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), Kapurthala, Punjab	30/7/2021	MoU signed to establish a strategic association on project to project basis (joint research in the field of bio energy) in the specific field of new and renewable energy system

award at 35<sup>th</sup> National Convention of Production Engineers organized by The Institution of Engineers (India), Durgapur Local Centre during 31-30 October, 2021 for the paper entitle “A brief review on reported novel applications of friction stir processing”.

- Dr. Amit Kumar received the best presentation of the paper “Enriched Finite Element for Transient Thermal Shock Response of Functionality Graded Piezoelectric Cylinders” from all excellent presentation at 7<sup>th</sup> Asian Conference on Mechanics of Functional Materials and Structures (ACMFMS202+1) held online during 13-15 March 2021.

Technology Developed

Sl No.	Technology developed
1	Mechanized Drain Cleaning System (Mechanical Scavenger)
2	Solar PV energy based electric cooking system
3	Oxygen Enrichment Unit (OEU) Model-2 (FiO2) & Flow Rate Control
4	Tractor Operated Iron Ore Dust Collecting machine
5	Tractor Mounted Sprayer for Reduction of Air Pollution
6	Tele-operated Mining Robot
7	Low cost cold storage
8	Solar Biomass and Electric Powered Hybrid Dryer
9	System integration for spraying applications using multi-copter

Sl. No.	Name of Partners	Date of Sign	Signed for (Brief details)
04	Durgapur Municipal Corporation, Durgapur-713216, WB	18/8/2021	MoU signed to function as IoR a technical partner and provide technical assistance (necessary knowledgebase support) to DMC & WBPCB
05	Michael Madhusudan Memorial College, Kabi Guru Sarani, City Centre, Durgapur-713216, WB	8/10/2021	MoU signed for Hands on skill promotion to 100 no. of students per year on Water Quality Assessment having training fee Rs.800/- per student.
06	Kanyapur Polytechnic, Asansol, Paschim Burdwan-713305, WB	2/11/2021	MoU signed for hands on Skill Development Programmes for students in mutually identified areas, jointly organizing academic programs, undertaking collaborative R&D work for technology infusion in MSME sector etc.
07	McNally Sayaji Engineering Limited, P.O.-Kumardubi-828203, Dist-Dhanbad, Jharkhand	17/11/2021	MoU signed for Drawing ,Design analysis and value engineering of different engineering components (crushing, screening, feeding, grinding, material handling and mineral processing equipment), Failure analysis of critical engineering components manufactured by MSEL, Quality assurance and material characterization of engineering components manufactured by MSEL.
08	I-Hub Foundation for Cobotics (IHFC), MZ-122, Hauz Khas, South Delhi-110016	15/12/2021	MoU signed on collaboration for investment in research & development of the innovation being developed by the students, faculty & start-ups (Dr. Ranjit Roy, Sr.Pr.Sct.))
09	Dr. B.C. Roy Engineering College, Durgapur, WB	18/12/2021	MoU signed for joining hands to deliver Industry Ready Skilled Youth Force for the Nation. Prof. Harish Hirani, Director, CSIR-CMERI and Dr. Sanjay S Pawar, Principal, Dr. B.C. Roy Engineering College, Durgapur, signed and exchanged the MoU.
10	CDAR, Aizawl-796001, Mizoram	07/01/2022	MoU signed for design, development, installation and commissioning of 200 kg/ day capacity prototype of fish drying system at Tuiral, Aizawl, Mizoram.
11	I-Hub Foundation for Cobotics (IHFC), MZ-122, Hauz Khas, South Delhi-110016	28/01/2022	MoU signed on collaboration for investment in research & development of the innovation being developed by the students, faculty & start-ups (Dr.Soumen Sen, Pr.Sct.)
12	SAIL, RDCIS, Ranchi-834002	23-03-2022	MoU signed on joint research & development projects, technical support/ services/assistance, failure analysis and material characterization to provide mutual exchange of scientific information



Confidentiality/NDA Agreement signed during 2021-22

Sl. No.	Name of Partners	Date of Sign	Signed for (Brief details)
1.	Guinness World Record Ltd., London (International)	15/11/2021	Non-Disclosure Agreement on design of 53.6 kWp Solar Tree (World's Largest Solar Tree).
2	Maniar & Co., Maniar Trailer Road, Rakhial-380023, Ahmedabad, Gujarat, INDIA	26/11/2021	Confidentiality Agreement signed to explore development of Vehicle Mounted Drain Cleaning System (Mechanized Scavenger) on Commercial Vehicles ("Project")
3.	M/s KAM-AVIDA Enviro Engineers Pvt.Ltd., Plot No.2, Survey No.255/1, Hinjewadi, Tal:Mulshi, Dist.Pune-411057, Maharashtra	9/12/2021	Confidentiality Agreement signed for the purpose of Demonstration of Vehicle Mounted Drain Cleaning System (Mechanized Scavenger) ("Project")
4.	TATA Motors, Bombay House, 24 Homi Mody Street, Mumbai-400001	9/12/2021	Confidentiality Agreement signed for 'Development of novel A13M (Zr, Sr, Ti, Sc) strengthened aluminum alloy for high temperature application'.
5.	The Directorate of Naval Design, Submarine Design Group [DND(SDG)], IHQ, MoD (NAVY), R.K.Puram, New Delhi-110066	30/12/2022	NDA signed for protection of confidential information pertaining to 'Requirements of technologies for Unmanned Underwater Vehicles'.
6.	M/s Mitsuchem Plast Limited, 329, Gala Complex, 3 <sup>rd</sup> Floor, Din Dayal Upadhyay Marg, Mulund (W), Maharashtra	28/03/2022	Confidentiality Agreement signed for Development of high pressure (350BAR and 700BAR) Hydrogen Storage Tank of Type-IV



Technology Transferred (April 2021 to March 2022)

Sl. No.	Title of Technology	Date of Transfer	Name of Industry / Licensee
01	Oxygen Enrichment Unit	22/4/2021	M/s Apollo Computing Laboratories (P) Ltd., Hyderabad-500062 Telangana
02		29/4/2021	Jyoti CNC Automation Ltd.,Rajkot-360021, Gujarat
03		29/4/2021	GRID Engineers Private Limited, Janak Puri, West Delhi-110058
04		02/05/2021	C and I Calibrations Pvt.Ltd., Kota-324005, Rajasthan
05		02/05/2021	SA CORP, IMT Manesar, Gurgaon-122050, Haryana
06		07/05/2021	Central Tool Room And Training Centre, P.O.Bhubaneswar-751024, Odisha
07		11/05/2021	M/s Auto Malleable, Jaipur-302012, Rajasthan
08		11/05/2021	M/s Mech Air Industries, Vadodara-390016, Gujarat
09		12/05/2021	M/s CBS Technologies (P) Ltd. Greater Noida-201306, U.P.
10		21/05/2021	M/s Automation Engineers P.S.Hare Street, Kolkata-700 001, WB
11	High flow rate Iron Removal Filter	21/05/2021	M/s A B Elasto Products (P) Ltd Krishnapur, North 24PGN, Kolkata, WB
12		21/05/2021	M/s Conquerent Control Systems (P) Ltd., IMT Manesar, Gurgaon-122050, Haryana
13		03/05/2021	Maa Durga Sales Agency, Uzzala Market, Fatasil Bazaar, Guwahati-781009, Assam
14		12/05/2021	M./s Taurus Industries, Guwahati-781005, Assam
15		29/06/2021	M/s Hindustan Engineering,Guwahati-781007, Assam
16		29/09/2021	M/s Parth Multi Aqua Pvt.Ltd.,Kankarbagh, Patna, Bihar
17		25/11/2021	M/s MARUTI TECH, Mouza: Uttar Rampur, P.O.Chapore, P.S. Chakulia, Uttar Dinajpur-733209, WB
18	Community Level Improved Iron Removal Plant	11/05/2021	M/s Swastick Aquatech, Gauripur, Ward No.1, Dhubri-783331, Assam
19	1 TPD Fully Automatic Bio Diesel Plant	31/07/2021	M/s Hindustan Petroleum Corporation Limited, Vibhuti Khand, Gomti Nagar, Lucknow-226010, UP
20	Solar PV energy based Electric Cooking System	22/09/2021	M/s Asansol Solar & LED House Gupta Market, 22, G.T.Road, Asansol-713301, Burdwan, WB
21		22/09/2021	M/s Meeco Solar & Infrastructure Associates, Gouri Bhavan, Sagarbhanga, Durgapur-713211, Burdwan, WB
22	IoT based Smart Parking System	18/11/2021	M/s STEEL SHEET PILING SOLUTIONS INDIA, Netaji Nagar, Kolkata-700092, WB
23	Vehicle Mounted Drain Cleaning System with 3 modules namely Recycled Slurry Water Unit, Closed Loop Feed Back System, Post Cleaning Inspection Unit	28/12/2021	MANIAR & CO., 110, NR Ajit Mill, Rakhial Road, Ahmedabad-380021, Gujarat
24	Intelligent UVC LED Sterilizer Unit	12/01/2022	Enthu Technology Solutions India Pvt.Ltd., Peelamedu, Coimbatore, TN,
25	Biomass Briquetting Technology	02/03/2022	SIYA INSTRUMENTS, Madri, Udaipur-313031, Rajasthan



## Publication in SCI Journals (April 2021 to March 2022)

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- Barnwal RP, Roy P and Pal PK, Experimental Evaluation of Indoor Localization Methods for Industrial IoT Environment, *Journal of Scientific and Industrial Research (JSIR)*, **2022**, 81(3), 294-307.
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- Biswas P, Samanta S, Dixit AR and Sahoo RR, Investigation of mechanical and tribological properties of electroless Ni-P-B ternary coatings on steel, *Surface Topography: Metrology and Properties*, **2021**, 9(3), Art No. 035011.
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IP Portfolio

Patent Filed & Granted (April 2021 to March 2022)

Filed in India:

1. <b>Title:</b> A composition for high strength construction bricks utilizing fluoride contaminated sludge and a process for the preparation thereof. <b>Inventors:</b> Asit Kumar Batabyal, Priyabrata Banerjee, Udayan Mondal, Somrita Nag, Harish Hirani <b>Application No. :</b> 202111051869, <b>Dated:</b> 11-11-2021	mentha reaper. <b>Inventors:</b> Bittagopal Mondal, Ajay Yadav, Ramesh K Srivastava, Avik Chatterjee, Dipankar Chatterjee <b>Application No.:</b> 202211019405 <b>Dated:</b> 30-03-2022
2. <b>Title:</b> Glycerolysis process of fatty acid and use thereof in biodiesel production from high free fatty acid feedstock. <b>Inventors:</b> Rajen Kundu, Krishnendu Kundu, Harish Hirani <b>Application No.:</b> 202111047810, <b>Dated:</b> 20-10-2021	7. <b>Title:</b> An innovative clip for snap fitting of solar photovoltaic panels with roof purlins for making solar roof shed. <b>Inventor:</b> Swarup Ranjan Debbarma, Ajay Kumar Gupta, Prasant Adhikari, Debashis Das, Harish Hirani <b>Application No.:</b> 202111045124 <b>Dated:</b> 04-10-2021
3. <b>Title:</b> Outdoor air purifier with parallel arrangement of air suction and discharge. <b>Inventors:</b> Poulomi Roy, Shitanshu Shekhar Chakraborty, Nilrudra Mandal, Bittagopal Mondal, Harish Hirani <b>Application No.:</b> 202111045355, <b>Dated:</b> 04-10-2021	8. <b>Title:</b> An automated bio-mass briquette production system. <b>Inventor:</b> Krishnendu Kundu, Siddappa Yellappa Pujar, Siva Ram Krishna Vadali, Prabhu Dutt Sharma, Arup Majumder <b>Application No.:</b> 202111045121 <b>Dated:</b> 04-10-2021
4. <b>Title:</b> Portable UV Disinfection device to sanitize public transport <b>Inventors:</b> Swarup Ranjan Debbarma, Debashis Das, Sumanta Banerjee, Dayamay Bouri, Harish Hirani <b>Application No.:</b> 202211019402 <b>Dated:</b> 30-03-2022	9. <b>Title:</b> Remotely operated Vehicle for inspection and intervention in colling water areas of thermal power plants. <b>Inventor:</b> Dip Narayan Ray, Sankar Karmakar, Umesh Patkar, Radhey Shyam Maurya, Jitendra Singh Sandeep Kumar Patel, Gurubuksh Singh <b>Application No.:</b> 202111029400 <b>Dated:</b> 30-06-2021
5. <b>Title:</b> Pneumatically operated mobile indoor disinfection unit. <b>Inventors:</b> Malay Kumar Karmakar, Dilpreet Singh, Sandeep Jain, Vinay Tigga, Harish Hirani <b>Application No.:</b> 202211019404 <b>Dated:</b> 30-03-2022	10. <b>Title:</b> A process for nano grade silica extraction from agro-waste without ash formation. <b>Inventor:</b> Subhra Samanta, Poulomi Roy, Nilrudra Mandal, Harish Hirani <b>Application No.:</b> 202111045117 <b>Dated:</b> 04-10-2021
6. <b>Title:</b> Hydraulic power driven tractor front mounted	



11.

**Title:** Tractor PTO powered drain cleaning system using on-site filtered drain water.

**Inventor:** Avinash Kumar Yadav, Dilpreet Singh, Partha Das, Sandeep Jain, Harish Hirani

**Application No.:** 202111046257**Dated:** 11-10-2021

12.

**Title:** A combined mechanical and physico-chemical method for municipal sewage water treatment.

**Inventor:** Priyabrata Banerjee, Harish Hirani, Sourav Bej, Partha Das, Dipankar Chatterjee

**Application No.:** 202111045215**Dated:** 05-10-2021

13.

**Title:** A process for preparation of M20 to M25 grade cement concrete by legacy waste as substitute of natural sand.

**Inventor:** Harish Hirani, Swarup Ranjan Debbarma, Biswajit Ruj, Debashis Das, Dayamay Bouri

**Application No.:** 202111053721**Dated:** 18-11-2021

14.

**Title:** Driving Circuit for piezoelectric actuator based inchworm motor and system thereof.

**Inventor:** Saikat Kumar Shome, Sandip Jana, Partha Bhattacharjee

**Application No.:** 202211007603**Dated:** 11.02.2022

15.

**Title:** Solar Photovoltaic (PV) Energy Based Electric Cooking System.

**Inventor:** Chanchal Loha, Partha Sarathi Pal, Harish Hirani, Md Musraph Hussain, Biswajit Chakraborty

**Application No.:** 202211015645**Dated:** 21-03-2022

16.

**Title:** Vehicle Mounted Hydraulically operated foldable type Retractable Mobile Protective shield.

**Inventor:** Ajay Yadav, Ashwani Kumar Kushwaha, Harish Hirani, Avik Chatterjee

**Application No.:** 202211013670**Dated:** 11-03-2022

Granted in India:

1.

**Title:** Cabinet Dryer for Ginger and Turmeric.

**Inventor:** Pradip Kumar Chatterjee, Chanchal Loha, Biplob Choudhury, Prakash Chandra

**Patent No.:** 376864 **Grant Date:** 09.09.2021

2.

**Title:** Arsenic water filtration device, method and nano metal-oxides coated rice husk char as adsorbent medium there for.

**Inventor:** Nripen Chanda, Nagahanumaiah, Vimlesh K Sharma, Peuli Nath, Ravi K Arun, Biswajit Ruj, Swarup R Debbarma

**Patent No.:** 387699 **Grant Date:** 28-01-2022

3.

**Title:** Development of scaled-up graphite oxide production technology starting from natural flake graphite.

**Inventor:** Tapas Kuila, Milan Jana, Pranab Samanta, Naresh Chandra Murmu

**Patent No.:** 380259 **Grant Date:** 27-10-2021

4.

**Title:** A process for the detection of fluoride level in an aqueous specimen with distinct colorimetric change.

**Inventor:** Priyabrata Banerjee, Pritam Ghosh, Suparna Paul, Asit Kumar Batabyal, Naresh Chandra Murmu

**Patent No.:** 378228 **Grant Date:** 29-09-2021

Copyright (April-2021-March 2022)

Filed:

1.

**Title:** Design and Development of a Pan-Tilt camera based video conferencing system architecture (PTC-VCSA) for semi-autonomous wheeled mobile robot to assist patients with contagious diseases.

**Authors:** Srinivasan Aruchamy, Aman Arora, Nalin Paul, Md. Musraph Hussain, Harish Hirani

**IPU-CSIR Ref.:** 032CR2021 **Dated:** 11-08-2021

2.

**Title:** Automated control for boom gate, sanitization spray and signaling system for restricted entry/exit of vehicle.

**Authors:** Kalyan Kumar Mistry, Pratap Karmakar, Harish Hirani

**IPU-CSIR Ref.:** 043CR2021 **Dated:** 31-08-2021

3.

**Title:** Intrinsically safe (IS) circuit of the Tele-operated mining robot.

**Authors:** Dip Narayan Ray, Umesh Patkar, Atanu Maity, Nalin Paul, Sukanta Bhattacharjee

**IPU-CSIR Ref.:** 044CR2021 **Dated:** 31-08-2021

4.

**Title:** Circuit for maintaining the TTL level voltage in long distance wired communication.

**Authors:** Pratap Karmakar, Arpita Mukherjee, Sandip Jana, Tapas Naskar, Kalyan Kumar Mistry

**IPU-CSIR Ref.:** 046CR2021 **Dated:** 02.09.2021

5.

**Title:** Embedded code for generation of control signals of Piezo Electric Inchworm Motor based on PIC30F4011 Microcontroller.

**Authors:** Siddheswar Sen, Saikat Kumar Shome, Partha Bhattacharjee

**IPU-CSIR Ref.:** 045CR2021 **Dated:** 02-09-2021

6.

**Title:** Development of 10 kLd (kilolitre per day) Sewage Treatment Plant for serving 7.5 acre of agricultural land.

**Authors:** Satya Prakash Singh Krishnendu Kundu, Harish Hirani

**IPU-CSIR Ref.:** 048CR2021**Dated:** 15-09-2021

7.

**Title:** Portable sanitizing fogging machine for disinfection and sanitization in indoor spaces.

**Authors:** Md. Musraph Hussain, Subho Samanta, Partha Sarathi Pal, Harish Hirani

**IPU-CSIR Ref.:** 047CR2021**Dated:** 15-09-2021

8.

**Title:** Drawing for battery powered electric motor operated tractor.

**Authors:** Avinash Kumar Yadav, Munshi Amirul Alam, Sandeep Jain, Suman Kumar Char, Harish Hirani

**IPU-CSIR Ref.:** 054CR2021 **Dated:** 07-01-2022

9.

**Title:** Solar biodiesel hybrid minigrid of 50kW-Peak capacity.

**Authors:** Hanumath Prasad Ikkurti, Sumit Kumar, Krishnendu Kundu, Jagroop Singh Mungra, Harish Hirani

**IPU-CSIR Ref.:** 055CR2021 **Dated:** 27-01-2022

10.

**Title:** A scalable architecture for IoT based smart parking slot identification system for Unconnected area.

**Authors:** Jyotirmoy Karmakar, Aman Arora, Srinivasan Aruchamy, Siva Ram Krishna Vadali, Harish Hirani

**IPU-CSIR Ref.:** 056CR2021 **Dated:** 22-11-2021

11.

**Title:** Deep learning based smart video surveillance: An architecture for event recording and On-demand video summarization.

**Authors:** Srinivasan Aruchamy, Siva Ram Krishna Vadali, Jyotirmoy Karmakar, Harish Hirani

**IPU-CSIR Ref.:** 002CR2022 **Dated:** 05-04-2022

12.

**Title:** DC-DC Boost Converter for heating of tubular resistive coil

**Authors:** Mohd Afroz Akhtar, Partha Sarathi Pal, Md Musraph Hussain, Chanchal Loha, Harish Hirani

**IPU-CSIR Ref.:** 005CR2022 **Dated:** 15-02-2022

13.

**Title:** Circuit Schematics and PCB Layout of BLDC Motor Drive for Subsea Thruster.

**Authors:** Sumit Kumar, Srinivasa Reddy N, Chandan Har, Tapas Naskar, Harish Hirani

**IPU-CSIR Ref.:** 011CR2022 **Dated:** 10-05-2022

14.

**Title:** Drawing for Tractor Mounted Sprayer for reduction of Air Pollution.

**Authors:** Poulomi Roy, Harish Hirani, Bittagopal Mondal, Palash Kumar Maji, Ishita Sarkar

**IPU-CSIR Ref.:** 018CR2022 **Dated:** 30-03-2022

15.

**Title:** Electronically controlled pulse mode oxygen rich air inhaler for conservation of oxygen-product description.

**Authors:** Shitanshu Sekhar Chakraborty, Kalyan Chatterjee, Palash Chowdhury, Harish Hirani, Poulomi Roy

**IPU-CSIR Ref.:** 017CR2022 **Dated:** 17-05-2022

16.

**Title:** Topology Planning for CNC operation of the proximal arm in a 5-sided machining center.

**Authors:** Rakesh Kumar Padhi, Samit Biswas, Santanu Naskar

**IPU-CSIR Ref.:** 015CR2022 **Dated:** 30-03-2022

17.

**Title:** Topology Planning for CNC operation of the motor shell in a CNC lathe.

**Authors:** Arup Majumder, Rakesh Kumar Padhi, Rabisankar Mondal

**IPU-CSIR Ref.:** 014CR2022 **Dated:** 30-03-2022

18.

**Title:** Circuit Schematics and PCB layouts of Transceiver Units of Wireless Sensor Network Module for Structural Health Monitoring System.

**Authors:** Pradyumna Kumar Sahu, Pratap Karmakar, Kalyan Kumar Mistry

**IPU-CSIR Ref.:** 016CR2022 **Dated:** 02-05-2022

19.

**Title:** Engineering Drawings of 1kW Subsea Thruster.

**Authors:** Chandan Har, Srinivasa Reddy N, Sumit Kumar, Srinivasan A, Dipankar Chatterjee

**IPU-CSIR Ref.:** 019CR2022 **Dated:** 05-04-2022

20.

**Title:** Engineering drawings of Mechanical Type Jute Baling Press.

**Authors:** Ashok Kumar Prasad, Arun Baiju Velukutty Gomathy, Sabyasachi Mosan, Manoja Kumar Biswal,Debasish Datta

**IPU-CSIR Ref.:** 025CR2022 **Dated:** 05-04-2022

21.

**Title:** Development of E-Tractor clutch plate housing through novel approach of wire arc additive manufacturing process.

**Authors:** Manivannan R, Manidipto Mukherjee, Soumyajit Kundu, Arup Majumder, Rakesh Kumar Padhi

**IPU-CSIR Ref.:** 027CR2022 **Dated:** 05-04-2022

22.

**Title:** Drawing for long range intrusion detection pole for perimeter surveillance application.

**Authors:** Pratik Saha, Srinivasa Reddy N, Srinivasan Aruchamy, Siva Ram Krishna Vadali, Manoja Kumar Biswal

**IPU-CSIR Ref.:** 024CR2022 **Dated:** 05-04-2022

23.

**Title:** Hand Motion Sensing GUI Software.

**Authors:** Soma Banerjee, Anirudh Kumar, Amit Kumar

**IPU-CSIR Ref.:** 026CR2022 **Dated:** 05-04-2022

24.

**Title:** Smart Glasses for Sleep Detection.

**Authors:** N.V.V. Krishna Chaitanya, Sahadeb Shit, K. Harish Kumar, Dipankar Chatterjee, Dip Narayan Ray

**IPU-CSIR Ref.:** 021CR2022 **Dated:** 05-04-2022

25.

**Title:** System integration for pesticide spraying using Multi-Copter.

**Authors:** Moloy Narayan Das, Umesh Shrikrishna Patkar, Sandeep Jain, Abhijit Das

**IPU-CSIR Ref.:** 020CR2022 **Dated:** 05-04-2022

26.

**Title:** Decentralized Solar PV Powered Modified Atmosphere storage system for post-harvest storage of fruits and vegetables.

**Authors:** Subho Samanta, Partha Das, Jnanendra Prasad Maji, Amit Ganguly

**IPU-CSIR Ref.:** 022CR2022 **Dated:** 05-04-2022



27. **Title:** Production of paper throughrecycling of combination ofwaste paper and leaves.\n**Authors:** Ishita Sarkar, Manikandan Muthu, Jiten Mandal, Biswajit Chakraborty\n**IPU-CSIR Ref.:** 023CR2022 **Dated:** 05-04-2044

Granted:

1. **Title:** Mechanized segregation and processing of construction and demolition waste to generate value added products for reutilization in construction work.\n**Authors:** Partha Das, Subho Samanta, Amit Ganguly, Harish Hirani\n**Registration No.:** L-105033/2021 **Dated:** 05-07-2021
2. **Title:** Intelligent control for mechanical ventilator.\n**Authors:** Sanjay Hansdah, Kalyan Chatterjee, Harish Hirani\n**Registration No.:** SW-14418/2021 **Dated:** 19-04-2021
3. **Title:** Engineering Drawings of Beam Stoppers (BC1, BC2 and BC3)\n**Authors:** Anindya Chattopadhyay, Tanmoy Kumar Das, Amit Kumar, Abhijit Mahapatra, Avik Chatterjee, SanjayKumar Ghosh, Subhasis Chattopadhyay\n**Registration No.:** L- 106038/2021 **Dated:** 03-08-2021
4. **Title:** Design of a non-transferred plasma torch.\n**Authors:** Kalyan Kumar Mistry, Chanchal Loha, Gourab Kumar Bagchi, Biswajit Chakraborty\n**Registration No.:** L-110819/2022 **Dated:** 24-01-2022
5. **Title:** Solar-biomass-electric hybrid dryer for post-harvest processing of horticulture produce.\n**Authors:** Subho Samanta, Partha Das, Jnanendra Prasad Maji, Amit Ganguly, Harish Hirani\n**Registration No.:** L-110828/2022 **Dated:** 24-01-2022
6. **Title:** Continuous moisture measurement and monitoring system for ginger dryer.\n**Authors:** Kalyan Kumar Mistry, Chanchal Loha, Amit Ganguly, Harish Hirani\n**Registration No.:** L-111854/2022 **Dated:** 10-02-2022
7. **Title:** Engineering drawings of synthetic blood permeation test set-up.\n**Authors:** Samik Dutta, Pranab Samanata, Arabinda Sarkar, Avik Chatterjee, Harish Hirani\n**Registration No.:** L-111624/2022 **Dated:** 03-02-2022
8. **Title:** System integration for geo-terrain mapping using multi-copter from an optimal height.\n**Authors:** Moloy Narayan Das, Palash Kumar Maji, Avik Chatterjee, Harish Hirani\n**Registration No.:** L-110715/2022 **Dated:** 24-01-2022
9. **Title:** Fabrication of a Smartphone based colorimetric sensory prototype for low level “naked eye” detection of CN- like toxic industrial pollutant from semi-aqueous

- medium.\n**Authors:** Priyabrata Banerjee, Suparna Paul, Arabinda Sarkar, Subhasis Biswas, Harish Hirani\n**Registration No.:** L-110822/2022 **Dated:** 24-01-2022
10. **Title:** Portable oxygen enrichment unit.\n**Authors:** Sanjay Hansdah, Sudeshna Das, Palash Chowdhury, Tapas Naskar\n**Registration No.:** L-111851/2022 **Dated:** 10-02-2022
11. **Title:** Drawing of the remotely operated sewage inspection robot.\n**Authors:** Dip Narayan Ray, Sankar Karmakar, Partha Das, Sukanta Bhattacharjee, Anjan Lakra\n**Registration No.:** L-111839/2022 **Dated:** 10-02-2022
12. **Title:** Drawing for pipeline inspection robot for monitoring and inspection of pipelines.\n**Authors:** Ravi Kant Jain, Abhijit Das, Dip Narayan Ray, Pratap Karmakar\n**Registration No.:** L-110760/2022 **Dated:** 24-01-2022
13. **Title:** Block Schematic flow diagram of battery powered remote controlled UVC-LED Disinfection unit.\n**Authors:** Saikat Kumar Shome, Sandip Jana, Pratap Karmakar, Partha Bhattacharjee\n**Registration No.:** L-106040/2021 **Dated:** 03-08-2021
14. **Title:** Process for semi-quantitative analysis of Iron in groundwater.\n**Authors:** Biswajit Ruj, Rishya Prava Chatterjee, Arup Saha\n**Registration No.:** L-110821/2022 **Dated:** 24-01-2022
15. **Title:** Design and development of a Microcontroller-based electronics system architecture (MBESA) for a Semi-Autonomous wheeled mobile robot to assist patients with contagious diseases.\n**Authors:** Aman Arora, Dibyendu Pal, Nalin Paul, Md. Musraph Hussain, Harish Hirani\n**Registration No.:** L-111631/2022 **Dated:** 03-02-2022
16. **Title:** Engineering drawings of radial magnetic coupling and its test set-up.\n**Authors:** Chandan Har, Srinivasa Reddy N, Srinivasan A, Sumit Kumar, Avik Chatterje\n**Registration No.:** L-111845/2022 **Dated:** 10-02-2022
17. **Title:** Topology planning for CNC operation of the distal arm in a 5-sided machining center.\n**Authors:** Rakesh Kumar Padhi, Viji K., S Y Pujar, Arup Majumder, Pratik Saha\n**Registration No.:** L-110823/2022 **Dated:** 24-01-2022
18. **Title:** Interlocking based automatic outdoor COVID protection system (COPS).\n**Authors:** Pratap Karmakar, Arpita Mukherjee, Sandip Jana, Anirudh Kumar, Partha Bhattacharjee\n**Registration No.:** L-111633/2022 **Dated:** 03-02-2022

Design Registration (April-2021-March 2022)

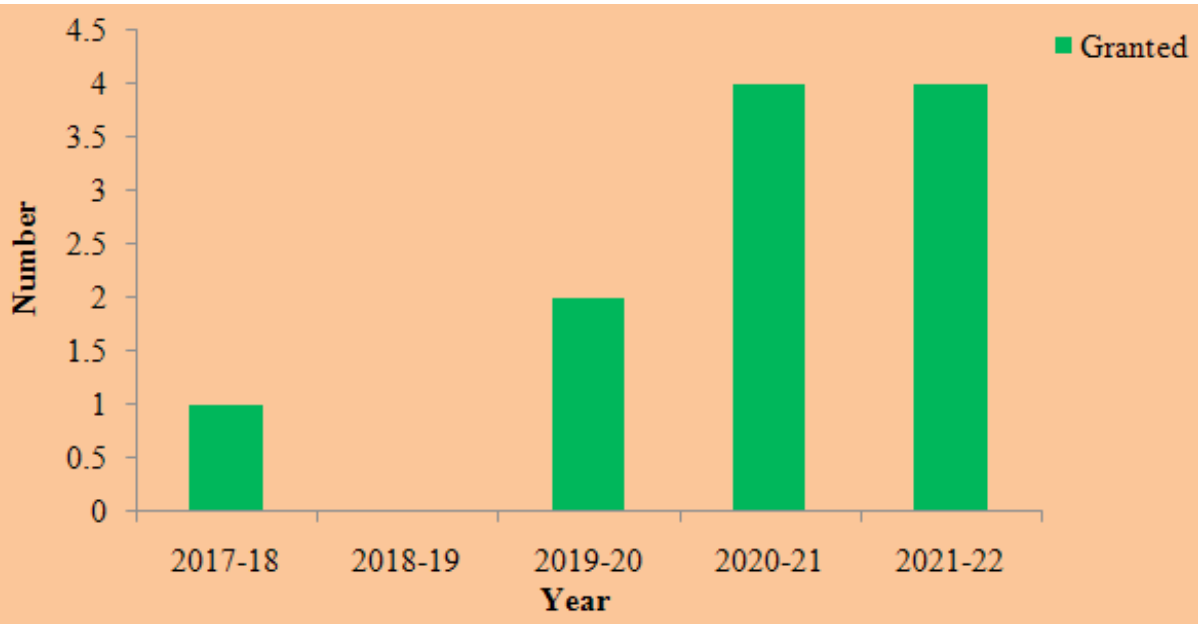
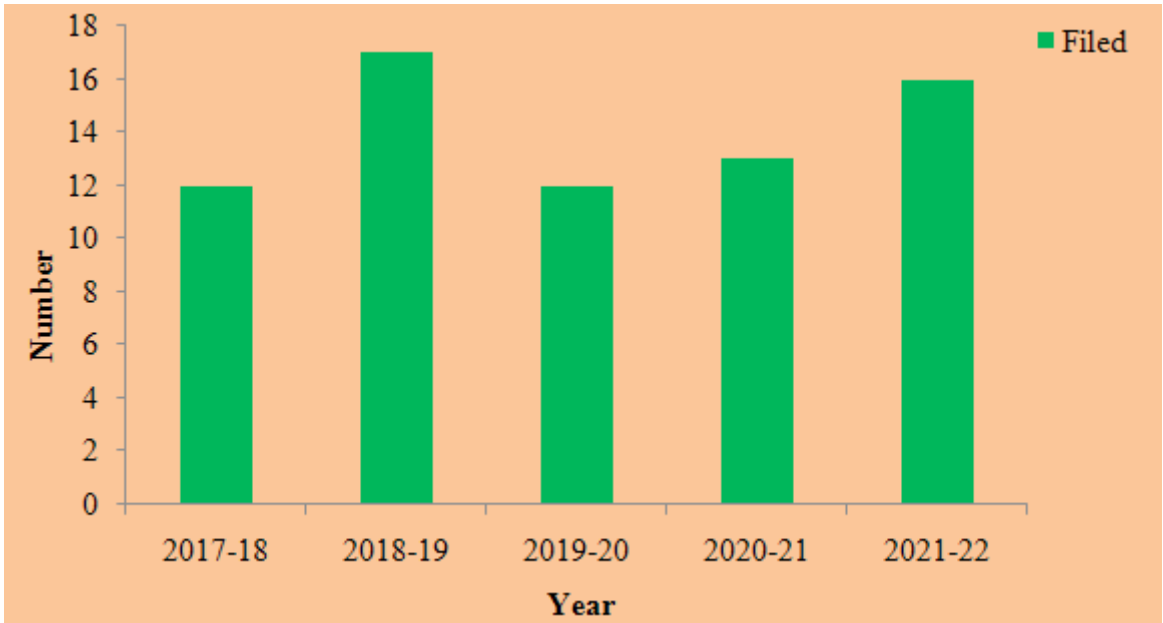
1. **Title:** Solar assisted improved biomass cook stove.\n**Designers:** Chanchal Loha, Harish Hirani, Partha Sarathi Pal, Biswajit Chakraborty, Ishita Sarkar\n**IPU-CSIR Ref.:** 019DN2021 **Dated:** 02.09.2021
2. **Title:** Machine for manufacturing of surgical tools.\n**Designers:** Saurav Halder, Siddappa Yellappa Pujar, Anmol Khalko, Sudip Samanta, Harish Hirani\n**IPU-CSIR Ref.:** 017DN2021 **Dated:** 02.09.2021
3. **Title:** Reduction gear box casing for self-propelled 3-row potato seeding\n**Designers:** Ashok Kumar Prasad, Arun Baiju Velukutty Gomathy, Subrata Kumar Mandal, Atanu Maity, Sabyasachi Mosan\n**IPU-CSIR Ref.:** 018DN2021, **Dated:** 02.09.2021
4. **Title:** Tractor operated spading machine\n**Designers:** Jagdish M, Pradeep Rajan, Harish Hirani, Jagroop Singh, Bharat Saini\n**IPU-CSIR Ref.:** 024DN2021 **Dated:** 06.10.2021
5. **Title:** A tubular electrical heating element\n**Designers:** Partha Sarathi Pal, Chanchal Loha, Md. Musraph Hussain, Harish Hirani\n**IPU-CSIR Ref.:** 029DN2021 **Dated:** 01.11.2021
6. **Title:** Adjustable Overhang Unit for a Single Sensor based Smart Parking System.\n**Designers:** Pratik Saha, Meraz Ansari, Aman Arora, Srinivasan Aruchamy, Harish Hirani\n**IPU-CSIR Ref.:** 031DN2021 **Dated:** 08.12.2021
7. **Title:** Truss mounted Solar Artifact.\n**Designers:** Malay Kumar Karmakar, Biplob Roy, Partha Sarathi Pal, Vinay P Tigga, Harish Hirani\n**IPU-CSIR Ref.:** 037DN2021 **Dated:** 17.12.2021
8. **Title:** 53.6 kWp Solar Tree\n**Designers:** Malay Kumar Karmakar, Biplob Roy, Ashwani Kumar Kushwaha, Abhishek Kumar, Harish Hirani\n**IPU-CSIR Ref.:** 038DN2021 **Dated:** 28.12.2021
9. **Title:** Solar Shree\n**Designers:** Atanu Maity, Sabyasachi Mosan, Ashok Kumar Prasad\n**IPU-CSIR Ref.:** 011DN2022 **Dated:** 03.02.2022
10. **Title:** Mechanical type jute bailing press.\n**Designers:** Ashok Kumar Prasad, Arun Baiju Velukutty Gomathy, Atanu Maity, Sabyasachi Mosan\n**IPU-CSIR Ref.:** 012DN2022 **Dated:** 17.02.2022
11. **Title:** Design of 1kW Subsea Thruster.\n**Designers:** Chandan Har, Srinivasa Reddy N, Sumit Kumar, Srinivasan A, Harish Hirani\n**IPU-CSIR Ref.:** 016DN2022 **Dated:** 30-03-2022
12. **Title:** Compatible and compact body for solar cooking stove.\n**Designers:** Deevesh Sharma, Chanchal Loha, Partha Sarathi Pal, Rahul Prajapati, Biswajit Chakraborty\n**IPU-CSIR Ref.:** 020DN2022 **Dated:** 05-04-2022



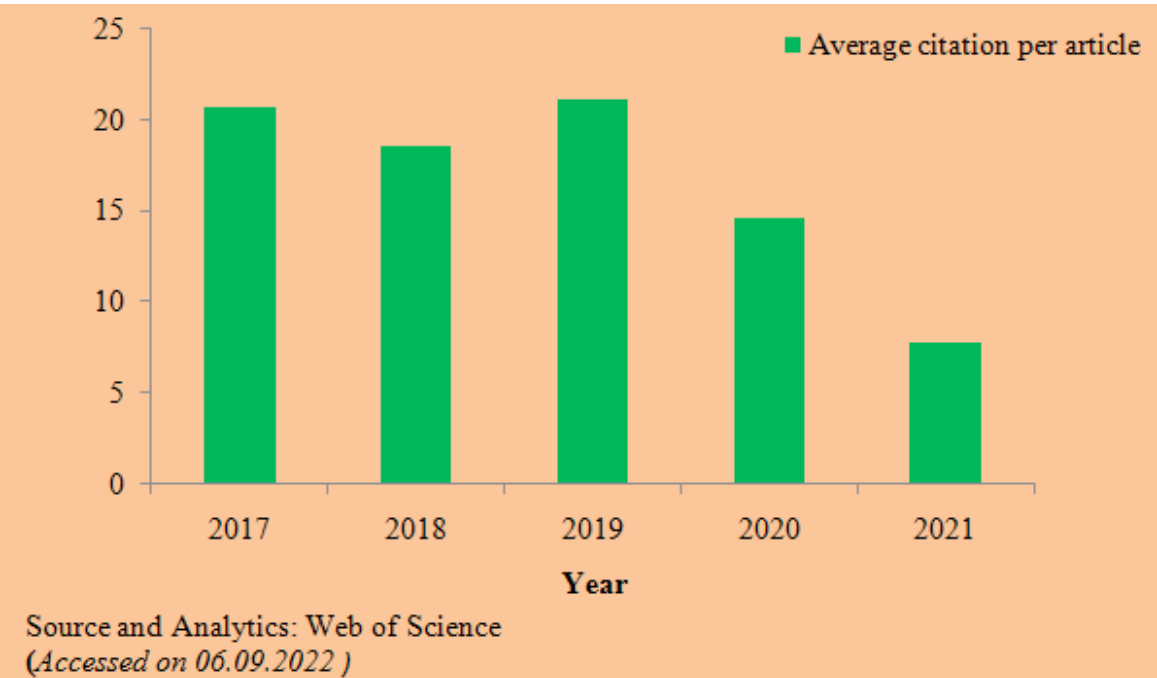


Performance Indices

Patent (last 5 years)

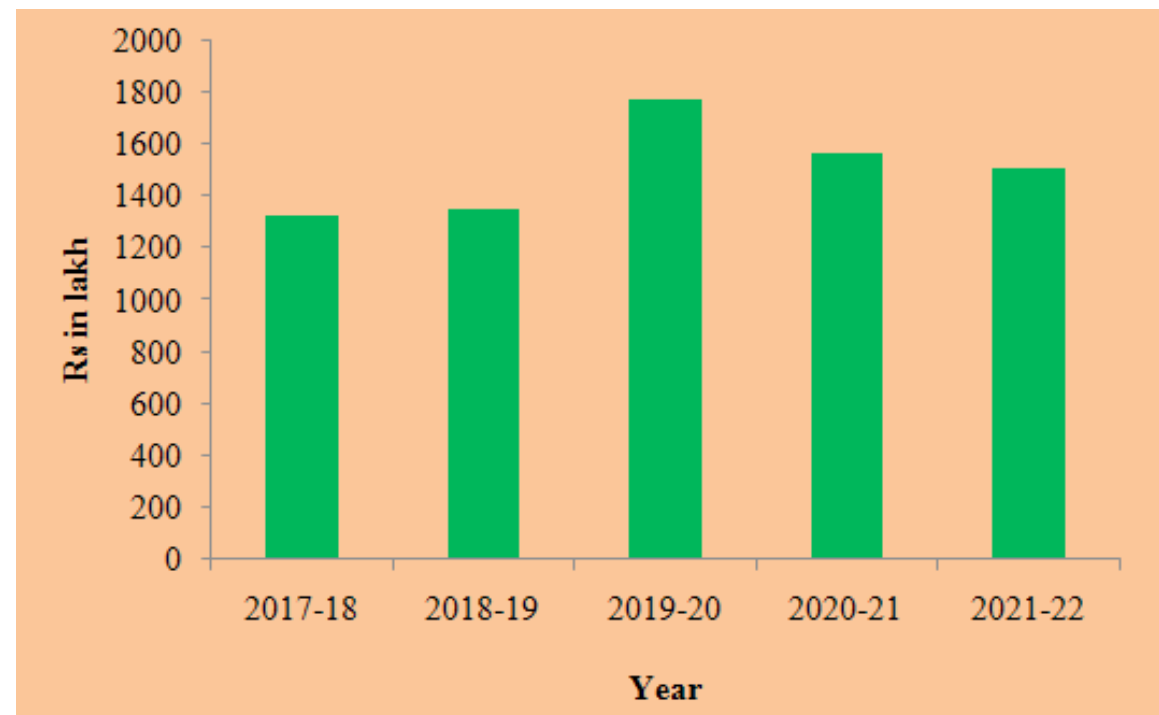


SCI Publication (last 5 years)

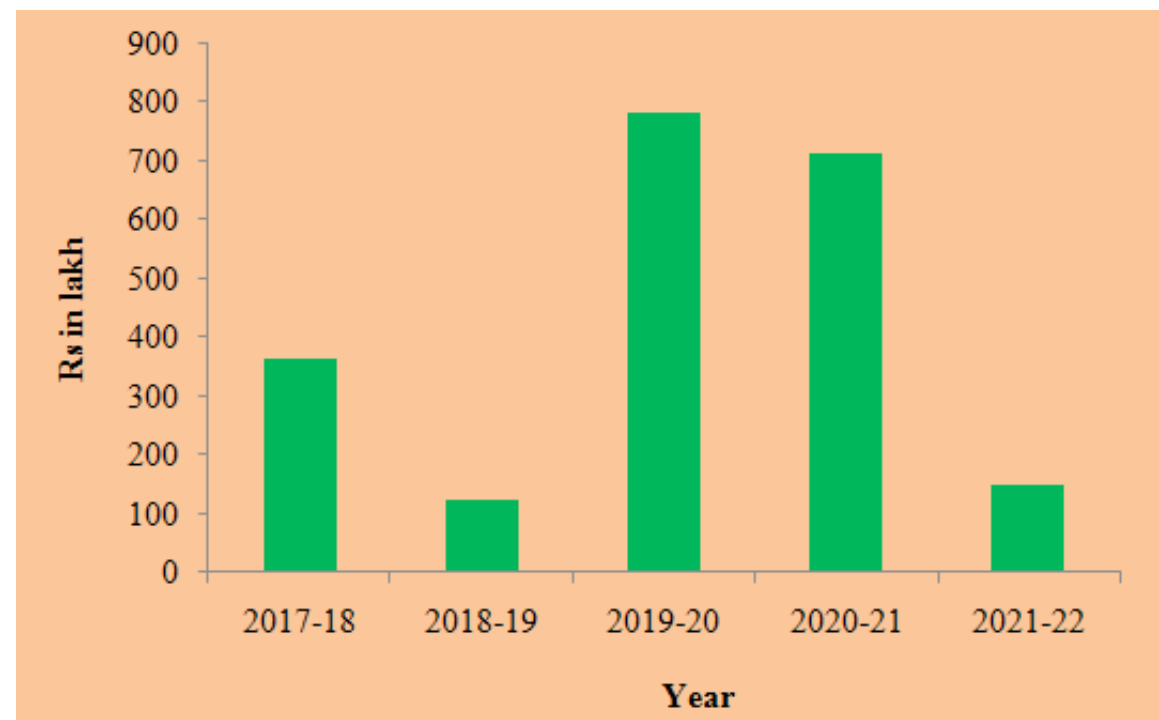




### ECF (last 5 years)



### LRF generated (last 5 years)



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