SERB Fund for Industrial Research Engagement (SERB- FIRE)

Request for Proposals

The Scheme for funding Industry Relevant R&D (IRRD) of SERB aims to utilize the expertise available in academic institutions and national laboratories ("academic partners") to solve industry specific problems for larger benefit of society. The Program titled 'Fund for Industrial Research Engagement (FIRE)' under IRRD supports ideas that address well-defined problems of industrial relevance in project mode. SERB signed partnership agreements with a few selected industries including GE India Industrial Private Limited (GE India). Funding support by SERB and GE India shall be on equal basis of 1:1 ratio for projects jointly executed by academic partners and GE India under the program.

R&D proposals are solicited from scientists in specified themes. The themes fall under the following research areas:

Research Areas

1. Healthcare Technologies
2. Aviation Technologies
3. Renewable Technologies

Healthcare Technologies (5 Themes)

1. A scalable image quality transfer approach for differential diagnosis of dementia using MR oximetry at low field strengths.
2. Meta-learning framework for Imaging applications.
3. Patient-specific Precision Surgical Aids.
4. Oncology Digital Model for Home Infusion
5. Smart Patient Summaries for Oncology

Aviation Technologies (3 Themes)

1. Development of miniatured auto-focus high resolution camera for Inspection which can map the Airfoil defects.
2. Understand and Model MTR Evolution in Titanium-64.
3. Developing Robust containment system for high-speed rotating components in aircraft systems.

Renewable Technologies (2 Themes)

1. Development of a modelling framework with appropriate meso and micro scale models for accurate wind resource estimation.
2. Matrix performance improvement in composite structure using Carbon Nano Tubes.

Illustrations on the problem statement under each theme will guide the prospective investigators to align and sharpen their proposal. Accordingly, the Investigators are requested to go through the details carefully before submitting the proposal.

Healthcare Technologies: Theme 1

A scalable image quality transfer approach for differential diagnosis of dementia using MR oximetry at low field strengths

[Healthcare technologies -Artificial Intelligence, Deep Learning]

Project Summary

Due to the commonality and frequency of stroke cases in the country, timely diagnosis of vascular dementia (VAD) has become a critical clinical problem that requires a safe and cost-effective neuro-imaging solution. Histopathological evaluation of brain tissue is the primary means for this differential diagnosis. A non-invasive imaging approach like MR oximetry can play an important in differential diagnosis of dementia and can potentially be included as part of an imaging-based screening process. Thus, a robust MR oximetry tool on a low-filed widely accessible MRI system can significantly impact the clinical practice in these scenarios.

The aim of this project is to explore the feasibility of robust MR oximetry in a low field strength accessible MRI system by leveraging state-of-the-art image quality transfer based deep learning approaches.

Expected outcome

- Non-invasive oximetry tool developed for 1.5T
- Simulation of QSM data acquired at low field but having image quality equivalent (or better) compared to a high-quality 3T data.
- Real QSM data acquired from low field system but having an image quality equivalent (or better) compared to a data from high field system.
- Radiological evaluation of results from low field system
- Working implementation of the approach that can be used on real-world subjects with dementia.
- The entire framework implementation with the source code for any application.

GE contact person

Name: Kaur, Ravinder
Email: ravinder.kaur@ge.com
Phone: +91-7899049844

Healthcare Technologies: Theme 2

Meta-learning framework for Imaging applications

[Healthcare technologies - Precision Health, Artificial Intelligence, Deep Learning, Machine Learning]

Project Summary

AI/ML/DL is extensively used and explored across every aspect within the imaging chain. DL models are task-specific and necessitate discrete instantiation and re-training for different tasks. Thus, there is proliferation of specialized models per context. Secondly, task-specific models might not interpolate or extrapolate in task context; quick adaptation to new tasks with domain shift is also not possible. Thirdly, a large amount of training data is needed to model useful representations, the preparation of which is a demanding exercise. There is a strong need for an AI/ML/DL approach which will overcome these limitations.

Exploration of a state-of-the-art generalized machine learning framework which can handle multiple tasks for a given model and with relatively less stringent data requirements for model training. In this project, the proposed framework would be tested, evaluated, and optimized for regression-analysis-based tasks for applications in MRI.

Expected outcome

- Novel machine learning framework.
- Application of the proposed framework to address the regression-analysis-based needs in MRI.
- Illustrated advantages of the proposed framework in realistic scenarios.
- Demonstrated reduction in number of data sets needed for reaching similar training and performance accuracy and precision.
- Demonstrated capability of addressing multiple tasks without compromising the performance accuracy and precision.
- The entire framework implementation with the complete source code.

GE contact person

Name: Kaur, Ravinder
Email: ravinder.kaur@ge.com
Phone: +91-7899049844

Healthcare Technologies: Theme 3

Patient-specific Precision Surgical Aids

[Healthcare technologies – Biomedical Engineering]

Project Summary

The proposed project aims a solving a Precision Health problem, where surgical aids will be designed and translated into reliable high-quality products through a phased approach encompassing, designing, prototyping, & validation. The first phase of the project will aim at designing and importing of the e-surgical aids, into a proprietary visualization application that supports and enables decision-making and planning by Radiologists and Surgeons, respectively.

The proposed project aims at solving a Precision Health problem, where patient-specific precision surgical aids that are critical to patient outcomes, will be designed and translated into reliable high-quality products.

Expected outcome

- Visualization tools
- Simulation tools
- Navigation tools
- Tactile tools
- Workflows

GE contact person

Name: Kaur, Ravinder
Email: ravinder.kaur@ge.com
Phone: +91-7899049844

Healthcare Technologies: Theme 4

Oncology Digital Model for Home Infusion

[Healthcare technologies – Artificial Intelligence/ Machine Learning]

Project Summary

One of the main barriers in oncology is the treatment cost. Treatment cost is dominated by drug and infusion costs. In emerging markets, 60% of cancer treatment cost is non-treatment related. This is driving distributed cancer care by moving patients to lower cost of care sites, e.g., moving from a busy metro city to a 2nd tier town for infusing the same drug or to receive radiotherapy. These problems need technology advancement and workflow fitment to render cost effective yet high-quality care. A major shift on cost control has been moving chemo infusions away from in/out-patient settings, physician's office to home and yet get the safety and quality of a hospital. Home infusion and shifting care is a rising trend and is a win-win for all. In emerging countries, home infusion can be performed in local hospitals/clinics/primary care centers.

The proposal seeks for solutions to create prediction models for home infusion and home monitoring of oncology patients to allow skill shift to primary care centers - Develop a Digital Twin to model risk to determine which of the cancer patients have a potential for home infusion and determine measures to be taken to remotely monitor them post-infusion.

Expected outcome

- A risk prediction model for safe home infusion that takes in patient parameters, disease parameters, drug parameters, gives out risk scores for various adverse events.
- A risk prediction model for patients after infusion/surgery/radiation therapy to be monitored at home. The model takes in vitals, patient parameters, disease parameters, treatment parameters and gives out risk scores for various adverse events.

GE contact person

Name: Kaur, Ravinder
Email: ravinder.kaur@ge.com
Phone: +91-7899049844

Healthcare Technologies: Theme 5

Smart Patient Summaries for Oncology

[Healthcare technologies – Precision Health, Artificial Intelligence, Natural Language Processing]

Project Summary

Cancer patients often undergo lengthy multimodal treatments with many phases of diagnosis, treatment, and monitoring encounters across different care providers. Each of these encounters results in clinical reports and notes, which becomes a recorded history of the progression of the disease, its treatments, and the outcomes of those treatments. But as the length of patient journey becomes longer, so does the cognitive load of the doctor who need to go through this history before taking treatment decisions. Insufficient time for reading patient reports has been reported as a major barrier to patient care by doctors in many regions of the world. Hence, there is a dire need of computer assistance in helping doctors to efficiently go through the patient journey. One of the ways of providing computer assistance is to use AI/NLP methods to generate a concise summary of each clinical report, so that the doctor can quickly decide if a certain report needs his/her attention.

Provide AI-assistance to Oncologists to help navigate the patient's clinical reports efficiently, by using AL/NLP algorithms to create concise summaries of clinical reports.

Methodology:

The input to the solution will be a longitudinal single patient jacket (a structured file format with all available patient data). The first step is to identify the diagnostic and therapeutic context (type of cancer, disease parameters, type of treatments undergone etc) of the patient at every point in time. Representation formats like mCODE can be used for this. The next step is to determine the diagnostic and therapeutic intent of the Oncologist along with the corresponding information needs of the Oncologist for each context. Oncological domain knowledge resources like clinical practise guidelines and medical ontologies/taxonomies can be used here. The final step is to identify the snippet of information from each clinical report which satisfy the information needs of the Oncologist in that context in the patient's journey. Natural Language Processing and Generation techniques like extractive and abstractive summarization can be used in the final step.

Expected outcome

- Develop AI/NLP based approach(es) to identify all the pieces of information contained in a clinical report and rank them according to their relevance towards various diagnostic, curative, or palliative intents a doctor might have in the context of a given patient in his/her present stage of diagnosis or treatment.
- Develop AI/NLP based approach(es) to identify a subset of words/phrases from the clinical report which convey the most relevant pieces of information (chosen during step 1) in a complete and unambiguous way to the reader.

GE contact person

Name: Kaur, Ravinder
Email: ravinder.kaur@ge.com
Phone: +91-7899049844

Aviation Technologies – Theme 1

Development of miniatured auto-focus high resolution camera for Inspection which can map the Airfoil defects

[Aviation Technologies – Robotic Inspection]

Project Summary

The regular inspection of machine/engine is critical for safety and avoiding any unplanned maintenance. Technology advancement of miniatured camera capability will enable:

- the enhanced visual inspection of critical components in situ (in assembly state), and
- usage in repair application utilizing advanced 3D measurement capabilities.

The target application is "Inspection of component inside an assembled system with constraint access". Currently BSI is used for similar inspection with constraints. The developed technology can also be leveraged for Automotive, Power, Healthcare, and other industries as well.

Development of miniaturized auto-focus high resolution camera system for Inspection which can map component defects. Camera Envelope including lens (Max Dia. 6mm, Max length 15mm):

- ***Minimum Resolution: 5 MP or above***
- ***Lens: FOV range: 77D to 99D***

Expected outcome

- Development of 2D Miniatured sensor (Imaging system) fixed focus with optimum optical performance
- Upgrade the above camera for auto-focus capability within envelop
- Miniatured sensor (Imaging system) to measure defects including depth (keeping field of view)
- Embedded sensor positioning system within the camera to accurately determine the position w.r.t defined fixed base reference.

GE contact person

Name: Swaminathan, Srinivasan
Email: srinivasan.swaminathan@ge.com
Phone: +91-740889809

Aviation Technologies – Theme 2

Understand and Model MTR Evolution in Titanium-64

[Aviation Technologies – Advance Materials]

Project Summary

Microtextured regions (MTRs) have been known to exist in titanium alloy forgings for decades and these can cause cold dwell fatigue failure. However, Ti-64, the most widely used titanium alloy in aviation applications, had not been associated with any cold dwell fatigue issues until recent years. Minimizing Ti-64 MTR formation and evolution during billet conversion & component forging is critical to engine safety.

The proposed project will utilize a systematic, Design of Experiments (DoE) approach targeting industrially relevant processing space/paths to understand MTR break-up as a function of deformation conditions. Resultant model will enable optimized billet/forge routes to be employed, minimizing impact on component life.

Expected outcome

- Understand and Model MTR evolution in Ti-64
- Leverage model to predict industrially relevant processing windows/paths to eliminate MTRs, and Validate

GE contact person

Name: Ramesh, Padmini A
Email: padmini.ramesh@ge.com
Phone: +91-7259243839

Aviation Technologies – Theme 3

Developing Robust containment system for high-speed rotating components in aircraft systems

[Aviation Technologies – Next Gen Gas Turbines - Impact Dynamics]

Project Summary

Aircraft Engine Systems have multiple high speed rotating discs. A containment structure needs to be part of the product to contain the high energy fragments in a disc burst scenario. These containment structures need to have very high energy absorption capability with less deformation. Internationally the state of the art includes a good understanding of material candidates like Steel, Titanium, and their capability of Kinetic energy absorption. However, there is an opportunity to further understand the high strain rate behavior (for different loading and thermal conditions) of candidate materials (like Steel) and explore their full potential in containment structures.

Develop containment solution by either improving the existing design envelope through design of experiments or coming up with radically different material solutions for containment system without impacting the cost and weight at system level.

Expected outcome

- Advanced Material Model Development for conventional materials (like Steel) with Coupon Level Testing
    a. High Strain Rate, Elevated Temperatures & Tension / Compression / Shear / Torsion) Material Testing
- Material data generation for analytical modelling
- Device techniques for simulation of high energy absorption physics
- Device coupon tests to correlate some of the system level interactions using material models generated

GE contact person

Name: Ramesh, Padmini A
Email: padmini.ramesh@ge.com
Phone: +91-7259243839

Renewable Technologies – Theme 1

Development of a modelling framework with appropriate meso and micro scale models for accurate wind resource estimation

[Renewable Technologies -Wind flow characterization]

Project Summary

A crucial factor that determines the financial viability and operation of a wind farm is wind resource estimation (WRE). Important outcome of WRE is prediction of annual mean wind speed distribution and annual mean energy production along with quantification of uncertainties over the lifetime of the wind farm. WRE involves several standard steps such as long-term correction, horizontal and vertical extrapolation of measured data. Wind resource technology development for predominantly simple or flat sites is decently matured. However, the current trend in the wind energy industry is to build farms in areas with complex terrains or complex flows. Unfortunately, wind resource estimates on such complex sites have been found to be inaccurate or uncertain.

Proposals are sought on development of a modelling framework with appropriate meso and micro scale models for accurate wind resource estimation at complex sites.

Expected outcome

- An uncertainty quantified and cross-validated meso and micro scale modelling framework for wind resource estimation at complex sites in India.

GE contact person

Name: Rwitam Mitra
Email: rwitam.mitra@ge.com
Phone: +91-9008866117

Renewable Technologies – Theme 2

Matrix performance improvement in composite structure using Carbon Nano Tubes

[Renewable Technologies -Advance Materials]

Project Summary

In a modern wind turbine blade, there are number of interfaces (such as adhesive bond lines scale of meters) and parts of interfaces (such as the end drop offs of fiber plies or pultrusion's, bushing interface etc.- scale of millimeters), by which the design and the design safety is limited by the mechanical performance of the adhesive or resin in that interface.

The purpose of this project is to investigate the impact of carbon nano tubes (CNT's) on the interlaminar & interface strength properties and therefore the increase of performance and safety/reliability of these interfaces due to CNT's. It will be important to not only look at the change in average properties but also the change in variability (standard deviation) of properties as this will indicate tightness of processing and is critical for design calculations.

Expected outcome

- Improvement in interlaminar fracture toughness & composite material adhesion strength (Target is 50% improvement between without CNT & with CNT system). More specifically the characteristic values (used for design) for both interlaminar shear strength and Fracture toughness to be increased by at least 50% over current epoxy infusion resin & epoxy adhesive systems.
- Provide guidelines to implement in wind turbine blade scale level (scale of meters for interfaces such as adhesive bond lines & scale of millimeters for parts of interfaces such as ply drop offs of fiber plies or pultrusion's, bushing interface etc.

GE contact person

Name: Ashwini Katre
Email: Ashwini.B.Katre@lmwindpower.com
Phone: +91 8066470225/9740810993

EXPECTATION FROM THE PI/INSTITUTION

- The PI/Co-PI should have carried out projects in the theme specified and have a minimum of 5 years of experience in the domain.
- GE India will have a Co-PI on the selected proposal.
- The projects to be identified should be at TRL 3 or above. Typical duration of the project should be 2 years with strict performance review.
- Sharing of Intellectual property rights emanating from the projects shall be determined based on the mutual discussions between the Industry Partner and the identified academic institution / investigator. An agreement (individual agreement) defining the modalities of IP sharing will be made between the academic partner and GE India before commencement of the project.

GENERAL GUIDELINES

- Applicants [Principal Investigator (PI) and Co-Principal Investigator(s) (Co-PI(s))] should be Indian citizens. The applicant(s) must hold a regular academic/research position in a recognized academic institution or national laboratory or in any other recognized R & D institution in India.
- The funding is provided for a period of two years. The research grant is provided for minor equipment (essential), manpower, consumables, travel and contingency. "Overheads" is also be provided to the implementing institution as per prevailing norms of SERB.
- All the rights, duties and obligations pertaining to any intellectual property, profit sharing/royalty and / or related aspects shall be discussed and agreed separately in writing with the participating academic institute(s) and GE India under definitive agreement(s), in order to enable GE India to commercialize and benefit from the developed solutions.

	GE India	**SERB**
Nodal contacts	Ms. Ramesh, Padmini A John F Welch Technology Centre Division, located at Plot No. 122, Export Promotion Industrial Park, Phase 2, Hoodi Village, Whitefield Road, Bangalore – 560 066 padmini.ramesh@ge.com Phone: +91-7259243839	Programme Coordinator (SERB-FIRE) Science and Engineering Research Board 3rd & 4th Floor, Block II, Technology Bhawan, New Mehrauli Road New Delhi – 110 016 vajra@serb.gov.in Phone: 011-2655 2126

Please visit SERB online portal for more details & submission of proposals.
(www.serbonline.in)