HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

Centre for Automation and Robotics

Funded Research Projects and Publications

This document contains the abstract of the funded research projects and notable publications carried out by the faculty of Centre for Automation & Robotics, School of Mechanical Sciences during the period of 2014 - 2022

CENTRE FOR AUTOMATION & ROBOTICS

About

Centre for Automation and Robotics (ANRO) at Hindustan Institute of Technology and Science (formerly as Hindustan University) was established on 20th October 2014 to promote educational and research activities in the field of robotics, automation and computer vision. This Centre bridges the gap between industries and University with a distinctive capability to harness the intellectual energy of academia to influence Indian industries. ANRO is established as an interdisciplinary centre for schools of mechanical, electrical, aeronautical and computer sciences of Hindustan Institute of Technology and Science (HITS) in response to the rapidly growing interest of Indian industries in robotics and automation in recent years.

Vision of ANRO is to establish a research team with synergetic strengths with an emphasis on robotics and automation related research, product development, teaching, training and consultancy. The goal is to innovate and disseminate new knowledge to meet the needs of industries and society. The mission of ANRO is to engage in multidisciplinary research in the fields of robotics and automation, condition monitoring, vision system and artificial intelligence. Centre strives to provide solutions that will support industrial automation systems. It also focuses on providing the students with a varied academic and research experience on industrial automation and robotics, and helps the University in educating the future work force in meeting the oncoming technical challenges and advancements in the field of automation and robotics.

ANRO has five state-of-the-art laboratories, Robotics lab, Pneumatics and Automation lab, CNC and Condition monitoring lab, Motion control lab and Human Machine Interaction lab. Robotics, Pneumatics and Automation and Motion control lab are established in collaboration with Yaskawa, SMC Pneumatics, and SEW Eurodrives respectively.

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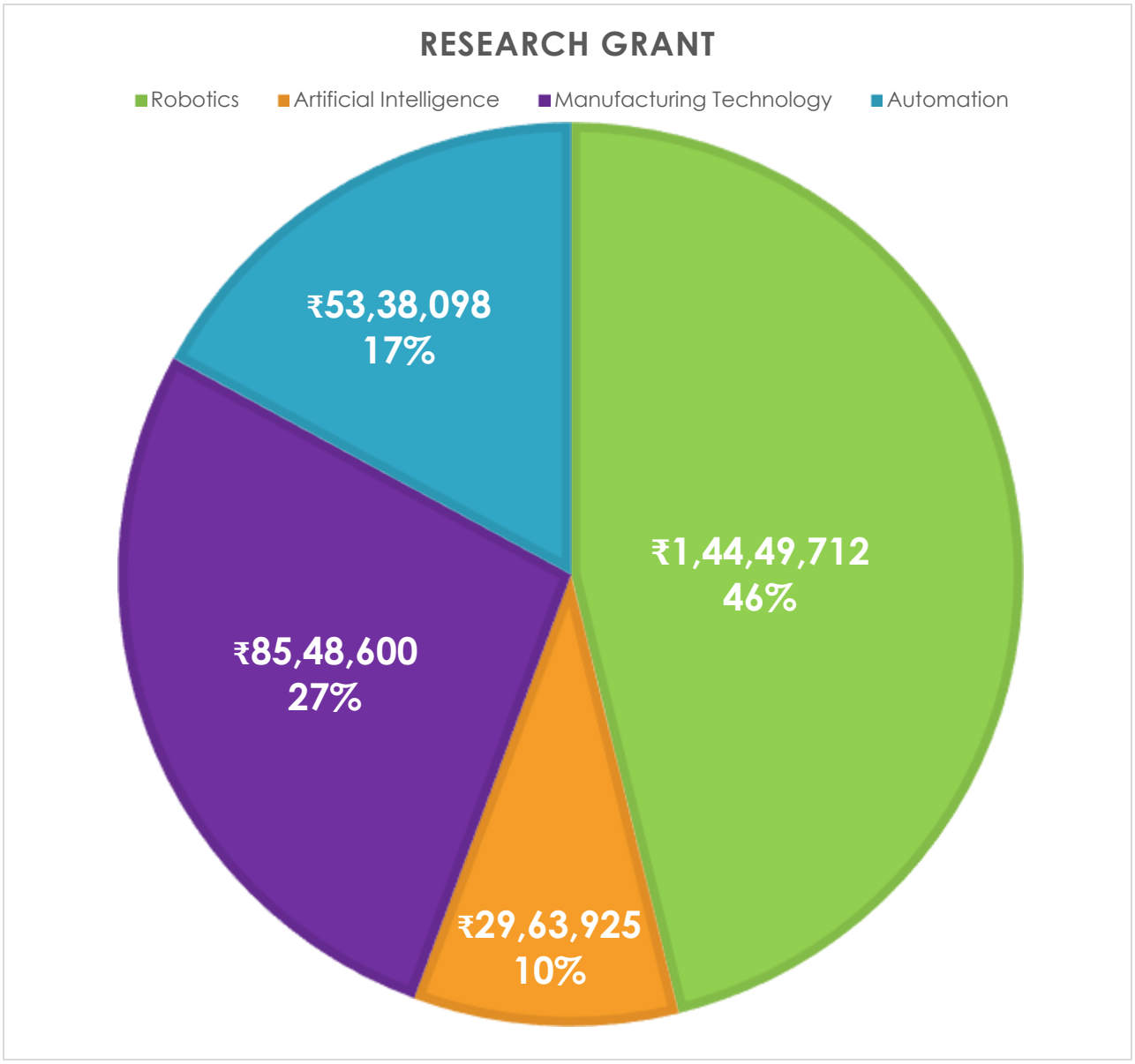
Table of Content

Status of the Project

Sl. No.	Year	Title of Project	Funding Agency	Status
1.	2021 to 2023	Development of Autonomous Heterogeneous Robotic Swarm Simulator for Faster Disaster Reconnaissance and Mitigation	Royal Academy of Engineering, UK Partner(s): University of Leicester, Siva Subramaniya Nadar (SSN) College of Engineering, Menzel Vision and Robotics Pvt. Ltd, Yagen Robotics.	Ongoing
2.	2021 to 2022	Modeling and Simulation of An Electromagnetic Retarder for Automotive Applications	RAMBAL Limited.	Completed
3.	2020 to 2022	Adaptive Control of Robotic Fettling for Asymmetric Geometry and Close Tolerance Cast Components	Science and Engineering Research Board (DST)	Completed
4.	2019 to 2021	Development of a mobile wall climbing robot for the internal non-destructive testing (NDT) of storage tanks and for project based learning on mechatronics program	Royal Academy of Engineering, UK Partner(s): London South Bank University, National Institute of Technology, Warangal, Nugenix	Completed
5.	2018 to 2020	Low Cost Assistive Robot for Elderly	Royal Academy of Engineering, UK. Partner(s): University of Leeds, Axis Global Automation	Completed
6.	2017 to 2019	Development of Ultra Response Gas Purging System	Micro Tube Research and Development Centre, DRDO, Govt. of India	Completed
7.	2016 to 2018	Application of NDT for Foundry Products and Improving Skill of Indian Foundry Men	Royal Academy of Engineering, UK. Partner(s): University of Northampton, INDSAT Corporation	Completed
8.	2016 to 2018	Developing Technologies to Manufacture Specific Grades of Austempered Ductile Iron for Automotive Components	Royal Academy of Engineering, UK. Partner(s): Warwick Manufacturing Group, Nelcast Ltd.,	Completed
9.	2015 to 2018	Trainer for Tactical Warfare	Combat Vehicles Research & Development Establishment, DRDO, Govt. of India	Completed
10.	2013 to 2017	Intelligent System for Adaptive Enhancement of Underwater Images for Accurate Object Recognition	Naval Research Board, DRDO, Govt. of India	Completed

Major Areas- Funding Received



Development of Autonomous Heterogeneous Robotic Swarm Simulator for Faster Disaster Reconnaissance and Mitigation

Investigator(s): **Dr. RM. Kuppan Chetty, Dr. M. M. Ramya & Ms. N. Seenu**



The goal of this project is to develop a cost effective collaborative robotics methodology and a simulator in virtual environment for search and rescue operations during disaster situations. Another goal is to train rescue personals / first responders to use the developed simulator for successful search and rescue operations during disaster situations.

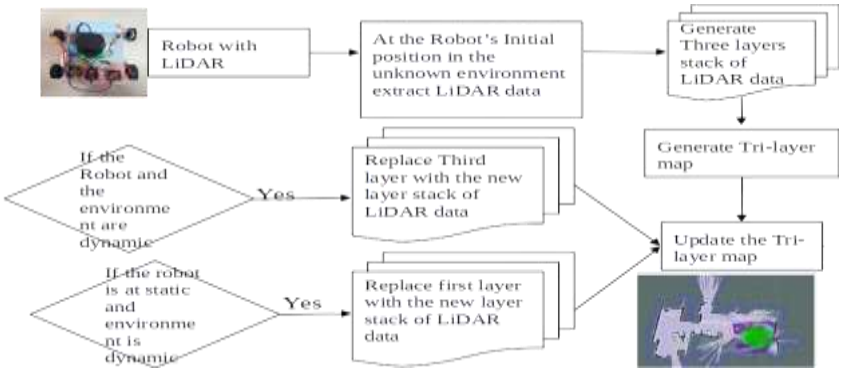
The objectives are:

1. Development of robust and scalable task distribution and path planning techniques for successful search and rescue operations by multiple heterogeneous mobile robots.

2. Development of a robust coordination scheme within the heterogeneous mobile robots deployed in cluttered and harsh communication disaster fields, therefore, the maximum number of victims could be rescued by the proposed methodology

3. Development of an effective disaster assessment methodology by incorporating artificial intelligence techniques in the search and rescue robots.

4. Design of virtual simulator incorporating robotic tools and provide training for the search and rescue personnel's to use the developed robotics strategy



Funding Details

Funding Agency:

Royal Academy of Engineering, UK

Partner(s):

University of Leicester

SSN College of Engineering

Menzel Vision and Robotics Pvt. Ltd

Yagen Robotics.

Duration:

2021 - 2023

Status:

Ongoing

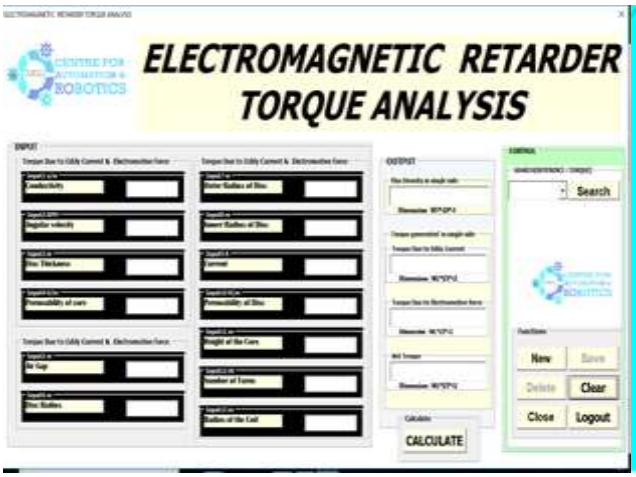
Modeling and Simulation of an Electromagnetic Retarder for Automotive Applications

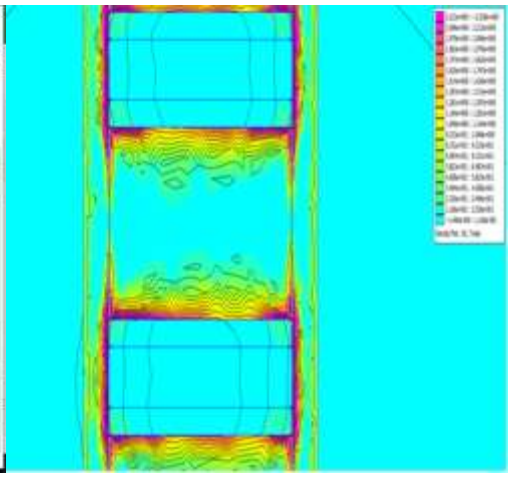
Investigator(s): **Dr. D. Dinakaran, Dr. RM. Kuppan Chetty & Ms. Manju Mohan**



Electromagnetic retarders are also called electromagnetic brakes, uses Electromagnetic induction to provide a retardation force to reduce the speed of the rotating machine. Numerous parameters account for the generation of the required amount of retarding force that has to be studied, monitor, and estimate the amount of braking force required to optimize the complete system. The main aim of this work is to model analytically and simulate the electromagnetic retarder to correlate the influence of braking force, Torque, Speed, and other factors affecting the braking torque. The specific goals of this proposed work are to

1. Study of variables affecting the retarding force
2. Developing a mathematical model for retarder force vs braking torque
3. Performance Investigation through Simulation study
4. Experimental study and performance evaluation of the developed electromagnetic retarder and braking system.





Funding Details

Funding Agency:

RAMBAL Limited

Duration:

2021 – 2022

Status:

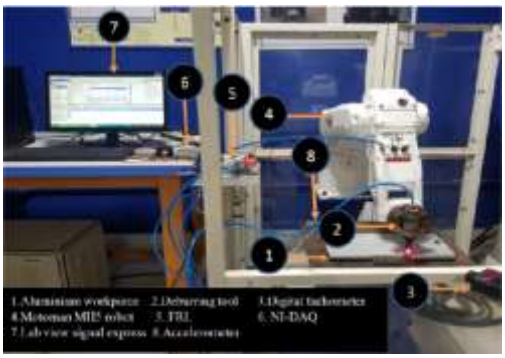
Completed

Adaptive Control of Robotic Fettling for Asymmetric Geometry and Close Tolerance Cast Components

Investigator(s): **Dr. D. Dinakaran**

Fettling is one of the unsafe and fatigue intensive process in an unconducive environment in the foundry. This results in Hand Arm Vibration Syndrome (HAVS), Musculo-Skeletal Disorders and respiratory diseases. Robotic fettling would replace human workers and will improve the productivity and quality of the cast components. However, the development of control algorithms for robotic fettling is challenging due to the variations in the cast components like size, geometry, shape and unwanted excess material. The excess material to be removed varies in each component and hence detection and removal of the same adds in additional complexity to the control. The project proposal focuses on developing Adaptive Control by Optimization algorithm for rough and finish fettling for better Material Removal Rate and Surface Finish. A heuristic algorithm is also to be developed for identifying the minimal trajectory to reduce the lead time. Machine vision system, force, torque and vibration feedback will be used to realize the system. The proposed work will result in implementation of an intelligent retrofitting system for adaptive fettling which may be readily fitted in industrial robots. This will ensure the safety and improve the quality & productivity of the cast components.

Junior Research Fellow: Mr Rajesh



Funding Details

Funding Agency:

Science and Engineering Research Board (DST)

Duration:

2020 - 2022

Status:

Completed

Development of a mobile wall climbing robot for the internal non-destructive testing (NDT) of storage tanks and for project based learning on mechatronics program

Investigator(s): **Dr. D. Dinakaran, Dr. M. M. Ramya & Dr. RM. Kuppan Chetty**



The focus of the project is to develop a low cost mobile robot for ultrasonic inspection of the internal ferrous surface of storage tanks and use the model for teaching the interdisciplinary concepts of Mechatronics program.

The use of robotic technology is limited among Indian Industries due to high cost and lack of awareness in quality of inspection. Manual periodic inspection of hazardous chemical storage tanks is not feasible due to the health and safety risks and is time-consuming requiring lengthy preparation to gain access to test sites. Hence, there is a need for a robotic inspection system that constitutes a wall climbing robot platform and an NDT system that is capable of detecting cracks, corrosion, and welding defects.

Junior Research Fellow: Mr Jaise Jose


Funding Details

Funding Agency:

Royal Academy of Engineering, UK

Partner(s):

London South Bank University

National Institute of Technology, Warangal

Nugenix

Duration:

2019 - 2021

Status:

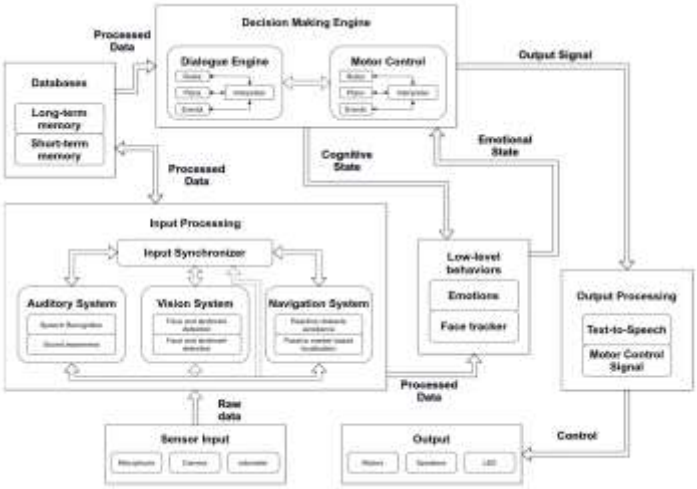
Completed

Low Cost Assistive Robot for Elderly

Investigator(s): **Dr. M. M. Ramya and Dr. D. Dinakaran**

Ageing in India is exponentially increasing due to the impressive gains that society has made in terms of increased life expectancy. It is projected that the proportion of Indians aged 60 and older will rise from 7.5% in 2010 to 11.1% in 2025. The traditional Indian society with an age-old joint family system has been instrumental in providing care for elderly. However, with the emerging prevalence of nuclear family set-ups in recent years, the elderly is likely to be exposed to emotional, physical and financial insecurity in future. There is a dire need to develop an integrated and responsive system to meet the care needs and challenges of elderly in India. The most relying technology that can assist elderly care is development of an assistive robot. The main objective of this project is to develop an indigenous assistive robot that is affordable, aware of regional culture and user-friendly to meet future demand. The project aims to design and develop a low cost robot to assist elderly in various scenarios such as everyday activities, entertainment and emergency situations, who needs continuous care and monitoring.

Junior Research Fellow: Mr Karthik Kumar



Funding Details

Funding Agency:

Royal Academy of Engineering, UK

Partner(s):

University of Leeds

Axis Global Automation

Duration:

2018 - 2020

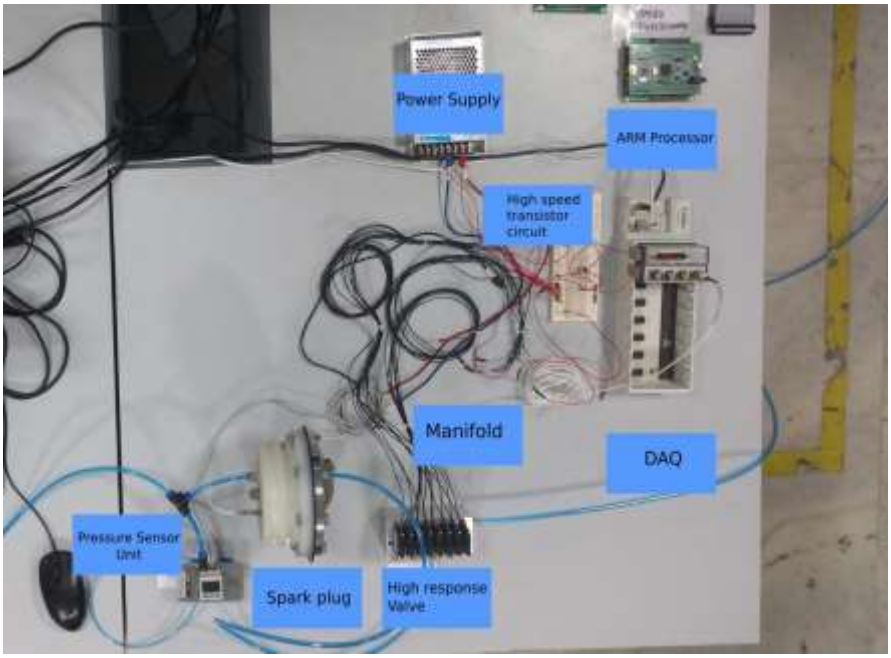
Status:

Completed

Development of Ultra Response Gas Purging System

Investigator(s): **Dr. D. Dinakaran**

An ultra-response gas purging system required by MTRDC for repetitive Marx generator is to be developed for continuously supplying N2 and SF6 gas to the switch chamber with the gas pulse cycle time of 10 ms. It allows the system to operate up to 100 Hz and this will be realized with ultra-response valves and switches. The methodology of proposed work involves study and simulation of pneumatic system, development of ultra-response gas purging system, integration, testing and validation. The proposed project will be carried out at SMC Advanced Pneumatics Automation Laboratory, Hindustan Institute of Technology and Science.



Funding Details

Funding Agency:

Micro Tube Research and Development Centre, DRDO, Govt. of India

Duration:

2017 – 2019

Status:

Completed

Application of NDT for Foundry Products and Improving Skill of Indian Foundry Men

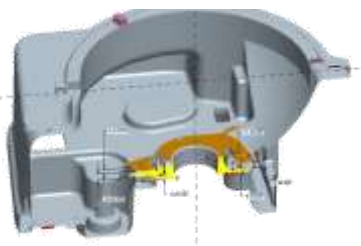
Investigator(s): **Dr. D. Dinakaran, Dr. D. G. Harris Samuel & Dr. M. M. Ramya**



The second outcome of the project is the development of hybrid laser, ultrasonic 3D scanning system for complex components with blind inaccessible areas. To accommodate components with very high roughness variations. a method for nullifying this effect on ultrasonic thickness gauging is studied and presented.

Austempered ductile iron (ADI) castings are widely used as automotive components and Accessories. ADI comprises of a matrix and graphite nodules. Samples with nodularity ranging from 90 to 98% is the one of the key selection criteria for automotive components. Due to the Industrial requirement for measuring nodularity percentage with high accuracy to characterize their castings, an investigation carried out to inspect the percentage of nodularity using spectrum frequency. Samples were inspected using ultrasonic velocity measurements which is not capable of identifying components within a narrow nodularity range. A novel inspection of nodularity of components using Fast Fourier Transform (FFT) is presented and validated.

Junior Research Fellow: Mr Arun Balaji


Funding Details

Funding Agency:

Royal Academy of Engineering, UK

Partner(s):

University of Northampton

INDSAT Corporation

Duration:

2017 - 2019

Status:

Completed

Developing Technologies to Manufacture Specific Grades of Austempered Ductile Iron for Automotive Components

Investigator(s): **Dr. D. G. Harris Samuel & Dr. D. Dinakaran**

The project focuses on indigenous development of austempered ductile iron for automotive applications. After preliminary trials, process optimization of ADI was carried out. Tensile strength, yield strength, percentage elongation, impact energy, wear resistance and fracture toughness were evaluated for the as-cast and austempered samples. Hardness and strength decreased, whereas ductility and impact strength improved with increase in the austempering temperature. XRD analysis revealed that the increase in austempering temperature increases the retained austenite content. A decrease in wear resistance with austempering temperature was observed. The fracture toughness of ADI was improved by treating ductile iron at a higher austempering temperature (360°C) to obtain more retained austenite in its microstructure. A Modified Quality Index (MQI) values were envisaged, incorporating tensile strength, elongation and wear resistance. MQI for samples austempered at 340°C and 360°C showed a better combination of properties. About an 8% reduction in energy consumption was gained when the heat treatment parameters were optimized. The effect of Nickel on ADI as well as few trials to study the effect of nano additions of WC, TiC, ZrO_2, ZnO, SiO_2, SiC, CeO_2 and TiO2 were also executed. The research resulted in commercialization of a component namely "coupler head" used to connect railway bogies and for supply to Faiveley Transport (France).

Post Doctorate Fellow: Dr Prabukumar Sellamuthu

Funding Details

Funding Agency:

Royal Academy of Engineering, UK

Partner(s):

Warwick Manufacturing Group

Nelcast Ltd.,

Duration:

2016 – 2018

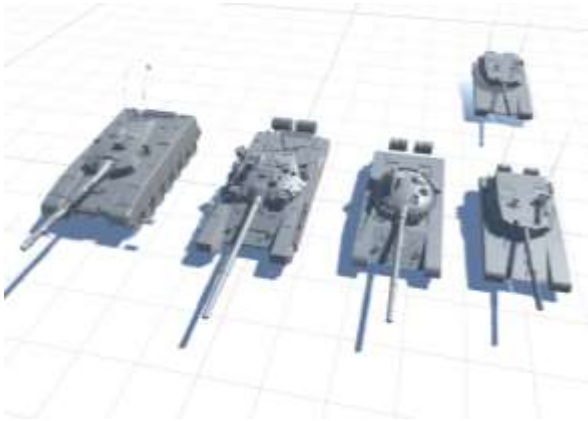
Status:

Completed

Trainer for Tactical Warfare

Principal Investigator: **Dr. M. M. Ramya**

Leadership, decision making and situational awareness are the important skills that any young officer must acquire and cultivate to become an effective military leader. It is understandable that in all military schools, training academy and school of military training the endeavor is to train, cultivate and evaluate their students on these skills. However, conventional training methods involve huge training costs, time, risk of life and paucity of training aids and resources. This has forced us to adopt newer simulation technologies to educate and train the junior and young leaders on costly, most sophisticated military equipment's exist in the Armed forces. To realize the effectiveness of simulation as a tool for tactical training up to Regt and Brigade level, an attempt is being made for the design and development of tactical warfare simulation software using an open source game engine Unity 3D. This project highlights how the constructive simulation is being used to represent the combat effectiveness of battle groups and forces as a single platform or network of active player nodes for network centric warfare. The basic system architecture required to escalate the tactical exercises and training drills conducted from single battle tank level to integrated troop, squadron and regiment level would also be discussed.



Funding Details

Funding Agency:

Combat Vehicles Research & Development Establishment, DRDO, Govt. of India

Duration:

2015 – 2018

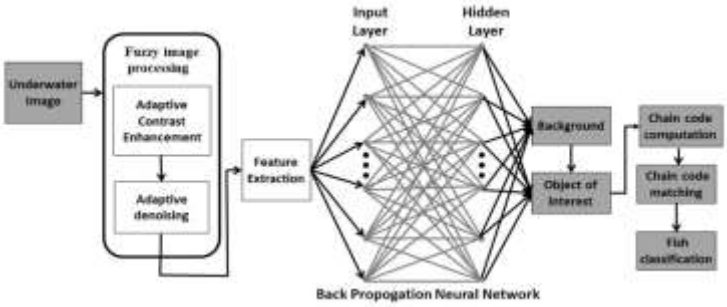
Status:

Completed

Intelligent System for Adaptive Enhancement of Underwater Images for Accurate Object Recognition

Principal Investigator: **Dr. M. M. Ramya**

Image processing as an aid for underwater vision has been subject to intensified interest in recent years. However, it is very difficult to recognize the objects from underwater images as they are essentially characterized by their poor visibility. Some underwater images are so poorly contrasted that the objects in it are not clearly visible, making underwater image analysis a challenging task. Recently, many researchers have used image enhancement methods that use qualitative subjective criteria to produce a more visually pleasing image. However, as the underwater images are affected by various factors, a global image enhancement algorithm may not be sufficed. Each image needs to be adaptively analyzed, based on its characteristics. Hence, a fuzzy based technique that can intelligently deal with the imprecision, uncertainty, and noise associated with is proposed. The images obtained from such fuzzy based algorithm will be classified to identify objects underwater such as navigation, seabed mapping, fishing, oil exploration etc. Artificial neural network based application system for object recognition in underwater images will be developed. The proposed methodology will comprise of several successive independent processing steps which will correct non-uniform illumination, suppress noise, enhance contrast adaptively and perform accurate identification of object of interest.



Funding Details

Funding Agency:

Naval Research Board, DRDO, Govt. of India

Duration:

2013 – 2017

Mentor(s):

National Institute of Ocean Technology, Chennai

Status:

Completed

Notable Publications

Sl. No.	Authors	Title	Year	Source Title	Vol.	Type	Impact Factor
1.	Mohan, M., Ramya, M.M.	Classification of process conditions in martensitic stainless steel: A machine learning approach on magnetic Barkhausen emission signals	2022	Journal of Applied Physics	131	Article	**2.877**
2.	Arockia Dhanraj, J., Alkhawaldeh, R.S., Van De, P., Sugumaran, V., Ali, N., Lakshmaiya, N., Chaurasiya, P.K., Priyadharsini, S., Velmurugan, K., Chowdhury, M.S., Channumsin, S., Sreesawet, S., Fayaz, H.	Appraising machine learning classifiers for discriminating rotor condition in 50W–12V operational wind turbine for maximizing wind energy production through feature extraction and selection process	2022	Frontiers in Energy Research	10	Article	**3.858**
3.	Saha, B.C., Dhanraj, J.A., Sujatha, M., Vallikannu, R., Alanazi, M., Almadhor, A., Sathyamurthy, R., Erko, K.G., Sugumaran, V.	Investigating Rotor Conditions on Wind Turbines Using Integrating Tree Classifiers	2022	International Journal of Photoenergy	2022	Article	**2.535**

4.	Srinivas, T., Karigiri Madhusudhan, A.K., Arockia Dhanraj, J., Chandra Sekaran, R., Mostafaeipour, N., Mostafaeipour, N., Mostafaeipour, A.	Novel Based Ensemble Machine Learning Classifiers for Detecting Breast Cancer	2022	Mathematical Problems in Engineering	2022	Article	**1.430**
5.	Srinivas T., Madhusudhan A.K.K., Manohar L., Pushpagiri N.M.S., Ramanathan K.C., Janardhanan M., Nielsen I.	Valkyrie—design and development of gaits for quadruped robot using particle swarm optimization	2021	Applied Sciences (Switzerland)	11	Article	**2.838**
6.	Jose J., Devaraj D., Mathanagopal R.M., Ramanathan K.C., Tokhi M.O., Sattar T.P.	Investigations on the effect of wall thickness on magnetic adhesion for wall climbing robots	2021	International Journal of Robotics and Automation	36	Article	**1.250**
7.	Joshuva, A., Kumar, R.S., Sivakumar, S., Deenadayalan, G., Vishnuvardhan, R.	An insight on VMD for diagnosing wind turbine blade faults using C4.5 as feature selection and discriminating through multilayer perceptron	2020	Alexandria Engineering Journal	59	Article	**6.626**

8.	Joshuva, A., Sugumaran, V.	A lazy learning approach for condition monitoring of wind turbine blade using vibration signals and histogram features	2020	Measurement: Journal of the International Measurement Confederation	152	Article	**5.131**
9.	Seenu, N., Kuppan Chetty, R.M., Ramya, M.M., Janardhanan, M.N.	Review on state-of-the-art dynamic task allocation strategies for multiple-robot systems	2020	Industrial Robot	47	Review	**1.352**
10.	Susai Mary, J., Sai Balaji, M.A., Krishnakumari, A., Nakandhrakumar, R.S., Dinakaran, D.	Monitoring of drill runout using Least Square Support Vector Machine classifier	2019	Measurement: Journal of the International Measurement Confederation	146	Article	**5.131**
11.	Sellamuthu, P., Samuel, D.G.H., Dinakaran, D., Premkumar, V.P., Li, Z., Seetharaman, S.	Austempered ductile iron (ADI): Influence of austempering temperature on microstructure, mechanical and wear properties and energy consumption	2018	Metals	8	Article	**2.351**
12.	Padmakumar, M., Guruprasath, J., Achuthan, P., Dinakaran, D.	Investigation of phase structure of cobalt and its effect in WC–Co cemented carbides before and after deep cryogenic treatment	2018	International Journal of Refractory Metals and Hard Materials	74	Article	**4.804**