Vol. 9, No.2 December, 2021

THE ROBOTICS SOCIETY

NEWSLETTER

AT A GLANCE..

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REPORT ON AIR 2021 AT IIT KANPUR

Advances in Robotics (AIR) is a series of biennial conferences organized by The Robotics Society (earlier referred to as Robotics Society of India). This conference aims to create a forum to present and exchange new ideas by researchers and developers from India and abroad in the field of robotics and its applications. The conference encompasses plenary talks, oral and poster presentations, workshops, and special industry-oriented sessions. The previous editions of AIR's were held at R&DE, DRDO Pune (AIR 2013), BITS Pilani Goa Campus, Goa (AIR 2015), IIT Delhi (AIR 2017), and IIT Madras (AIR 2019). This year's AIR2021 Conference was held in online mode at IIT Kanpur from June 30 to July3,2021.

On June 30, 2021 a workshop on: "Robotics in Japan and India" was conducted jointly by the Robotics Society of Japan (RSJ) and The Robotics Society, India (TRS, India) where each side was represented by six speakers. The RSJ (Japan) was represented by, Prof. Hiroki Murakami (President RSJ), Prof. Tomohiro Shibata (Kyushu Institute of Technology), Prof. Kanako Harada (University of Tokyo), Prof. Kimitoshi Yamazaki (Shinshu University), and Prof. Gentiane Venture (Tokyo University of Agriculture and Technology). TRS (India) was represented by, Prof. Santanu Chaudhury (President TRS, IIT Jodhpur), Prof. Subir Kumar Saha (IIT Delhi), Prof. Asokan T. (IIT Madras), Prof. Ekta Singla (IIT Ropar), and Prof. Ashish Dutta (IIT Kanpur). The workshop was followed by two tutorial sessions on "Machine Learning Applications in Robotics using MATLAB" by Dr. Dhruv Chandel, MathWorks India, and "Design and Control of Rehabilitation Robots" by Prof. Sunil Agarwal, Columbia University, USA.

On July 1, 2021, the conference was formally inaugurated by Prof. Abhay Karandikar, Director, IIT Kanpur and the office bearers of the TRS. Subsequently, the first keynote talk on "Autonomy in humans and machines: Robot sense of agency: self, pain, and ethics" was given by Prof. M. Asada, Osaka University, Japan. The sessions for oral and poster presentations were then conducted. The conference received a total of 115 papers and after a double-blind review, 56 papers were accepted for the final presentation. This included 38 full paper presentations (14 minutes presentation) and 18 short presentations (7 minutes) followed by posters. All the accepted papers have appeared as full papers in the proceedings published by ACM in the Digital Library.

Inaugural Session

Prof. Ashish Dutta, IIT Kanpur

Prof. T Asokan, IIT Madras

Prof. Santanu Chaudhury, Director, IIT Jodhpur

Prof. Abhay Karandikar, Director, IIT Kanpur.

Prof. M. Asada, Osaka University

Prof. Mangal Kothari, IIT Kanpur

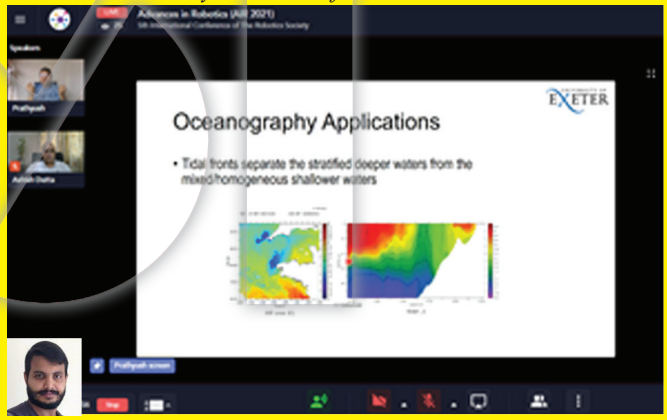
Prof. Sameer Khandekar, IIT Kanpur

PHOTO GALLERY-AIR 2021

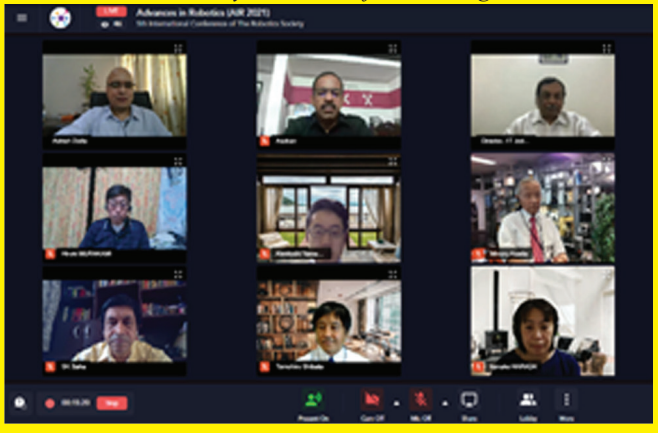
Plenary Talk 1: Prof M. Asada

Plenary Talk 2: Prof. Paolo Fiorini

Plenary Talk 3: Prof. Seul Jung

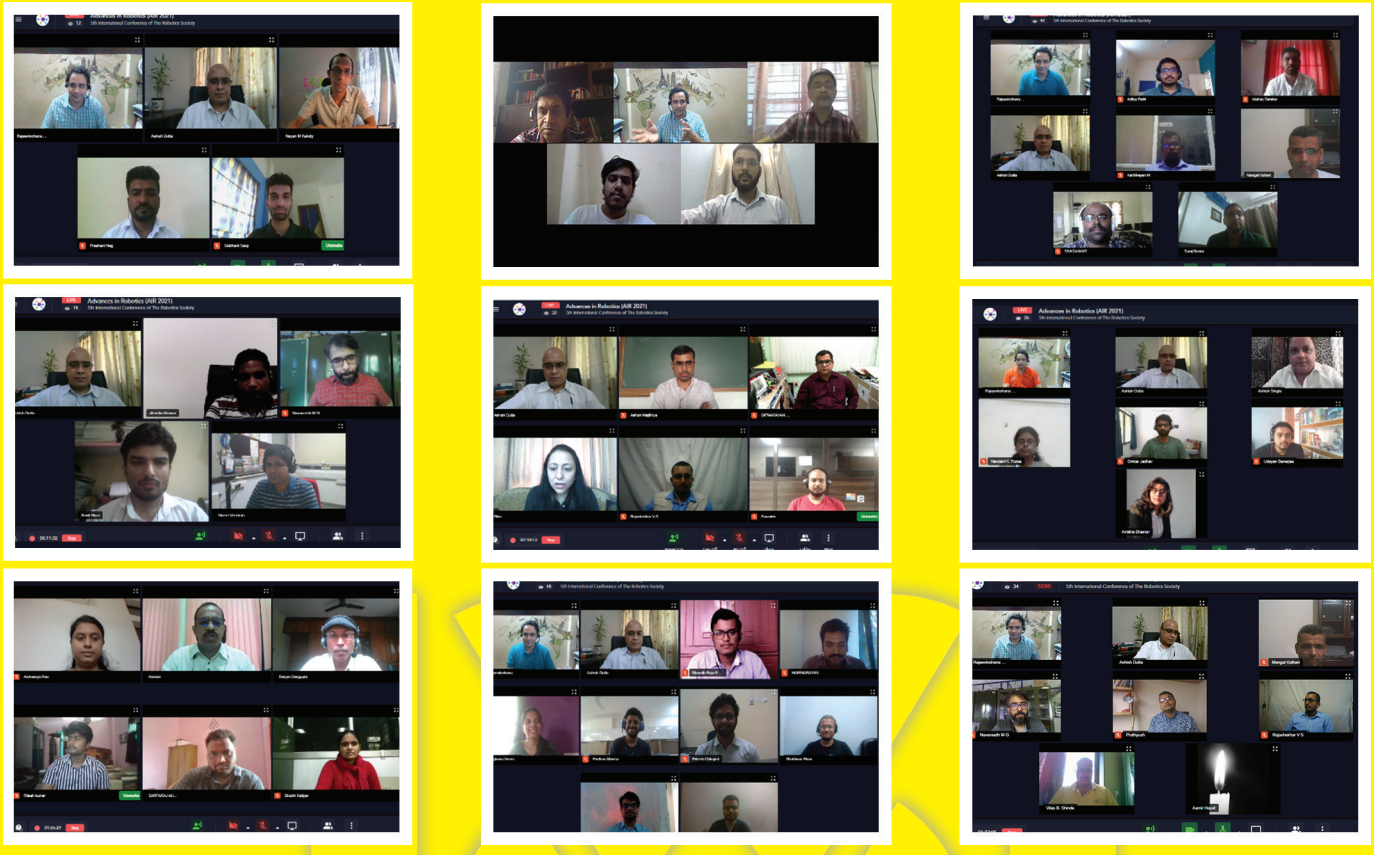


Keynote Talk: Prof. Prathyush P. Menon



Workshop on Robotics in Japan and India

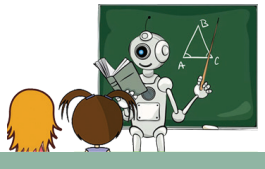
Tutorial by Prof. Sunil Agarwal



Session Chairs and Presenters from various Technical Sessions

There were 9 technical sessions at the conference chaired by Prof. Ashokan T. (IIT Madras), Prof. Ashish Singla (Thapar Institute of Engineering & Technology, Punjab), Prof. Ekta Singla (IIT Ropar), Prof. Vineet Vashista (IIT Gandhinagar), Prof. Mangal Kothari (IIT Kanpur), Prof. Ashish Dutta (IIT Kanpur), Prof. Subir Kumar Saha (IIT Delhi), Prof. Sudheer A.P. (NIT Calicut), and Prof. Nayan M. Kakoty (Tezpur University, Assam). All these sessions were distributed over 3 days in between the keynote talks and expert talk by industrialists. On the third day, Prof. Paolo Fiorini, University of Verona, Italy, delivered a plenary talk on the topic “Dreams in medical and surgical robotics: Intelligence and affordability”. On the last day a plenary talk was given by Prof. Seul Jung, Chungnam National University, South Korea, on “Balancing mechanism and control in research and life”, and a keynote was delivered by Prof. Prathyush P. Menon, University of Exeter, UK, on “Autonomous oceanographic sampling”. Dr. Jaganath Raju, Systemantics India, shared his expertise on the topic “Design evolution of collaborative robotic arms”.

Due to the pandemic situation, the conference was held in fully online mode using the online platform ‘Remo’. This provided us with a unique opportunity to meet participants, discuss ideas, view posters, etc. The presentations were also broadcast on YouTube for other interested persons to view the conference online. All the presentations were recorded and uploaded online on the AIR 2021 website. It needs to be mentioned here that all the paper presentations were held at the exact scheduled time with minimum delay. The organizers would like to thank all the reviewers, session chairs, authors, and the participants for making AIR 2021 a grand success. The next AIR 2023 conference will be held in IIT Ropar and we all hope to meet you again at AIR 2023.



Shalu is an Indian version of Sophia humanoid robot developed by Dinesh Patel, Kendriya Vidyalaya Computer Science teacher from Bombay. Shalu robot is a homemade robot made up of waste materials. Shalu can speak 47 different languages including 9 Indian and 38 different languages around the world. The robot can recognize people and different objects. The Shalu robot is dedicated to all girls and women of India towards the Government of India ‘Beti Bachao Beti Padhao’ mission.

I-HUB FOUNDATION FOR COBOTICS (IHFC) @IIT DELHI

"We is entering an era of "manned + unmanned" teaming where humans and robotic systems must work together towards common goals

I-Hub Foundation for Cobotics (IHFC), the Technology Innovation Hub at IIT Delhi was established by the Department of Science and Technology (DST), Ministry of Science and Technology, Govt. of India in June 2020 under the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) with a funding of Rs. 170 crores (USD 20 million) for 5 years. The human collaborative systems provide a unique opportunity to address this scientific research in an integrated way which would be beneficial in achieving human-robot collaboration for enhancing human capabilities, reducing risk, and improving productivity. Advances in sensing, computation and autonomy are enabling robots and autonomous systems to enter real-world domains such as manufacturing, defence, medical, and agriculture. where machines must work alongside and interact with humans.

IHFC's visions encompass development of complex physical mechanisms and control for performing dexterous real-world tasks, realization of high-fidelity sensing, energy efficient computing and smart actuators for environment interaction, and machine intelligence for cognition, planning and learning from experience. IHFC, Technology Innovation Hub at IIT Delhi aims to further the following objectives:

- Research on Novel Technology areas of Robotics and Automation Science.
- Development of products for the benefit of society
- Inculcation of start-ups and promoting entrepreneurship

Advancing Indian Cobotics: IHFC Grand Projects

IHFC research and development activities include seven "Grand Projects" in four Perceived Application Scenarios (PAS) of IHFC, namely, Medical Robotics, Agriculture and Disaster Management, Defence, and Smart Manufacturing (Industry 4.0). Based on about 50 initial proposals received from about 40+ researchers (faculty and industry), the Grand Projects were formulated over several months in order to focus on the targeted hardware/software in next 3 years, and to create expert groups in the country who could take up national and international level challenges faced by the society, be they individual companies or Government bodies. Each Grand Project consists of several projects spread across several institutes with one Grand Project Coordinator (GPC) led by a senior professor of an institute. The Grand Projects (GP) is expected to bring in close collaboration between various Principal Investigators (PIs) to get the deployable products in the market. The team of the GP will be the country's expert group in that area. IHFC Grand Projects (GPs) are as follows:

Thrust to Medical and Healthcare capacity building: IHFC Medical Cobotics Centre

IHFC is working towards a unique Medical Cobotics Centre (MCC) in the country comprising of physical simulation facilities and robotic devices to train young doctors before they really get into real surgery. The center will also act as the validation platform for the devices/software coming out of the Grand Projects.

Upskill on Cobotics: IHFC Global Online Courses

IHFC conducts corporate courses catering the need of the employees of an industry, and global online courses as part of its skill development program for engineering and science graduates, teachers and industrial professionals. We concluded one corporate course in May 2021 on Natural Language Processing (NLP), the first course of the Global Online Course on the Fundamentals of Cobotics in July 2021. Our next global online course on Machine Learning for Cobotics started on October 16 till November 15, 2021. Please see the details in the following link https://www.ihfc.co.in/GOCMLC/index.html

No Challenge is Big enough: IHFC Grand Challenge

IHFC in partnership with the Foundation for Innovation and Technology Transfer (FITT) invited start-up ideas in the areas of medical devices and healthcare as part of the Grand Challenge competition in the months of June and July, 2021. Seven (7) entries spanning diverse areas such as diagnostics, AI, medical robotics and oxygen sensing were received. μkron technologies, a start-up launched by Mr. Neeraj Bagi in the area of rapid prototyping of healthcare diagnostic devices has been approved under Grand Challenge. Neeraj will incubate to take his idea from concept to product stage.

Are you Ready! IHFC Ready Program 'from ideation to incubation'

IHFC offers internship opportunity to young and talented Indian engineering graduates and final year students who have an inclination towards product development through research and development in the field of collaborative robotics. The program aims to enable young talents of the country to work with some of the best academic and research minds of the country and a sense of satisfaction to contribute towards the development of this country. Under READY (Research, Entrepreneurship, And Development for You) program IHFC provides financial support, mentorship, and guidance to all those looking to go beyond the traditional route of an internship and contribute towards the society in a meaningful way. At present, there are three from colleges in South, West and North of India.

Know more about Cobots and Cobotics?

CoboTalks and iCoboTalks are featured as online seminar series hosted by IHFC. The webinar series brings together experts from the domain of Cobotics and related domains. IHFC successfully conducted thirteen monthly seminars by exposing the audience to various aspects of Cobotics and allied areas. IHFC is starting its iCobotalks, the Industry seminar series, from October 20, 2021 to capture progress in the area of Cobotics in Industry. IHFC thanks Springer to support the felicitation to the speakers of CoboTalks.Watch Featured Cobotalks @ https://ihfc.co.in/Cobotalks/index.html#about-section

Curious about Cobotics and the IHFC Logo

Cobots abbreviated for Collaborative Robots are complex machines which work hand in hand with human beings. In a shared work process, they support and relieve the human operator'' (Source: IFA). In contrast to industrial robots, Cobots perform their tasks in conjunction with, and in close proximity to humans.

The IHFC Logo portraying how humans and robots can work together and achieve shared goals has been designed by Prof. Jyoti Kumar, Department of Design, IIT Delhi.

To engage with IHFC IIT Delhi contact us @
I-Hub Foundation for Robotics (IHFC)
MZ-122, IIT Delhi, Hauz Khas, New Delhi-110016, India
Phone:(91)-11-2654-8493 | e-mail: contact@ihfc.co.in

IHFC Perspectives

"It is expected that these areas of Rehabilitation Robotics, Medical Simulators, Healthcare Robotics, Drone Applications, Human-Robot Interaction, Industry 4.0, and Intelligent Systems and Secured Communications will represent expert groups in the country to take any kind of challenges to cater to the requirements of industries and government departments."-Prof. S. K. Saha, Project Director IHF

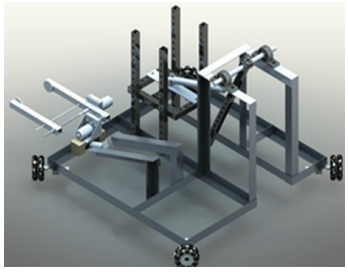
"If you examine our CoboTalks (our seminar series) participants, you will notice every single person has a very lucrative career yet chalks out their valuable time willingly because they see the impact that our work will have over time." Mr. Ashutosh Dutta Sharma, CEO, IHFC

TRS STUDENT CHAPTER ACTIVITIES

Amrutvahini college of Engineering, Sangamner, Maharashtra's AVCOE Robotics Club and department of Production engineering under TRS student chapter, Sangamner organized Two webinar session on 28.05.2021 on virtual Google meet platform.

The first session was on "Industrial Robot Trajectory Planning Using Evolutionary Techniques" delivered by Dr. S. Ramabalan, Principal, E.G.S. Pillay Engineering college, Nagapattinam. The second session on "Intelligent computation and kinematics analysis of various robot manipulators" was delivered by Dr. Panchanand Jha, Raghu Engineering College, Vishakpattinam

The fundamentals of industrial robotics, Intelligent computation and kinematic analysis of various robot manipulators using MATLAB, Trajectory Planning using evolutionary techniques such as Genetic algorithm and PSO were the key topics of the webinar. In all 45 + Student participants from Mechanical and Production engineering and 12 faculties participated in the webinar.



A team of 12 multi-disciplinary students participated in 2020, ABU (Asia-Pacific Broadcasting Union) theme as 'Rugby playing Robot' for Robocon 2020 Competition. The main and unique challenge of this game was a goal kick, kicking the ball over the cross bar of the conversion post because of the unique shape as same as that of the rugby game. Developing a robot based to achieve the desired task helped the students to Learn the fundamentals on designing mechanism, programming and control the robot.

TRS student chapter

To know the Guidelines for formation of TRS students Chapter in your institue,
visit: http://rs-india.org/student-chapter/

ROBOTICS ACTIVITIES @ NIT CALICUT

New technological advances in robotic manipulators, legged, wheeled and tracked robots, flying and underwater robotics help to achieve agility and efficiency in various applications. The applications of robotics are spread over various sectors such as agriculture, survey and rescuing tasks, healthcare, defense and military, manufacturing, space exploration, and entertainment. Advanced research in the area of robotic manipulators and mobile robotics help to attain excellence in manufacturing and service industries. Robotics Interest Group (RIG) of NIT Calicut is a collective of UG students from various branches of science and engineering developing innovative robotic and mechatronic systems. The primary focus of RIG is to work towards bridging the gap between technology and real life. This group also supports and promotes robotics through workshops, seminars, and product development within and outside NITC. Few of the recent developments by the RIG community are presented here.

In most developing nations like India, the ratio of patients to doctors are generally high. Therefore, keeping a track record of each patient is a difficult task for the doctor. Riggu is a semi-humanoid robot built by RIG-NITC with the motive to help Doctors in this regard (Fig.1). Riggu can listen to questions and provide answers thereby help its co-workers in decision-making by providing necessary information. The Vosk API is used for speech recognition which supports 20+ languages. Riggu uses the ROS framework to interact with the real world. It uses the ROS-AIML package to answer the questions. A camera with pan and tilt motion is attached to the head of RIGGU. This allows object/person recognition, tracking and to navigate/follow a human colleague. The YOLO deep learning model is used to provide real-time object recognition. The differential drive and Gmapping packages are used for Riggu's locomotion. The data from encoders and the position of its colleague are used as feedback to control the two driving motors with PWM signals. A PID controller helps for fast and smooth motion of motors to find its colleague and provide assistance. Currently, the robot is under development with navigation, speech recognition and vision integration.

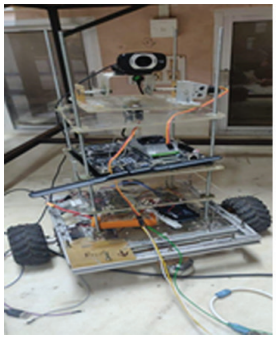


Fig. 1 : Riggu

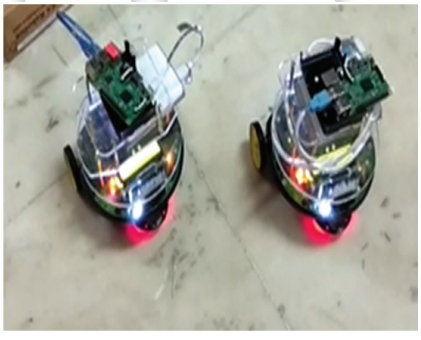


Fig 2. Swarm robots - Firebird V

Swarm robotics is an approach to the coordination of multi-robot systems which consist of large numbers of simple physical robots. Swarm systems are faster and reliable at searching and retrieving targets as compared to single robot systems (Fig. 2). One of the tasks of this system is to avoid the obstacles, retrace the path, build the map of area in which they are moving, and displaying it in augmented reality.

In the era where inclusive development is growing as an indicator of sustainable development, an initiative for the empowerment of disabled persons is essential. A well-recognized method to enhance the physical abilities of these patients is the use of wheelchairs. RIG has developed a low-cost electric powered wheelchair as shown in Fig. 3. It is equipped with multiple control modes such as joystick control, gesture control, iris control and mobile app Various ergonomic features such as adjustment of seat height, footrest position, and seat recliner are provided in this wheelchair.

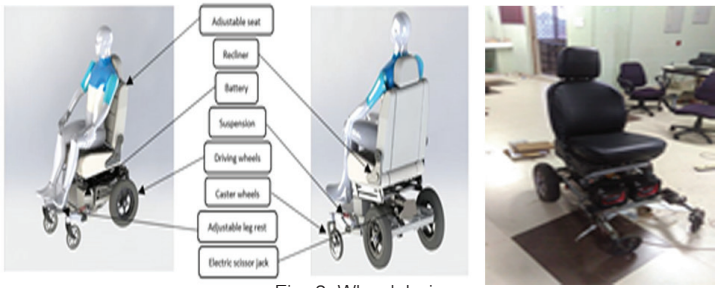


Fig. 3. Wheelchair

Environmental pollution is one of the most severe global threat that requires suitable solutions to control air, soil and water pollution. More than two third of earth's crust is covered with water out of which less than 2.5% only is edible. Many initiatives are taken to control water pollution such as manual and machine-based cleaning. However, these techniques need human supervision all the time. The use of manual labor for removing waste can be hazardous to humans. Therefore, a robot that cleans the waste autonomously from the water can make a significant impact on pollution control and human safety. A pond cleaning robot mechanism is designed to perform different applications such as collection of floating waste and underwater inspection. underwater inspection (Fig. 4). This robot consists of a cylindrical hull, thrusters and wide arms for waste collection. A preliminary test was successfully conducted in a swimming pool for floating plastic waste collection.

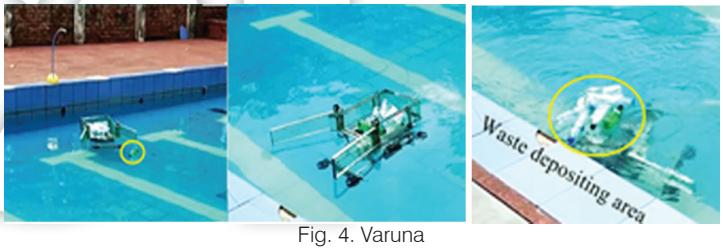


Fig. 4. Varuna

A finger point reader is a standalone wearable device being developed at our lab for the blind. It can read out the text pointed by the finger from any printed paper. The device consists of a finger-mounted camera connected to Raspberry Pi. Using OpenCV, tesseract, and pyttsx3 modules, the words can be extracted from the image and be converted into audio. Following are few of the Robotics research activities carried out at NITC.

- Vision system plays a vital role in autonomous navigation. An omnidirectional mobile robotic platform is built to navigate based on the motion of small-size objects. A novel deep learning architecture called RFSOD is developed to detect the small-size targets as show in Fig.5. The architecture is designed to be light-weight with lesser computations for use in real-time applications. Reusability of feature maps and Receptive fields are the main characteristics of this network. The architecture is developed on the darknet framework and can detect at more than 30 fps on Jetson Nano. This vision system is intended for use in the navigation of an omnidirectional platform. Development of a control strategy for a high-speed motion control of the mobile robotic platform based on visual feedback is currently carried out. The obtained results are planned for use in sports robotic systems.

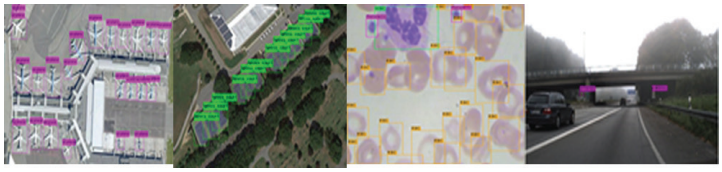


Fig. 5. Detections of small-size objects using RFSOD

• The tree-type upper-body humanoid robots with mobile platforms are gaining popularity in recent years due to diverse applications in various fields. Most of the conventional humanoid robots are designed with limited degrees of freedom in hip and hand joints. Hence, these types of humanoid robots cannot offer human-like motion capabilities. An upper body humanoid robot with redundant arms is developed as shown in Fig.6. The upper body consists of 3-DoF torso, 2-DoF neck and two arms with 5-DoF identical joints each. Redundant dual arms are implemented for the upper body to increase the dexterity of hands. The developed humanoid robot can imitate the dexterous motions of human hip and hand joints up to a certain limit. It can be used in entertainment, service and industrial applications.

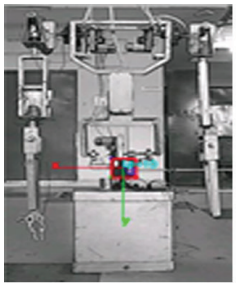


Fig. 6. Upper body Humanoid

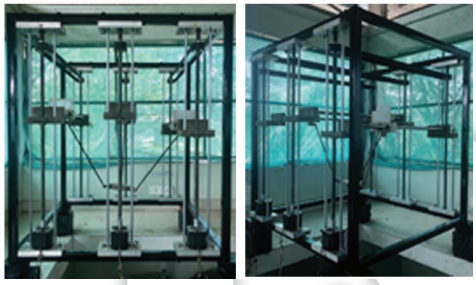


Fig. 7. Spatial parallel manipulator

• A large number of robotic manipulators have been designed over the years to perform specific tasks within confined spaces without any direct physical contact by the operator. The choice of manipulator design must ensure a large workspace, high payloads, good positional accuracy, and excellent dynamic performance based on the application. A novel 3-PPSS (P – Prismatic, S – Spherical) parallel manipulator that exhibits six Degree of Freedom (DoF) for the mobile platform is designed to overcome some of the inherent shortcomings of parallel manipulators, such as complicated kinematic modeling, coupled motions, and small workspace. THe proposed parallel manipulator is shown in Fig. 7. Besides, the implementation of intelligent control for real-time and performance evaluation is carried out on the fabricated prototype. Soft computing techniques are to determine the manipulator kinematic solutions in real-time with maximum accuracy. The proposed manipulator fits into a broad spectrum of applications such as human body scanning, quality checks, Laser cutting, and Coordinate Measuring Machine (CMM).

• The modern world prefers automated assistance to increase the task effectiveness. In robotics, Humanoid and Biped research is one of the most challenging studies due to the non-linearity in biped locomotion, that currently aiming at application in areas like Medical, Public service, Hazardous operations etc. The major drawback in existing Humanoids is the difficulty to walk over uneven terrains under varying contact conditions. The generation of stable dynamic gait based on Contact Wrench Cones (CWC) is an important method used in Biped robots to incorporate the contact stability along with Zero Moment Point (ZMP) control. A 12-DoF Biped robot is developed in our lab to generate stable locomotion over uneven terrains to focus on applications like treading rough surfaces. The contact force variations of the biped during ditch-crossing simulation is shown in Fig.8.

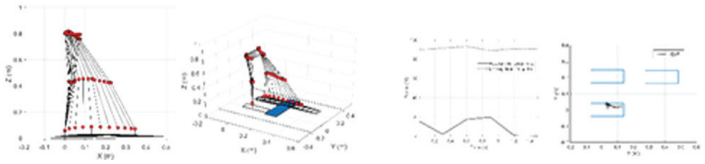


Fig. 8. Biped Robot Ditch crossing- instantaneous configurations, contact forces and Center of Pressure

• Mobile robotics is one of the most important field that deals with robots that can move around and handle several tasks. The field possesses high research potential due to wide variety of possible applications. The standard types of locomotion for these robots are walking, sliding, rolling, hopping, etc. Among these, the rolling motion has certain advantages over others as the problem of wear and tear is less when compared to wheeled or legged robots. Also, the spherical structure is statically stable, and the robot recovers easily from the collisions with unknown obstacles due to its shape. To combine these advantages, a spherical mobile robot BALL-E capable of executing rolling and walking motions as in Fig.9 is abstracted. The potential applications of the proposed spherical robot may include automated surveying, exploration in unknown environments, surveillance and security, light material transportation, etc. The proposed robot can also transform into a quadruped based on the terrain conditions. The advantage of combining these motions in the robot is that it improves the collision recovery and manoeuvrability over multiple terrains.

Fig. 9. BALL-E Robot with spherical & quadruped configurations

• Visual servoing is a well-advanced method of controlling the robot movement in real-time based on visual sensor feedback. The projection of 3D information onto a 2D image plane in the camera obviously causes the loss of data. This loss of data is a challenge in vision-based control. A model predictive and neural network-based predictive control strategy are proposed for image-based visual servoing (IBVS) of a 6-DOF industrial robot manipulator.

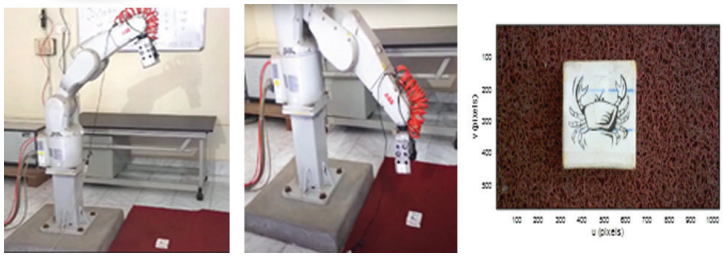


Fig. 10. a. Initial pose b. Final pose c. Final view of the object

The IBVS task is achieved using model predictive controllers by incorporating control input and visibility constraints in the problem formulation. A switching approach termed NN-based predictive control is introduced to minimize the overall settling time of the task. The proposed method also handles the problem of feature loss in IBVS. Further, these methods reduce the convergence time of the servoing task as well as the execution time of the controller. The proposed visual servoing control frameworks are integrated with the ABB IRB 1200 industrial robot manipulator for real-world applications.The setup and working are shown in Fig. 10.

• In the manufacturing and service industries, mobile manipulators are widely employed in a variety of applications. Most mobile manipulators are based on a movable platform with wheels. Though the wheeled mobile platform works well on flat terrains, it is not ideal for uneven terrain mobility. Rough terrain applications are popular with legged robots. However, they have a slower navigation speed than wheeled mobile robots. To tackle these challenges, a hybrid wheel-legged robot (quadruped) with 5-DoF in each leg is conceptualized. The model is simulated in ADAMS and SIMSCAPE for dynamic analysis.

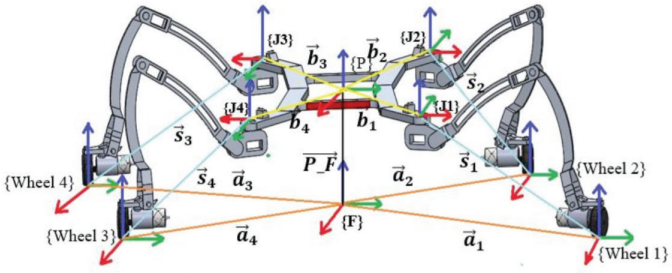


Fig. 11. Hybrid Wheel-legged robot

Publications:

1. Amudhan, A.N., Vrajesh, S.R., Sudheer, A.P. and Lijiya, A., 2021. RFSOD: a lightweight single-stage detector for real-time embedded applications to detect small-size objects. Journal of Real-Time Image Processing, (Article in press) pp.1-14, https://doi.org/10.1007/s11554-021-01170-3.
2. Sulaiman, S. and Sudheer, A.P., 2021. Dexterity analysis and intelligent trajectory planning of redundant dual arms for an upper body humanoid robot. Industrial Robot: the international journal of robotics research and application, 48(6), pp. 915-928, https://doi.org/10.1108/IR-12-2020-0279.
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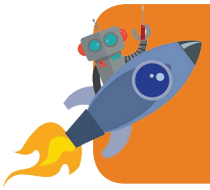
• A developing country like India with the second largest population in the world, creates unique road scenarios that are challenging for an autonomous car. For planning its path ahead, autonomous vehicles must detect, classify and estimate the depth of obstacles that they encounter on roads. This leads to the need for datasets providing information about various traffic situations in India. A dataset for object classification, detection and stereo vision corresponding to Indian roads is generated and can be used as a platform for developing effective algorithms for autonomous cars. The object classification is benchmarked using confusion matrix obtained from various deep learning models, detection is evaluated using Faster R-CNN and depth estimation processed by Real sense stereo camera is compared by applying convolutional neural network based algorithms.



VYOMMITRA

Vyommitra is an upper body humanoid robot developed by the Indian Space Research Organization (ISRO) to assist the space crew of Gaganyaan. Vyom Mitra can recognize speech and interact with people. The robot can also handle different tasks in the spacecraft such as switch panel operations, environment monitoring, provide warnings, etc.