Vol. 6, No.2 July, 2018

THE ROBOTICS SOCIETY

NEWSLETTER

TRS

AT A GLANCE..

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REPORT ON NATIONAL WORKSHOP ON HUMAN-CENTERED ROBOTICS (NWHCR'18)

A National Workshop on Human-Centered Robotics (NWHCR'18) was organized at IIT Jodhpur in collaboration with The Robotics Society (TRS) during 17th-18th March 2018. The workshop had two Keynote Talks, seven Expert Lectures and a Panel Discussion in the area of Human-Centered Robotics by eminent Professors/Scientists/Researchers from Academia/R&D organization/Industry. The workshop received a very encouraging response and it was attended by more than ninety participants. The workshop emphasized on bringing forward various problems and research opportunities in the area of Human-Centered Robotics. More specifically, it focused on robotic rehabilitation, medical robotics, robotics simulators for training of human, assistive robotics, robot navigation in a human environment, robot learning from human and safe robots.

Prof. Kaushal A. Desai, General Chair and Head of the Department of Mechanical Engineering welcomed the Participants and Experts to the workshop. The workshop was inaugurated by Prof. K. Madhava Krishna (IIIT Hyderabad), Prof. S. Bandyopadhyay (IIT Madras) and Shri. Ranjan Dasgupta (TCS Innovation Lab., Kolkata). Shri U. K. Singh (Director, Defence Bio-engineering and Electro-medical Lab., DRDO) and Prof. S. K. Saha (IIT Delhi) delivered keynote talks whereas Prof. K. Madhava Krishna (IIIT Hyderabad) delivered the inaugural invited talk. This was followed by the invited talks by Prof. S. Bandyopadhyay (IIT Madras), Prof. B. Ravindran (IIT Madras), Prof. Sudipto Mukherjee (IIT Delhi), Prof. Arun Dayal Udai (BIT Mesra), and Prof. Vineet Vashistha (IIT Gandhinagar). The workshop was concluded with a panel discussion on challenges, opportunity, and road ahead in the area. The panel discussion was steered by Prof. S. K. Saha with panel members as Prof. S. Bandyopadhyay (IIT Madras), Prof. Vineet Vashistha (IIT Gandhinagar), Shri. A. K. Yadav (Defence Lab Jodhpur), Prof. Abhay Elhence (AIIMS Jodhpur), Shri. Ranjan Dasgupta (TCS Innovation Lab., Kolkata), and Prof. Suril V. Shah (IIT Jodhpur)

The workshop also provided an opportunity to the participants to showcase their research in the form of poster/demo in front of the experts to get valuable inputs. The participants were taken to Robotics Lab at IIT Jodhpur and explained the ongoing research and were made aware of the facilities available in the Institution.

Report on International Conference on Robotics and Smart Manufacturing (RoSMa 2018), IIITDM, Kancheepuram, Chennai

Indian Institute of Information Technology Design and Manufacturing Kancheepuram (IIITDM Kancheepuram) organized a 3 day International Conference during 19-21 July 2018 to discuss about the current issues and trends in the development of robotics and application of robotics in smart manufacturing. RoSMa2018 attracted submissions from Canada, Italy, Kazakhstan, Malaysia, Mexico, New Zealand, Singapore, Taiwan, and USA, besides India. All accepted papers were presented in the conference and published in the Journal of Procedia Computer Science, Elsevier. An "International Student Robot Competition (ISRC-RoSMa2018)" was also part of the conference which was conducted in parallel with paper presentations. Rosma2018 was supported by Indian Space Research Organization (ISRO), Indian National Science Academy (INSA), University of Genova, Italy, Emaro (European master on advanced robotics), IFToMM (International Federation for the promotion of Mechanism and Machine Science), Association of machines and mechanisms (AMM) and The Robotics Society. This conference was organized under the chairmanship of Prof M Sreekumar, faculty of mechanical engineering with the initiatives of the Director, Prof Bashidhar Majhi. Cultural and heritage events such as bharatham, classical vocal, silambam and cendai melam were also organized as a part of the conference. The next edition of the conference will be in 2020.

Japan, one of the world's top industrial robot manufacturers, has the highest number of robots in operation today. According to the International Federation of Robotics data, Japan exported nearly 1,15,000 industrial robots in 2016 worth 309 billion yen (about US$ 2.7 billion) and has a stock of 2,87,300 units of operational robots.

4th International Conference of The Robotics Society

ADVANCES IN ROBOTICS

AIR 2019

Indian Institute of Technology Madras, Chennai, 600036 India

2 - 6 July 2019

The Robotics Society

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School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney, Australia

Prof. Jan Peters
Intelligent Autonomous Systems, Dept. of Computer Science, Technische Universitaet Darmstadt, Germany.
Senior Research Scientist. Max-Planck Institute for Intelligent Systems

Prof. Blake Hannaford
Professor and Director, Bio robotics Laboratory. Dept. of Electrical Engg, University of Washington.
Co-Founder of Applied Dexterity. Adjunct Professor, Dept. Mechanical Engineering, University of Washington

Advances in Robotics

International Conference on Advances in Robotics (AIR) is a series of biennial conference organized by The Robotics Society. The conference aims to create a forum to present and exchange new ideas by researchers and developers from India and abroad working in the fields of robotics and its applications.

The Robotics Society

The Robotics Society is a registered body of robotic professionals in India. In the last few years robotics activities in India has moved well beyond the traditional areas of industrial applications, atomic energy, etc. and entered newer domains of education, rehabilitation, entertainment, and domestic applications. Indian robotics researchers have similarly grown from a handful to over a hundred engaged in research labs, education, industry, atomic energy, etc. The society was formed to further augment the robotics activities and for better interaction among researchers.

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Mail Id: 2019@advancesinrobotics.com
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Important Dates

Call for papers	: 1 Dec 2018
Full paper submission	:15 Feb 2019
Acceptance notification	:5 April 2019
Registration Deadline:	
Camera-Ready Submission:	5 May 2019

Robotics Activities @ VIT CHENNAI

Robotics group (VITCC), the official robotics group of Vellore Institute of Technology Chennai is a community of both UG and PG students from various branches of engineering developing robots for various industrial application like pick and place, palletizing and de-palletizing and other autonomous mechatronic system like surveillance of underwater pipeline systems to find the cracks using underwater robots. VITCC-Robotics group has developed a variety of robots for underwater pipe inspection robot, mobile, biped, manufacturing and household applications.

Manipulation and Path Planning for KUKA (LWR/LBR 4+) Robot in a Simulated and Real Environment

Researchers: Tarwadi Parag Jitendra, Arockia Selvakumar A, Juan Antonio Corrales Ramon

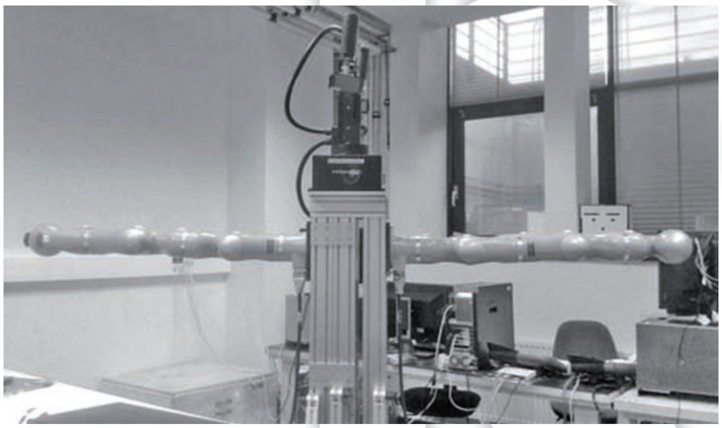


Fig 1: Prototype of the KUKA LWR/ LBR 4+

This work aims to perform path planning using a KUKA (LWR/ LBR 4+) robot platform as well as a simulator to grasp the object. This whole implementation is carried out in a ROS environment with Ubuntu (Linux) as an operating platform. The KUKA (LWR/ LBR 4+) has 7 degrees of freedom with several joints and linkages. It uses KR C2 LR as the main hardware controller. Figure 1 shows the KUKA assembly in the real environment. The robot gets visual information of an object by Microsoft Kinect RGB-D camera and carries out necessary actions to clasp the object using a shadow hand and Barrett hand. The simulation and manipulation of robot gantry is performed by using C++ and python as a programming language. The bilateral robot platform and main PC hub are linked together by using Ethernet cable. Baaed on the OMPL suit of MOVEIT,

KUKA arm gains some advanced features like an effortless way to define and couple the degrees of freedom and also modify the planning accordingly, smooth parameterization for planners, the dynamic simulation and integration with task planner.

A Humanoid Neck using Parallel Manipulators

Researchers: Pavan Kalyan, Arockia Selvakumar A.

Current treatment for patients suffering from cervical spine injuries is by static braces which causes discomfort and immobilization of the neck. This paper presents a novel comfortable wearable therapy device for treating patients suffering with head/neck posture problems using parallel mechanism concept. To achieve this, a conceptual design of a three-degrees-of-freedom Revolute-Prismatic-Spherical configuration parallel manipulator with 3 extensible links is proposed.

The architecture of a 3-RPS parallel manipulator is shown in Figure 2 which consist of a movable platform (top) and a base (fixed) platform and three identically structured supporting limbs or links. Each link joins the top and fixed platform by a Revolute joint (R), Prismatic joint (P), Spherical joint (S) in a sequential order, where the prismatic joint is actuated by an electric linear actuator.

The design idea of the device is to provide controlled movement of the human head by supporting the neck using parallel mechanism. To fulfill this objective, the brace is made with a platform to rest the chin and the platform is attached with adjustable metallic straps to fit and hold the head and on the base platform it is supported with three actuators which are equally aligned with each other. The linear actuator has a revolute joint at the base and a spherical (or) a ball joint at the top

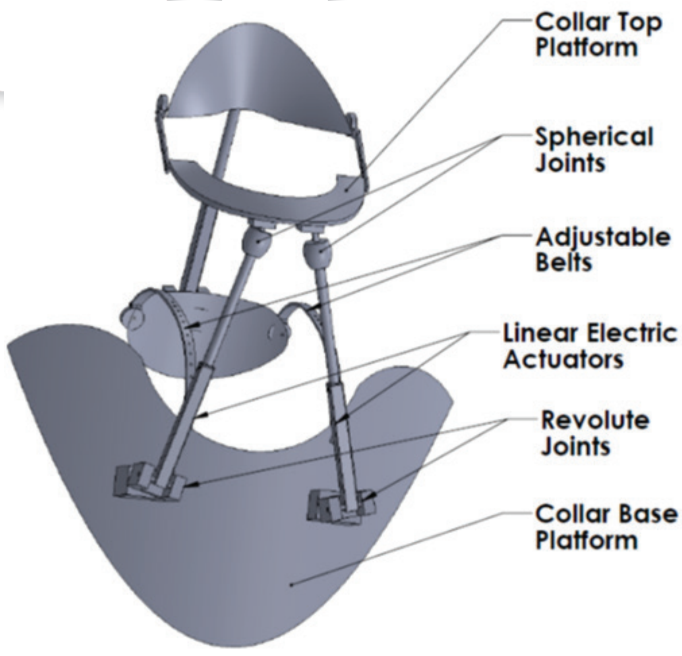


Fig 2: Conceptual design of the Parallel Mechanism

Experimental Investigation on Position Analysis of 3RPR Parallel Manipulator

Researchers: Harishchandra D. Salokhe, Saket M. Pardeshi, Arockia Selvakumar A.

Figure 3 shows a 3RPR parallel manipulator for angular drilling operations. The robotic manipulator has three prismatic actuators to the movable and fixed platform with revolute joints at each end of the actuator.

The angle made between the movable platform and the linear actuator is 700 and with this arrangement the manipulator can attain maximum workspace. In this design, the base revolute joints are constrained to ±200 about y-axis to reduce the chance of singularity.

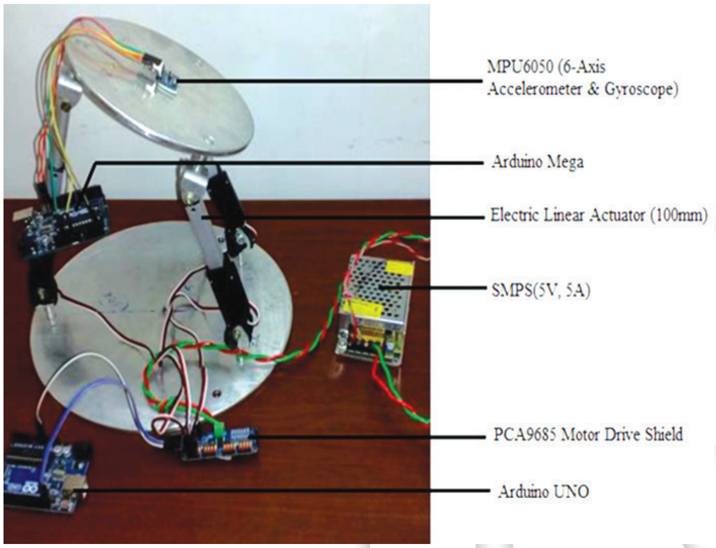


Fig 3: 3-RPR Parallel Manipulator for drilling applications

A Low Cost Underwater Robot with Grippers for Visual Inspection of External Pipeline Surface

Researchers: M. Manjunatha, A. Arockia Selvakumar, Vivek P Godeswar, R. Manimaran.

Underwater robots are used in surveillance, academic and military applications because of their capability to execute risky tasks underwater without human intervention. In this study, a robot is built at low cost budget to carry out inspection at specified depth in a water body.

Preliminary studies are performed to understand the buoyancy and stability of an underwater robot. Different configurations of propeller arrangements are identified. Figure 4 shows the final prototype of the underwater robot for specific applications. Dual grippers are incorporated with the underwater robot, one for holding the pipe to avoid underwater currents and other for gripping/releasing the pipe. Gyroscope sensor is embodied in the underwater robot to maintain stability from its feedback signals. A high definition camera is mounted in front of the underwater robot for live video and image capturing purposes. Thus the underwater robot is able to meet all its requirements with minimal frontal drag.

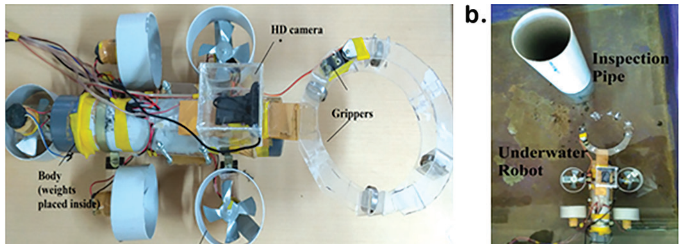
a.


Fig. 4 (a) Final prototype of the underwater robot; (b) the testing of underwater robot in water tank.

The group organizes workshops and exhibitions in other schools and colleges. The club students have also proved their active participation in international Robotics competitions. The group has also been a constant participant in Robocon, an International Robotic competition, since 2013. Figure 5 shows the TECHNOCRATS students participation in ROBOCON 2018 competition.

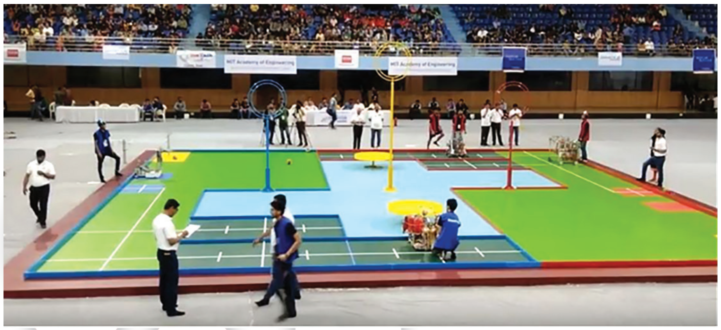


Fig 5. ROBOCON contest 2018.

Publications:

1. Jitendra, Tarwadi Parag, Arockia Selvakumar A, and Juan Antonio Corrales Ramon. “Manipulation and path planning for KUKA (LWR/LBR 4+) robot in a simulated and real environment.” Journal of Automation Mobile Robotics and Intelligent Systems 11 (2017).

2. Pavan Kalyan and Arockia Selvakumar, A. A humanoid neck using parallel manipulators. Proceedings of the International Conference on Robotics and Automation for Humanitarian Applications (RAHA), 1-6, 2016.

3. Pavan Kalyan and Arockia Selvakumar, A filed a Patent on ‘An Orthopedic Wearable Device for Treating Patients with Cervical Spine Injuries’, 04/09/2015. Application No: 201841014653. The Patent office, Chennai, India, Journal No. 16/2018, filed on: 20/04/2018.

4. Saket M. Pardeshi and Arockia Selvakumar A. 2017. Kinematic and Velocity Analysis of 3-DOF Parallel Kinematic Machine for Drilling Operation. In Proceedings of the Advances in Robotics (AIR ‘17). ACM, New York, NY, USA, Article 18, 6 pages. DOI: https://doi.org/10.1145/3132446.3134882.

5. Arockia Selvakumar, Harish, Saket. “Experimental Investigation on Position Analysis of 3RPR Parallel Manipulator.” Journal of Adv Research in Dynamical & Control Systems 10 (5), 556-564. 2018.

Robotics Activities @ IIT Indore

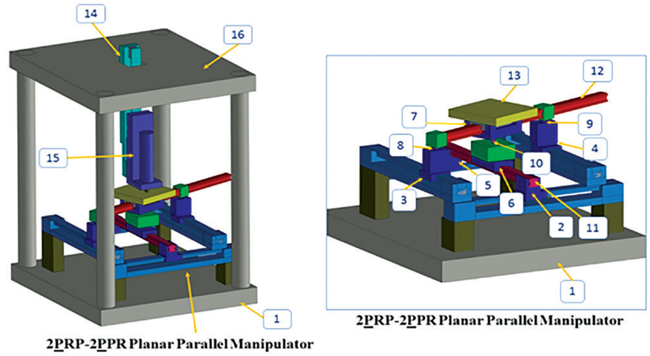
Professor: Dr. Santhakumar Mohan

Students: Yogesh Singh, Jayant Kumar Mohanta, Jagadeesh Kadiyam, Swati Mishra and Barre Alex Epenetus

1. Development and Performance Evaluation of a XYZ Parallel Motion Stage for Milling Operation

The proposed project presents the development and performance evaluation of a planar 2PRP-2PPR parallel configuration used as a worktable of a milling machine. The kinematic relations and the prototype development of the proposed system is described in this project. To demonstrate the system performance, linear, circular, triangle and complex shape trajectories are selected for the end-milling experiments. The end-milling experiments on a soft aluminum alloy demonstrate that the proposed parallel mechanism has better performance and capability as a worktable of a milling machine for high precision machining applications.

This project demonstrates the prototype development of the milling machine work table based on the 2PRP-2PPR manipulator and their cutting/milling performance in associated with three different end-effector velocity variations. Proposed machining system has four-axes (four degree-of-freedom) of which two translation motions are along with x and y axis, respectively and one rotational motion is about z axis. These three motions are obtained during the motion of 2PRP-2PPR worktable in a xy plane. The fourth motion is a translation motion along z axis to have the depth of cut on the workpiece using milling/cutting tool spindle system attached with the fourth prismatic actuator. The complex trajectory in association with the straight line, ramp and arc is selected for the analysis of the hysteresis of the proposed worktable of a milling machine. The task space position errors and joint space position errors are observed during this hysteresis analysis experimentally and their maximum, minimum and mean numeric values are shown in Fig. 3. From the results, it is found that the task space position and joint space position errors' mean numerical values are in the range of macro. Therefore, the ability to track the desired trajectory from both ways either forward or reverse of the proposed manipulator is good.



1. Fixed base platform
2. Active prismatic joint 1 (x direction)
3. Active prismatic joint 2 (y direction)
4. Active prismatic joint 3 (y direction)
5. 6 and 7. Passive prismatic joint

8, 6 and 10. Passive rotary joint

11 and 12. Passive link

13. End-effector/mobile platform
14. Active prismatic joint 4 (z direction)
15. Spindle motor and tool holder
16. Top plate

Fig. 1. Solid model representation of the developed prototype of a worktable of milling machine

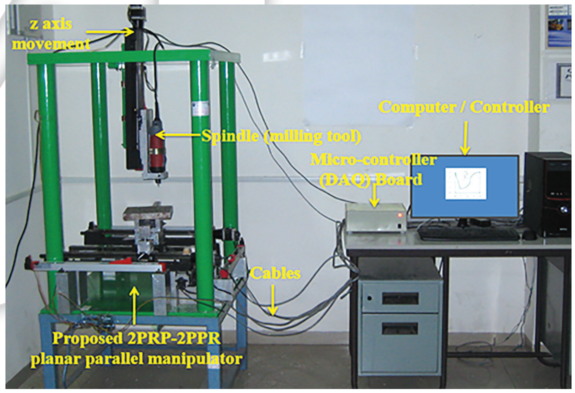


Fig. 2. Prototype of the proposed 2PRP-2PPR manipulator along with its experimental arrangement as a worktable of a milling machine

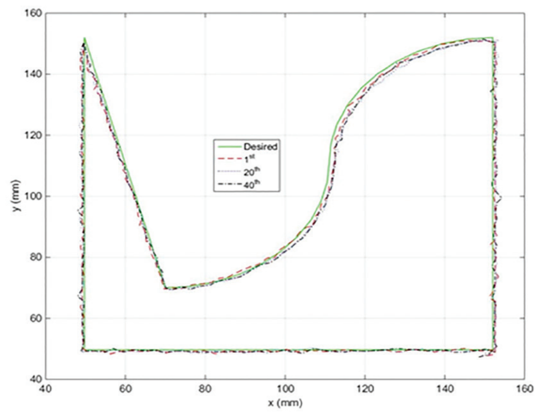


Fig. 3. End-effector (task space) trajectories of the manipulator during repeatability analysis (experiment) at orientation angle

DST SERB, TRS and TEQIP
'Winter School on Advanced Robotics'
will be held from
27th to 31st Jan 2019 at IIT Kanpur.
The workshop would be focused on advanced topics such as autonomous mobile systems, human robot interaction, AI in Robotics.

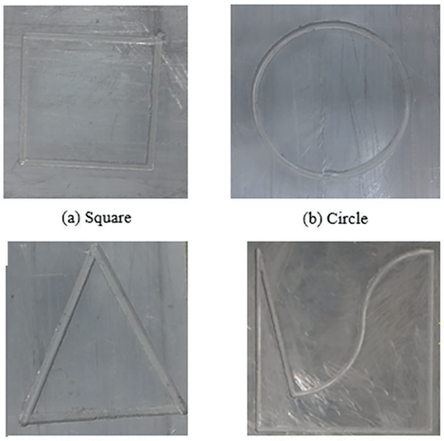


Fig. 4. Machined square-circle-triangle-complex shape test parts

As shown in Fig. 4, the milling machining tests demonstrate that the present developed milling worktable have better performance in low speed during actual machining operations. The error is overcome with the help of better structural rigidity of the machine. For fine finishing of the end product, the recommended speed of operation is 10mm/s.

2. Lower Limb Rehabilitation Robot

Worldwide, limb disability is one of the major problems faced in the medical sector and it is more common among the older age group. There are numerous reasons for these disabilities; one of the major reasons is stroke which happens due to a brain attack, spinal cord injury (SCI) which happens due to an accidental injury to the spine, disability due to a non-polio acute flaccid paralysis (NPAFP), etc.

These limb impairments need to go through rehabilitation process to regain normal functioning of limb activities. To increase the effectiveness of treatments, the therapists need to use some mechanised devices which can assist them to perform rehabilitation therapies and hence the rehabilitation robotics came into existence.

Here at CRC IITI we are working on parallel manipulator based Lower Limb Rehabilitation Robot (LLRR) the conceptual diagram is shown in Fig. 5 Passive range of motion consists of gait movements or movement of the limbs specified by the therapist as per the recommended rehabilitation strategy. In this type of therapy, the patient's limbs are not subjected to any resistance. In other words, the patient will not provide any effort for the therapeutic movements. To perform Passive range of motion on the ANKUR-LL 2 suitable control methods are selected and implemented on the scaled down real-time prototype, which is shown in Fig 6. From the control experiments it was found that the error in the manipulators joint and error in ankle, knee and hip joint is less than the 1°, results of an experiment is shown in Fig 7.

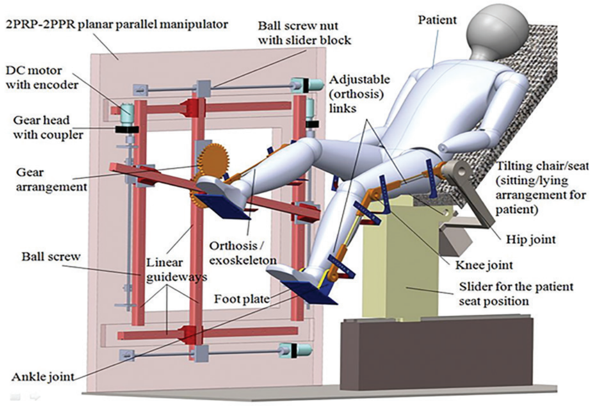


Fig. 5. Conceptual diagram of the ANKUR-LL 2

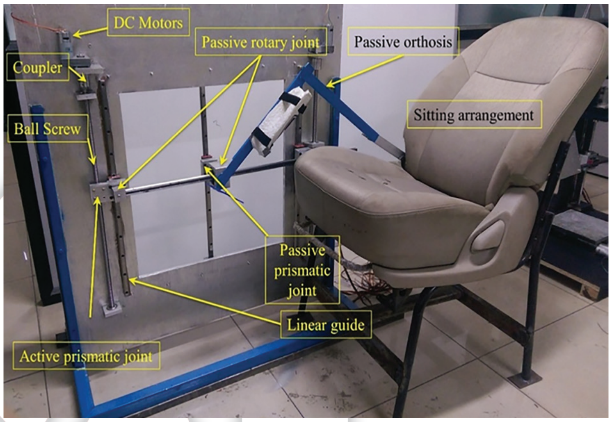


Fig. 6. Real-time scaled down prototype of ANKUR-LL 2

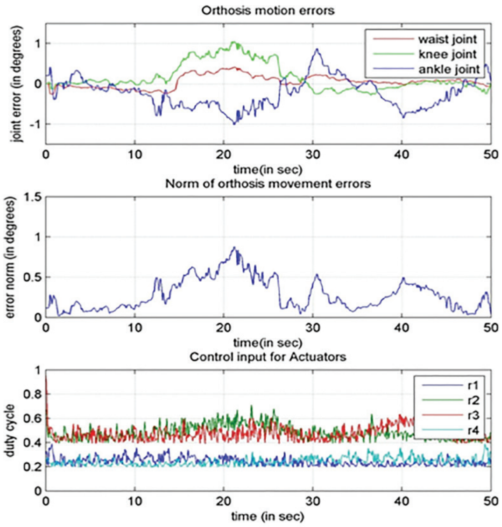


Fig. 7. Motion control experiments results

3. Hybrid Underwater Vehicle for Ocean Observations

In ocean observation applications, underwater Gliders use buoyancy propulsion and act as virtual mooring until required depths. But the speed and the vehicle response are limited. On the other side. Fish don't have propellers and get along very well without them. Fishes have efficient propulsion and easy maneuverability. They do not disturb their environment needlessly. Research shows that different fish swimming techniques have been developed as an alternate to conventional propellers, but could not achieve longer endurances when operating for long range applications. Thus a combination of both these techniques would help improve the vehicle performance in terms of speed and also response, whenever required.

As far as the propulsion, pitching and maneuverability issues are concerned, fish employ different strategies such as caudal fin, pectoral fins, dorsal fin and buoyancy variation etc. Many fish swim using their pectoral fins alone. In the other forms of diving, many fish control their buoyancy in the water. Its volume can be finely controlled, making it possible to move up and down under water. An organ known as swim bladder allows the fish to quickly adjust its density relative to its surroundings by changing the volume of the bladder. Some underwater robots employ piston mechanisms to model ballast of a submarine. The fin mechanism and the buoyancy tank would be integrated to test for effective control of swimming

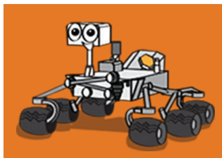
Fig. 8. Hybrid Underwater Vehicle with fin propulsion

The proposed development is a novel underwater vehicle hybridized for long term ocean observations with minimum energy consumption. This vehicle uses the buoyancy based propulsion for vertical profiling (similar to underwater gliders) for depth based measurements and biomimetic technique of fish propulsion using caudal and pectoral fins in place of conventional propellers for cruising in horizontal direction.

The vehicle consists of three different mechanisms for achieving the depth and for pitching motion viz., (1) pitch and dive using pectoral fins, (2) pitch and dive by varying buoyancy of the vehicle as well as for emergency surfacing of the vehicle and (3) pitch and roll by using moving mass and rolling mass mechanism respectively. The three mechanisms mentioned above can be controlled independently and also in combination as and when required.

Other on-going developmental projects include

- Design, Development and Control of a Smart Lower Limb Rehabilitation Robot
- Design, Development and Control of a Multipurpose Mobile Manipulator
- Design and Development of an Agricultural/Horticultural Robot
- Development of Robust and Intelligent Motion Control Designs for Different Robotic Systems
- Design and Development of a Robust Underwater Vehicle-Manipulator System
- Design and Development of a Modular Motion Platform for Gait Training
- Development of a Meso-size Automated Machining Centre



The University of Texas at San Antonio are now the world record holders in the Guinness World Records for creating the Smallest Medical Robot. The robot is technically a series of nanocomposite particles of two different types of multifunctional oxide materials that can be re-motely controlled by an electromagnetic field.