Selected Recent Publications

Ashish Singla, Sandeep Kumar and Bhaskar Dasgupta, "High-index Norm Redundancy Resolution Scheme for Kinematically Redundant Serial Manipulators" International Journal of Computational Science, Vol 1 No. 4, 351-370 (2007).

M. Shrivastava, A. Dutta, A. Saxena, "Trajectory generation using GA for an 8 DOF biped robot with deformation at the sole of the foot", Journal of Intelligent and Robotic Systems, Vol.49, no.1, 2007, pp.67-84.

Anjali V. Kulkarni, Ravdeep Chawla, "Structure and Analysis of a Snake-like Robot", T. Shobh et al. (eds.) Innovative Algorithms and Techniques in Automation, Industrial Electronics, and Telecommunications, 43-47, Springer, 2007.

P. Kulkarni, D. Goswami, P. Guha and A. Dutta, "Path planning for a statically stable biped robot using PRM and Reinforcement learning", Journal of Intelligent and Robotic Systems, vol. 47, 2006, pp. 197-214.

Karan Gupta, Anjali Kulkarni, Implementation of an automated single camera object tracking system using frame differencing and dynamic template matching, International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering CISSE 07, Dec. 2007

Ekta Singla, Bhaskar Dasgupta, Konstantin Kondak, Christian Fleischer and G\"{u}nter Hommel, "Optimal Design of an Exoskeleton Hip using Three-Degrees-of-Freedom Spherical Mechanism", Proceedings of the Joint Conference on Robotics, (ISR/ROBOTIK 2006), Munich, Germany (2006).

V. K. Tripathi, Bhaskar Dasgupta, K. Deb and Hari K. Voruganti, "A Simple Surface Representation Scheme for Rigid Body Docking", Proceedings of the 2006 Nanotechnology Conference and Trade Show, Boston, USA, Vol. 2, 313-316 (2006).

Anjali V. Kulkarni, Mukesh Singh, A. Mukerjee, "Physical and Intelligent Programmable blocks based Educational Toy Robot", RDFTME 2006, NIT Hamirpur.

P. Aggarwal, A. Dutta , B. Bhattacharya, "Cooperation between a 4 DOF robotic hand and a human", Proceedings of the SICE International Conference on Instrumentation Control and Information Technology ,Kagawa, Japan, 2007, pp. 2354 - 2359.

Prithwijit Guha and Amitabha Mukerjee and K.S. Venkatesh, "Multi-Agent Tracking under Complex Occlusions", Pacific Rim Conference on AI, Guilin China, August 2006

Susmit Sen, Parag K. Taktawala, Prabir K Pal, "Development of a Range-Sensing Indoor Mobile Robot with Wireless Ethernet Connectivity", Proceedings of the National Conference on Advanced Manufacturing and Robotics, Durgapur, India, Jan 10-11, 2005

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Center for Mechatronics

The Center for Robotics at IIT Kanpur was established in 1989 through a grant of Rupees 5 million from the Ministry of Human Resource Development, mainly through the efforts of **Prof. Amitabha Ghosh**. Thereafter, the activities in Robotics at IIT Kanpur increased through more student projects, both at the postgraduate and undergraduate levels, more thesis work at M.Tech and Ph.D. levels, and many sponsored and consultancy projects. It moved to its current premises at Room NL 312 at the Northern Lab Building in 1990. The same year the first formal Head, **Prof. Ashok Mallik** was appointed. During this time, work in the area of Mobile Robotics got well established.

It was realized that to have a balanced growth in an area like Robotics, it was necessary to involve more than a single department. Students from almost every department, and faculty from at least four academic departments and several interdisciplinary programs were soon participating in the activities. Subsequently, to better reflect its interdisciplinary nature, the Centre was renamed 'Center for Mechatronics' in 1994, during the Headship of **Prof. Himanshu Hatwal**. However, the names 'Robotics Center' and 'Roblab' remained, especially, amongst the students with whom the laboratory had become increasingly popular by this time.

Prof. Harish Karnick, the subsequent Head, took the Center strongly in the direction of Machine Vision and Image Processing, while the next Head, **Prof. Amitabha Mukerjee** laid the foundation for work in Artificial Intelligence, Natural Language Processing, Robot Gaming and many other areas.

The current Head is **Mr. Susmit Sen**, Senior Research Engineer. The thrust now is on sponsored research, development and consultancy work in areas such as hyper-redundant and flexible robots, humanoid robots, robots for exploration of space, and, robots and automation for the home, industry and hazardous environments. It is hoped that along with these activities, M.Tech., and Ph.D. programs in Robotics will soon be started.

We are proud that two recipients of the Distinguished Teacher Award (Prof. Mallik & Prof. Karnick) and a winner of the prestigious Shanti Swaroop Bhatnagar Award, **Prof. Kalyanmoy Deb,** are associated with the Center for Mechatronics.

Student Activities

The primary mandate of the IIT's is to provide high level technical education. In keeping with this aim, the Center provides hands-on educational experience to the students through its very pro-active student-centric curricular and co-curricular activities. Some of these are listed below.

- **B.Tech. Projects:** More than 20 B.Tech project work have been done through the Center under the guidance of the associated faculty, research and project staff. More than 50 M.Tech. thesis work, both experimental and theoretical have been completed at the Center. Five students completed Ph.D. Thesis work at the Centre.
- **BRICS:** Through its Build Robots Create Science initiative, the Centre provides hand-on experience in Robotics and allied sciences to school children.
- **Design Program:** Many students from the M.Des., Master of Design, program and the design course offered by the Humanities Department (ART404) have utilized the facilities of the Center and its expertise to bring into fructification innovative design ideas and products.
- **Robotics Club:** The Center has established a Robotics Club at the students' hostel and actively encourages and guides the students in participating in **Techkriti, Yantriki. ASME** and other technical exhibitions, fairs and competitions.
- **Robocon:** The Center for Mechatronics organized the first National Doordarshan Robocon contest for the inaugural ABU Robocon competition in Tokyo in 2002. Since then it has been actively involved in the organization of the National Doordarshan Robocon contest at various places in the country for selection of the national team. It has, also been fielding its own team for the last four years.

Objectives

The Center for Mechatronics has the following major objectives.
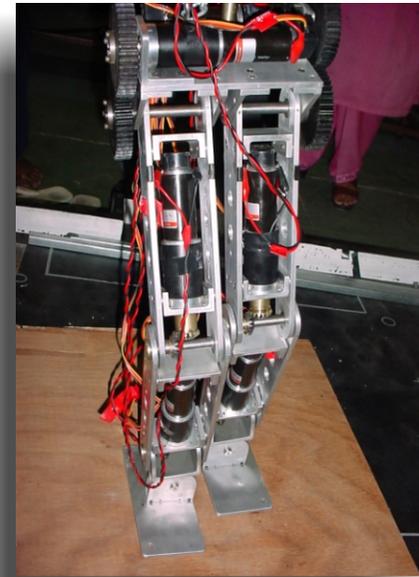
✖ *Laboratory Support for Students*
- ✖ *For undergraduate projects,*
- ✖ *For postgraduate thesis.*

✖ *Research and Development through*
- ✖ *Academic research,*
- ✖ *Sponsored research,*
- ✖ *Industrial consultancy.*

✖ *Training and Information Dissemination*
- ✖ *Through Workshops and Short-term Courses,*
- ✖ *Through development of a reference library,*
- ✖ *Through M.Tech. And Ph.D. courses (planned).*

Research & Development Activities

The spectrum of R&D activities and capabilities in the area of Robotics can be broadly classified into two categories,

✖ Theoretical/Simulation Studies: Here the task is to develop new technologies and to test and verify them. This does not need too much infrastructure except computational resources, but is dependent on the quality of manpower available. In recent years, the Robotics Center has been fortunate in its ability to attract top quality individuals. Current theoretical studies include **design**, **analysis** and **simulation** of **parallel**, **hyperredundant manipulators and humanoids**, robot **motion planning** and **optimization** using **Genetic Algorithms** and other tools, higherpair mechanism design, fast **collision avoidance algorithms**, and models for qualitative **spatial reasoning** along with work on virtual reality and machine vision .

✖ Developmental Activities: Here the task is to implement and demonstrate a technology so that design for the product, as well as the manufacturing process, can be finalized. This requires considerable infrastructural support. The Center has been able to build up a reasonably sound infrastructure base in the course of executing a large number of industrial and sponsored research projects over the last decade and more. These include several multi-axis and mobile robots, cameras and image processing modules, sensors and integration electronics, motors, controllers, radio interfaces, and, computational infrastructure, as well as access to excellent machine shops and prototype manufacturing facilities.

Robotics Projects

The Center for Mechatronics actively pursues projects that require integration of electronics and control hardware with sensors and actuators. It takes up research and development projects from Govt. and other funding agencies, public sector undertakings, as well as from the private sector. In areas where a good amount of expertise has already been built-up, it takes up design and development work as consultancy projects through the faculty members and other research staff. It has also started taking up turn-key factory automation projects. Some of the recent projects are listed below.

Snake-like robots: The aim of the present project is to design and develop a small but reasonably versatile 8 dof robot and subject it to a variety of experimentations to the hilt of its potential.

Humanoid project: This is a multi-scale project in biped locomotion, involving analysis, design, control, evolution, communication etc. Two **biped robots** have been built, One is a statically stable walker having 4 DOF and the other is a dynamic walker having 8 DOF. Aspects of advanced control, AI and Robot -Human communication are being studied at present.

Educational Robots: This involves development of small **do-it-yourself** kits for young students with small motor actuators and sensors at **low costs**. An innovative idea in this field is the development of **programmable blocks** which allow students to learn robot motion and programming concepts using physical blocks with active control circuitry.

Tele-operated Robots: Several tele-operated mobile robots have been built at the Center. One **wheeled** and one **tracked** vehicle capable of taking manipulator payloads were built for the BARC in the 90's. A state-of-the-art wheeled robot, **SmartNav**, with multiple SONAR's, a LASER ranging device, a video camera and **wireless Ethernet connectivity** was built for the BARC in 2004.

Factory Automation: This turn-key **consultancy project** uses National Instruments **Data Acquisition** devices to input process data and control the Heat Stretching Lines (STR) for the manufacture of sewing threads using **LABVIEW**. The idea is to provide a level of control far superior to that obtainable through PLC's. All five STR's would be automated and networked into a single computer with an interface to the **ERP** data-base.

Faculty

✖ *A.K. Mallik* : Dynamics, Vibration, Non-Linear System
✖ *Amitabha Ghosh :* Robotics & Control
✖ *Amitabha Mukerjee :* Artificial Intelligence, Computer Vision, Micro-Robots
✖ *Ashish Dutta :* Humanoid Robotics, MEMS Teleoperation, Control
✖ *Bhaskar Dasgupta* : ROBOTICS, CAD, Mechanisms, Scientific Computation
✖ *H. Hatwal :* Robot Dynamics, Control, Robotics
✖ *H. Karnick :* Artificial Intelligence, Computer Vision
✖ *Kalyanmoy Deb :* Genetic Algorithms, Legged Robot Optimization
✖ *Kripa Shankar :* Computer Integrated Manufacturing, Flexible Manufacturing
✖ *K.S. Venkatesh :* Signal Processing, m/c Vision.
✖ *S.G. Dhande :* CAD/CAM, Kinematics, Rapid Prototyping
✖ *Sumana Gupta :* Digital Signal Processing, Image Processing

Research Staff

✖ *Susmit Sen :* Mechatronics, Control, Virtual Instrumentation, Embedded Systems, Factory Automation.
✖ *Anjali Kulkarni :* Electronic Circuts, Devices Motion Control, Virtual Instrumentation, Micro-fabrication.