

# CONTROL, INSTRUMENTATION & ROBOTICS

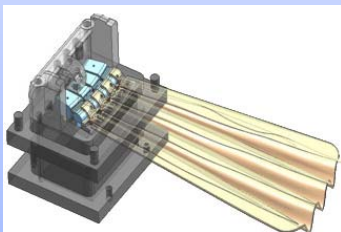
## Department of Mechanical Engineering



<http://meche.mit.edu/research/controls/>

The Control, Instrumentation, and Robotics (CIR) area seeks to promote research and education into identifying fundamental principles and methodologies that enable systems to exhibit intelligent, goal-oriented behavior, and developing innovative instruments to monitor, manipulate, and control systems. Our area is based on strong core disciplinary competencies in dynamic systems, and control, supplemented by knowledge of a diverse array of topics including mechanical design, manufacturing, electronics, materials, and biology. Our applications span a broad spectrum of social and national needs, including: autonomous mobile robots for energy exploration, security, defense, and environment monitoring; advanced medical devices and systems for surgery, rehabilitation, and elderly care; precision machines for manufacturing, manipulation, and measurement at micro- and nano-scales; novel sensors, actuators, and materials; and humanoids for home automation, education, and entertainment.

### Novel Actuator and Sensor Technology



Advances in sensors, actuators, materials, and communication technology have enabled a new area for the fields of robotics, mechatronics, and dynamic systems and control. Recent projects in this area in our group include the investigation of novel actuator technologies that can greatly surpass biological muscle in terms of stress, energy density, efficiency, response speed, and degrees of freedom. New actuator materials, such as conductive polymers and dielectric elastomers, open up new possibilities for activating diverse objects, including garments, surgical tools, and robots.

*Faculty: Asada, Dubowsky, Hart, Hogan, Hunter, Leonard, Rowell*

### Biorobotics and Bioinstrumentation



Our laboratories are developing new diagnostic and therapeutic tools for biology and medicine. This research spans a diverse spectrum of spatial scales, from the development of rehabilitation robots and new tools for surgery and drug delivery to the development of nano-scale bioinstrumentation devices that can probe biological systems can probe biological systems with functional measurement of cellular and molecular level machinery

*Faculty: Asada, Dubowsky, Hogan, Hunter, Lang, Slotine, So*

#### Control, Instrumentation & Robotics Faculty and Principal Research Staff:

Anuradha Annaswamy	Douglas Hart.	John Leonard	Michael Triantafyllou
Harry H. Asada	Neville Hogan.	Seth Lloyd	David Trumper.
George Barbastathis	Ian W. Hunter	Derek Rowell	Kamal Youcef-Toumi
Steven Dubowsky	Karl Iagnemma	Jean-Jacques Slotine	Richard Wiesman
David Hardt	Matthew J. Lang	Peter So	Steven Leeb

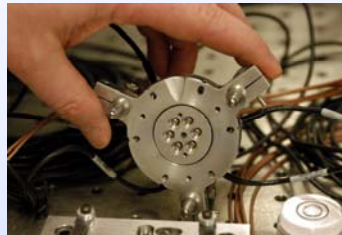
## Control of Complex Systems



Modeling and control of dynamic systems is a core discipline in mechanical engineering. Department faculty conduct research on a broad variety of control topics, such as the development of new methodologies for control of nonlinear systems, investigation of new techniques for stochastic control of highly parallel systems, and the development of adaptive controllers for complex systems. These innovations are applied to a wide variety of systems, from biomimetic robots to precision manufacturing devices

*Faculty: Annaswamy, Asada, Dubowsky, Iagnemma, Slotine, Trumper, Triantafyllou*

## Precision Instrumentation



Our faculty are working at the frontier of manufacturing technology to create devices capable of rapid and precise fine-scale motion. This work includes the design of electromechanical systems for precise positioning applications such as semiconductor photolithography, high-speed machine tools, and scanned probe microscopy. This entails the integration of electro-mechanics, controls, and mechanical design with other core mechanical engineering disciplines to create machines, actuators, and sensors for advanced manufacturing processes.

*Faculty: Hardt, Hunter, Trumper, Youcef-Toumi*

## Autonomous Robotic Vehicles



Autonomous navigation, mapping, path planning and control, are vitally important to numerous envisioned applications of mobile robots, operating in land, air, space, underground, and underwater environments. Recent efforts in the department in these areas include the development of active safety technologies for the automobile industry, the creation of navigation and mapping algorithms for autonomous underwater vehicles, and participation in the DARPA 2007 Urban Challenge.

*Faculty: Dubowsky, Iagnemma, Leonard, Triantafyllou*

## Optics



Optics is a fascinating discipline at the intersection of science and engineering. In the Mechanical Engineering context, Optics is driven by advances in manufacturing technologies and precision engineering including the micro and nanoscales; conversely Optics contributes measurement and sensing tools for a broad variety of Mechanical Engineering subdisciplines ranging from fluid mechanics (particle image velocimetry) to robotics and controls (ranging, imaging), and bioengineering (imaging molecules, cells, and tissue)

*Faculty: Barbastathis, Lang, So*

### Subjects in Control, Instrumentation & Robotics

2.003J: Dynamics and Control I	2.161: Signal Processing: Continuous and Discrete
2.004: Dynamics and Control II	2.165: Robotics
2.111J: Quantum Computation	2.166: Probabilistic Techniques for Mobile Robotics
2.12: Introduction to Robotics	2.167: Hands-on Marine Robotics
2.14/2.140: Analysis and Design of Feedback Control Systems	2.168: Analysis, Design, and Control of Automated Equipment
2.141: Modeling and Simulation of Dynamic Systems	2.171: Analysis and Design of Digital Control Systems
2.151: Advanced System Dynamics and Control	2.183: Biomechanics and Neural Control of Movement
2.152: Nonlinear Control System Design	2.193: Decision-Making in Large-Scale Systems
2.154: Maneuvering and Control of Surface and Underwater Vehicles	2.671: Measurement and Instrumentation
2.160: Identification, Estimation, and Learning	2.71/2.710: Optics
	2.717: Optical Engineering
	2.737: Mechatronics

**For information on the Course 2-A track in Control, Instrumentation and Robotics, please visit:**  
<http://meche.mit.edu/academic/undergraduate/course2a/samplecon/>