Robotics Seminar

Date **5/12 (Tuesday), 2009 14:40-16:00**
Place **Seminar Room of Mechanical Systems, East Wing 4F**
Biwako-Kusatsu Campus, Ritsumeikan University

Robot Assembly: From Vibratory Manipulation to Self-Organization

Professor Kevin Lynch

IEEE Trans. Robotics, Senior Editor
Department of Mechanical Engineering
Northwestern University

Traditional robot assembly is a sequential centralized top-down process, where one or more robot manipulators place parts into a growing assembly. Self-assembly, on the other hand, is a parallel decentralized bottom-up process, where parts are designed to bond with each other so that the desired assembly is an attractor. In both cases, the "assembly program" is encoded in the control algorithms and physical properties of the manipulators, environment, and the parts themselves.

Between these centralized and decentralized extremes lies most current and future industrial assembly. In this talk I will describe our work at two points on this spectrum. In the first part of the talk, I will describe the PPOD, the Programmable Parts-feeding Oscillatory Device. The PPOD uses six-degree-of-freedom vibration of a rigid plate to create frictional force fields that can control the motion of several parts simultaneously. In the second part of the talk, the parts are "smart" and capable of communication, actuation, and locomotion. I will describe a systematic design procedure to compile a desired "swarm" behavior into decentralized communication and control laws for the individual agents.

This work is joint with my students Tom Vose and Peng Yang and my colleagues Randy Freeman and Paul Umbanhowar.

BIOGRAPHY

Research: Motion planning and control for robotic manipulation and underactuated systems; decentralized control of multi-robot systems; physical human-robot interaction.

Professor Lynch's research in motion planning and control includes sensor-based motion control for an underwater robot navigating using an active electric field sensor; planning and control of robotic manipulation; and motion planning for vehicles and other underactuated systems. Work in robotic manipulation focuses on the use of pushing, throwing, juggling, rolling, vibration, etc., to increase the dexterity of robot manipulators. Manipulation of an object with many degrees-of-freedom by a robot with fewer actuators is called underactuated manipulation. Other underactuated systems of interest include robot arms with failed actuators, and space, air, and underwater vehicles with limited control authority. Control for these underactuated systems raises challenging issues in mechanics, design, controllability theory, and robot motion planning.

Another area of interest is decentralized control of multi-robot systems. The challenge is to design local estimators and controllers running on each robot so that the group exhibits desired collective behaviors. Inspiration can be found in animal groups such as flocking birds and schooling fish. Applications of this research include vehicle formation control, cooperative surveillance, mobile sensor networks, and other self-organizing systems.

Physical human-robot interaction involves physically coupling a human with a robot, which may be an intelligent assist device, exoskeleton, prosthetic, or haptic interface. Our research on physical human-robot interaction focuses on better understanding the human half of the coupled control system, in order to design and control robots for comfortable and intuitive interaction.

http://www.mech.northwestern.edu/web/people/faculty/lynch.php