

WTEC ROBOTICS WORKSHOP

RESEARCH AREA

Actuators/Mechanisms; Bio/Nano/MEMS; Industrial

By

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The three research areas in this summary represent blends of "old" technology with new developments. Clearly, actuators and mechanisms have been of interest in robotics from its earliest days, when pneumatic and hydraulic sources of power for motion were used, as well as electric motors. Recently, this area has been invigorated by research on new types of actuation. Industrial robotics is where the field began. Yet, even here, new developments in sensing and control for robot manipulators enable the area to continue to be active and vigorous. The third area in this summary, "Bio/Nano/MEMS", concerns the continuing trend in the field toward miniaturization, as well as continuing to obtain inspiration from biological systems (as robotics has done from its inception).

Actuators and mechanisms: Current developments and challenges in actuators come from two separate communities: smart structures (from the materials community) and kinematics (from the machine design community). Robotic exoskeletons, with a multitude of electromechanical actuators, present challenges in kinematics as well as coordination and control. Recent developments in new actuators include work in the use of conducting polymers, which change dimensions when electrically stimulated, as well as shape memory alloy (SMA) actuators. While the latter have been used for some years, there is significant current work in the use of multiple SMA actuators with improved reliability and response time. Shape deposition fabrication methods are now being used to fabricate complete robot structures, including actuators.

Bio/Nano/MEMS: Microrobotics refers to the design and fabrication of robots in the 100 nm to 100 μm , while nanorobotics concerns devices in the 1-100 nm scale. There is significant progress in the development of robotic systems in both of these areas. The traditional tools of mechanics and control used in macro-robotics do not apply to micro- and nano-systems. Rather, such disciplines as solid state physics, quantum physics, chemistry and the theory of MEMS are used. Examples of microrobotic systems include included a flying "insect" and a solar powered MEMS-based crawling robot. Examples of nanorobotic prototypes include nanomanipulation of 15 nm gold particles and development of a nanowire sensor. This is a high visibility area with a great deal of promise for future developments in robotics.

Industry applications involve the representation of both robot motion control and the processes to which the robots are applied, whether machining or welding or manipulation. New systems involve control of multiple manipulators, rather than a single arm. Current manipulator control systems include compliance control and methods of handling disturbance torques, in addition to the traditional position, velocity and torque

control. There are also significant advances in motion planning based on force sensing and control, the use of 3-D vision and other sensory modalities, multi-arm off-line programming and increased robot intelligence. Needs for future developments include smaller robots requiring less floor space, increased safety, integration of process control with robot control and reduced robot teaching time.