Design and Control of Arrayed MEMS

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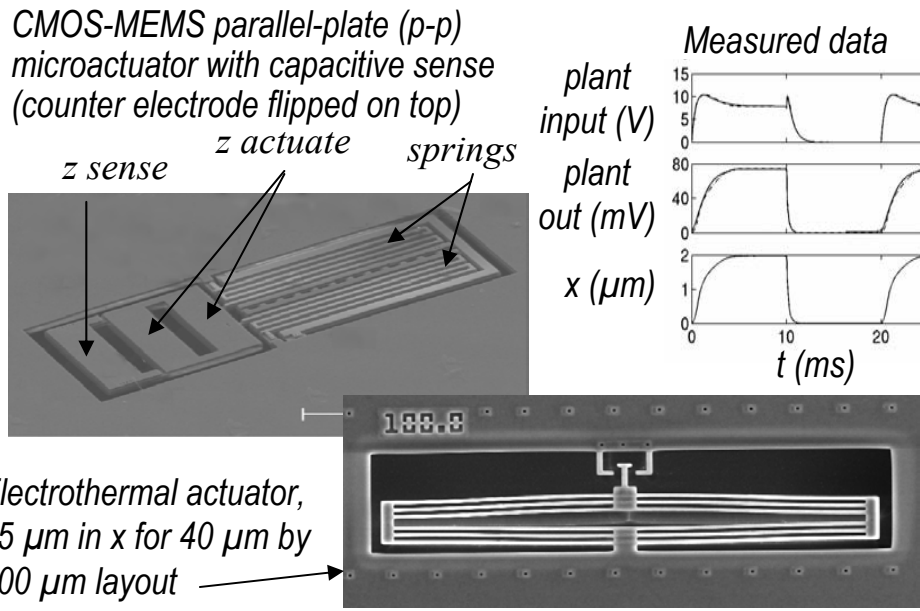
Goals and Potential Impact if Successful

MEMS arrayed control has numerous applications: micro/nano manipulation systems, optical beam steering, ciliary actuators, and probe-based data storage, inspection and sensing.

Massively parallel microservo manipulators with nanometer precision will help pave the way to manufacture of micro/nano systems that cannot be made with conventional batch fabrication. Robust interfacing to micro/nano parts requires control systems with local sensing and actuation. Such microservo systems may work synergistically with self-assembly techniques.



Approach and/or Accomplishments

Arrayed control can be achieved through integration of MEMS with electronics. Servo micromechanisms include embedded sensing and actuation for each degree of freedom. These functions can be integrated into compact cells with modular design for tiling in arrays. Complexity is supported with a mixed-physics/electronics design environment.

Key challenge problems must be identified to drive the research. For example, robust gear on peg placement and/or nanotube placement would be appropriate to drive understanding of issues in manipulation at these respective scales.

Bottlenecks and Open Research Questions

To date, most successful micromechanical systems interact without contact physics, especially contact with things existing off chip. The presence of Van der Waals, surface tension and surface charge forces poses challenges in manipulation. Research is needed at the device and system level to characterize these phenomena under practical circumstances. modeling and verification for various materials encountered in micro/nano systems. Local control methodologies and associated engineering implementations that reject on- and off-chip disturbances and are robust under plant uncertainty must be found. Handling the design complexity of large integrated microsystems remains a challenge as well.