STEVENS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

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Carnegie Bldg, Room 315, Time 2:45 PM

Design of six-axis flexure-based Macro-, Micro- and Nano-scale Nanopositioners

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Many emerging nano-scale components/features are 3D in nature and therefore they must be positioned or studied by machines that are capable of complex multi-axis motions. The absence of such equipment prevents the full understanding and utilization of many new nano-scale components/features. Through our research, we have made advances in precision machine design technologies that have enabled six-axis nanopositioners with better than 3 nanometer/1 microradian resolution and 10s to 100s of Hz scanning speeds. The work has resulted in new types of macro-, micro-, and nano-scale nanopositioning equipment for nanomanufacturing and nanoinstrumentation. In this seminar, we examine the new concepts and their performance:

(1) Macro-scale: We are able to fabricate monolithic, compliant nanopositioners wherein actuators are used to control the flexing of the nanopositioner and thereby induce six axis motions with nanometer-level positioning. Compared to the state-of-the-art, these nanopositioners are capable of over 300 times better performance at 2 - 10 times lower cost.

(2) Micro-/Meso-scale: We have created a planar, monolithic six-axis positioner that is compatible with lithography-based micromanufacturing processes. This device has been used to create a 1mm diameter six-axis nanopositioner that is capable of 1Angstrom/1 microradian resolution and several 100s Hz bandwidth.

(3) Nano-scale: Lithographic techniques are not well-suited to create compliant links/bearings for nano-scale flexure-based positioners. An alternative is to create the mechanisms from molecular machine elements such as Carbon nanotubes (CNTs). We will examine nascent modeling efforts in this research that are aimed at creating compliant structures and mechanisms for nano-scale nanopositioners.

Dr. Martin Culpepper received his BSME (1995) from Iowa State University, and his MS/PhD (1997/2000) from the Massachusetts Institute of Technology. Prof. Culpepper is the recipient of an NSF Presidential Early Career Award (PECASE) for his work in Nanomanufacturing, two R&D 100 awards (1999, 2003), a TR100 award, and a Joel and Ruth Spira Teaching Award. Prof. Culpepper is listed on seven patents issued/pending. He is the Assistant Director of the MIT Laboratory for Manufacturing and Productivity, Co-chair of the 2006 International Conference on Micromanufacturing, and Co-chair of the 2006 International Symposium on Nanomanufacturing. His research is focused on (1) the design of meso/micro/nano-scale equipment for micropositioning and nanopositioning, (2) compliant instrument and mechanism design, and (3) the design of multi-scale systems.