Friday, June 8th, 2012, 2:00 P.M.

Room No. 109, DASAN bldg. 1st Floor

(Host: Prof. HyukSang Kwon / Language: English)

Development of Precision Machines and Instrumentations for Nano-/Biomedical Applications

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Study of nanoscale phenomena and biological systems has been the focus of researchers across different fields in recent years. Accordingly, small-scale machines such as biological imaging equipment, equipment for nanomanufacturing and instruments for nanoscale research are increasingly needed. These machines/positioning systems must be of small scale in order to achieve viable bandwidth (kHz), high resolution (nanometers), low cost ($10s/device) and high thermal stability (Å/min). Miniaturized precision machines require an integrated structure, powerful and efficient small-scale actuators, well-designed flexural bearings, and control systems. Unfortunately, the current state-of-the-art is not capable of simultaneously satisfying all of these requirements. For example, the design of an endoscopic scanner requires a micro-actuator to simultaneously generate high force (~10mN), stroke (~100μm) and bandwidth (~1kHz).

This talk will address these issues with examples from two projects: (1) Development of two-photon endomicroscope with sub-cellular volumetric imaging capability. The heart of the instrument is a thermally actuated 3-D micro-scanner that runs at 3.5kHz x 100Hz x 30Hz throughout a 125x200x200 μm^3 volume. This performance can be achieved by thermomechanical actuators (TMAs) through the use of two new design techniques that I developed—Geometric Contouring and Mechanical Frequency Multiplication. (2) Development of the μHexFlex, the first microscale six-axis nanopositioner that provides 0.6 nanometer repeatability and angstrom level resolution. The μHexFlex, which has a 2.5-mm device envelope, sandwiches a layer of silicon dioxide between two layers of silicon. The integrated TMAs can exert both in-plane and out-of-plane forces on the central stage and flexure bearings, and thus enable six-axis positioning.

The presentation will be concluded with future research directions, including the development of the next-generation small-scale biomedical devices/machine elements, and issues relating to light microscopy and endoscopy for minimally-invasive imaging.

Biographical Sketch:

Dr. Shih-Chi Chen received his B.S. degree in Mechanical Engineering from the National Tsing Hua University, Taiwan, in 1999. He received his S.M. and Ph.D. degrees in Mechanical Engineering from the Massachusetts Institute of Technology, Cambridge, in 2003 and 2007, respectively. Following his graduate work, he entered a post-doctoral fellowship in the Wellman Center for Photomedicine, Harvard Medical School, where his research focused on biomedical optics and endomicroscopy. He is currently an Assistant Professor in the Department of Mechanical and Automation Engineering at the Chinese University of Hong Kong (CUHK). Before joining CUHK, he was a Senior Scientist at Nano Terra, Inc., a start-up company founded by Prof. George Whitesides at Harvard University, to develop novel methods and instruments for the control of various interface functionalities and soft lithography. His current research interests include precision engineering, biomedical devices/optics, microcontact printing, and nanomanufacturing. Prof. Chen is a Member of the American Society of Mechanical Engineers (ASME) and the American Society for Precision Engineering (ASPE). He is the recipient of a 2003 R&D 100 Award for the design of a microscale six-axis nanopositioner.