WHITAKER BIOMEDICAL ENGINEERING INSTITUTE

DEPARTMENT OF BIOMEDICAL ENGINEERING
FRIDAY SEMINAR SERIES

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"Modeling and Control of Micro-Scale Systems: Control of droplets by Electrowetting Actuation and Steering of Cells by Flow Control Tweezers"

DATE: September 23, 2005

TIME: 1:00 p.m. – 2:00 p.m.

PLACE: **Clark 110**

Host: Dr. Nitish Thakor

Abstract:
On the macro scale, feedback control is routinely applied to improve performance and enable new tasks in complex and uncertain systems operating in noisy environments. Our lab has focused on applying feedback control ideas to systems on the micro scale. Here we show how control methods can improve existing performance in the UCLA lab-on-a-chip electrowetting system and can create entirely new capabilities in our 'fluidic tweezers' cell steering devices.

In the Electro-Wetting-On-Dielectric (EWOD) system developed at UCLA by CJ Kim, a grid of electrodes is used to locally change surface tension forces on liquid droplets. By choosing the electrode firing sequence it is possible to move, split, join, and mix liquids in the droplets. We present an experimentally validated 2-phase fluid flow model of the liquid dynamics, and then show the development of control algorithms validated on this model. Control ideas and real time image algorithms are presented for controlling material points on the liquid/gas boundaries, for precision splitting of droplets, for steering of particles inside the droplets, and for dealing with external noise sources.

For the second example, we show how feedback flow control can enable particle steering in cheap, handheld micro-fluidic systems using real time vision feedback and routine electro-osmotic actuation. Here we create temporally and spatially varying flow fields that carry all the particles along their desired trajectories. We have demonstrated flow steering of many particles at once both in simulations and in experiments. This system is being further developed to enable sample preparation (remove all but the interesting objects from the sample) and for cell loading for a 'cell clinics' olfactory and bio-chemical sensing system at the University of Maryland.

I will close the talk by outlining the underlying challenges that must be addressed for control of micro-scale systems based on other project in our lab (e.g. shape control of vesicles with laser tweezers, modeling/control of conducting plastic actuators) and on the results of the 2004 NSF workshop on 'Control and System Integration of Micro- and Nano-ScaleSystems'.

Any questions, contact 410-955-3132.
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