Interdisciplinary Instrumentation Colloquium

Microfluidic Systems for Biological Automation

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The current state of automation in biological instrumentation revolves around the use of liquid handling robots or systems built with discrete fluidic components. This has enabled many exciting breakthroughs such as the sequencing of the human genome. But these systems are large and expensive to build and maintain, and there is a limit to the scale and complexity of automation that can be achieved with them. The greatest impact of automation has been in the biotechnology and pharmaceutical industries, and large government projects, while typical academic scientists have little opportunity to use large automated tools in their daily research. Microfluidics may enable much higher degrees of biological automation than conventional technologies while also making automation more ubiquitous. Besides automation, microfluidic devices offer other significant advantages. Handling microscopic amounts of fluids saves precious reagents, and hundreds or even thousands of processes can be carried out in parallel in a single small device.

Additionally, many novel and interesting physical and chemical phenomena emerge at the micro scale, and they can be exploited to create components and processes with no macroscopic analogs. In this talk I will present two examples of microfluidic systems aimed at two different biological applications. The first device was designed to perform fast electronic detection of small numbers of bacteria in a liquid sample. The second device is a highly automated platform for long-term culturing of mammalian cells. It's most interesting applications are rapid screening of cell culture conditions, and the study of stimulus/response dynamics of cultured cells with very high temporal resolution. The microfluidic chip at the heart of this system is fabricated with a very powerful and simple technique for making cheap devices that contain hundreds to thousand of microscopic valves. Such valves make it possible to create large scale integrated fluidic circuits that can perform highly automated processes.

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