Interactive Web-based Education on Biomedical Microdevices

Nano-Micro-Bio: Interfacing Engineering, Biology and Medicine Education Online

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I. Motivation

❑ The emerging novel healthcare technologies create the immediate need for more effective education and exchange of knowledge with professionals around the world.

❑ The conventional classroom instruction cost is high and not scalable. The interactive web-based education can serve instruction globally with a dramatically reduced the cost.

Our objective: Develop interactive and animated technologies on the web to teach micro and nano-scale biomedical device physics and applications in healthcare.

II. Wed-based Education

❑ The trend: many world-leading universities and educational organizations including MIT, Stanford University, National Science Digital Library, and Coursera have contributed lectures and research material online through various web platforms.

❑ The common goal: enhance human learning worldwide by the availability of a web of knowledge.

MIT OPENCOURSEWARE MASSACHUSETTS INSTITUTE OF TECHNOLOGY · webcast.berkeley · MERLOT Multimedia Educational Resource for Learning and Online Teaching · NSDL THE NATIONAL SCIENCE DIGITAL LIBRARY · coursera

III. Preliminary Effort

❑ Supported by UT Academic Development Fund (ADF) in 2008, my laboratory at UT Austin launched a web-based learning center with a focus on cell manipulations, nano-scale imaging, and cancer diagnoses.

❑ The virtual learning center is open to students at multiple levels from the middle school to the post-graduate professionals.

❑ The web-based content has also been used in courses at multiple institutions including Harvard Medical School and the University of California.

❑ Key initiatives: disseminate the knowledge and new frontiers on multi-scale medical devices science and engineering through digitized media (animation, 3D graphics and video) with focuses on interdisciplinary educational and research topics relevant to healthcare and biomedical engineering.

IV. Learning Modules

In addition to traditional lecture notes, the interactive learning modules feature the interactive presentations and videos of principles of micro and nano devices.

❖ *Design Principles*

❑ The design principles section serves as an introduction to micro and nano devices by discussing the motivation, theory, and physics behind biosensors, microdevices and nano phenomena.

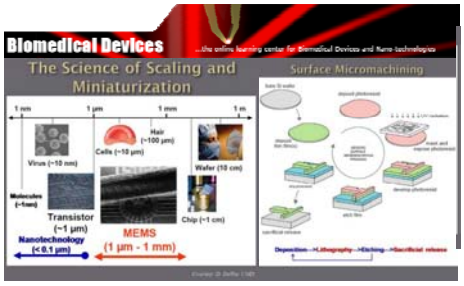

Figure 1: An introduction to MEMS devices and scaling laws in miniaturization presentation is one of many interactive learning modules available for students to review at their own pace.

❖ *Device Microfabrication*

❑ Multimedia presentations are powerful tools to show the advanced micro and nanofabrication equipment operations and techniques.

❑ Classical training methods would involve the vicinity to a comprehensive cleanroom manufacturing facilities, long hours and limited access, all of which are associated with an increasing cost.

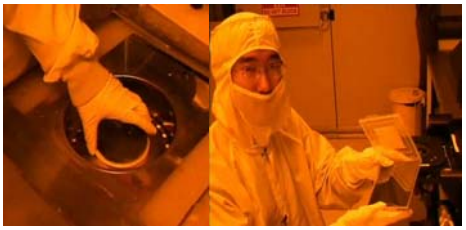

Figure 2: Samples from a micro-fabrication video demonstrating photo lithography techniques. The sample frames show how to create a thin photoresist layer on a Si wafer and use a mask alignment system.

❑ We present the key process flow of micro-fabrications through video streams available online, as shown in Figure 2.

❑Students will experience a virtual cleanroom environment to see how each tool is used in the fabrication of various biomedical micro-nano devices.

V. Applications

❑ Each module is viewed as a single step through the ongoing development process; therefore the results are extendable to include future modules reflecting emerging technologies over time.

❖*Cell Manipulation*

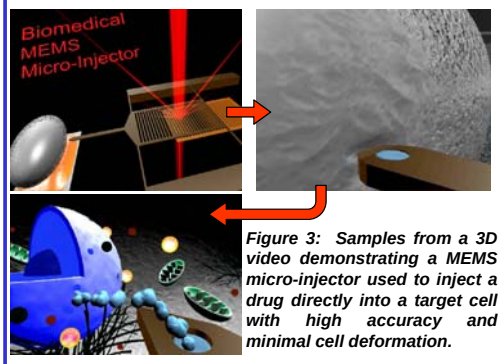

Figure 3: Samples from a 3D video demonstrating a MEMS micro-injector used to inject a drug directly into a target cell with high accuracy and minimal cell deformation.

❖*Near-field Imaging*

Figure 4: The Near-field Imaging learning module shows students how to build a "light source on-tip" structure and how it could be used to detect nanovector distribution in cancer tissue.

❖*Cancer Diagnostics*

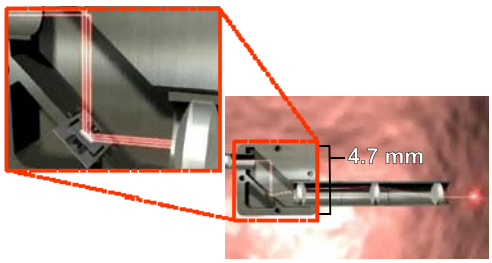

Figure 5: The micro-scanner is placed in a small form factor probe which is sent deep into the body to relay images to the outside world. The end tip of the endoscope is 4.7 mm in diameter to allow unrestricted access to many of the typical sites of cancer in the human body.

The technological platform will be readily extendable to other modules in the broad areas of advanced biomaterial, product design and fabrication at disparate scales, and multiscale simulations for advanced medical technologies.

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