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Photonics Symposium Showcases Innovations in Point-of-Care Diagnostics

By Mark Dwortzan

To better understand, diagnose and treat specific diseases, scientists are increasingly seeking technologies to investigate biological systems at the cellular and molecular levels. Among the most promising is biophotonics, the study of the interaction of light with biological material. Drawing on research in the life sciences, physical sciences and engineering, emerging biophotonics technology is extending scientists' ability to image, analyze and manipulate living tissue in minimally invasive ways.

Associate Professor Jerome Mertz (BME), Professor Irving Bigio (BME, ECE) and Assistant Professor Satish Singh (BME, BUSM) during a break at the Future of Light Symposium.

On Nov. 16 at the Photonics Center, the 13th annual Future of Light Symposium, "Biophotonics Sensors and Systems: Point of Care Diagnostics," showcased leading edge research in biophotonic imaging and biomedical photonics. Chaired by Professor Irving Bigio (BME, ECE), the symposium highlighted the achievements of Photonics Center researchers and collaborators from academic and medical institutions in Greater Boston and across the country.

Contributing to three separate technical sessions of the conference, three College of Engineering faculty members — Professor Selim Ünlü (BME, ECE), Associate Professor Jerome Mertz (BME) and Assistant Professor Satish Singh (BME) — presented new methods that could improve the accuracy, efficiency and cost-effectiveness of point-of-care diagnostic tools.

Mertz described HiLo microscopy, a new imaging technique that could be used in endoscopic microscopes. Rather than requiring researchers and clinicians to extract and bring tissue to the microscope, endomicroscopy enables them to bring the microscope to the tissue. HiLo microscopy produces a three-dimensional image of a tissue sample based on an inexpensive modification to a wide-field fluorescence microscope.

Fusing low-resolution data obtained from a non-uniformly illuminated image — one generated by illuminating the tissue sample with a grid-based or other pattern of light — with high-resolution data from a uniformly illuminated image, the method yields a high-contrast, in-focus image.

"It's very simple, there are no moving parts, it's very fast, there are reduced motion artifacts, and it's very insensitive to the type of structural illumination used," noted Mertz, whose lab is seeking to implement HiLo microscopy in a clinically useful endoscope to facilitate early cancer detection in the colon and other tissues.

Singh, a staff gastroenterologist at the Veterans Administration Boston Healthcare System, introduced a promising new fiber optic probe that he's devised that could considerably improve the effectiveness of traditional colonoscopy. Incorporating optical spectroscopic imaging into a conventional colonoscopic forcep, the probe performs an optical biopsy in concert with the physical biopsy of the colon.

"The analysis to date reveals great promise for the system to classify colonic polyps *in situ*," said Singh, citing a study that he and colleagues conducted at the Boston VA. "The system has the potential to be a low cost, low maintenance, user-friendly, easily adopted clinical tool."

Ünlü discussed the development of a simple technique — the Spectral Reflectance Imaging Biosensor (SRIB) — based on the interference of light reflected from a silicon dioxide surface. Measuring optical path length differences caused by biomolecular binding on the surface, the SRIB could be used to detect proteins, DNA and single viruses.

"We can get not only multiplexed, label-free results, but we can also do dynamic measurements," said Ünlü, who has already commercialized the high-throughput technique and applied it to the study of liver and Alzheimer's diseases.