Electrical & Computer Engineering

S E M I N A R

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Biomedical Instrumentation for Image-Guided Cancer Surgery

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Abstract—In the cancer surgery, the complete resection of cancers is the single most essential predictor of the prognosis of patient. However, even in US, local recurrence rate at 5 years approaches 40% following tumor resection, due to the failure of completely removing cancerous tissues. Surgeons rely on presurgical imaging, intraoperative visualization/palpation, and experience to optimize tumor removal. I developed a biomedical instrument system for intraoperative cancer identification: 1) a portable visible/near-infrared (VIS/NIR) camera system, to help the surgeons to visualize the cancer location; 2) a hand-held spectroscopic device, together with indocyanine green (ICG) as imaging contrast agent, for quantitative analysis of tissue properties; 3) a set of miniaturized devices, for cancer diagnosis in the minimally invasive surgery. The intensity of fluorescence on tissues helps to distinguish cancers, normal tissues, positive and negative margins, in less than 1 sec. Clinical trials with my biomedical instruments were conducted on human patients, primarily with pancreatic cancers and breast cancers; high sensitivity (94.8%) and specificity (95.0%) of diagnosis were achieved. The quantitative spectral analysis reveals that the majority ($> 95\%$) of the NIR fluorescence comes from the fluorescence of imaging contrast agents, other than tissue autofluorescence. Detailed spectral features, e. g. peak positions and widths, helps to differentiate tissue types that the camera imaging systems cannot distinguish. Fundamental study indicates that this spectral difference originates from the different ICG fluorescence under various environments.

Bio—Dr. Jian Xu received a B.S. and a M.S. degree in Physics at Nanjing University, China; he received the M.S., M.Phil., Ph.D. degrees in Electrical Engineering at Yale University. Now he conducts interdisciplinary research on biomedical instrumentation for image-guided cancer surgery in the department of biomedical engineering at Emory University and Georgia Tech. He designs and optimizes medical camera systems to facilitate the visualization of cancer locations and spectroscopic devices to help surgeons to distinguish cancerous tissues from normal tissues intraoperatively. His medical devices have been put into clinical trials in several major hospitals, including Emory University Hospital and Saint Joseph's Hospital at Atlanta. His device demonstrates high diagnosis accuracy (94.9%) on pancreatic cancer (the most deadly cancer) and breast cancer (the most common female cancer). His work is the core part of an ongoing TR01 funding ("Contrast-enhanced and Image-guided Surgery") from NIH.

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