SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

NOVEL PET SYSTEMS AND IMAGE RECONSTRUCTION WITH ACTIVELY CONTROLLED GEOMETRY

DISSERTATION DEFENSE

By

Ke Li

PhD Candidate

Preston M. Green Department of Electrical and Systems Engineering
Washington University in St. Louis

Abstract: Positron Emission Tomography (PET) provides in vivo measurement of imaging ligands that are labeled with positron emitting radionuclide. Since its invention, most PET scanners have been designed to have a group of gamma ray detectors arranged in a ring geometry, accommodating the whole patient body. Virtual Pinhole PET incorporates higher resolution detectors being placed close to the Region-of-Interest (ROI) within the imaging Field-of-View (FOV) of the whole-body scanner, providing better image resolution and contrast recover. To further adapt this technology to a wider range of diseases, we proposed a 2nd generation of virtual pinhole PET using actively controlled high resolution detectors integrated on a robotic arm. Monte Carlo simulation shows that by focusing the high-resolution detectors to a specific organ of interest, we can achieve better resolution, sensitivity and contrast recovery.

In another direction, we proposed a portable, versatile and low cost PET imaging system for Point-of-Care (POC) applications. It consists of one or more movable detectors in coincidence with a detector array behind a patient. The movable detectors make it possible for the operator to control the scanning trajectory freely to achieve optimal coverage and sensitivity for patient specific imaging tasks. Since this system does not require a full ring geometry, it can be built portable and low cost for bed-side or intraoperative use. We developed a proof-of-principle prototype that consists of a compact high resolution silicon photomultiplier detector mounted on a hand-held tracking device and a half ring of conventional detectors. We also performed Monte Carlo simulations for two POC PET geometries with Time-of-Flight (TOF) capability.

To support the development of such PET systems with unconventional geometries, a fully 3D image reconstruction framework has been developed for PET systems with arbitrary geometry. For POC PET and the 2nd generation robotic Virtual Pinhole PET, new challenges emerge and our targeted applications require more efficiently image reconstruction that provides imaging results in near real time. Inspired by the previous work, we developed a list mode GPU-based image reconstruction framework with the capability to model dynamically changing geometry. Ordered-Subset MAP-EM algorithm is implemented on multi-GPU platform to achieve fast reconstruction in the order of seconds per iteration, under practical data rate. We tested this using both experimental and simulation data, for whole body PET scanner and unconventional PET scanners. Future application of adaptive imaging requires near real time performance for large statistics, which requires additional acceleration of this framework.

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TIME: 3:30 pm
PLACE: Green Hall, Room 0120

Dissertation advisors:
Dr. Joseph O'Sullivan
Dr. Yuan-Chuan Tai

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