SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

A FOUR-DIMENSIONAL IMAGE RECONSTRUCTION FRAMEWORK FOR PET UNDER ARBITRARY GEOMETRIES

DISSERTATION DEFENSE

By

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Abstract: Positron Emission Tomography (PET) is a functional imaging modality with applications ranging from the treatment of cancer, studying neurological diseases and disease models. Virtual-Pinhole PET technology improves the image quality in terms of resolution and contrast recovery. The technology calls for having a detector with smaller crystals, placed near a region of interest in a conventional whole-body PET scanner. The improvement is from the higher spatial sampling of the imaging area near the detector.

We have built a prototype half-ring PET insert for head-and-neck cancer imaging applications. In the first half of this work, we extend the use of the insert to breast imaging and show that such a system provides high resolution images of breast and axillary lymph nodes while maintaining the full imaging field of view capability of a clinical PET scanner.

Our lab is focused on designing unconventional PET geometries for specific applications. A general purpose 4D PET reconstruction framework was created to estimate the radionuclide uptake in the subject. Quantitative estimation in PET requires precise modeling of PET physics. Data acquired in a PET scanner is well modeled as a Poisson counting process. Reconstruction given the forward model is implemented using MAP-OSEM. The framework is capable of reconstructing PET data under arbitrary position of the detector elements and different crystal sizes. A novel symmetry finding algorithm is created to reduce the system matrix size, without loss of resolution. The framework motivates investigation into different PET system geometries for different applications, as well as optimizing the design of PET systems. A generalized normalization procedure was developed to model unknown components. The programs are parallelized using OpenMP and MPI to run on small workstations as well as supercomputing clusters.

The performance of our reconstruction framework is presented through four novel and unconventional PET systems, each designed specifically for a different geometry. The Virtual-Pinhole half-ring system is a half-ring insert integrated into a Siemens Biograph-40, for head and neck imaging. The flat-panel system is a modular and flexible insert system integrated into the Biograph-40, designed for breast cancer imaging. The MicroInsert II is the second generation full ring insert device, integrated into the MicroPET scanner to improve the resolution and contrast recovery of the MicroPET scanner. The Plant PET system is a PET system designed to image plants vertically, and integrated into a plant growth chamber. Further improvements to the framework are also discussed.

DATE: Friday September 5, 2014
TIME: 9:30 a.m.
PLACE: Green Hall, Room 0120

Dissertation advisor:
Dr. Joseph O'Sullivan

This seminar is in partial fulfillment
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SCHOOL OF ENGINEERING & APPLIED SCIENCE