SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

RECONSTRUCTION ALGORITHMS FOR NOVEL JOINT IMAGING TECHNIQUES IN PET

DISSERTATION DEFENSE

By

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Abstract: Positron emission tomography (PET) is a strong functional in vivo imaging modality with many clinical applications. Its enormously wide range of applications has made both research and industry combine it with other imaging modalities such as X-ray computed tomography (CT) or magnetic resonance imaging (MRI). The general purpose of this work is to study two cases in PET where the goal is to perform image reconstruction jointly on two data types.

The first case is the Beta-Gamma image reconstruction. Measurements and resulting PET images are not quantitative when imaging young plants or plant leaves due to positrons escaping from thin objects before annihilation. To address this problem we have designed, assembled, modeled, and tested a nuclear imaging system, a simultaneous beta–gamma imager. The imager can simultaneously detect positrons (β^+) and coincidence-gamma rays (γ). A forward model for positrons is proposed along with a joint image reconstruction formulation to utilize the beta and coincidence-gamma measurements for estimating radioactivity distribution in plant leaves.

Detection of small metastatic lesions in the body remains an unmet challenge clinically, the single most critical task for which whole-body PET/CT technology was designed. Our group has developed the so-called virtual-pinhole PET insert technology to provide zoom-in images using existing PET/CT scanners. The virtual-pinhole PET technology has shown that higher resolution and contrast recovery can be gained by adding a high-resolution PET insert that has smaller crystals. Such enhancements are obtained when the insert is placed in proximity of the region of interest (ROI) and in coincidence with the conventional PET scanner. Intuitively, the insert may be positioned within the axial field-of-view (FOV) of the scanner and radially closer to the ROI than the scanner's ring. One of the complicating factors of this design is the insert's blocking the scanner's lines-of-response (LORs). Such data loss may be partially compensated through attenuation correction in image reconstruction. However, an alternative solution is to place the insert outside of the axial FOV of the scanner and to move the body to be in proximity of the insert. We call this imaging strategy the surveillance mode. As the main focus of this work, we have developed an image reconstruction framework for the surveillance mode imaging with a proper normalization procedure. The results show improvement in resolution, signal-to-noise ratio (SNR), and contrast recovery. Improvement in contrast recovery will directly result in enhancement in tumor detectability which is of invaluable clinical significance.

DATE: Tuesday, December 5, 2017
TIME: 3:00 p.m.
PLACE: Green Hall, Room 0120

Dissertation advisors:
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