SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

Basis Vector Model Method for Proton Stopping Power Estimation Using Dual-Energy Computed Tomography

DISSERTATION DEFENSE
By

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Abstract: The accurate estimation of the proton stopping power ratio (SPR) is important for the treatment planning and dose prediction of proton beam therapy. Compared with the state-of-art clinical practice based on single-energy computed tomography (SECT) images, which in principle may introduce large intrinsic uncertainties into SPR estimates, dual-energy CT (DECT) technique has shown the potential of reducing uncertainties of proton SPR prediction.

In this work, we implement a new DECT approach for proton SPR mapping, which integrates image reconstruction and material characterization using a joint statistical image reconstruction (JSIR) method based on a basis vector model (BVM). This method reconstructs two images of material parameters simultaneously from the DECT measurement data and then uses them to predict the electron densities and the mean excitation energies, which are required by the Bethe equation for computing proton SPR.

The proposed JSIR-BVM method is first compared with image-domain and sinogram-domain decomposition methods in a well-controlled simulation framework. The intrinsic SPR modeling accuracy of the investigated DECT-SPR models is validated via theoretical computed radiological quantities for various reference human tissues. The JSIR-BVM method is then experimentally commissioned on a Philips Brilliance Big Bore CT scanner, using the DECT measurement data acquired for two phantoms containing soft and bony tissue surrogates.

The JSIR-BVM method outperforms the other investigated methods in both simulation and experiment settings. By taking advantage of an accurate polychromatic CT data model and a model-based DECT statistical reconstruction algorithm, the JSIR-BVM method accounts for both systematic bias and random noise in the acquired DECT measurement data. Therefore, the JSIR-BVM method achieves much better accuracy and precision on proton SPR estimation compared to the image- and sinogram-domain methods for various materials and object sizes. The results suggest that the JSIR-BVM method has the potential for better SPR prediction in clinical settings.

Dissertation advisor: Dr. Joseph A. O'Sullivan

DATE: **Monday, October 29,2018**
TIME: **2:00 p.m.**
PLACE: **Green Hall, Room 0120**

This seminar is in fulfillment of the Doctor of Philosophy degree

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