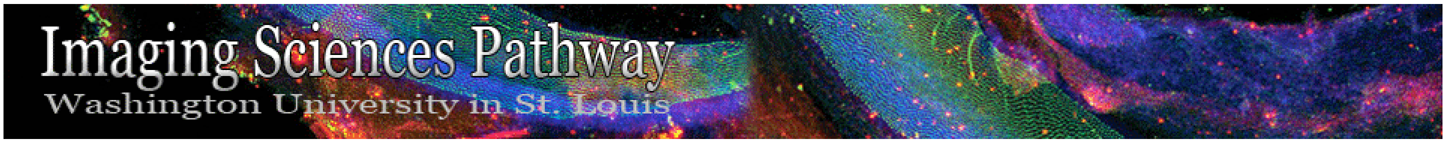

Imaging Science Seminar

Modeling Deformation of Pelvic Anatomy: Application to Prostate and Cervical Cancer Radiation Therapy Planning

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Abstract: Deformable image registration (DIR) seeks to estimate the voxel-to-voxel mapping (displacement vector field or DVF) between images representing different instances of 3D organ anatomy, i.e., shapes and locations. In radiation therapy, DIR is used to map organ segmentations or other data from feature-rich images onto differently deformed instances of patient anatomy (usually CT images) and to sum dose distributions across a sequence of deformed anatomies representing different fractions or time quanta of treatment delivery. Two applications of DIR technology to pelvic organ registration recently investigated by our group will be presented.

Population-based statistical models of systematic and random 3D interfraction voxel displacement for prostate cancer radiation therapy: By quantifying the daily displacement of the tumor centroid from its planned location for a population of patients, simple statistical models of rigid organ motion can be constructed. Tumor safety margins needed to assure that 95% of the population achieves acceptable target coverage can be derived. Our group has generalized this approach to individual deforming organ voxels by mapping each patient's- daily CT image to his planning image as well as deformably registering each patient's planning image onto a single reference anatomy. DVFs representing patient-specific systematic (mean over fractions) and random day-to-day voxel displacements are then deformed via vector transport onto the reference anatomy. By applying principal components analysis (PCA) to the resultant population statistics, statistical models of systematic and random organ deformation can be used to support generalized probabilistic treatment planning.

Dose accumulation for cervical cancer patients treated with external-beam and intracavitary brachytherapy: Insertion of bulky intrauterine and vaginal applicators gives rise to large and often discontinuous DVFs as organs slide or separate along common boundaries. Another challenge is the extensive tumor regression during treatment. These features give rise to what is arguably the most difficult, unsolved registration problem in radiation therapy. Our novel finite element analysis (FEA) approach starts with physician organ delineations of both the moving (intracavitary applicator moving image set) and fixed (external beam) MRI images. We have developed a novel process to create smooth inner and outer wall surfaces for hollow organs (bladder, rectum, vagina, and uterus) from which high quality tetrahedral 3D organ wall meshes can be derived. The moving 3D organ-wall mesh is deformed by FEA until it matches the stationary organ-wall model. Our FEA achieves surface- and volume-matching by solving a single unified energy minimization problem which does not require *a priori* knowledge of point-to-point surface correspondence.

Time:	8:40-9:30 a.m.
Date:	Friday, October 27, 2017
Room:	0120 Green Hall

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