Department of Computer Science

Research Seminars 2011

"Towards the "Ideal" Image-Guided Radiotherapy to Translating, Rotating and Deforming Tumors"

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Abstract

With mounting scientific evidence on the benefits of dose escalation and tremendous progress in the attainable precision of radiation therapy (RT) planning and delivery, achieving a high degree of geometric accuracy has become ever more important. This requirement is especially critical in lung cancer RT, where respiratory motion causes the thoracic anatomy to change continuously in all four dimensions (4D = space + time). Therefore, the ideal motion-managed image-guided radiotherapy (IGRT) requires **(i)** 4D imaging and treatment planning, **(ii)** 4D delivery, comprising real-time monitoring of the entire irradiated volume (IV) and corresponding real-time beam adaptation. Current methods to accomplish these are inadequate. For example, current guidance tools (e.g., 4D computed tomography [4DCT], internal or external surrogates) are relatively crude because they monitor only a small subset of the 4D data. Consequently, these tools do not adequately capture and therefore do not account for complex effects such as tumor/organ deformation, relative movement of the tumor and organs at risk (OARs), cycle-to-cycle spatiotemporal changes in the IV, etc. Moreover, there exist no techniques of beam adaptation that can account for complex motion such as rotation and deformation. Such limitations in guidance and delivery cause significant geometric and therefore dosimetric uncertainties during each stage of radiotherapy. These uncertainties are often cumulative and can result in non-lethal dose to tumor tissue (which reduces local control) and/or excessive radiation damage to normal tissue and critical organs (which increases toxicity). In order to address these challenges, we describe a motion management approach that uses:

(i) **Real-time 4D MRI** for monitoring of motion and deformation within the entire volume

(ii) **Real-time multileaf collimator (MLC) tracking**-based beam adaptation

We expect that this integrated approach will represent the ideal anatomic image-guided solution for lung cancer radiotherapy.

Brief bio

Amit Sawant research interests focus on the investigation and characterization of novel forms of image-guidance for radiation therapy in thoracic and abdominal tumors. He obtained his Ph.D. from the University of Michigan where he worked on the development of high-efficiency megavoltage x-ray imagers for radiotherapy imaging. Following his Ph.D., he worked at Stanford University first as a postdoctoral fellow and later as a junior faculty on real-time motion management of moving tumors. At Stanford, they developed and experimentally demonstrated the first real-time tumor tracking system using a dynamic multileaf collimator (MLC - a standard feature on most radiotherapy linacs). The tracking system is capable of tracking 3D tumor motion in real time with sub-1mm accuracy. Currently, he is investigating rapid MRI for real-time, non-invasive volumetric imaging for hypofractionated thoracic and abdominal radiation therapy.