

From 4D Imaging to 4D Radiation Therapy

Radiotherapy is an image-guided intervention and imaging is involved in every key step of the process, ranging from patient staging, simulation, treatment planning, and radiation delivery to patient follow up. The evolution of radiation therapy has been strongly correlated with the development of imaging techniques. The emergence of CT in the 1970s revolutionized radiation therapy and allowed us to use image data to build a 3D patient model and design 3D conformal radiation treatment. Recent technical advances in planning and delivering IMRT provide an unprecedented means for producing exquisitely shaped radiation doses that closely conform to the tumor dimensions while sparing sensitive structures. The utility of modern radiation technologies, such as 3D CRT and IMRT, cannot be fully exploited without eliminating or significantly reducing these uncertainties. The need to improve targeting in radiation treatment has recently spurred a flood of research activities in image-guided radiation therapy (IGRT).

Many IGRT solutions have been proposed to attack various aspects of the problem. Briefly, IGRT developments are focused in four major areas: (1) biological imaging tools for better definition of tumor volume; (2) time-resolved (4D) imaging techniques for modeling the intra-fraction organ motion; (3) on-board imaging system or imaging devices registered to the treatment machines for inter-fraction patient localization; and (4) new radiation treatment planning and delivery schemes incorporating the information derived from the new imaging techniques. In this talk I will highlight the recent developments of various available imaging techniques. After hearing the talk, it is hoped that the audience will have an overall picture of IGRT, find it easier to navigate themselves through the vast literatures of IGRT, and get a brief idea on how to implement the new IGRT techniques in their clinics.