A Cone-Beam CT Scanner Based Upon a Flat-Panel Imager: Evaluation for Image-Guided Radiotherapy

Organ motion and setup errors in radiotherapy limit the coverage dose applied to the clinical target volume. We have proposed the installation of a cone-beam computed tomography (CBCT) system on a conventional accelerator for kilovoltage image-guided radiotherapy for guiding field placement and minimizing geometric uncertainty. A prototype CBCT scanner has been constructed to study the logistics of performing CBCT with a flat panel and to evaluate its tomographic imaging performance. The main components in the system are an x-ray tube, a rotation stage, and a 20.5x20.5cm$^2$ flat panel imager (133mg/cm$^2$ $Gd_2O_2S$:Tb converter, 512x512 matrix of photodiodes+TFTs, 400μm pixel pitch). All components operate under computer control and are mounted on an optical bench. The Feldkamp algorithm reconstructs a volumetric CBCT data set from 300 radiographic projections acquired over 360°. Parameters examining scanner performance include uniformity of response (±2%) and linearity (±0.6%). MTF measurements indicate that the system can pass spatial frequencies up to 1.5lp/mm[MTF(1.5lp/mm)≅10%]. The noise in the CBCT images follows an inverse-root-exposure dependence, ranging from 54 to 13 HU over an exposure range of 100 to 2200mR. These values are comparable to those generated on a conventional CT scanner. Finally, CBCT images of small animals were found to be comparable in terms of detail and contrast to those produced on the conventional scanner at equivalent technique and exposure. *Supported in part by the U.S. Army Prostate Cancer Research Program (PCRP-970201),National Cancer Institute (CA66074) and Elekta Oncology Systems.*