

AbstractID: 2739 Title: Radiation Dose Reduction in 4D Computed Tomography

Purpose: 4D CT is useful clinically for detailed abdominal and thoracic imaging over the course of the respiratory cycle. However, it usually delivers 10~15 times more radiation dose to the patient as compared to the standard 3D CT, since multiple scans at each couch position are required to obtain the temporal information. In this work we propose a method to obtain high quality 4D CT with low tube current, hence reducing the radiation exposure of patients.

Method and Materials: The improvement of the signal-to-noise ratio (SNR) of the CT image at a given phase was achieved by superposing the imaging information from other phases with the use of a deformable image registration model. To further reduce the statistical noise caused by low tube current, we developed a novel 4D penalized weighted least square (4D-PWLS) method to smooth the data spatially and temporally. The method was validated by motion-phantom and patient studies using a GE Discovery-ST PET/CT scanner. A Varian RPM respiratory gating system was used to track the motion and to facilitate the phase binning of the 4D CT data.

Results: We calculated the SNRs for both studies. The average SNR of 10 mA phantom images increased by more than three-fold from 0.051 to 0.165 after the proposed 4D-PWLS processing, without noticeable resolution loss. The patient images acquired at 90mA showed an increase from 2.204 to 4.558 for the end-inspiration phase, and from 1.741 to 3.862 for the end-expiration phase, respectively. By examining the subtraction images before and after processing, good edge preservation was also observed in the patient study.

Conclusion: By appropriately utilizing the temporal information in 4D-CT, the proposed method effectively suppresses the noise while preserving the resolution. The technique provides a useful way to reduce the patient dose during 4D CT and is thus valuable for 4D-radiotherapy.