AbstractID: 14260 Title: Minimizing Radiation Dose in Stereoscopic X-ray–Based Monitoring of Tumor Motion with the Effective Use of Partial Information

Purpose: A number of stereoscopic X-ray imaging techniques based on kV, hybrid kV/MV X-ray systems (with or without other auxiliary external surrogate devices such as RPM) have been proposed for real-time therapeutic guidance. The patient radiation exposure during the X-ray image guided procedure is a major concern. We propose a general strategy of minimizing the patient imaging dose by effective use of the partial system information and demonstrate its potential clinical utility.

Methods: While the nature of partial information depends on the specific stereoscopic imaging system and application, in this work we use the information from the primary imagers to estimate the tumor position during IMRT and/or VMAT and switch on the second imager only when an over-threshold abnormal motion is observed. For a kV/MV system for example, the intrafraction tumor motion is monitored by two separate but related steps: (i) detect potential target motion beyond a pre-defined threshold by using MV images and (ii) confirm the displacement and determine whether an intervention is needed through combined MV-kV imaging. A Trilogy IX and a newly available Varian Trilogy MX linac with onboard kV imager were used to evaluate the performance of the strategy. The performance of the algorithm was evaluated for the case of prostate motion using computer simulation and 4D phantom measurements for 536 Calypso-measured tracks from 17 patients, and for the case of thoracic motion using Cyberknife lung data from 5 patients. Mean position tracking algorithms were used on the latter case.

Results: Over-threshold displacement was detected for more than 98% of the time. The use of kV imaging was significantly reduced compared to continuous or periodic stereoscopic x-ray imaging.

Conclusions: A “failure” detection strategy for prostrate and thoracic motion has been presented that achieves high targeting accuracy while minimizing radiation dose.

Conflict of Interest: None.