AbstractID: 13824 Title: Development of Statistical/Mathematical Predictive Model For Lung Tumor Motion

Introduction: Predicting tumor respiratory motion for image-guided radiation treatment, especially in the thoracic and abdominal regions of the body is essential, since the effectiveness of radiation therapy is degraded by respiratory motion. To minimize the radiation dose to the surrounding tissues and critical structures, precise tumor localization and dose delivery during treatment is crucial. The objective of this project is to develop a Hidden Markov Model (HMM) predictive model for precise lung tumor motion prediction under free breathing.

Method and Materials: A finite state model (FSM) for respiratory motion representation using line segments is used to develop a statistical/mathematical predictive model to predict tumor motion based on historical motion information of the same patient, or data collected from a group of patients. De-identified and previously acquired tumor motion data from the real-time tumor-tracking radiation therapy (RTRT) system and Cyber-Knife data will be used in the study.

Results: Two probability distributions are built to determine the current motion state and state transition which can be dynamically built and adjusted and are used in real-time motion prediction. These probabilities can be derived for any parameters such as velocity, time or amplitude. These dynamic probability distributions can aid in predicting the current state and future state transitions of a tumor. An algorithm to process raw motion signal consisting unrecoverable and recoverable error has been implemented which will facilitate and improve motion prediction. HMM and FSM based predictive model is expected to predict more accurately than current prediction methods and models and to provide reliable results for different imaging rates (from 30Hz to 1Hz) and different system latency (from 33ms to 2 seconds).

Conclusion: A HMM predictive model based on FSM for future tumor positions using the previous motion patterns is under investigation for real-time radiation treatment.