AbstractID: 7407 Title: Intra-fraction and inter-fraction real-time tumor motion prediction using multiple external surrogates

Purpose: To determine the feasibility of predicting real-time tumor positions using multiple external surrogates and Partial-Least-Squares (PLS) regression.

Methods: Nine patients with lung tumors underwent extracranial stereotactic radiosurgery comprising 3 fractions with the Cyberknife Synchrony^{TM} system. Three LED markers were placed on the patient's abdomen and in close contact with the skin. Synchronous LED marker and tumor marker coordinates were measured periodically using an LED camera and stereoscopic x-ray images, respectively. PLS performs regression on a small number of latent variables (LVs), which represent the underlying factors responsible for the variation in the output response. They are linear combinations of the original independent variables. The number of LVs in the PLS model was determined by performing a cross-validation using a training data set and minimizing the error. The LV coefficients were then extracted from the cross-correlation of input and output variables. Tumor position prediction errors were evaluated for the following scenarios: (1) tumor/external surrogate relationship for a given fraction, (2) predictive model developed in one fraction and applied to other fractions. Prediction errors were compared with standard multiple linear regression (MLR).

Results: The mean tumor motion displacement was 7.3 mm for the patient data investigated. The average error for intra-fraction tumor position prediction based on external markers was 1.47±0.90 mm for PLS and 3.07±1.67 mm for MLR when data from a single fraction was used. When the predictive model from one fraction was applied to the remaining two fractions, the average real-time inter-fraction error was 1.48±0.57 mm for PLS and 6.69±3.58 mm for MLR.

Conclusion: PLS can predict the tumor position using external surrogates with errors of < 2mm and with superior accuracy compared with MLR. Intra- and inter-fraction prediction errors were statistically similar.