AbstractID: 11061 Title: Ordinary Least Squares and Partial Least Squares for Intra-Fraction Lung Tumor Motion Modeling

Purpose:

For accurate operation, real-time tumor tracking devices for radiation therapy require the real-time position of the radiation target. In this study, we assess Ordinary-Least-Squares (OLS) and Partial-Least-Squares (PLS) modeling methods for inferring intra-fraction motion from external markers.

Method and Materials:

We obtained the concurrent 3D positions of three optically tracked external markers affixed to the skin and the 3D centroid position of a set of three internal fiducials implanted in lung tumors localized with fluoroscopy by the Cyberknife system. We analyzed 134 treatment fractions from 63 patients, each including 40-112 (mean=62) samples spaced at approximately 1-2min. For each fraction, we used a randomly selected subset of *N* (4-35) points to train OLS and PLS models to infer tumor motion from the positions of the optical markers, and we repeated this process 40 times for each fraction and each *N*. We then tested the models against the remaining datapoints in that fraction to determine the position error.

Results:

The PLS mean(±standard deviation) errors decreased monotonically as *N* increased, from 0.3±2.6cm at *N*=4 to 0.2±1.4cm at *N*=35. In contrast, the OLS error peaked (mean=5.3cm) at *N*=10 training samples, a consequence of the Moore-Penrose pseudo-inverse regression technique. OLS errors at *N*=4 and *N*=35 were 0.4±4.6cm and 0.2±1.7cm, respectively. PLS and OLS mean and maximum errors converged for large *N* (approximately $N \geq 20$). To achieve mean errors less than 0.25cm or 0.20cm over the entire dataset with PLS, at least 8 or 18 training samples, respectively, must be used.

Conclusion:

The results of this study indicate that PLS shows potential as an efficient (few image acquisitions) and accurate (2-3mm) intra-fraction lung tumor motion modeling technique. Future work will focus on investigating methods for and consequences of non-random training sample selection.