AbstractID: 2699 Title: Auto-Regressive-Moving-Average Modeling of Respiratory Motion in Radiation Therapy

Purpose: To construct a linear regression model of respiratory motion for prediction of future behavior from past records. Combined use of accurate respiration prediction and adaptive beams would ensure more accurate delivery of planned radiation, which is normally degraded due to patient breathing during treatment, especially for tumors in abdominal and thoracic regions.

Method and Materials: Respiratory data were obtained by tracking a fiducial marker placed on the lateral chestwall of a female volunteer in supine position, using 2D dynamic MRI with a temporal resolution of 0.8 *sec/frame*. The data were analyzed using Auto-Regressive-Moving-Average modeling with the mathematical form $y_t + \sum_{i=1}^{p} a_i y_{t-i} = e_t + \sum_{j=1}^{q} b_j e_{t-j}$, where { y_t } is the fiducial position with mean adjusted to zero, { e_t } is the fiducial localization error assumed to be Gaussian white noise, *p* and *q* respectively represent orders of auto-regression and moving-average, and the $a_i^{'}s$ and $b_j^{'}s$ are autoregressive and moving-average coefficients. The model was identified as Auto-Regressive (AR), Moving-Average (MA), or Auto-Regressive-Moving-Average (ARMA) by visual inspection of the autocorrelation and partial-autocorrelation functions of { y_t }. The order(s) of the model, i.e. *p* and/or *q*, were determined by minimizing the *Akaike's Information Criterion (AIC) value*, a widely used goodness-of-fit measure compromising least-square fitting and number of parameters to be estimated.

Results: A 5^{th}-order autoregressive model was determined for the respiratory data. Qualitative observation of the actual and predicted breathing traces illustrated their similarity to each other. Quantitative analysis, which included autocorrelation function and histogram inspection of the prediction error, showed its randomness (uncorrelated in time) and small magnitude, indicating validity and reliability of the model.

Conclusion: A prospective modeling and prediction method has been demonstrated for respiratory motion compensation in radiation therapy without prolonged treatment time. We will further test the approach on different volunteers and patients, with regular and irregular breathing traces.