AbstractID: 1663 Title: Improving the long term predictive ability of linear models for respiratory motion in 4D radiation delivery

Predicting respiratory motion is necessary to account for system (e.g., MLC) response lag in 4D radiation delivery due to finite time delay (response time) between target position acquisition and system response. In increasing order of complexity, classes of predictive filters range from stationary linear filters to adaptive nonlinear filters. Limited predictive accuracy of some stationary linear and adaptive linear filters in predicting respiratory motion reported in recent literature has been linked to non-stationary signal nature, complex character of individual cycles and limited adaptation time. Our experience with adaptive filters based on analysis of 60 sessions of patient data yielded prediction errors of ~ 0.2 cm (1σ) for prediction intervals as low as 0.4 seconds, irrespective of breathing training modality. Based on MLC leaf velocity and acceleration measurements, high predictive accuracy is desired for response times reaching 0.5 seconds for successful 4D radiation delivery. Testing respiratory motion for stationarity, nonlinearity and determinism before prediction is critical to improving performance of predictive models. The aim of this study is to propose a middle ground approach to improve predictive accuracy by employing stationary linear prediction with singular value decomposition on respiratory motion data that are segmented based on stationarity, periodicity or determinism. Reduced autoregressive models, generalized and correlation dimension estimation are employed to yield stationary models of respiration motion. The application of linear prediction to such conditioned motion data is expected to improve long term predictive accuracy, facilitating reliable and accurate 4D radiation delivery.

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