AbstractID: 7343 Title: Application of a PARMA algorithm to predict Intrafraction Respiratory motion

Purpose:

Accurate motion tracking can decrease normal tissue dose, PTV margins, and shorten treatment times required for radiation therapy. A Periodic Autoregressive Moving Average (PARMA) model was developed to predict one-dimensional respiratory motion in human subjects.

Methods and Materials:

A PARMA prediction algorithm was applied to clinical respiration signals from three categories: free-breathing, audio instruction, and audio-visual coaching. The PARMA model of the respiration motion is a dual-component signal, a partially correlated time-series superimposed onto a periodic pattern. The periodic component was estimated by averaging over the inhale-exhale cycles in a 60-second sample of the respiration signal, and the autocorrelation in the residual signal was modeled by linear autoregressive moving average equations. The PARMA predictions were compared to the system latency errors produced when tumor tracking is done without forward predictions.

Results:

For audio-visual coaching, the PARMA prediction errors (1σ) were 0.09 mm, 0.23 mm and 0.99 mm at 0.1 s, 0.2 s and 0.5 s respectively. A prediction error of 0.99 mm is equivalent to 7.2% of the average end-inhale to end-exhale motion. By comparison, the errors were 0.60 mm, 1.20, and 2.90 mm when the lagged signal is used as an estimate of current position at 0.1 s, 0.2 s and 0.5 s respectively. For free-breathing respiration, PARMA predictions were accurate to within 0.10 mm (1σ) at 0.1 seconds, 0.24 mm at 0.2 seconds, and 1.07mm at 0.5 seconds. The system latency errors were also similar to the coached signals.

Conclusion:

Tumor tracking with dynamic MLC can theoretically achieve system latency times of 0.16 seconds with accuracy of about 1 mm. The prediction errors of the PARMA algorithm was well under one-third of the calculated system latency error for all lag times investigated.