

Purpose: We investigate the feasibility of tracking and correcting respiration-averaged drift in target position by means of couch adjustments on a radiotherapy accelerator equipped with such capability. This is particularly applicable to hypofractionated treatment where high precision is required and patients are subject to longer treatments. Our motivation is that these types of slower variations are easier to predict and correct than for full breathing motion.

Methods: A breathing-motion phantom is programmed to move according to previously recorded patient respiration signals from an external monitor. A retro-reflective marker on the phantom is monitored by an optical tracking-system whose signal is assumed to represent internal target motion. Use of a Kalman filter allows prediction of the respiration-averaged (baseline) position 5s in advance for application of couch corrections every 10s. The couch corrections are programmed into a research mode of the accelerator (Varian TrueBeam) and synchronized with the motion phantom and optically monitored to evaluate the system's ability to correct for drift. We examined synthetic motion signals as well as 10 recorded patient breathing traces. In each case, root-mean-squared-error (RMSE) or deviation of the baseline from the treatment planned position is computed with and without couch corrections.

Results: Drift in the uncorrected baseline is evident and clearly reduced with scripted couch adjustments. In 10 patient cases, RMSE is reduced from a mean of 4.1mm (range 2.3-8.9mm) before correction to 0.7mm (range 0.4-1.7mm) after correction. Treatment time with this scheme is increased ~5% relative to that for no correction; mean time for a couch motion segment is 0.2s.

Conclusions: This work illustrates the efficacy of using Kalman-based couch corrections with a 5s prediction window to effectively reduce baseline target drift. We anticipate future machine upgrades will permit near real-time couch correction computation and application. Research supported by NIH award T32CA61801 and Varian.