AbstractID: 10998 Title: Performance Characteristics of an Experimental Couch for Real-Time Tumor Motion Tracking

**Purpose:**
To investigate the dynamics and control of an experimental couch for respiration-induced real-time tumor motion tracking.

**Method and Materials:**
The couch dynamics were evaluated using time constants and latency times, and were investigated using step input responses varying from 0.5–2.0 cm in the superior-inferior (SI), anterior-posterior (AP) and medial-lateral (ML) directions. The resulting couch step data was fit to a second order linear system with two equal time constants, $\tau$ and latency, $\theta$. The feedback control system was modeled with the couch as a second-order system and a first-order control algorithm with a first-order robustness filter. Control of 3D real-time lung tumor motion data from 20 patients was evaluated by simulating the experimental couch dynamics and control algorithm in Simulink. The ability of the couch to reproduce the 3D motion of the tumor trajectories was also evaluated.

**Results:**
For step inputs of 0.5-2.0 cm, $\tau$ and $\theta$ varied from 50-270 ms and 100-210ms, respectively. No differences were observed in the dynamics by varying the load on the couch. The variation of $\tau$ and $\theta$ is a consequence of the underlying nonlinear dynamics. Simulations were performed by approximating the controller as a linear system with $\tau$=160 ms and $\theta$=100 ms. The net tumor displacement following control of 3D lung tumor motion ranged from 0.1-4.8 mm with an average of 1.4 mm (standard deviation = 1.2 mm). Finally the couch was made to follow patient tumor centroids trajectories. The average error was 1 mm (range = 0-4 mm) and the standard deviation was 0.8 mm.

**Conclusion:**
We have evaluated an experimental couch which has the dynamic characteristics needed for real-time respiration-induced motion control. Even though the couch exhibited nonlinear behavior, a linear control approximation provided good control of clinically exhibited lung-tumor motion trajectories.