AbstractID: 7139 Title: Validation of the 5D breathing motion model using a 64-slice CT scanner

Purpose: A breathing motion model was developed that mapped the positions of lung and lung tumor tissues to the tidal volume and airflow of the patient. This model is tested using a state-of-the art CT scanner.

Methods and Materials: CT images were acquired on a Philips Brilliance 64-slice CT scanner using ciné mode with 25 images per couch position and 0.68 x 0.68 x 0.625 mm^3 voxels (4.0 cm longitudinal coverage). Simultaneous quantitative spirometry-based tidal volume measurements were also acquired. The positions of the internal lung tissues were tracked by subdividing the lung tissues into 1 x 1 x 1 cm^3 cubic regions and determining where those regions went in each of the 25 images. Registration was conducted using cross-correlation maximization. The resulting positions $\vec{r}$, tidal volumes and airflows (derivative of the tidal volume) were fit to the linear motion equation $\vec{r} = \vec{p}_0 + \alpha v \hat{r}_v + \beta f \hat{r}_f$, where *v* and *f* are the volume and flow, $\hat{r}_v$ and $\hat{r}_f$ are the unit volume and flow vectors, and α and β are the volume and flow fitting parameters.

Results: The values of images α and β varied smoothly across the lungs. In specific transverse slices, α (the ratio of motion to tidal volume) was smaller near the anterior of the lungs, increasing to a maximum near the center of the lungs and decreasing slightly near the posterior. β (the ratio of motion to airflow, a measure of hysteresis) was greater in the lateral portions of the lungs than the medial portion with little anteroposterior variation.

Conclusions: Quantitative mapping the “5D” breathing model is feasible using a 64-slice CT scanner. Quantitative mapping using fewer slices will require validated deformable registration techniques. This 5D model provides a quantitative model of the free-breathing motion throughout the lungs.

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