AbstractID: 7191 Title: Construction of 4D-CT motion model using deformable registration: comparison of Eulerian and Lagrangian approaches

Purpose: To analyze and compare two motion models constructed from 4D-CT using deformable registration using two different computation approaches: Eulerian and Lagrangian.

Method and Material: Accurate motion modeling within the lung is an important consideration in different clinical applications. We consider 4D-CT scans for three patients treated in radiotherapy for lung cancer. 4D-CTs were acquired using a 4-slice fan-beam CT scanner (GE Lightspeed QX/i; GE Heathcare Technologies, Waukesha, WI), and a respiratory surrogate (Real-time Position Management; Varian Medical Systems, Palo Alto, CA). Two motion models were constructed from vector fields computed with demons algorithm with Gaussian regularization. We used also a image pre-treatment method, a priori lung density modification, to handle this limitation of the demons algorithm. The first model, obtained with the Eulerian approach, uses small deformation estimations between successive phases of the 4D-CT. The second model, obtained with the Lagrangian approach, was generated by estimation of larger deformations between the end-exhale phase and all other states. The models were validated and compared using consistency (symmetry and transitivity) and accuracy (based on landmark points) metrics.

Results: Mean values of accuracy were on the order of the image resolution and comparable to inter-observer variability (1.9 mm), with slightly better results for the Lagrangian approach: 2.3 mm vs. 2.6 mm. The differences were not statistically significant for consistency.

Conclusions: The results of this study suggest that the Lagrangian approach is more appropriate to use for generating a 4D-CT motion model with deformable registration. In ongoing works, lung and GTV contours are used in order to conclude on the superiority of one motion model over the other for an automatic contour propagation tool, and for lung physiological information computation and analysis.