AbstractID: 13613 Title: Evaluation of deformable registration in CT images with limited feature visibility

Purpose: Applications of deformable image registration (DIR) often assume deformations to be correct everywhere in the patient volume of interest, but prior studies of DIR accuracy have been limited mostly to high-contrast features in lung. This study examines DIR accuracy with respiration-correlated CT (RCCT) images of software and physical deformable phantoms and with patient images in abdomen. **Methods and Materials:** DIR uses a fast free-form algorithm, which minimizes an energy function consisting of pixel grayscale similarity and smoothness terms. We evaluate its accuracy in 3 types of RCCT images: an anthropomorphic software phantom that models diaphragmatic contraction and chest expansion and whose known voxel displacements provide ground truth; a physical deformable abdominal phantom with implanted radiopaque markers; and patient data in which the motion between end expiration (EE) and end inspiration (EI) images of small low-contrast features in or near the liver are compared to rigid registration as an approximate ground truth. **Results:** The mean 3D vector EE-to-EI discrepancy between DIR and ground truth displacement in software phantom is 4.5 mm in lung and 5.0 mm in abdomen. This is larger than that observed by comparing visible features in images alone. Mean 3D vector discrepancy is 6.1mm in physical phantom. In both phantoms, larger discrepancy appears to correlate with regions that lack visible features. In patient images, visible features in liver show good agreement between DIR prediction and ground truth, with mean 3D vector EE-to-EI discrepancy of 2.0 mm. **Conclusions:** Visible internal features in CT images are important for guiding deformable registration. Radiotherapy applications that assume DIR is accurate throughout the volume may underestimate errors in regions lacking visible features. Results in patient images show that reasonable results can be obtained for features in abdomen. Research supported by NIH/NCI grant R01CA126993.