Purpose: To develop a real-time and accurate lung tumor tracking algorithm from fluoroscopic images based on deformable image registration.

Methods: The new tracking algorithm is developed based on deformable image registration (DIR) of fluoroscopic images using our GPU-based Demons algorithm. Choosing an initial frame image as a reference image, we deform all the incoming frame images to this reference image to obtain deformation vector fields (DVFs). And consequently, the physician contoured tumor region on the initial frame can be properly propagated to the incoming frames and the new tumor location can be obtained by calculating the centroid of the propagated tumor.

Results:The proposed tracking algorithm is initially tested on four lung cancer patients' fluoroscopic images. The average computation time for the tumor tracking for each frame is between 0.21 and 0.26 seconds on an NVIDIA Tesla C1060 equipped workstation. The accuracy of tracking results are quantified by comparing the numerical tracking tumor centroid with physician determined tumor centroid in each frame. In superior-inferior direction, the average of tumor centroid localization error is found to be 0.97 mm for the best testing case and 1.29 mm for the worst cases, and the error at 95 percentile is smaller than 3.2 mm for all testing cases. In lateral direction, the average error is in the range between 0.8 and 1.02 mm, and 95% error is smaller than 3.5 mm for all testing cases. The average of 2D vector errors range from 1.49-2.00mm and 95% 2D error is smaller than 4.0mm.

Conclusions:The preliminary results indicate that high computational efficiency and tumor location accuracy can be achieved using the proposed real-time DIR based lung tumor tracking method. This method provides a real-time markerless tumor tracking tool for lung cancer radiation therapy.