

Purpose:

Elastic tumor deformation and different intra- and inter-fractional tumor paths between inhalation and exhalation were observed for some lung patients. For high accuracy and possibly 100% duty cycle dose delivery, we propose and evaluate a noninvasive method to fluoroscopically track location and shape variations of lung tumors with different types of deformations.

Method and Materials:

During a fluoroscopic simulation, lung tumor contours in one complete respiratory period are manually drawn by an expert. Each contour is described by 65 landmarks. The respiratory period is divided into 9 phases and a Point Distribution Models (PDM) statistically describing typical tumor shape variations are built for each phase. When tracking starts, the breathing phase for an incoming frame is first determined by the respiratory signal generated simultaneously from diaphragm motion and the PDM for this frame is also found. Starting from an initial estimate of the tumor contour, the Active Shape Models algorithm searches the area near each landmark and finds a better location. Based on the shifts found for these landmarks, the initial estimate is deformed within a certain range of typical shape variations found in PDM and also rigidly transformed to match the shifts. The new generated contour iteratively updates the previous contour estimate until no significant difference appears between two consecutive iterations or a user defined number of iterations is reached.

Results:

Tumors demonstrating distinct types of deformations in fluoroscopic videos were well tracked. All the landmarks of the tracked objects were manually revised by an expert using a GUI tool. The average magnitude of the deviation between the tracked and revised results was within 2 mm for 95% the landmarks and within 3mm for all landmarks.

Conclusion:

This method affords precise tracking of lung tumor location and deformation and may be used for real-time tracking or DMLC radiotherapy.