AbstractID: 9167 Title: Analysis of Breathing Pattern for Radiotherapy by Studying Diaphragm Trajectory

Introduction Understanding breathing patterns would help in designing a patient-specific treatment plan. This work pursues a robust means finding individual breathing patterns by studying diaphragm motion. To our best knowledge, no previous work utilized an automated 4-D image segmentation technique for analyzing diaphragm motion.

Method and Material In this study we intend to accurately segment the diaphragm from 4-D image datasets to analyze breathing patterns. The core of the problem is to develop an effective 4-D surface segmentation method for diaphragm. We developed a novel 4-D optimal surface detection method capable of simultaneously detecting diaphragm over the entire respiration cycle. The optimality is controlled by cost functions designed for surfaces and by several geometric constraints defining the surface smoothness and position changes between phases. The problem is solved by transforming it into computing a minimum *s-t* cut in a derived arc-weighted directed graph. Gradient Vector Flow (GVF) is incorporated into cost function design to allow flexible initialization of the diaphragm surface and to encourage convergence to boundary concavities. A pre-segmentation of the diaphragm in one phase is used as initial surfaces for all other phases.

We implemented our algorithm and experimented on 7 sets of 4-D chest/abdomen CT images. Dome point of the diaphragm in the first phase is found and those in the remaining phases within a neighborhood are detected to generate the diaphragm trajectory.

Results Our method converges quickly and yields highly accurate contouring results by visual examination. The diaphragm trajectory over the breathing cycle can then be computed from the segmentation result.

Conclusion We developed a novel 4-D surface segmentation method for accurate detection of diaphragm over the entire respiration cycle from 4-D CT image data. The breathing pattern can then be analyzed from the motion of diaphragm. The method helps in developing patient-specific treatment plan.