Purpose: To enable real-time magnetic resonance (MR)/computer tomography (CT) image-guided radiotherapy (IGRT) and to reduce treatment planning durations in the radiotherapy of lung cancer through the design and implementation of computationally efficient four-dimensional (4D) MR/CT based automated segmentation algorithms.

Methods: Hyperpolarized helium-3 (HP3He) and proton-density 4DMRI lung data was acquired for six subjects. Thoracic 4DCT data of ten subjects with lung cancer was also acquired. Automated segmentation was performed using a novel Morphological Processing and Successive Localization (MPSL) approach. Three different MPSL segmentation algorithms were developed to segment the regions of tumor, body and lung respectively.

MPSL segmentation: A mask that includes the intensity range of the region-of-interest was generated. Then morphological processing (and/or reconstruction) was performed to separate the target volume(s) from other regions. Then the different connected regions were labeled using the union-find algorithm and their areas/volumes were calculated. A limit on the maximum/minimum possible area/volume of the target volume was used as a filter to segment the target volume. Morphological processing/reconstruction were performed again to create the final contours.

Results: MPSL was shown to successfully segment the regions-of-interest (tumors, lung and body) from the images with both high and low signal-to-noise ratio. With the use of 3D processing and successive localization MPSL was shown to separately classify tumor and diaphragm (that may appear within the 2D contours of the lung). MPSL segmentation was compared with manual segmentation.

Average computational time for achieving automated lung segmentation using MPSL on one phase volume (128×128×128) of 4D HP3He MR data was 0.5s. For proton-density 4DMRI data, the average time for automated segmentation of body and lung on one phase volume (128×128×128) was 2s.

Conclusions: With the computation speed of the order of seconds for achieving automated segmentation, MPSL has realistic potential for application in real-time image-guidance for adaptive radiotherapy.