COMPUTERIZED SEGMENTATION AND MEASUREMENT OF PLEURAL DISEASE

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BY

WILLIAM F. SENSAKOVIC

E-mail: wfsensak@uchicago.edu

Advisor: Samuel G. Armato III

CHICAGO, ILLINOIS

The measurement of disease extent is vital for tracking disease progression and determining treatment efficacy. Current methods for measuring pleural disease extent do not take advantage of the volumetric measurements possible on modern computed tomography (CT) scans because of the time necessary for manual disease delineation. This dissertation describes computerized methods to three-dimensionally (3D) segment and volumetrically measure pleural disease. Novel and robust automated methods to segment the thoracic skin boundary, airway, and lung parenchyma were developed and specific techniques created for these the segmentation methods may find application in other computerized systems and imaging modalities. The lung parenchyma segmentation method was implemented to confirm the ability of surgical intervention to free lung that is restricted by pleural disease. A novel hemithoracic cavity segmentation method was developed which requires minimal user initialization and delineates the cavities in 3D from automatically identified boundary structures. Finally, a pleural disease segmentation method was developed which delineates pleural disease in 3D and calculates disease volume. The computer-derived segmentations and volume estimates demonstrated good agreement with observer-defined disease delineations. In addition to the development and application of the computerized methods, several studies related to the underlying theory of computerized segmentation and disease measurement were conducted. The selection of corresponding sections on serial CT scans was identified as a source of variability when the current standard (linear measurement) is used to measure disease extent. This variability was quantified and an automated registration method is implemented as a potential solution. The mathematical definitions of boundary and area were investigated as a source of measurement bias and variability. Finally, the influence that an initial segmentation has on observer-defined segmentations was quantified and the strong influence raises several questions related to the ability of observers to correct computer-generated outlines used both for determining disease extent and delineating treatment volumes for radiation therapy. This dissertation developed and investigated a novel method for the computerized segmentation of pleural disease. These methods will form the basis of a system that we hope will allow researchers and clinicians to efficiently segment and measure pleural disease to monitor disease progression and evaluate treatment efficacy.