



DEFORMABLE LUNG CANCER IMAGE REGISTRATION
BY FUSION OF CT IMAGE INTENSITY, SEGMENTED
AIRWAY BRANCHES, AND SEGMENTED BLOOD
VESSEL STRUCTURES

By

Alaa El-Din Ahmed Megawer

A Thesis Submitted to the
Faculty of Engineering, Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
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in
Biomedical and Systems Engineering

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Title of Thesis:

Deformable lung cancer image registration by Fusion of CT image intensity, segmented airway branches, and segmented blood vessel structures

Key Words:

Deformable image registration; optical flow; image segmentation; fusion; Radiotherapy.

Summary:

Deformable image registration is the process of finding a point to point correspondence map between positions in one medical scan and positions in another scan. This is a necessary prerequisite to accurately evaluate the accumulated doses from a number of radiation therapy techniques. We propose an intensity based image registration algorithm, fused with combining segmentation of both airway branches and pulmonary vascular structures into the registration process. In a Demon deformable image registration, each image is viewed as a set of iso-intensity contours. The main idea is based on the deformation of the image by a regular grid of forces through pushing the contours in the normal direction. The orientation and magnitude of the displacement are derived from the instantaneous optical flow equation. The segmentation is used to evaluate the Demon registration by segmentation the two airway and pulmonary trees. Two passes of multi seeded region growing are applied on the output of Frangi filter to segment the whole airway tree then a thinning algorithm is applied and followed by branch voxels detection. For the vascular structures, 3D centerline extraction algorithm is applied on the output of the two passes of Frangi filter followed by branch point detection. After segmentation, the source and transformed images are divided into a certain number of regions determined within experiment then the Dice similarity coefficient is calculated for each region to decide which region is needed to be enhanced by applying a thin plate spline warping technique using the branch voxels of airway and vascular tree as a landmark voxels. The proposed fusion algorithm, based on the employment of geometrical information from segmented airway and pulmonary structures to deform the output of the Demon deformable registration, showed superior enhancement of the registration accuracy (up to 95% in alignment) compared to 85% than when applying Demon alone.

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Dedication

It is my honour to dedicate this research thesis to my family, my wife and my lovely daughter

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