Edge Detection and Segmentation of Lungs in CT Images

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***Abstract*—In this project we are provided with 10 Lung CT scan images and our aim is to segment the lungs from those images. We will attempt to segment the lungs from noisy images and different points of views.**

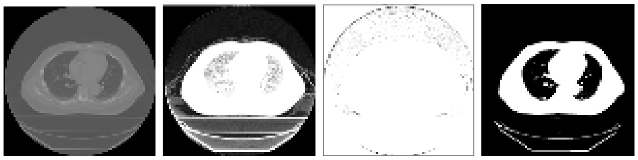
***Keywords*—Lung Segmentation, Segmentation, CT scans, Noisy images, MATLAB**

I. INTRODUCTION

In the medical field, we can use lung segmentation as a crucial factor for early diagnosing and treating lung diseases. Early diagnosing of lung diseases can lower the death rate. With the help of medical image processing, we can aid the medical teams in diagnosing lung diseases at early stages. Lung segmentation is the first step of the analysis, regardless lung segmentation methods are widely used for moderate lung diseases. The widely used method for lung segmentation used in modern medical fields is with the help of deep learning; however, the traditional lung segmentation methods are mostly used to observe the shape and region information of the lungs. In this project, we will be using the thresholding-based method to segment the lungs from the given CT images.

II. METHODOLOGY

In this project, we were provided with ten upper-body CT images with different time intervals. Each has 136 slices of 512*512 image. We aimed to segment the lungs from each volume from different points of view and compare the results. Each image in the volume is in a *double* format. Changing the image format to *uint8* or *logical* will give us a different image presentation. We will have the best image representation if we keep the format *double.*



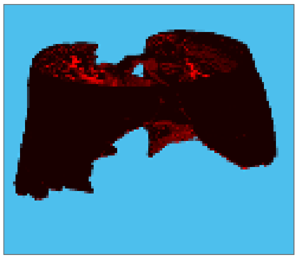
Format: double uint8 Logical Binarized

We binarize all the volume slices using the Matlab function *imbinarize* with one-third of the max intensity level of the black pixel (255/3). We would separate the slices that include the lungs from the original volume. The lungs are only within the first 76 slices of the volume.

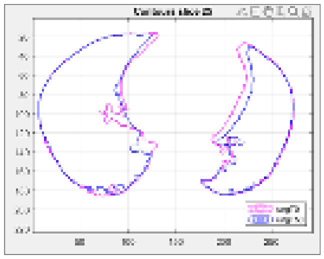
We can use the *bwselect* Matlab function to select the lungs to be segmented. Since the *bwselect* selects the white parts of the image and the lungs are in black in our image, we would use the *imcomplement* to invert the white and black pixels to have the lungs as white-colored. We cropped the volume slices to get a closer view of the lungs that can help us have a better segmentation. We would use the *imfill* Matlab function on the volume to get a clearer representation of the lungs; the *imfill* will eliminate the black holes within the image that can be caused by an error while producing the images. With the help of *sliceViewer* and *getpts*, we can go through all of the volume slices and select the regions in which the lungs are located, and with the help of *bwselect* and the selected areas, we can segment the lungs throughout all the slices.

Original binarized image Binarized image with imfill Selecting regions with lungs

We can save the selected region coordinated and use it for other volumes made in different time intervals and have the segmented lungs. After segmentation of the lungs, with the mentioned steps, we can have a clear 3D presentation of the lungs with the help of the *VolumeVeiwer* and use the *contours* to compare the size at different slices or even with different time intervals within the same slice.



3D representation of the lung



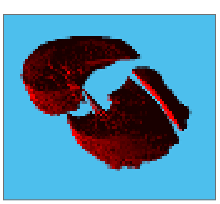
Size comparison of the lungs in time interval 0 and 50 on slice 25

III. Segmentation from Coronal and Sagittal Point of View

Segmenting the lungs from the coronal and sagittal points of view was quite challenging. To transform them to a different point of view, we would have to change the dimensions, reshape and rotate them to have a clear representation. Instead of having 136 slices of 512*512 images, we would have 512 slices of 136*512 images. We would separate the slices that included the lungs in the image, apply the *imfill* on them and select the regions that had the lungs in the image as the previous method. The most challenging part of segmenting the lungs in these points of view compared to the axial point of view was selecting the regions with the lungs due to having more slices and the regions overlapping with the background and not having a clear representation of the lungs. Some parts of the lungs could not be segmented in some time intervals and would be missing from the segmented volume. The most suitable and efficient lung segmentation method was from the axial point of view.

IV. Segmentation with Noise

We decided to add *Salt & Pepper* noise to the original image and apply the method mentioned above to segment the lungs. To have a clear representation of the lung with noise, we would have to convert our image to *uint8* format. We added the *Salt & Pepper* noise with the default threshold and binarized the image. It was not possible to binarize using a certain value as the binarization threshold due to the noise of the image. We binarized the image using the '*adaptive*' parameter as the threshold, which would take the average intensity of the slice and apply the binarization. Due to the image having noise, there was not a clear representation of the lung, which caused selecting the regions of the lungs to be very challenging and impossible for some cases.



Segmentation on time interval 40 with from sagittal point of view on

Segmentation on time interval 40 with from coronal point of view on

Segmentation on time interval 0 with from noisy images

V. Comparisons

We have four lung segmentation for each time interval, one for each in the axial, coronal, sagittal point of view, and one segmentation from a noisy image. Since the best segmentation was done from the axial point of view, we will compare the lungs' volume and area in different time intervals.

Time interval of the measured lung	**Comparison table**	
	Volume	***Area***
Lung_T0	**251**	**100**
Lung_T10	**242**	**97**
Lung_T20	**229**	**91**
Lung_T30	**217**	**86**
Lung_T40	**212**	**85**
Lung_T50	**206**	**82**
Lung_T60	**207**	**83**
Lung_T70	**211**	**84**
Lung_T80	**224**	**89**
Lung_T90	**240**	**96**

VI. Conclusion

After having four segmentation from each of the volumes and comparing them from each other, we can conclude that lung segmentation is best obtained from an axial point of view. Segmentation from an axial point of view is more straightforward and efficient, and it will have a more precise outcome than segmentation from other points of view. After adding noise to the images, no accurate segmentation could be obtained, the segmentation was vague, and nothing could be executed from noisy lung segmentation. References

VII. Refrences

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