

Lungs Detection in Ventilation and Perfusion Scintigraphy using Watershed Transform

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Abstract – In lung ventilation and Perfusion scintigraphy, separating touching tissues in an image is one of the more difficult image processing operations. Because of the presence of speckle noise in these images affects edges and fine details which limit the contrast resolution and make diagnostic more difficult. Thus, with using segmentation-based algorithm, choice of appropriate segmentation technique type for each circumstance becomes an essential task. The watershed transform is often applied to this problem. The watershed transform finds "catchment basins" and "watershed ridge lines" in an image by treating it as a surface where light pixels are high and dark pixels are low. Segmentation using the watershed transform works well if one can identify, or "mark," foreground objects and background locations. This algorithm was done on twenty-five patients. A watershed transform Algorithm lungs segmentation method was proposed in this study. Proposed method is able to determine the lungs boundaries accurately. It is able to segment lung and improves radiological analysis and diagnosis.

Keywords – Lungs, Matlab, Segmentation, Parallel Computing Algorithm.

I. INTRODUCTION

Image segmentation has been a long-standing problem in computer vision. It is a very difficult problem for general images, which may contain effects such as highlights, shadows, transparency, and object occlusion. Segmentation in the domain of medical imaging has some characteristics that make the segmentation task easier and difficult at the same time [1]. On the one hand, the imaging is narrowly focused on an anatomic region. The imaging context is also well defined. While context may be present to some extent in segmenting general images (e.g., indoor vs. outdoor, city vs. nature, people vs. animals), it is much more precise in a medical imaging task, where the imaging modality, imaging conditions, and the organ identity is known [2]. In addition, the pose variations are limited, and there is usually prior knowledge of the number of tissues and the Region of Interest (ROI) [3] [4]. On the other hand, the images produced in this field are one of the most challenging due to the poor quality of imaging making the anatomical region segmentation from the background very difficult. Often the intensity variations alone are not sufficient to distinguish the foreground from the background, and additional cues are required to isolate ROIs [5]. Finally, segmentation is often a means to an end in medical imaging. It could be part of a detection process such as tissue detection, or for the purpose of quantification of measures important for diagnosis, such as for example, lesion burden which is the number of pixels/voxels within the lesion regions in the brain [6]. In general, the information contained in an image can be modeled in

several ways. A simple approach is to record the intensity distribution within an image via a One-dimensional (1D) histogram and use simple thresholding to obtain the various segments. Several variations on classical histogram thresholding have been proposed for medical image segmentation that incorporate extended image representation schemes as well as advanced information modeling [7]. Multi-dimensional are histograms formed from the intensity values produced by each of the imaging protocols. It is often the case that several acquisitions are available for the same image. Spatial information: Since intensity histograms do not preserve spatial contiguity of pixels, one variation is to add spatial position (x, y) or (x, y, z) to form a multi-dimensional feature vector incorporating spatial layout. If the medical images are in a time sequence (e.g. moving medical imagery), then time can be added as an additional feature in the representation space [8] [9]. Thus, these approaches represent each image pixel as a feature vector in a defined multi-dimensional feature space. The segmentation task can be seen as a combination of two main processes; modeling which is the generation of a representation over a selected feature space [11]. This can be termed the modeling stage. The model components are often viewed as groups, or clusters in the high-dimensional space. Assignment, which is the assignment of pixels to one of the model components or segments [12]. In order to be directly relevant for a segmentation task, the clusters in the model should represent homogeneous regions of the image. In general, the better the image modeling, the better the segmentation produced. Since the number of clusters in the feature space are often unknown, segmentation can be regarded as an unsupervised clustering task in the high dimensional feature space [13].

II. MATERIALS AND METHODS

This was experimental study conducted to study segmentation of thyroid gland nuclear medicine images using edge detection and morphology filters. For lung, scintigraphy images each film scanned using digitizer scanner then treated by using image-processing program (MatLab), where the segmentation was studied. The scanned image was saved in a TIFF file format to preserve the quality of the image. Lungs can be easily detected in nuclear medicine image if the object has sufficient contrast from the background. We use edge detection and basic morphology tools to detect a thyroid gland. Steps of Segmentation:

- Step 1: Image Reading
- Step 2: Detection of Entire thyroid
- Step 3: Dilation of the Image
- Step 4: Filling the Interior Gaps

Step 5: Removal Connected Objects on Border
 Step 6: Smoothen the Object (lungs)

III. THE RESULTS

This is an experimental study deals with segmentation of lungs nuclear medicine images using edge detection and morphology filters using image processing technique (MatLab version R2009a). The segmentation of image started firstly by reading image as shown in (Figure 1).

original image

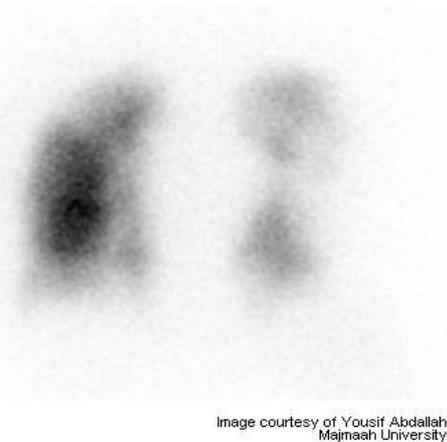


Fig.1. Original image used for lungs

Two lungs are present in this image and they can be seen in them entirety. I detected or segmented those lungs. The object to be segmented differs greatly in contrast from the background image. Operators that calculate the gradient of an image in contrast can detect changes. The gradient image can be calculated and a threshold can be applied to create a binary mask containing the segmented cell. First, I use edge and the Sobel operator to calculate the threshold value. I then tune the threshold value and use edge again to obtain a binary mask that contains the segmented lungs as shown in (Figure 2).

binary gradient mask

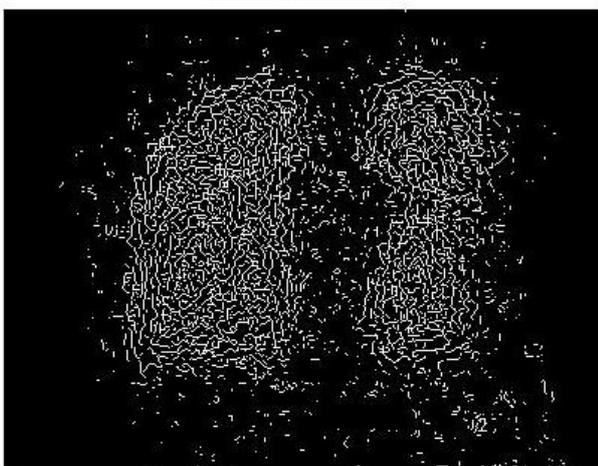


Fig.2. Binary Gradient Magnitude Mask

The binary gradient mask shows lines of high contrast in the image. These lines do not quite delineate the outline of the object of interest. Compared to the original image, I can see gaps in the lines surrounding the object in the gradient mask. These linear gaps will disappear if the Sobel image is dilated using linear structuring elements, which we can create with the strel function. The binary gradient mask is dilated using the vertical structuring element followed by the horizontal structuring element. The imdilate function dilates the image as shown in figure 3.

dilated gradient mask

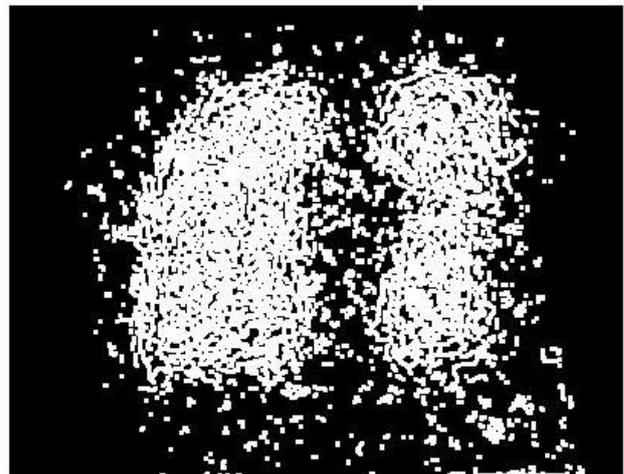


Fig.3. The dilated gradient mask

The dilated gradient mask shows the outline of the thyroid quite nicely, but there are still holes in the interior of the lungs. To fill these holes we use the imfill function as shown in figure 4.

binary image with filled holes

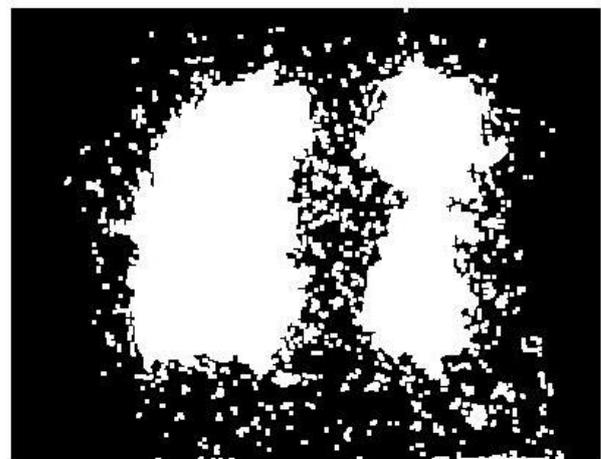


Fig.4. Binary image with filled holes

The lungs have been successfully segmented, but it is not the only object that has been found. Any objects that are connected to the border of the image can be removed using the imclearborder function. The connectivity in the imclearborder function was set to 4 to remove diagonal connections as shown in figure 5.

cleared border image

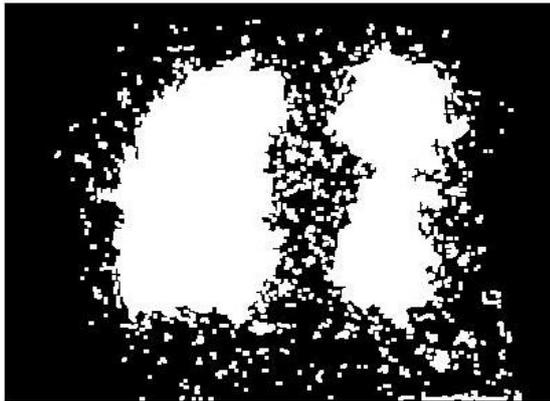


Fig.5. Cleared Border image

Finally, in order to make the segmented object look natural, we smoothen the object by eroding the image twice with a diamond-structuring element. I create the diamond-structuring element using the strel function as shown in figure 6.

segmented image

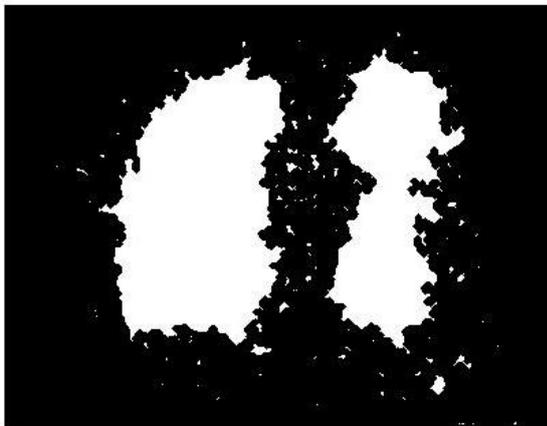


Fig.6. The segmented image

An alternate method for displaying the segmented object would be to place an outline around the segmented lungs. The outline is created by the bwperim function figure 7.

outlined original image



Fig.7. The Outlined original image

IV. CONCLUSION

MatLab is an interactive system whose basic data element is an array that does not require dimensioning. This allows operators to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or FORTRAN. Magnetic resonance imaging (MRI) has become a common way to study lungs. Information provided by medical images has become a vital part of today's patient care. The images generated in medical applications are complex and vary notably from application to application. The main objective of this research was to study an accurate lungs segmentation method using a parallel computing algorithm. In addition to detect the border of entire lungs using segmentation, filter technique. These techniques help in preservation of the image's overall look, persevered of the diagnostic content in the image, detected of small and low contrast details in the diagnostic content of the image, and highlighted the role of using image-processing technique in nuclear medicine. The result of edge detection now closely matches the original in-memory result. These were due to the different methods of padding used by the canny edge detector. Currently, blockproc only supports zero padding along the image boundaries. The smoothing of the object by eroding the image twice with a diamond-structuring element using the strel function will create the diamond-structuring element, which is useful of natural look of segmented object. So conclusion of this paper that edge detection and basic morphology tools are best tools to detect lungs. The detection of the noise is a complex procedure, which is difficult to detect by naked eye so that image analysis should be performed by using powerful image processing. A watershed transform Algorithm lungs segmentation method was proposed in this study. Proposed method is able to determine the lungs boundaries accurately. It is able to segment lungs and improves radiological analysis and diagnosis.

REFERENCES

- [1] Y., Abdallah, A., Hayder, and, E., Wagiallah Automatic Enhancement of Mammogram using Contrast Algorithm. International Journal of Science and Research (IJSR), 2014. 3(9): p. 1886-1891.
- [2] Y., Abdallah, A., Hayder, and Wagiallah ,E., Application of Texture Analysis Algorithm for Data Extraction in Dental X-Ray Images. International Journal of Science and Research (IJSR), 2014. 3(10): p. 1934-1939.
- [3] Y., Abdallah, M., Alkhir, A., Algaddal, , Improvement of Brain Tumors Detection Using Markers and Boundaries Transform. International Journal of Science and Research (IJSR), 2015. 4(1): p. 2372-2378.
- [4] D., Bidgood, & S., Horii, , Introduction to the ACR-NEMA DICOM standard. RadioGraphics, 1992. 12: p. 345-355.
- [5] G., Li, & Miller, R.W., Volumetric Image Registration of Multimodality Images of CT, MRI and PET, Biomedical Imaging. Youxin Mao (Ed.), 2010.
- [6] Y., Abdallah, Application of Analysis Approach in Noise Estimation, Using Image Processing Program. Lambert Publishing Press GmbH & Co. KG, Germany, 2011.

- [7] M., Lyra, M., Sotiropoulos, N., Lagopati, & M., Gavrilleli, Quantification of Myocardial Perfusion in 3D SPECT images – Stress/Rest volume differences, *Imaging Systems and Techniques (IST)*, IEEE International Conference 2010: p. 31 – 35
- [8] H., Narasimha-Iyer, Automatic Identification of Retinal Arteries and Veins From Dual-Wavelength Images Using Structural and Functional Features. *Biomedical Engineering, IEEE Transactions*, 2007. 54(8): p. 1427-1435.
- [9] Y., Abdallah, and E., Wagiallah, Segmentation of Thyroid Scintigraphy Using Edge Detection and Morphology Filters. *International Journal of Science and Research (IJSR)*, 2014. 3(11): p. 2768-2772.
- [10] Y., Abdallah, and A., Hassan, Segmentation of Brain in MRI Images Using Watershed-based Technique. *International Journal of Science and Research (IJSR)*, 2015. 4(1): p. 683-688.
- [11] S., Hong, Optimal scheduling of tracing computations for real-time vascular landmark extraction from retinal fundus images. *Information Technology in Biomedicine, IEEE Transactions on*, 2001. 5(1): p. 77-91.
- [12] Y., Abdallah, and R., Yousef Augmentation of X-Rays Images using Pixel Intensity Values Adjustments. *International Journal of Science and Research (IJSR)*, 2015. 4(2): p. 2425-2430.
- [13] Meyer, Fernand, "Topographic distance and watershed lines," *Signal Processing*, Vol. 38, July 1994, pp. 113-125

AUTHOR'S PROFILE



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