

Segmentation of Thyroid Scintigraphy Using Edge Detection and Morphology Filters

Yousif Mohamed Y. Abdallah^{1,2}, Eltayeb Wagjallah^{3,4}

¹Sudan University of Science and Technology, College of Medical Radiological Science, Khartoum, Sudan

²College of Applied Medical Science, Almajmah University, Riyadh, KSA

³Radiation and Isotopes Center of Khartoum (RICK), Khartoum, Sudan

⁴Elnileen Medical Center, Khartoum, Sudan

Abstract: *This was experimental study conducted to study segmentation of thyroid gland nuclear medicine images using edge detection and morphology filters. For thyroid 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. Thyroid gland 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. The segmentation of thyroid gland steps using detection and morphology filters were image reading, detection Entire thyroid, Dilation of the image, filling interior gaps inside the image, removal connected objects on borders and smoothen the object (thyroid). The results of this study were that it showed an alternate method for displaying the segmented object would be to place an outline around the segmented thyroid. Those filters approaches can help in removal of unwanted background information and increase diagnostic information of thyroid scintigraphy.*

Keywords: Segmentation, thyroid gland, Matlab, Morphology filters.

1. Introduction

The thyroid is made up of the isthmus which overlying the 2nd and 3rd rings of the trachea, the lateral lobes which each extending from the side of the thyroid cartilage downwards to the 6th tracheal ring and an inconstant pyramidal lobe which projecting upwards from the isthmus, usually on the left side, which represents a remnant of the embryological descent of the thyroid. The thyroid gland is enclosed in the pretracheal fascia, covered by the strap muscles and overlapped by the sternocleidomastoids. The anterior jugular veins course over the isthmus. When the thyroid enlarges, the strap muscles stretch and adhere to the gland so that, at operation, they often appear to be thin layers of fascia. On the deep aspect of the thyroid lie the larynx and trachea, with the pharynx and oesophagus behind and the carotid sheath on either side. Two nerves lie in close relationship to the gland; in the groove between the trachea and oesophagus lies the recurrent laryngeal nerve and deep to the upper pole lies the external branch of the superior laryngeal nerve passing to the cricothyroid muscle [1-4].

Nuclear Medicine is the section of science that utilizes the properties of radiopharmaceuticals in order to derive clinical information of the human physiology and biochemistry. The radiopharmaceutical follows its physiological pathway and it is concentrated on specific organs and tissues for short periods of time. Then, the patient is positioned under a nuclear medicine equipment which can detect the radiation emitted by the human body resulting in images of the biodistribution of the radiopharmaceutical. In Nuclear Medicine, there are two main methods of patient imaging, the imaging with Planar Imaging, Dynamic Imaging or SPECT and the PET. During the last decade, hybrid systems have

been developed integrating the CT technique with either SPECT or PET resulting in SPECT/CT and PET/CT respectively. This chapter will concentrate on the implementation of MatLab code in gamma camera planar imaging, SPECT and SPECT/CT methods [5-7]. The gamma camera is composed of a collimator, a scintillator crystal usually made of NaI (or CsI), the photomultiplier tubes, the electronic circuits and a computer equipped with the suitable software to depict the nuclear medicine examinations. In planar imaging, the patient, having being delivered with the suitable radiopharmaceutical, is sited under the gamma camera head. The gamma camera head remains stable at a fixed position over the patient for a certain period of time, acquiring counts (disintegrations). These will constitute the radiopharmaceutical distribution image. The counts measured in a specific planar projection originate from the whole thickness of patient [8-9]. In SPECT, the gamma camera head rotates around the patient remaining at well-defined angles and acquiring counts for specific periods of time per angle. What makes SPECT a valuable tool in nuclear medicine is the fact that information in the three dimensions of the patient can be collected in a number of slices with a finite known volume (in voxels). Thus SPECT technique is used to display the radiopharmaceutical distribution in a single slice removing the contribution from the overlying and underlying tissues. In order to obtain the most accurate quantitative data from SPECT images, two issues that have to be resolved are the attenuation correction and the Compton scattering that the photons are undergone until reach and interact with the slice of interest tissues. As an examining organ has certain dimensions, each slice along the axis of the gamma camera has different distance from the detector. Thus, each photon experiences different attenuation. These two phenomena usually lead to distortion of the measured activity concentration [10-11].

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2. Methods and Materials

This was experimental study conducted to study segmentation of thyroid gland nuclear medicine images using edge detection and morphology filters. For thyroid 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. Thyroid gland 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 (thyroid)

3. The results

This is an experimental study deals with segmentation of thyroid gland 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



Image courtesy of Yousif Abdallah
Sudan University

Figure 1: Shows the original image

Two lobes of thyroid are present in this image and they can be seen in their entirety. We detected or segmented those thyroid. The object to be segmented differs greatly in contrast from the background image. Changes in contrast can be detected by operators that calculate the gradient of an image. The gradient image can be calculated and a threshold can be applied to create a binary mask containing the segmented cell. First, we use edge and the Sobel operator to calculate the threshold value. We then tune the threshold value and use edge again to obtain a binary mask that contains the segmented thyroid as shown in figure 2.

binary gradient mask

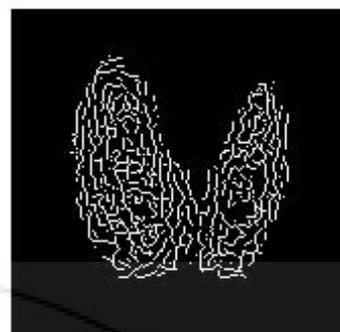


Figure 2: Shows detection of entire thyroid

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, we 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

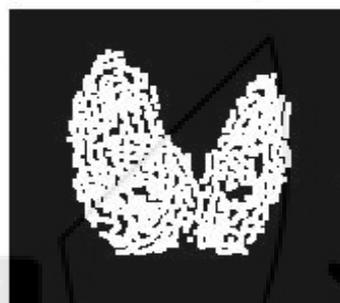


Figure 3: Shows dilation of the image

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

binary image with filled holes



Figure 4: Shows filling holes in the binary image

The thyroid has 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

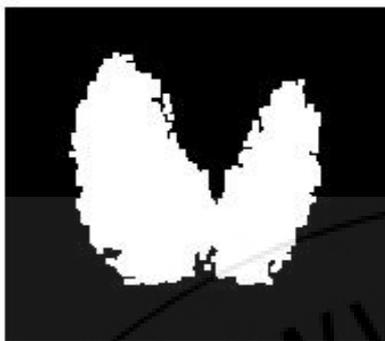


Figure 5: Showed cleared image borders

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

segmented image

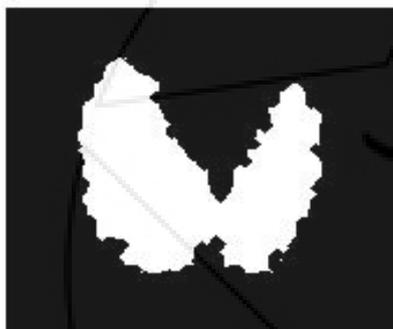


Figure 6: Shows the segmented thyroid gland

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

outlined original image

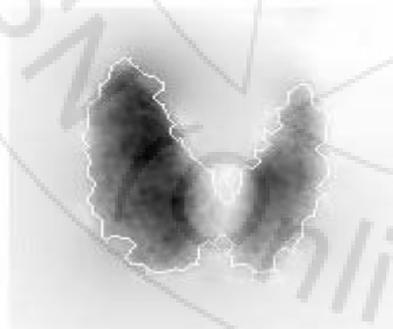


Figure 7: Shows outlined original thyroid image

4. Conclusion

This was an experimental study deals with segmentation of thyroid gland nuclear medicine images using edge detection and morphology filters using image processing technique (MatLab version R2009a).. In addition to detect the border of entire thyroid gland using segmentation filter technique. These techniques help in preservation of the image's overall

look, persevered of the diagnostic content in the image and 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 a thyroid gland. 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

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Author Profile



Yousif Mohamed Yousif Abdallah received the B.S., M.Sc. and PhD degrees and M.Sc. in nuclear medicine and Radiotherapy Technology from College of Medical radiological Science, Sudan University of Science and Technology in 2005, 2009 and 2013,

2014, respectively. During 2006 up to date, he is staying in College of Medical radiological Science, Sudan University of Science and Technology. He is now assistant professor in College of Medical radiological Science, Sudan University of Science and Technology and College of Applied Medical Science, Almajmah University, Saudi Arabia.

Eltayeb Wagallah received the B.S. in nuclear medicine technology, Rabat University and M.Sc. in nuclear medicine from College of Medical radiological Science, Sudan University of Science and Technology in 2005 and 2011, respectively. During 2006 up to date, he is staying in nuclear medicine department of Radiation and Isotopes Center of Khartoum (RICK) and Elnileen Medical Center.