Using Basic Morphology Tools in Improvement of Kidneys Detection

Yousif Mohamed Y. Abdallah[1], Masheel Abdallah[2]

[1]Department of Radiological Sciences and Medical Imaging, College of Applied Medical Science, Almajmah University, K.S.A

[2] Hager Specialized Clinic, Damam, K.S.A

Abstract: *In renal scintigraphy, detecting the borders of kidneys 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 basic morphology based algorithm, choice of appropriate technique type for each circumstance becomes an essential task. The segmentation transform is often applied to this problem. The segmentation 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 fifty renal scintograms. A watershed transform Algorithm kidneys segmentation method was proposed in this study. Proposed method is able to determine the liver boundaries accurately. It is able to segment liver and improves radiological analysis and diagnosis.*

Keywords: Nuclear Medicine, Kidneys, MatLab, Morphology filters.

1. Introduction

In nuclear medicine imaging, radiopharmaceuticals are taken internally, for example, intravenously or orally. Then, external detectors (gamma cameras) capture and form images from the radiation emitted by the radiopharmaceuticals. Nuclear medicine tests differ from most other imaging modalities in that diagnostic tests primarily show the physiological function of the system being investigated as opposed to traditional anatomical imaging such as CT or MRI. [1-4]. In some centers, the nuclear medicine scans can be superimposed, using software or hybrid cameras, on images from modalities such as CT or MRI to highlight the part of the body in which the radiopharmaceutical is concentrated. This practice is often referred to as image fusion or co-registration, for example SPECT/CT and PET/CT. The fusion imaging technique in nuclear medicine provides information about the anatomy and function, which would otherwise be unavailable or would require a more invasive procedure or surgery [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). The counts measured in a specific planar projection originate from the whole thickness of patient [8-9]. 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. The use of radioisotopes in studies of the urinary system is dedicated to three major goals:

quantification of renal function, dynamic imaging (i.e. renography) and parenchymal scintigraphy. [10-11].

2. Methods and Materials

This was experimental study conducted to study segmentation of kidneys nuclear medicine images using edge detection and morphology filters. For renal 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 JPEG file format to preserve the quality of the image. Kidneys can be easily detected in nuclear medicine image if the object has sufficient contrast from the background. I use edge detection and basic morphology tools to detect a thyroid gland.

Steps of renogram segmentation using MatLab program:
Step 1: Image Reading
Step 2: Detection of Entire kidneys
Step 3: Dilation of the Image
Step 4: Filling the Interior Gaps
Step 5: Removal Connected Objects on Border
Step 6: Smoothen the Object (kidney)

3. The results

This is an experimental study deals with segmentation of kidneys in renogram using basic morphology filters using image processing technique (MatLab version R2014a). The segmentation of image started firstly by reading image as shown in Figure 1.
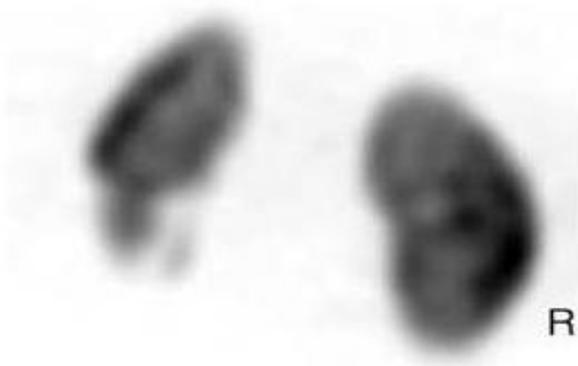
Step 1: Image Reading

Figure 1: Shows the original image

Two kidneys are present in this image and they can be seen in them entirety. I detected or segmented those kidneys and 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, 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 thyroid as shown in figure 2.
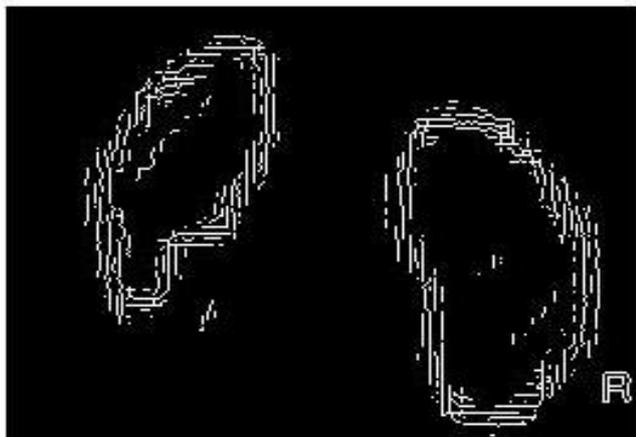

Figure 2: Binary gradient mask

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 saw 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 I created 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.

Figure 3: The dilated gradient mask

The dilated gradient mask shows the outline of the kidneys 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.
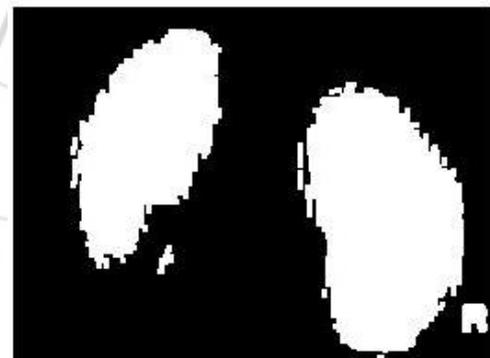

Figure 4: The binary image with filled holes

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.
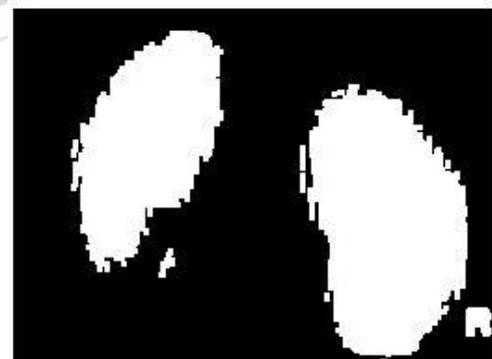

Figure 5: The cleared border image

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 created the diamond structuring element using the *strel* function as shown in figure 6.
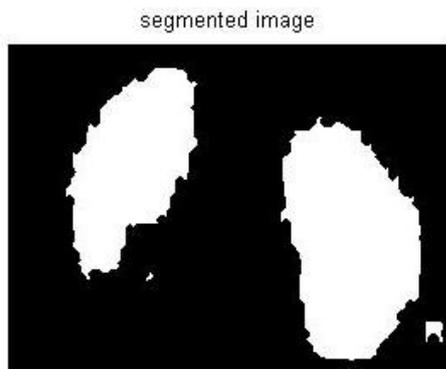
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Figure 6: The segmented image

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.
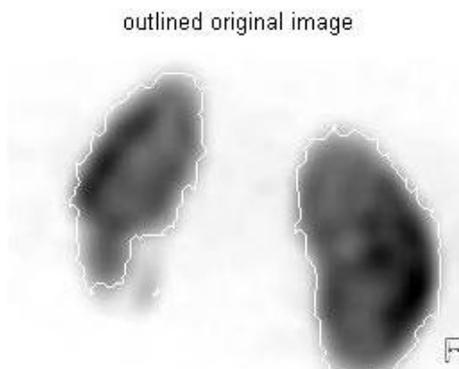

Figure 7: The outlined original image

4. Conclusion

This was an experimental study deals with segmentation of kidneys in renogram using basic morphology filters using image processing technique (MatLab version R2014a). 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 nuclear medicine and Radiation Therapy from College of Medical radiological Science, Sudan University of Science and Technology in 2005, 2009 and 2013 respectively. He is now assistant professor in department of Radiological Sciences and medical Imaging, College of Medical Applied Sciences, Majmaah University.

Mashael Abdallah received the B.S., M.Sc. degrees in medical physics from College of Medical radiological Science, Sudan University of Science and Technology. She is now Hager Specialized Clinic, Damam, K.S.A.

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