

Semi-automatic Thyroid Area Measurement Based on Ultrasound Image

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Abstract:-This paper presents the simple guide to determine the thyroid lobes in thyroid ultrasound image using MATLAB. The thyroid measurement and recognition system is very useful in medical field such as early thyroid cancer diagnostic. The thyroid ultrasound image will undergo the image enhancement method that is contrast enhancement histogram equalization to suppress speckle. Then the enhancement image will undergo local region-based active contour to segment the thyroid region. The thyroid region will be segmented into two parts that are right and left with the active contour method separately. This is due to the thyroid that divided into two lobes that is right lobe and left lobe. Thyroid ultrasound image transverse view will be used in this project. Therefore the measurement involve is only width, depth and area of thyroid region. The result of measurement involve of thyroid is successful calculated in pixel unit. The measurement is converted in centimeter (cm) unit. The proposed method can be used to enhance the image and segmentation the thyroid lobe. It shows that from five samples, different people have different size of thyroid especially in measurement of width, depth and area.

Key-Words:-Thyroid, active contour, contrast enhancement, local region-based, ultrasound

1 Introduction

Ultrasound is one of the non-invasive low cost imaging techniques for thyroid scanning. It can follow anatomical deformations in real time during biopsy and treatment and it is non-invasive and does not require ionizing radiation. However ultrasound images produced by this technique contain echo perturbations and speckle noise that can affect the diagnosis result for patient [1]. Therefore the appropriate thyroid region detection in ultrasound image may involve segmentation method and image enhancement to suppress the speckle noise[2].

Nowadays many techniques has make use of digital pre-processing of coherent echo signals to enhance the quality and information content of ultrasonic images of the body. Example of these methods consists of resolution enhancement, contrast enhancement to suppress speckles and imaging of spectral parameters [3]. Contrast enhancement is a technique that able to suppress speckle in thyroid ultrasound image. One of the popular methods in contrast enhancement is histogram equalization. Histogram Equalization is a technique for recovering some of apparently lost contrast in an image by remapping the brightness values in such a way as to equalize and distribute its brightness values [4].

Segmentation is a collection of methods allowing interpreting spatially close parts of the image as objects. Active contour is one of the methods in image segmentation and used in the domain of image processing to locate the contour of an image and allow a contour to deform so as to minimize a given energy

functional in order to produce the desired segmentation [5]. Example of active contour method is snakes, balloons and local region-based. In this project, local region based active contour is chosen because this method focused on the detection of region based of thyroid image. The advantage of region based compare to edge based is the robustness against initial curve placement and insensitivity to image noise.

2 Material and Methods

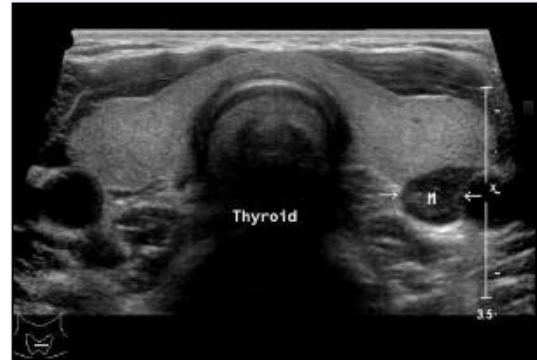
Several data collection has been done in order to get the raw human thyroid ultrasound images. The data have process using several images processing method which are image enhancement, segmentation and measurement to get the value of depth and width of thyroid. Even though the entire image enhancement is automatically; the initialization mask still manually done which is region of interest in order to choose the thyroid region must be done by medical expert.

2.1 Image / Data collection

In this project, five subjects were used to get thyroid ultrasound images. Five images collected from scanning and other sources are used in this project. Below are the images from five patients.

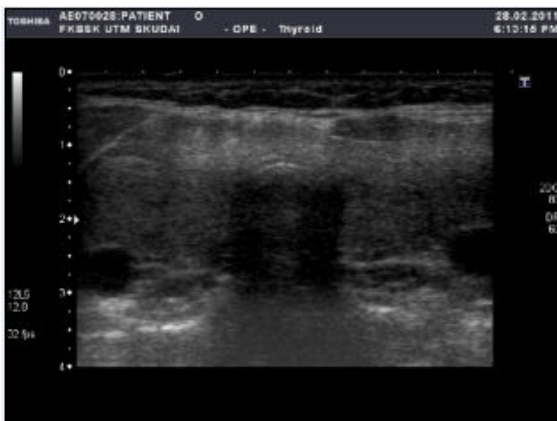


(a)

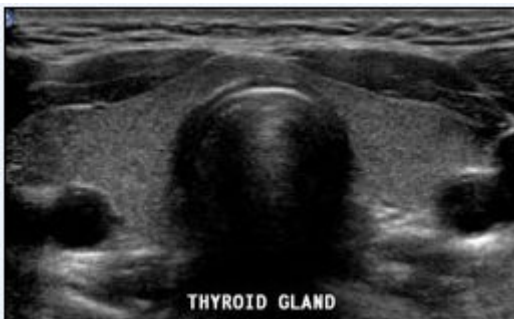


(e)

Fig. 1: Thyroid ultrasound image. (a), (b) scanning source and (c), (d), (e) web source



(b)



(c)



(d)

2.2 Flowchart / Algorithm for Image Processing

Some step is needed to be done to develop the software system that able to segment and enhance the thyroid ultrasound image. Problem detection related to the topic is important before any system can be developed. The development of software in this project is to overcome the problem occur due to the detection of thyroid region and problem in ultrasound image. Then literature reviews need to know the anatomy, physiology and pathology of thyroid to identify the position and shape of the thyroid region. After that the suitable method of segmentation and image enhancement is identified for the software development for automatic segmentation of ultrasound.

The experiment is done to test the software. The experiment involves five thyroid ultrasound images. The result is saved and analyzed. For the software development, MATLAB is used. MATLAB Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. Most toolbox functions are written in the open MATLAB language, giving user the ability to inspect the algorithms, modify the source code, and create your own custom functions [4]. In this work focused on technique to improve the quality and information of content of ultrasonic image of the thyroid, where the methods chosen are contrast enhancement to suppress speckles and local region based active contours.

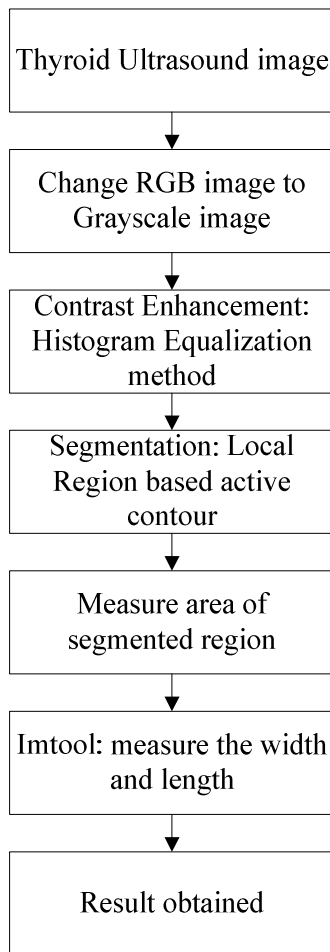


Fig. 2: Flow chart of software development

2.3 Image processing method

Transverse view of thyroid ultrasound image will be used in this project. Therefore the measurement involves in this experiment just width (W), depth (D) and area of thyroid region. The ultrasound image is in RGB type which is an additive color of red, green, and blue. The image is converted into gray scale image for further processing. Image processing toolbox provides image enhancement routines. The contrast enhancement of the image can be observed by applying histeq (enhance contrast using histogram equalization). The resulted image after histeq is show in Fig.4.

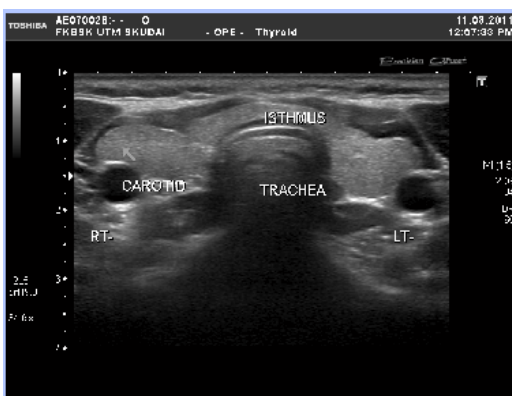


Fig. 3: Original Thyroid image



Fig. 4: Thyroid image after histeq

For the segmentation method, the thyroid region will be segmented into two sides that are right and left. For the right side of thyroid, the initialization mask is created suitable for the right thyroid region.

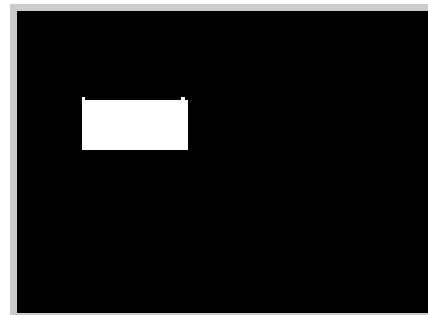


Fig. 5: Initialization mask

Resizing the image pixels into only the region of interest using initialization mask is significant for efficient image processing. For further processing, the thyroid image and initialization mask will undergo the local region-based active contour method.

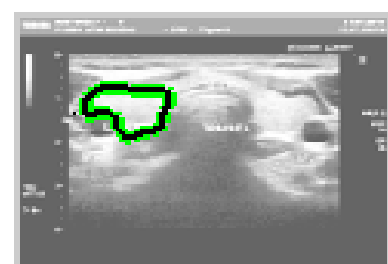


Fig. 6: Local region-based active contours



Fig. 7: Final segmentation

Then the thyroid region that has been segmented by this method is show in Fig. 7. Final segmentation image will be process again into binary format image which is the suitable value is 0.1. Fig. 8 shows the result for binary image. The process continues by enhancing the final image to remove any black spot (undesired spot) in the area of thyroid that will affect the calculation for the region. Before using both of the operators, the image is inverted in order to enhance the result.



Fig. 8: Binary image



Fig. 9: Inverted image

After the image is inverted, removing black spot on white area as in Fig. 9 by converting black spot into white color in the thyroid region. Then, the small pixel region will be removed as we assume it is the noise. In this case, the black color is filled if the spot are below than 30 pixels. The resulted image after operations is shown on Fig. 10.



Fig. 10: After removing noise

The boundaries of white region are detected using operators and follow by image region properties to measure the image. The data measured is in pixels unit. So it require step to convert the unit from pixels into meters. Then image will be inverted again using “~” operator and display the area of human thyroid. Once again the image needs to be measured to get the width and depth of thyroid. The image needs to resize to increase

the resolution of our interest image. The width (W) and depth (D) is measured in pixel unit and will be converted into centimeter (cm).

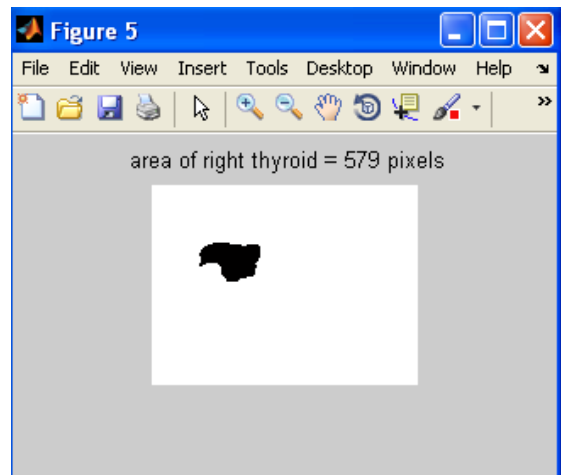


Fig.11: Final result image

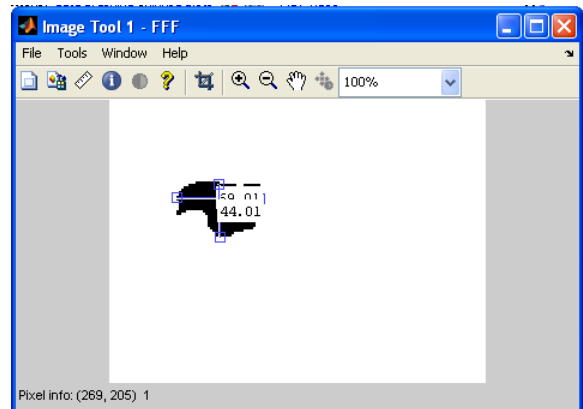


Fig.12: Measure width and depth thyroidregion.

For the left side of thyroid region, the methodology is similar to the right side. The different is for the initialization mask value. The left side initialization mask is show in Fig. 13.

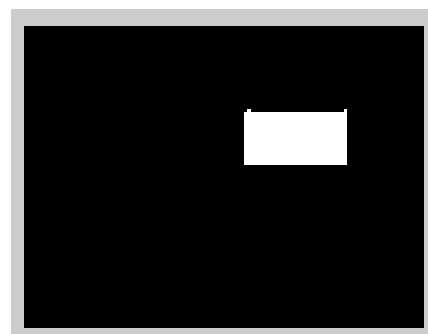


Fig.13: Initialization mask for left side thyroid

3 Result and Analysis

The measurements for width (W), depth (D) and area of human thyroid are presented in SI unit (centimeter). The experiments involve 5 samples of human thyroid ultrasound image from different of thyroid area between different people. Table 1 indicates the result from the image processing.

Thyroid region	Right Lobe (cm)			Left Lobe (cm)		
	W	D	Area	W	D	Area
A	1.8	1.2	15	1.4	1.0	13.6
B	1.7	1.1	16.7	1.7	1.3	26.5
C	1.6	1.2	19	1.6	1.1	22.5
D	1.5	1.3	20	1.5	1.0	18.3
E	1.7	1.5	23.5	1.8	1.1	20

Table 1: Thyroid measurement result obtained.

1.5cm. For left lobe person E have higher size of width with 1.8cm. For depth size of thyroid, the higher is person E with 1.5 cm for right lobe while for left lobe person B is higher that is 1.3cm. The higher area of thyroid is person E for right lobe and person B for left lobe.

Research found that the right lobe is usually slightly larger than the left [6]. When the thyroid gland enlarges, it extends superiorly and inferiorly to elongate the length of the lobes and laterally to broaden the width of the whole gland.

3.1 Comparison with snake active contour method

Local region –based active contour method is suitable for this project to segment the thyroid region. Other method of active contour such as snakes is focused on the edge-based. Edge-based active contour models utilize image gradients in order to identify boundaries not region. Snakes method very sensitive to image noise and highly dependent on initial curve placement.

3.2 Advantage and weakness of method

The advantages of region-based approach are robustness against initial curve placement and insensitivity to image noise. This local region-based method also can detect the region automatically by only specify the initialization mask compare to snake method that user need to identify the area want to segment by give specify point by point on the image. This is hard for user that not knows more about thyroid region. It found that edge detection technique inappropriate for ultrasound images compare to region based approach [7]. Although user can know the area of thyroid region automatically, users still need to measure the width and depth manually using MATLAB operators. This may cause to time delay before user can know the final result of thyroid measurement. This also may cause inaccurate result of thyroid measurement because of human error.

3.3 Recommendation to minimize the weakness

To minimize the weaknesses of this method, the automatic system that can give the width and length measurement of thyroid need to develop. By this system the error that occurs can be minimized. For further development of the system, the user friendly user interface need to been develop. This is because not all know how to use MATLAB especially doctor and radiologist. Therefore the user interface can help them to use the system.

4 Conclusion

As a conclusion, the measurement of width, depth and area of thyroid is successful applied in MATLAB. Ultrasound image are widely used tool for clinical diagnosis. Therefore the convenient system for thyroid segmentation, measurement and ultrasound image enhancement is of interest. The proposed MATLAB method is includes contrast enhancement using histogram equalization is important to reduce speckle that may

Fig. 14: Pie chart accuracy of develop software system for width measurement of left and right thyroid lobe.



Fig. 15: pie chart accuracy of develop software system for depth measurement of left and right thyroid lobe.



From the pie chart in Fig.14 and Fig. 15, for the width measurement the four out of five images have accurate measurement of width for their thyroid. While for the depth measurement three of image has an accurate measurement of depth. This analysis shows that majority of measurement using this system produce an accurate value.

From the observation, different people have different size of thyroid lobe. The higher width for right lobe is person A that have 1.8cm while the lower is person D that is

affect the segmentation results of thyroid. The experiment results show that the proposed method can be used to segmentation the thyroid region and give faster convergence compare to the active contour snake method. In future, this work could be extended to high level image processing such as processing in real-time application.

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