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A Review Paper on Various Segmentation Methods Used On Ultrasound Images for Thyroid Diagnosis

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Abstract - *Thyroid gland is a butterfly-shaped organ, which consists two lobes and it lies in front of the neck below the Adams apple. The thyroid measurement is very useful in the medical field because the doctor needs to diagnose various diseases. So, for examination of the thyroid, many techniques are available like X-RAY, CT (Computed tomography), Ultrasonography, MRI(Magnetic Resonance imaging), Scintigraphy but thyroid ultrasound examination is considered superior to other medical imaging modalities for its non-invasive, practical, inexpensive and painless. To give accurate identification of disease through the study of Ultrasonographic scan of gland proper segmentation of thyroid image is important. Moreover, this step of digital image processing is hard due to the speckle noise, intensity heterogeneity, and low contrast. So, here in this paper various segmentation methods applied on the same image like Watershed, Active contour, SVM (Support vector machine), Morphological operation etc., and give a comparison of their output. This helps the doctor to focus only on their area of interest.*

***Key Words*: Segmentation, Watershed algorithm, Active contour, Morphological Operations.**

1. INTRODUCTION

The thyroid gland is located in the anteroinferior part of the neck in a space outlined by muscle, trachea, esophagus, carotid arteries, and jugular veins. The thyroid gland is made by two lobes located along either side of the trachea and connected across the midline tissue by the isthmus[1].Each lobe is pear-shaped and ~5cm long, ~2.5cm wide and Isthmus is ~1.2cm long and ~1.2cm wide[1]. It controls the secretion of the thyroid hormone, which is useful in regulation of the human body temperature, and greatly affects childhood intelligence and growth. It also produces hormones that are helpful for the body to control metabolism. More than limit or under than limit, thyroid hormone secretion (due to a thyroid that is too large or too small, respectively) causes pathological changes and results in thyroid abnormalities. Therefore, an expert often diagnoses abnormal symptoms of the thyroid gland by its volume. There is main three type of thyroid diseases (1) Hyperthyroidism (2) Hypothyroidism (3) Thyroid nodule.

Hyperthyroidism occurs due to an extra production of thyroid hormone by the thyroid gland. Signs and symptoms of this abnormality differ between people and may include muscle weakness, sleeping problems, a fast heartbeat, heat intolerance, diarrhea, enlargement of the thyroid, and weight loss [17].Goiter is well-known diseases which occur because of hyperthyroidism. Second is Hypothyroidism, additionally called underactive thyroid, which is a typical issue of the endocrine framework. In which the thyroid organ does not deliver enough measure of thyroid hormone. It has numerous side effects, for example, poor capacity to endure icy, a sentiment tiredness, clogging, gloom, and weight pick up. Sometimes there may be swelling of the front part of the neck [17].Final is thyroid nodules are lumps that are not normal in the thyroid gland [12]. Nodules can be solids, liquids (cystic) and a combination of both (complex cystic) with irregular shapes like circles or irregular.

There are various techniques available for study of thyroid gland like Radiography (X-RAY), CT scan (Computed tomography), Ultrasonography, MRI (Magnetic Resonance imaging), Scintigraphy but thyroid ultrasound examination is considered superior to other medical imaging modalities because it is non-invasive, practical, inexpensive and painless and real-time modality [7]. Ultrasound takes after anatomical distortions progressively amid biopsy and treatment, and it is noninvasive treatment and does not require any ionizing radiation. Moreover, ultrasound images produced by this technique contain to echo perturbations and speckle noise that can affect the images which help in diagnosis result for a patient [7]. Therefore, the appropriate and accurate thyroid region detection in the ultrasound image is involved segmentation method and image enhancement to suppress the speckle noise.

Many methods available for the thyroid segmentation like Support vector machine, Active contour without the edge, Local area based active contour, ROI based segmentation, Morphological Process, Watershed algorithm, Neural network, Fuzzy control etc. This paper describes detail study of several segmentation methods and compared their results with each other to find out accurate and best way for segmentation of thyroid gland.

2. LITERATURE SURVEY

Thyroid gland situated on superficial part of the body. In this way, high-recurrence, high-determination constant dark scale, and shading Doppler sonography can portray typical thyroid life systems and neurotic conditions with great lucidity. Accordingly, ultrasound assumes an unfathomably essential part in the analytic assessment of thyroid malady.

2.1 Thyroid Ultrasound

High-frequency linear transducers (7.5-15.0 MHz) currently ultrasound provides penetration at depth of up to 5 cm with high-definition images and gives a resolution of 0.5 to 1.0 mm. No other imaging method can achieve this degree of spatial resolution. Linear array transducers with either rectangular or trapezoidal scan format are preferred to linear transducers because of the wide and near field of view and the capability to combine high-frequency gray-scale and color Doppler images. The thyroid gland is one of the most vascular organs of the body because it covered by many veins and arteries. Finally, as a result, Doppler examination provides useful diagnostic information in some critical thyroid diseases.Fig-1 shows the normal thyroid scan taken by ultrasound.

Fig -1: Normal thyroid ultrasounds scan [1]

Thyroid ultrasound is an accurate method to measure the various dimension of the gland. During an examination of thyroid measurement taken under consideration are length, width, depth and according to that the volume. the total volume of the thyroid is the summation of individual lobe's volume. Thyroid volume measurement is useful in the determination of goiter as well as early detection of other tissue growth. A thyroid nodule appears dark part in the structure of thyroid image it is highly contrasted part of scan as shown in fig 2.

Fig -2: Thyroid with nodule

To measure thyroid nodule as well as lobes by the computer aided system for accuracy first step is to scoop out this part for that various methods are shown below.

2.2 Segmentation Methods

In 2001, Keramidas et al. [16] in this author first threshold longitudinal image of thyroid gland than found the histogram for the same image and applied operation on the histogram to found the boundaries of the image as processing local histogram information extracted from vertically sampled horizontal stripes. After that anteroposterior diameter (AP) can be derived by measuring the distance between the hyper echoic lines that bound the thyroid lobes. But this is not applicable to the image when boundaries were not clear.

In 2004 T. Masayoshi et al. [8] propose an image sharpening method based on geometrical features of the input image. By using mathematical morphology with adaptive structuring elements, this provides the edge-sharpening effect various morphological techniques are proposed for noise removal. These methods can smoothen the noises and preserve edges of an image. However, these cannot sharpen the edges. Therefore, they applied various morphological operations on the image with a thyroid nodule and without thyroid nodule. Direct segmentation was not done by the only morphological operation so further edge filling and region filling also applied on an image but still, it needs more operations to get accurate part of an image.

In August 2011, N. H. Mahmood et al. [9] used area based active contour segmentation and bilateral filtering is combined to separate the thyroid nodule and lobe areas. For that first convert image into gray scale image and applied contrast enhancement using histogram equalization to smoother the image and segment the nodule part using Local region-based active contours than calculating the width and depth of a nodule in a pixel which they convert into centimeter. After applying this method we can conclude that this is best for the nodule segmentation but here for the various position of the nodule, we need to define different

mask so need more efforts to make this method general for all type of images.

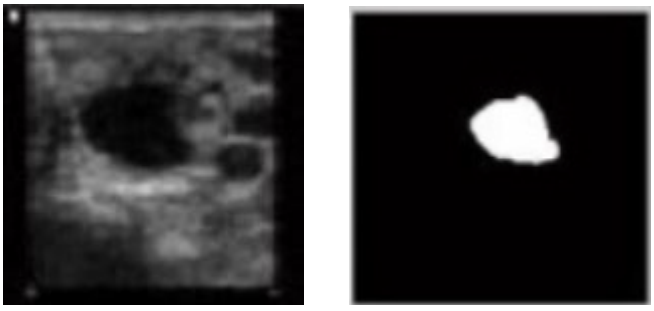
In 2014, Ling-Ying Chiu and Argon Chen et al. [13] proposed a method in order to avert variation due to expert's subjective judgments and to achieve a high degree of stability and accuracy, they described a computer-aided system with automatic segmentation and identification of the thyroid nodule boundary on ultrasound images to assist the physician's clinical decision and the development of computer-aided diagnosis. In this original image is first converted black and white image than after they manually made a point on major and minor axes. After that, the region of interest is generated and after that radiant gradient algorithm applied to image and value of boundary point is decided by the variance reduction statistic.

In 2015, Sneha Latha et al. [4] in this first input image went through PCA based data reduction method in which image converted in a single band from multi-band image. For that, they applied various operations first find the samples than calculating mean value followed by that found the difference matrix, covariance, and Eigenvector. This preprocessing gives a feature of the image which goes under morphological operation, masking and normalization which gives segmented area from the image.

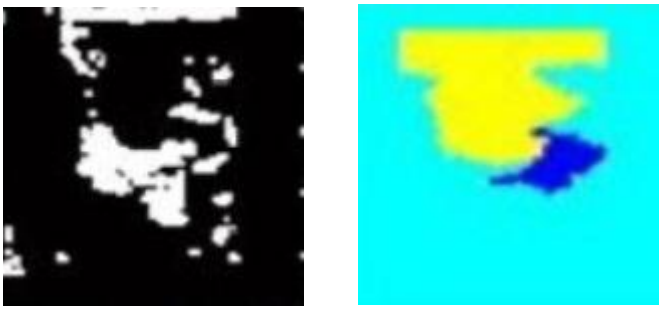
In 2015, N. Ponraj et al.[6]proposed method in which author first find the gradient magnitude of the image after that it converted into watershed transform gradient magnitude and applied various morphological operation on image for smoothening the image and reconstruct it. Moreover, regional maxima/ regional minima found and superimposed that on an original image then applied markers to segment the boundaries after an image was superimposed and converted into watershed color matrices. It segments the part of thyroid but not exactly the nodule so further work required for characterization of the image. For that, either color segmentation or SVM algorithm can be used for further feature extraction.

3. RESULTS

After applied various methods on the actual image of thyroid nodule, we got different output which shown in below images.



(a)



(b) (c)

Fig -3: Input image (a)Results after applying Local area based active contour (b)Results after applying morphological operation(c)Results after applying watershed algorithm

Here, the first image is input image which has nodule appeared as a dark black portion and needs to be segmented. Fig-3(a) shows the result after applying Local area based active contour algorithm which gives a binary segmented output of the whole area. Fig-3(b) is the result of applying opening operation with the mask of 7x7 in this in output the only boundary is detected but still; it needs more operation to get an actually segmented area. Fig-3(c) describes colored segmented area after applying the watershed algorithm.

4. CONCLUSIONS

Nowadays, the Ultra Sonogram images are the most helpful and inexpensive tool for clinical diagnosis. However, it is a time-consuming process to segment thyroid gland region by the help of the physician's eyesight. The effect of the speckle noise causes a disturbance in the segmentation result of the thyroid gland region. So, in Ultra Sonogram image segmentation possibility of inefficiency and inaccuracy is quite high. Therefore, our method includes image enhancement processing technologies to suppress noise after that procedure applied is Local area based active contour method which gives the best suitable method for segmentation of thyroid lobes. Moreover, it gives an accurate shape of lobe which is helpful to measure depth and width of the thyroid lobe.

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