Thyroid Disorder Detection Using Image Segmentation in Medical Images

[1]Polepogu Rajesh, [2]Kunduru Umamaheswari

Assistant Professor, Department of EIE
V.R.Siddhartha Engineering College, Vijayawada, Andhra Pradesh, India

***Abstract*— Now-a-days Bio-medical image processing is the most challenging and emerging field in medical diagnosis. Processing of US images is one of the crucial parts of this field. Thyroid is a small butterfly shaped gland located in the front of the neck just below the Adams apple. Thyroid is one of the endocrine gland, which produces hormones that help the body to control metabolism. Different thyroid disorders include Hyperthyroidism, Hypothyroidism, goitre, and thyroid nodules (benign/malignant). Ultrasound imaging is most commonly used to detect and classify abnormalities of the thyroid gland. Other modalities (CT/MRI) are also used. Computer aided diagnosis (CAD) help radiologists and doctors to increase the diagnosis accuracy, reduce biopsy ratio and save their time and effort. Numerous researches have been carried out in thyroid medical images and that are utilized for the diagnosis process. An automatic system is developed that classifies the thyroid images and segments the thyroid nodular area using machine learning algorithms. The thyroid measurement and recognition system is very useful in the medical field because the measurement of thyroid is important for the doctor diagnostic and medical analysis. The objective of this paper is to provide a complete solution to diagnosis the suspicious thyroid region in the thyroid gland. The integral region is further acquired by applying a thresholding method and specific region growing method to potential points. For better diagnosis purpose we can use MATLAB tool. The image undergoes the contrast enhancement to suppress speckle. The enhancement image is used for further processing of segmentation the thyroid region by local region-based active contour. The thyroid region is segmented into two parts, which are right and left with the active contour method separately. This is accordingly to the thyroid have two lobes; right lobe and left lobe. Experimental results of the thyroid region segmentation show high potential of our proposed approach.**

***Index Terms*— US (Ultrasonography), CT (Computer Tomography) algorithm, MRI (Magnetic Resonance Imaging), Threshold segmentation.**

I. INTRODUCTION

he thyroid gland belongs to the endocrine system and is located in the neck just in front of the larynx. It can appropriately T secrete thyroid hormone which regulates the temperature of the human body. The thyroid hormone greatly affects the kid's intelligence, growth and the adult metabolism. Too much or too few secretion of the thyroid hormone will cause pathological changes. In thyroid volume, either too big leading over secretion of thyroid hormone or too small leading under secretion of it are both categorized as an abnormal symptom. Therefore, physicians often diagnose symptom of thyroid gland on volume symbolically or representatively. Among several diagnostic modalities, US image is the most popular one. It has several favorable properties: it is inexpensive and easy to use; it is not inferior to magnetic resonance images (MRI) or computed tomography (CT) images in terms of diagnostic value; it can follow anatomical deformations in real-time during biopsy and treatment; and it is non-invasive and does not require ionizing radiation. However US image contains echo perturbations and speckle noise, which could make the diagnostic task harder. Although MRI and CT have clear visualization than US images, US images are often adopted due to their cost effectiveness and portability. This phenomenon is particularly true in smaller hospital or infirmary. Fortunately, US images provide a timely approach to acquire thyroid gland image, and it is useful for dispensary in remote districts or in mobile medical services. The processing techniques of US images are continuously developed in last years. Several segmentation methods for anatomical objects from US images have been developing in the prostate, tumors in the breast and thyroid nodule. Among these segmentation methods, active contour models attract researchers' attention for their performance. However, most of active contour methods are sensitive to the gradient of the edge. Figure 1 illustrates two different views of the thyroid gland in the same patient.

To recognize the thyroid regions and to extract significant features of thyroid, the physicians manually outline the rectangular regions of interest (ROI) in both thyroid and non-thyroid tissues, respectively. Texture-based information is calculated from both ROI blocks. With the features, the RBF neural network classifies the thyroid regions from US images. Then a region growing method is applied to retrieve complete thyroid region[1][2].

A. Ultrasonography

Ultrasonography is the most well accepted imaging modality for the diagnosis and follow-up of thyroid disorder. The advantages of using ultrasonic imaging include its mobility and low cost as well as the ability to measure the dimension of the gland check for the presence of masses or cysts and evaluate the structure and echogenicity of the parenchyma. US is the most sensitive imaging test available for the examination of the thyroid gland, to detect thyroid lesions, accurately calculate their dimensions, and identify the internal structure. A thyroid ultrasound examination provides an objective and precise method for

detection of a change in the size of the nodule, used to evaluate the US features, which include size, echogenicity (hypo echoic or hyper echoic), and composition (cystic, solid, or mixed), as well as presence or absence of coarse or, a halo and irregular margins[3].

Segmentation plays an important role in medical imaging to obtain the location of the object of interest as well as to detect the area, volume or the analysis of dynamic behavior of anatomical structure over time. Thus by segmentation process the affected or the region of interest can be separated from other tissues. To detect the abnormality of thyroid gland, first the location and size of the gland must be segmented. A segmentation algorithm based on localized based method that is basically to select the small region of the thyroid nodule or to segment the local area of the images and to segment the nodule which is gives the information of which type of nodule exist benign and malignant. In digital image processing techniques offer the opportunity for texture description. The thyroid nodule can be characterized by texture description and quantifying properties[4].

The thyroid texture characterization based on statistical parameter could provide an objective diagnostic tool and contribute to the use of computer assisted application in thyroid disorders. The most famous feature extraction technique are presented based on (GLCM) next, and famous classification method SVM classifier, KNN classifier and Bayesian classifier. In this project work, we proposed to develop a computer aided diagnosis system of thyroid ultrasound images. In this module, firstly thyroid gland region are segmented from the nodular (noncancerous) region in the normal thyroid nodule images and nodular (with cancerous) region in the abnormal thyroid nodule images. Then the segmented thyroid ultrasound images were use the features extraction techniques and also used SVM, KNN and Bayesian classifier. From this module classified result, the results obtained from the performance measures such as accuracy are calculated[6].

B. Different Disorders in Thyroid

1) Thyroid Diseases

Thyroid gland produces chemicals (hormones) that help the body to control metabolism. Thyroid hormone is normally produced in response to another hormone released by the pituitary gland. There are four main types of thyroid disease hyperthyroidism (too much thyroid hormone), hypothyroidism (too little thyroid hormone), benign (noncancerous) thyroid disease and thyroid cancer (malignant).

2) Thyroid Disease Symptoms

The signs and symptoms of hypothyroidism includes fatigue, mental fogginess and forgetfulness, feeling excessively cold, constipation, dry skin, fluid retention, non specific aches and stiffness in muscles and joints, excessive or prolonged menstrual bleeding (menorrhagia), and depression. Hyperthyroidism is suggested by a number of signs and symptoms. People with mild hyperthyroidism or those older than 70 years of age usually experience no symptoms. Common symptoms of hyperthyroidism includes excessive sweating, heat intolerance, increased bowel movements, tremor (usually a fine shake), nervousness; agitation, rapid heart rate, weight loss, fatigue, decreased concentration, and irregular and scant menstrual flow. The two most important thyroid hormones are thyroxin (T4) and triiodothyronine (T3), representing 99.9% and 0.1% of thyroid hormones respectively. The hormone with the most biological power is actually T3. Once released from the thyroid gland into the blood, a large amount of T4 is converted to T3 - the active hormone that affects the metabolism of cells throughout our body. The thyroid itself is regulated by another gland located in the brain, called the pituitary. The pituitary is regulated in part by the thyroid by another gland called the hypothalamus. The hypothalamus releases a hormone called thyrotrophic releasing hormone (TRH), which sends a signal to the pituitary to release thyroid stimulating hormone (TSH). In turn, TSH sends a signal to the thyroid to release thyroid hormones. If over activity of any of these three glands occurs, an excessive amount of thyroid hormones can be produced, thereby resulting in hyperthyroidism. Similarly, if under activity of any of these glands occurs, a deficiency of thyroid hormones can result, causing hypothyroidism. The hormone chain is represented as Hypothalamus – TRH, Pituitary- TSH, Thyroid - T4 and T3. There is another hormone that is produced by the thyroid called calcitonin. It is a hormone that contributes to the regulation of calcium and helps to lower calcium levels in the blood. Excess calcium in the blood is referred to as hypocalcaemia. Anatomical problems include goiter, endemic goiter, diffuse goiter, multinodular goiter, Lingual thyroid and thyroglossal duct cyst. Tumours include thyroid adenoma, thyroid cancer-Papillary, Follicular, Medullary, Anaplastic and lymphomas and metastasis. Defiance in adults causes Myxoedema[1].

3) Diagnosis

The measurement of thyroid hormone levels is often used by doctors as a screening test. If TSH is abnormal, decreased levels of thyroid hormones T4 and T3 may be present. There are two cancer markers for thyroid derived cancers. Thymoglobulin (TG) for well differentiated papillary or follicular adenocarcinoma and the rare medullary thyroid cancer has calcitonin as the marker. To differentiate between different types of hypothyroidism, a specific test may be used. Thyroid-releasing hormone (TRH) is injected into the body through a vein. This hormone is naturally secreted by the hypothalamus and stimulates the pituitary gland. The pituitary responds by releasing thyroid -stimulating hormone (TSH).Nodules of the thyroid may or may not be cancer. Medical Ultrasonography can help determine their nature because some of the characteristics of benign and malignant nodules differ[1].

Goals

- To diagnose the suspicious thyroid nodule of the thyroid gland in medical images.
- To get better diagnosis here MATLAB tool is used.

C. This paper is divided into number of sections as follows

- Section II deals with deals about the implementation of the segmentation over thyroid image.

- Section III presents simulation results.
- Section IV summarizes the work.

II. METHODOLOGY

A. Steps

The algorithm has two stages, first is pre-processing of given MRI image and after that Segmentation is done. Steps of algorithm are as following:

1) Give MRI image of thyroid as input.
2) Convert it to gray scale image.
3) Apply median filter to enhance the quality of image.
4) Compute threshold segmentation.
5) Finally output will be a suspicious thyroid region

1) Giving Ultrasound image of Thyroid as input

Take the Ultrasound image of thyroid as an input to MATLAB. The below figure is an example for the ultrasound image

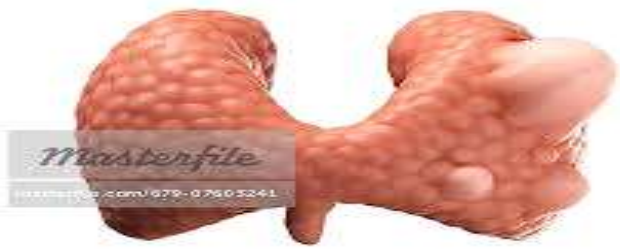

Figure 1Input thyroid image

2) Grayscale Imaging

Ultrasound imaging (sonography) uses high-frequency sound waves to view inside the body. Because ultrasound images are captured in real-time, they can also show movement of the body's internal organs as well as blood flowing through the blood vessels. Unlike X-ray imaging, there is no ionizing radiation exposure associated with ultrasound imaging which is under test or desired. Generally when we see MRI images on computer they look like black and white images. In analog practice, gray scale imaging is sometimes called "black and white," but technically this is a misnomer. In true black and white, also known as halftone, the only possible shades are pure black and pure white. The illusion of gray shading in a halftone image is obtained by rendering the image as a grid of black dots on a white background (or vice versa), with the sizes of the individual dots determining the apparent lightness of the gray in their vicinity. The halftone technique is commonly used for printing photographs in newspapers and as MRI image is taken on computer then In the case of transmitted light (for example, the image on a computer display), the brightness levels of the red (R), green (G) and blue (B) components are each represented as a number from decimal 0 to 255, or binary 00000000 to 11111111. For every pixel in a red-green-blue (RGB) gray scale image, R = G = B. The lightness of the gray is directly proportional to the number representing the brightness levels of the primary colors. Black is represented by R = G = B = 0 or R = G = B = 00000000, and white is represented by R = G = B = 255 or R = G = B = 11111111. Because there are 8 bits in the binary representation of the gray level, this imaging method is called 8-bit gray scale. Gray scale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. So because of the above reasons first we convert our Ultrasound image to be pre-processed in gray scale image[7].

Figure 2 Grayscale image

3) Wiener Filter

In image processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to

improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighbouring entries. The pattern of neighbours is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median. This filter enhances the quality of the Ultrasound image[7].

The goal of the Wiener filter is to filter out noise that has corrupted a image. It is based on a statistical approach, and a more statistical account of the theory is given in the MMSE estimator article.

Typical filters are designed for a desired frequency response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible. Wiener filters are characterized by the following:

- Assumption: image and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation
- Requirement: the filter must be physically realizable/causal (this requirement can be dropped, resulting in a non-causal solution)
- Performance criterion: minimum mean-square error (MMSE)

Figure 3 Image after applying filter

4) Threshold Segmentation

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and et all .k-means clustering can also be used. In computer vision, Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in Medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes[7].

Figure 4 Threshold output

5) Region Growing Segmentation

Region growing method mainly considers the relationship between the pixels and it's spatially neighbourhood pixels. It is a way of extracting connected region in a image according to predefined standard. Specific approach is as follows: first, identify one or more seed points as the starting point(s) of growth, and then merge the pixels which have the same or similar characteristics with the seed pixels in the neighbourhood into the area of the seed pixels. Regard these new pixels as new seed pixels to continue the process above until there is no pixels which suffice the conditions. The core of the region growing method is the selection of seed point and the measure of regional similarity. Region growing method has the advantage of simple calculation, and it also considers the pixel similarity and spatial neighbourhood, thus it can effectively eliminate isolated noise points, and it is especially suitable for the segmentation of small structures, such as tumor and scar detection and segmentation[7].

Figure 5 Region growing output

III. SIMULATION RESULTS

MATLAB is the most useful software package environment for engineering and technology implementation. It is used for the specific purpose in different fields of technology based on electronic programming, scientific and engineering, graphical illustration, accurate numerical calculation and algorithms development etc.The algorithm has been designed and implemented using Image Processing tool box.

A. Case-1

1) Input image

Figure 6 Input Thyroid Image

The above figure is the image of damaged thyroid nodule which is taken as input to our segmentation process.

2) Gray scaled image

Figure 7 Grayscaled image

The above figure is the grayscaled image of the input thyroid image. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

3) Wiener filter output

Figure 8 Wiener filter output

The above figure is the grayscaled image of the input thyroid image.Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

4) Output image after segmentation

a) Threshold Segmentation

Figure 9 Threshold output

The above figure is the output image after threshold segmentation. The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy.

b) Region Growing Segmentation

Figure 10 Region Growing Output

The above figure is the output of the region growing method. Region growing is a classical segmentation method. This method tries to extracting an image region that is connected based on some predefined criteria. These criteria can be based on intensity information and/or edges in the image.

B. Case-2

1) Input image

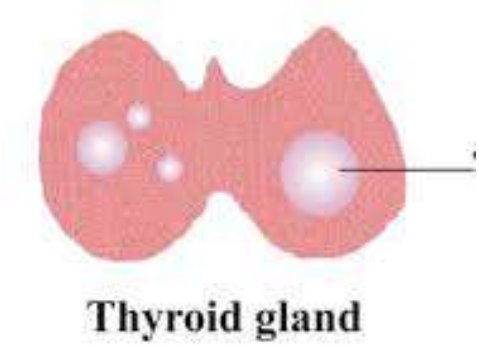

Figure 11 Thyroid gland

The above figure is the image of damaged thyroid nodule which is taken as input to our segmentation process.

2) Gray scaled image

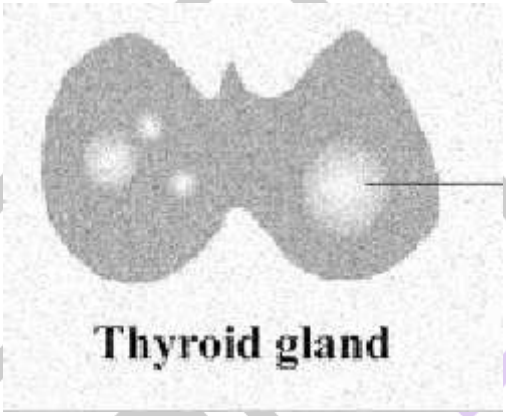

Figure 12 Grayscaled image

The above figure is the grayscale image of the input thyroid image. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

3) Wiener filter output

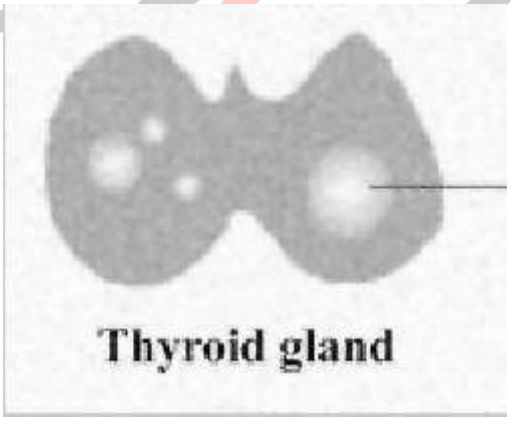

Figure 13 Wiener filter output

The above figure is the grayscaled image of the input thyroid image. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

4) Output image after segmentation

a) Threshold Segmentation

Figure 14 Thyroid gland

The above figure is the output image after threshold segmentation. The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy.

b) Region Growing Segmentation

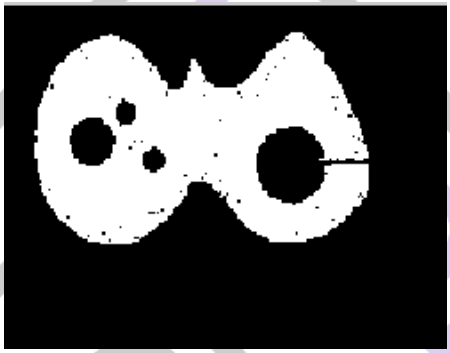

Figure 15 Region growing segmentation

The above figure is the output of the region growing method. Region growing is a classical segmentation method. This method tries to extracting an image region that is connected based on some predefined criteria. These criteria can be based on intensity information and/or edges in the image.

C. Case-3

1) . Input image

Figure 16 Input image

The above figure is the image of damaged thyroid nodule which is taken as input to our segmentation process.

2) Gray scaled image

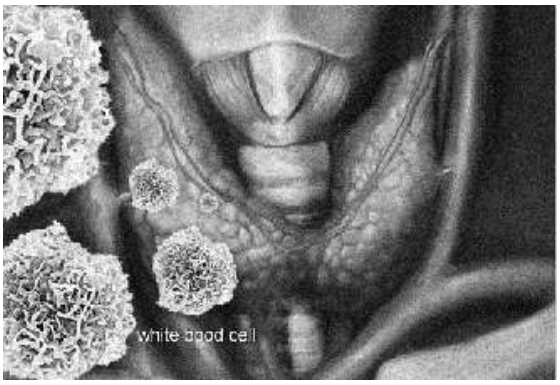

Figure 17 Grayscaled image

The above figure is the grayscaled image of the input thyroid image. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

3) Wiener filter output

Figure 18 Wiener filter output

The above figure is the gray scaled image of the input thyroid image. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths.

4) Output image after segmentation

a) Threshold Segmentation

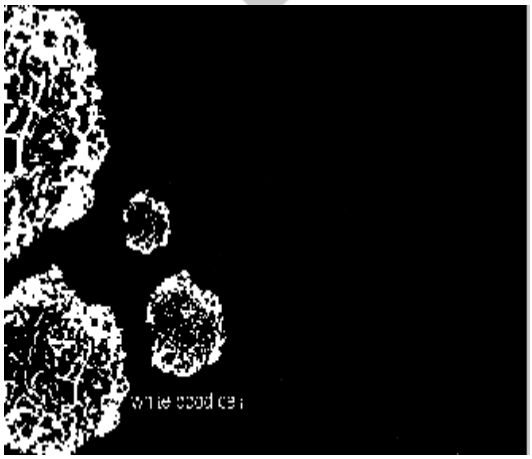

Figure 19 Threshold segmentation

The above figure is the output image after threshold segmentation. The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy.

b) Region growing segmentation

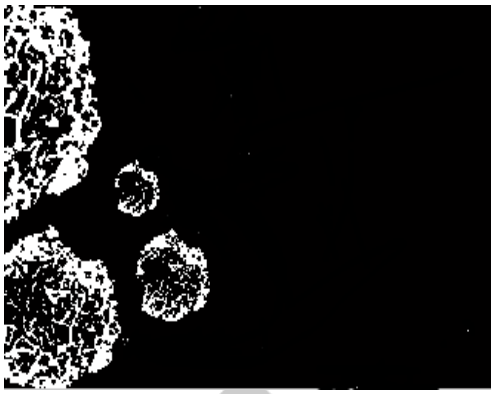

Figure 20 Region growing segmentation

The above figure is the output of the region growing method. Region growing is a classical segmentation method. This method tries to extracting an image region that is connected based on some predefined criteria. These criteria can be based on intensity information and/or edges in the image.

IV. CONCLUSION

In this paper we have proposed an innovative method for completely automatic identification of thyroid nodule by microscopic image in order to provide an automated procedure as support medical activity in reorganization of disorder in the in the thyroid.The results obtained show that the proposed methods are able to identify in a robust way the thyroid nodule present in the image being able to properly classify all the thyroid glands suffering from disease and offering a good level of overall accuracy.Further developments of the proposed methods would effect the separation step, which is of considerable importance in order to take into account all thyroid nodules in the image.

V. FUTURE SCOPE

In future we can extend the work to classify the thyroid according to its type and we can also analyze the thyroid growth by calculating the features like area, volume and centroid of sequential images of thyroid affected patient.

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AUTHOR'S BIOGRAPHY

Mr.Polepogu Rajesh[1] was born in Chejarla, Guntur district, A.P. On January 7th, 1985.He received his B.Tech Degree in Electronics and Instrumentation Engineering branch from Bapatla Engineering College, Bapatla, A.P in 2007 and M.Tech degree in Instrumentation and Control Systems Specialization from JNT University College of Engineering, JNTU Kakinada, Kakinada in 2010.He has 6 years of experience in teaching. He is at present working as an Assistant Professor, Department of EIE in V.R Siddhartha Engineering College, Vijayawada, A.P, India.He has authored over nine research papers in refereed journals and over six papers in conference proceedings. His interested areas are Adaptive Signal Processing, Stochastic Signal Processing, Biomedical Signal Processing and Biomedical Image Processing.

Mrs.Kunduru Umamaheswari[2] was born in Nellore, Nellore district. A.P, On July 16th, 1977.She received her B.Tech Degree in Electronics and Instrumentation Engineering branch from Bapatla Engineering College, Bapatla, A.P in 1998 and M.Tech Degree in Digital Systems and Computer Electronics Specialization at Narayana Engineering College, Nellore, A.P in 2012. She has 8 years of teaching experience. She is at present working as an Assistant Professor, Department of EIE in V.R Siddhartha Engineering College, Vijayawada, A.P, India.She has authored over ten research papers in refereed journals and over four papers in conference proceedings. Her interested areas are Adaptive Signal Processing, Biomedical Signal Processing and Biomedical Image Processing.