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THYROID SEGMENTATION IN US IMAGES USING NEURAL NETWORKS

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Abstract: *The thyroid gland is highly sensitive organ in the neck. It lies in the interior portion of the neck in front of the larynx.US imaging is commonly used for detection of abnormalities in thyroid gland due to less costly and easy process than other techniques like CT ,MRI.US images consist of noise and are blurred so there is a need to segment US image. In this paper we use neural networks with image processing for segmentation which give better results.*

Keywords- *Image enhancement, feature extraction, training of feed forward neural, thyroid segmentation.*

I. INTRODUCTION

Image processing is an endless zone comprehensive of many subareas but it can be seen as a single block in which given input is an image or a video and output is either a image or video or set of parameters connected with the image.[1] Its utilization broadly in medical imaging handling helps radiologist in determination of a problem and its spares time which consume during physically analysis. [2]Since radiologist meet many cases consistently, in this manner conclusion physically is timeconsuming and laborious.[3] PC supported conclusion incorporates the essential guideline of picture handling i.e. image acquisition, image pre-processing, picture division or some other assignment as indicated by one's need.[4]In medical image processing, there are different imaging modalities like X-ray, MRI, CT scan, OCT, ultrasound and so forth.[5]

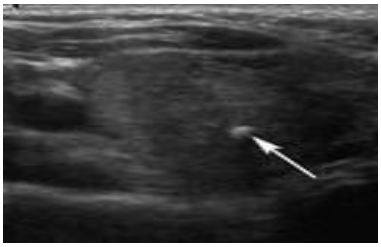
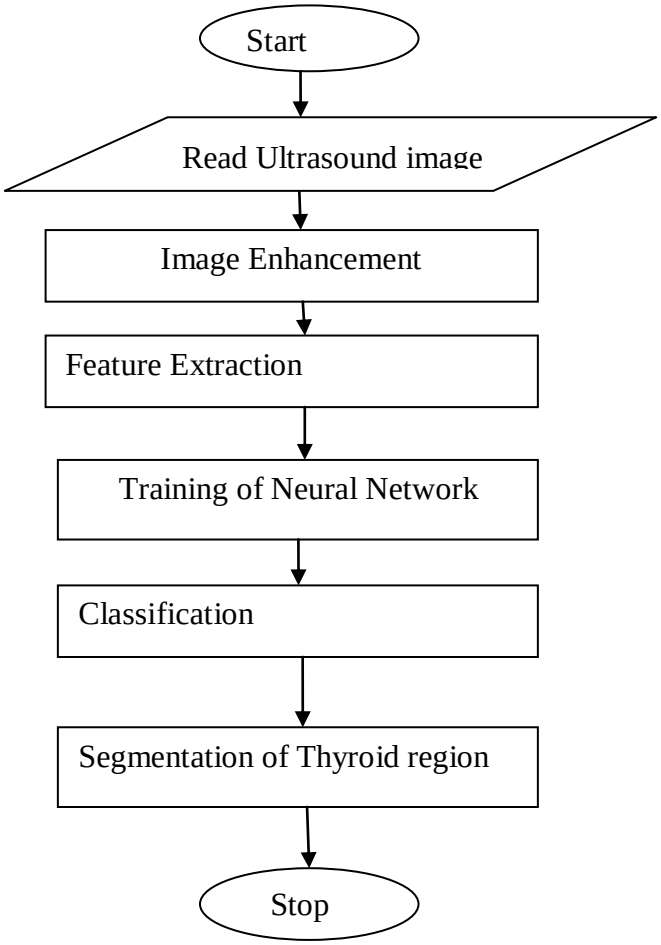


Figure 1: Thyroid Ultrasound Image

Thyroid gland is one of the largest endocrine gland and is located below the skin and muscles at the front of the neck.[6]Ultrasound is the foremost instrument for the finding of thyroid organ.US imaging main advantages include non-invasiveness, low-cost and short acquisition times.[7] The interpretation of US images is not a trivial task. A long learning curve is required for radiologists so as to acquire skills in recognizing the image features that comprise risk factors for different diseases, whereas it is difficult to remove the subjective element from the diagnostic process.In this paper we use Feed forward neural network to automatic segment thyroid gland.[8] Before

segmentation various feature extractions techniques are used to get features of the thyroid and non-thyroid region. In the rest of this paper image pre-processing i.e. image Enhancement, feature extraction ,feed forward neural networks and experiment results are given.

II. THYROID SEGMENTATION



Different image acquisition methods have diverse sorts of noise.Ultrasound image has speckle distribution in addition to structure and grain noise.[9]

After the image has been selected it is preprocessed to get a suppressed and an enhanced image. It needs to be transformed for further investigation i.e. here we have to segment the thyroid gland. Image segmentation is a fundamental step in image processing. Different segmentation techniques are active contour models (ACMs) , Watershed , Clustering and so on but due to better results and better performance ,neural networks are preferred. There are mainly four steps involved inour proposed methods which are as follows:

1. Image Enhancement
2. Feature Extraction
3. Training Feed Forward Neural Network
4. Thyroid Region Classification

- **Image Enhancement**

Image enhancement is a method of improving the definition of a video image by a computer program, which reduces the lowest grey values to black and the highest to white: used for images from microscopes, surveillance cameras, and scanners.Image enhancement is the methodology of enhancing the nature of a digitally put away picture by controlling the picture. It is simple, for instance, to make a picture lighter or darker, or to build or lessening difference. This task utilizing fuzzy improvement. In the field of picture enhancement, a tenet is equipped for performing a basic smoothing activity as takes after:[10] If a pixel is much brighter (darker) than neighboring pixels THEN decrease (build) its luminance, else abandon it unaltered.[11] Utilization of hypothesis of fuzzy sets to picture investigation is to consider pictures as fuzzy subsets of a plane. The utilization of fuzzy sets gives a premise to a precise route for the usage of unclear and uncertain ideas. The control of these ideas prompts hypothesis of estimate utilizing fuzzy frameworks as a part of picture preparing.[12] On the off chance that the watched information are exasperates by irregular commotion then the fuzzification administrator ought to change over the probabilistic information into fuzzy numbers or fuzzy (possibilistic) information, so that computational proficiency is improved since fuzzy numbers are much less demanding to control than arbitrary variables. The primary target of a picture improvement is to draw out the shrouded picture subtle elements or to build the picture stand out from another element range.[13]

There are two techniques for image enhancement
Histogram equalization
Morphological operator

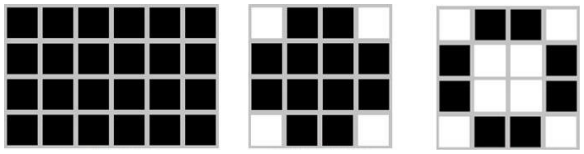
- **HISTOGRAM EQUALISATION**

Histogram equalization (HE) is a standout amongst the most famous systems utilized for picture contrast upgrade, since HE is computationally quick and easy to actualize [1, 2].[14] HE performs its operation by remapping the dim levels of the picture taking into account the likelihood dispersion of the data dark levels. Then again, HE is infrequently utilized in buyer electronic applications, for example, feature

reconnaissance, advanced cam, and TV, since HE has a tendency to present some irritating antiques and unnatural upgrade, including force immersion impact. One of the explanations behind this issue is that HE typically changes the shine of the picture fundamentally and along these lines makes the yield picture, get to be soaked with brilliant or dull force values. Thus, splendor safeguarding is a critical trademark that needs to be considered keeping in mind the end goal to improve the picture for shopper electronic items.

- **MORPHOLOGICAL OPERATORS**

The term morphology refers to the description of the properties of shape and structure of any articles.[15] In the connection of PC vision, this term refers to the portrayal of the properties of shapes of regions on the picture.[16] Operations of scientific morphology were initially characterized as operations on sets, yet it soon got to be pass that they are likewise helpful in the handling undertakings of the arrangement of focuses in the two-dimensional space. Sets in numerical morphology speak to protests in the picture. It is anything but difficult to see that the arrangement of all foundation pixels of twofold picture is one of the choices for a full depiction. In any case numerical morphology is utilized to concentrate a few properties of the picture, helpful for its presentation and portrayals. For instance, shapes, skeletons and curved frames.[17] Additionally morphological routines are utilized as a part of the preparatory and last picture handling. For instance, morphological sifting, thickening or diminishing. The information for the scientific morphology are the two pictures: prepared and extraordinary, contingent upon the kind of operations and tackle issues. Such an extraordinary picture called primitive or structural component. Regularly, a structural component is much littler than the transformed picture. Structural component can be viewed as a depiction of the region with some structure.[18] It is pass that the shape can be subjective, the length of it can be spoken to as a paired picture of a given size. In numerous picture preparing bundles the most widely recognized structural components have an uncommon name: BOX [H, W]-rectangle of given size, DISK [R] - drive a given size, RING [R] - the ring of a given size.



Regular type of structure components The aftereffect of morphological operation relies on upon the size and design of the first picture and the structural element.[19]The measure of the structural component is typically equivalent to 3, 4 or 5 * 5 pixels. This is because of the principle thought of the morphological handling, which are pursuit of the particular picture subtle element. The wanted thing is portrayed by a primitive, bringing about morphological preparing, you can highlight or evacuate such things overall picture. One noteworthy point of interest of the morphological methodology is its straightforwardness: both the info and yield handling system, we acquire the binarized picture. Different systems, ordinarily from the first picture first get a grayscale picture, which is then decreased to double utilizing a limit capacity.

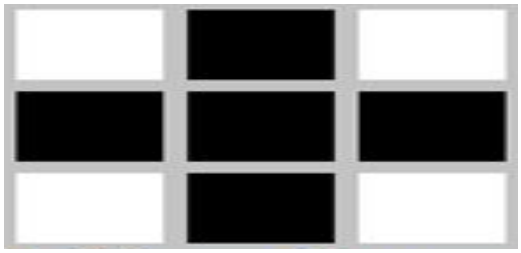
III. Basic operation

The essential operations of scientific morphology are the enlargement, disintegration, conclusion and separation. In these names catch the embodiment of operations: widening builds the picture, and disintegration makes it less, conclusion operation permits you to close the internal opening district and dispose of the coves along the outskirt territory, the operation of separation aides dispose of little sections, jutting districts close to its fringes. Next will be displayed a scientific meaning of morphological operations.

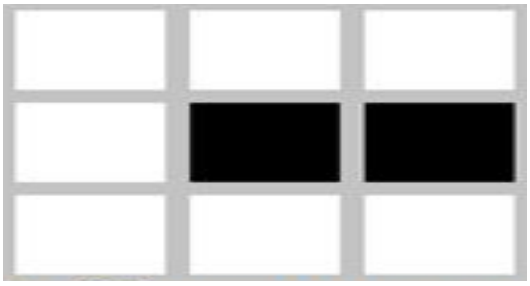
The union, intersection, complement, difference

Before undertaking to the operations of morphology, it bodes well to consider the set-theoretic operations fundamental scientific morphology.[20] The union of two sets An and B, which is indicated $C = A \cup B$, is by definition the situated of all components having a place with either the set An, or set B, or both sets all the while. Also, the crossing point of two sets An and B, meant $C = A \cap B$, is by definition the situated of all components that have a place at the same time to both sets An and B. Supplement of A will be an arrangement of components not contained in An: $Ac = \{w \mid w \notin A\}$. The distinction of two sets An and B is meant $A \setminus B$ and is characterized as takes after: $A \setminus B =$

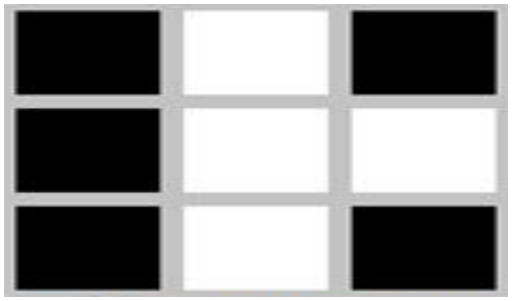
$\{w \mid w \in A, w \notin B\} = A \cap Bc$. This set comprises of components An, are excluded in situated B. Consider all the above operations on a example



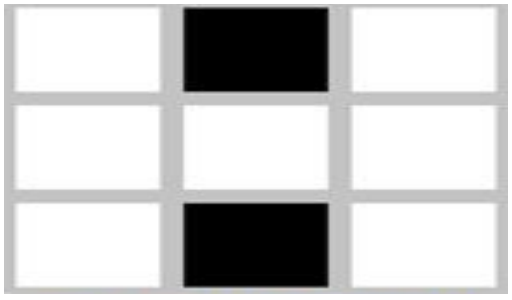
C = A ∪ B Union



C = A ∩ B Intersection



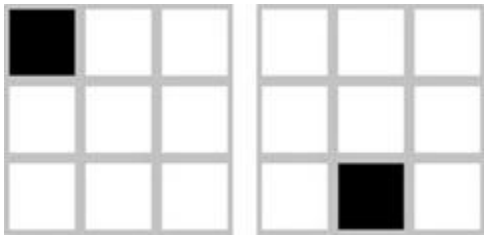
C = Ac Complement



C = A \ B Difference

Translation

Translation operation of Xt set of pixels X and the vector t is given in the structure $Xt = \{x + t \mid x \in X\}$. Thusly, the exchange of numerous individual pixels on the twofold picture moves all the pixels are situated at a predefined separation. Interpretation vector t can be determined as a requested pair (Δr, Δc), where Δr - a part of the move vector toward columns, and Δc - a segment of the move vector toward the picture seg



IV. Feature extraction

After division, highlights are removed either at the cell or at the tissue-level to quantify morphological attributes of picture for variation from the norm or to order the picture for distinctive evaluations of malady. The phone level highlights concentrates on evaluating the properties of individual cells without considering spatial reliance between them. For a solitary cell, the morphological, textural, fractal, and/or power based highlights can be separated. The point of the analysis step is (i) to recognize kindness and threat or (ii) to group diverse danger levels by making utilization of separated highlights.. These can be utilized for investigation of histology picture as 1) typical or anomalous picture, 2) for recognizing evaluations of tumor. Dim Scale, Texture, Symmetrical and morphological highlights are extricated. These removed highlights are given as information to encourage forward neural system for grouping

At the point when the data information to a calculation is so substantial it would be impossible be transformed and it is suspected to be repetitive[21] (e.g. the same estimation in both feet and meters, or the tedium of pictures displayed as pixels), then it can be changed into a decreased arrangement of highlights (additionally named highlights vector). This procedure is called highlight extraction. The extricated highlights are relied upon to contain the pertinent data from the information, so that the wanted errand can be performed by utilizing this decreased representation rather than the complete starting information.

Log Gabor filter

In signal processing it is useful to analyze space and frequency characteristics simultaneously. While the Fourier change gives the recurrence data of the sign, it is not limited. This implies that we can't figure out which some piece of a (maybe long) flag delivered a specific recurrence. It is conceivable to utilize a brief time Fourier change for this reason, however the brief time Fourier change constrains the premise capacities to be sinusoidal. To give a more adaptable space-recurrence signal deterioration a few channels (counting wavelets) have been proposed. The Log-Gabor channel is one such channel that is a change upon the first Gabor filter.The preference of this channel over the numerous choices is that it better fits the insights of characteristic pictures contrasted and Gabor channels and other wavelet channels.

Applications

The Log-Gabor channel has the capacity portray a sign regarding the nearby recurrence reactions. Since this is a major sign investigation system, it has numerous applications in sign handling. For sure any application that uses Gabor channels, or other wavelet premise capacities may advantage from the Log-Gabor channel. However there may not be any profit relying upon the particulars of the configuration issue. By the by, the Log-Gabor channel has been indicated to be especially helpful in picture preparing applications, in light of the fact that it has been demonstrated to better catch the insights of characteristic pictures.

In picture transforming, there are a couple of low-level cases of the utilization of Log-Gabor channels. Edge location is one such primitive operation, where the edges of the picture are named. Since edges show up in the recurrence area as high frequencies, it is regular to utilize a channel, for example, the Log-Gabor to select these edges. These identified edges can be utilized as the information to a division calculation or a distinguishment calculation. A related issue is corner identification. In corner location the objective is to discover focuses in the picture that are corners. Corners are valuable to discover on the grounds that they speak to stable areas that can be utilized for picture coordinating issues. The corner can be portrayed as far as confined recurrence data by utilizing a Log-Gabor filter.

In example distinguishment, the information picture must be changed into a highlight representation that is less demanding for a characterization calculation to discrete classes. Highlights structured from the reaction of Log-Gabor channels may structure a decent arrangement of highlights for a few applications in light of the fact that it can provincially speak to recurrence data. Case in point the channel has been effectively utilized as a part of face statement classification. There is some confirmation that the human visual framework forms visual data in a comparative way.

There are a large group of different applications that require restricted recurrence data. The Log-Gabor channel has been utilized as a part of utilizations, for example, picture enhancement, discourse analysis,and picture denoisingamong others.

Feed forward neural network

A **feed forward neural network** is an artificial neural network where connections between the units do not form a directed cycle.[22]The feedforward neural network was the first and simplest type of artificial neural network devised.[23] In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes. There are no cycles or loops in the system.

Classification

The Feed Forward neural system comprises of neurons, that are orchestrated into the layers. The primary layer is the info layer, the last layer is known as the yield layer, and the layers between data layer and yield layers are shrouded layers. This systems data streams just in one course that is forward, from information towards the yield. The info to this Feed Forward neural system is the highlights removed from the cell cores of the Histopathology picture.[24] The Back proliferation calculation is utilized to prepare this Feed forward neural system.

1. Compute weighted entireties in the first hidden layer
2. Apply the initiation work
3. Figure the weighted total
4. Get the results

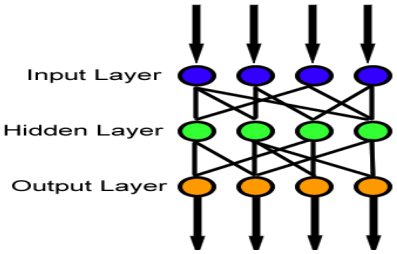


Figure-2 Feed forward neural network

V. RESULTS

The proposed algorithm is now applied to the images and the required region of thyroid gland is extracted. various experiments were performed on the ultrasound images of thyroid gland to check the performance of proposed method. To check the performance of the proposed method 5 standardized measurements are taken i.e. Accuracy, Sensitivity, Specificity, True positive rate, False positive rate. These are defined as follows:

$$\text{Accuracy} = \frac{TP+TN}{AP+AN}$$

$$\text{Sensitivity} = \frac{TP}{AP}$$

$$\text{Specificity} = \frac{TN}{AN}$$

$$\text{TPrate} = \frac{TP}{TP+FN}$$

$$\text{FP rate} = 1 - \frac{TN}{(TN+FP)}$$

TABLE 1: SEGMENTATION EFFICIENCY OF EXISTING METHOD

Us image	Accuracy	Sensitivity	specificity	FP rate	FN rate
Case 1	97.44	93.11	99.32	0.68	6.89
Case 2	94.90	80.63	98.82	1.18	19.37
Case 3	96.94	95.84	97.43	2.57	4.16
Case 4	97.02	85.98	99.83	0.17	14.02
Case 5	96.27	89.75	99.14	0.86	10.25
Average	96.51	89.06	98.90	1.09	10.93

TABLE 2: SEGMENTATION EFFICIENCY OF PROPOSED METHOD

Us image	F measure	Accuracy	Sensitivity	TP rate
Case 1	98.90	98.32	97.84	97.84
Case 2	98.78	98.39	97.60	97.60
Case 3	98.68	98.28	97.41	97.41
Case 4	98.87	98.22	97.77	97.77
Case 5	98.51	97.92	97.07	97.07
Average	98.75	98.22	97.53	97.53

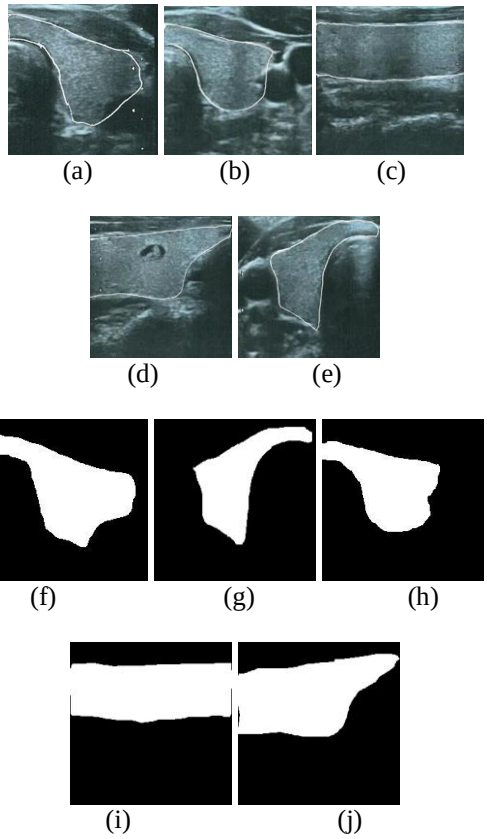


Figure 3.(a)-(e) Original ultrasound images,(f)-(j)segmented thyroid region using proposed method.

Experiments are done on few US images and results of some images are shown in fig. Fig (a)-(e) shows original US images.(f)-(j) shows segmented thyroid region using proposed method. Table 1 shows the segmentation efficiency of existing method and table 2 shows the segmentation efficiency of proposed method.

VI. DISCUSSION AND CONCLUSION

Us images are most common and have less cost rather than MRI and CT images. In the proposed method, US IMAGE is taken and noise is removed by image enhancement then features are extracted and then FF neural networks are used for intensity based classification and thyroid segmentation is done. The proposed method gives better results than existing methods.

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