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Segmentation for Thyroid Nodule in Ultrasound Images Using Fuzzy Histogram and Feed Forward Neural Networks

Mandeep Kaur[1], Deepinder Singh[2] and Mritunjay Kumar Rai[3]*

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

1. INTRODUCTION

Image processing is any type of signal processing for which the input is an image, such as a photograph or video outline; the output of image processing can be either an image or a arrangement of characteristics or parameters identified with the image [1]. The use of image processing is classification, feature extraction, pattern recognition and etc. Image segmentation is the process of partitioning or dividing a digital image into multiple segments. The objective of segmentation is to simplify alter the representation of an image into something that is more important, meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. It is vastly used in medical imaging processing which gives radiologists for diagnosis of problem which physicallyconsumes lot of time, so it saves time & relatively less laborious

Medical Imaging Analysis plays important role to identify various kinds of human diseases..Medical imaging is the strategy, procedure and art of creating visual representations of the interior part of a body for clinical analysis and medical mediation [2]. Medical imaging seeks to reveal inner structures hidden by the skin and bones, as well as to analyze and treat problem. In case of medical image processing various techniques are there to analize the human body like CT Scans,MRI, X-rays, OCT, US etc. US (Ultrasound) is the most broadly used tool since it has many advantages over other techniques like non-invasiveness, low cost, and short acquisition times [3]. Likewise, Ultrasound Images are able to give immediate information as well as various important characteristics & they does not include ionizing radiations [4]. But Ultrasound images containspeckle noise and grain noise. .Noise is the result oferrors which can effect the quality of an image.In order to improve the quality of image or to make the image noise-free image enhancement is necessary [5]

Thyroid Gland is a butterfly shaped organ & comprises of two cone lobes. It belongs to the endocrine system & situated in the neck just front of the larynx[6]. It controls the secretion of the thyroid hormone

[1,2] Department of Electronics and Communication, BGIET Sangrur, *Email: Manibhangu1991@gmail.com, wadhwadeepinder@gmail.com*

[3] School of Electronics and Electrical Engineering , LPU, Phagwara, *Email: raimritunjay@gmail.com*

* Corresponding Author

Figure 1: Thyroid ultrasound image

which regulates the human body temperature and also greatly affects the childhood intelligence,growth as well as adult metabolism.The undesirable development of cells on the thyroid forms a mass of tissue called as thyroid nodules . Nodules are nothing but some kind of disorders[7].The thyroid produces hormones that control metabolism. Metabolism is the sum of the physical and chemical processes in and a life form by which its material substance is created, maintained, and destroyed[8]. Every living substance has a metabolism. When the thyroid becomes faulty or malfunctions, metabolic disorders occur. There are two main types of thyroid malfunctions: hypothyroidism and hyperthyroidism.

2. THYROID SEGMENTATION

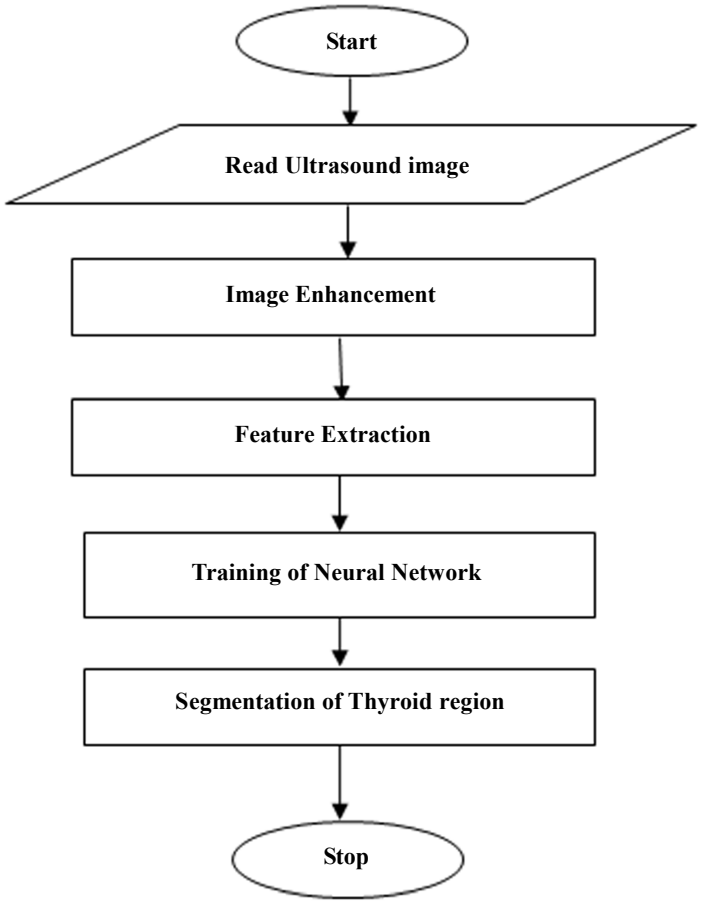


Figure 2: Flowchart Representing the Process

Input image contain different sort of noise. US image contain speckle noise and grain noise. After the image is chosen it should be preprocessed to get a noise free and enhanced image [9]. Image segmentation is a main step in image processing. Various segmentation algorithms are active contour models (ACMs),Watershed, Clustering[10]etc but use of neural network gives better performance and results. There are four major steps in our proposed method for thyroid segmentation which are as follows: 1) Locating the apparent thyroid region and image enhancement; 2) Feature extraction; 3) Training Feed forward neural networks; 4) Thyroid segmentation. These are classified as follows.

2.1. Image Enhancement

Image enhancement is the way toward enhancing the quality of a digitally stored image by manipulating the image[11]. Image enhancement is a method of improving the definition of a video image by a computer program, which reduces the minimal grey values to black and the highest to white: used for images from microscopes, surveillance cameras, and scanners [12]. Fuzzy histogram equalization is used for contrast enhancement in proposed work.

2.2. Fuzzyhistogram Equalization

Fuzzy enhancement is utilized , to make an image lighter or darker, or to incrementor decrement contrast [13]t simply fuzzy enhancement is utilizedfor contrast enhancement. As a part offield of image enhancement, a rule is equipedfor performing a simple smoothing activity as follows: If a pixel is much darker (brighter) than neighboring pixels THEN lessen (increase) its luminance, else leave it unaltered[14]. Application of theory of fuzzy sets to image examinations is to consider images as fuzzy subsets of a plane. The utilization of fuzzy sets provides a basis for a systematic way for the implementation of vague and imprecise concepts. The manipulation of these concepts leads to theory of approximation using fuzzy systems in image processing. If the analized data are disturbed by random noise then the fuzzification operator should convert the probabilistic data into fuzzy numbers or f, so that computational effectiveness is improved since fuzzy numbers are much easier to control than random variables.

2.3. Morphological Operators

Morphological Operators are additionally utilized for image enhancement. The essential operations of mathematical morphology are the dilation (enlargement), erosion, closure and disconnection(separation)[15]. In these names catch the essence of operations: dilation increases the image, and erosion makes it less, closure operation allows you to close the inner whole region and dispose of narrows along the border area, the operation of disconnection helps disposes of little fragments, protruding regions near its borders. Closing and opening operators were connected to the image to remove the repetition enhanced by AWMF.

2.4. Feature Extraction

Feature Extraction strategy is mainly used to separate important features from original image which contains repetitive data but not much information[16]. The target of utilizing feature extraction techniques is to change the input data into a decreased representation set of elements in order to remove significant information., features are extracted either at the cell or at the tissue-level to quantify morphological characteristics of image for abnormality or to classify the image for different grades of disease[17]. The cellular-level components concentrate on measuring the properties of individual cells without considering spatial dependency between them. For a single cell, the morphological, textural, fractal, and/or intensity-based features can be extracted.

2.5. Feed forward neural network

The remarkable capacity of the neural network to give important information from complex and imprecise data makes its applicability wide in extracting patterns and objects that are too difficult to notify by humans

or by other computer techniques[18]. An artificial neural network is a gathering of interconnected nodes similar to the huge network of neurons in a brain. Each circular node represents an artificial neuron and an arrow represents a connection from the output of one neuron to the input of another neuron as shown below. Basically neural network has three layers i.e. input layer, hidden layer & output layer. These layers communicate with each other over a large number of weighted connections.

In our proposed work, we utilized a feed-forward neural network, trained with back propagation, for extracting pattern. There are three different layers in the network that are input, hidden and output layer. The connections in the feed forward neural network are unidirectional, which means signals or information being processed can only pass through the network in a one direction, starting from the input layer(s), passing through the hidden layer(s) to the output layer. Depending upon the number of inputs and extracted features, input and hidden layer contains enough number of neurons. In our applications a feed-forward network with a single layer of hidden units is used with a sigmoid activation function for the neurons. The architecture of FF neural network is shown in figure below:

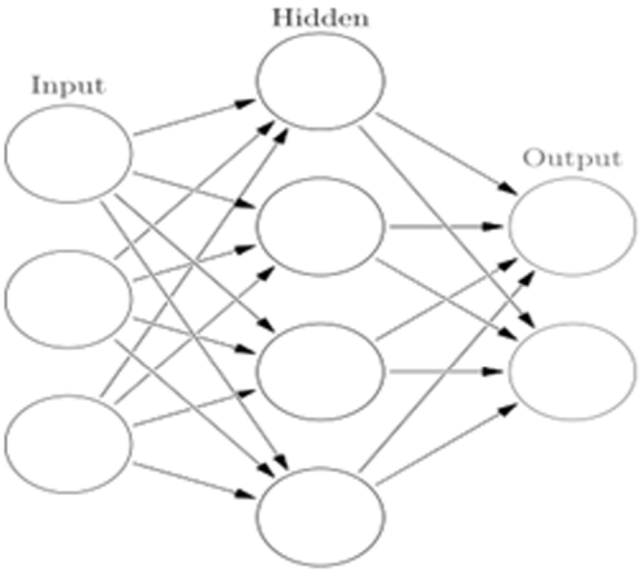


Figure3: Architecture of Feedforward network

The function of this network can be alienated into two phases: Training phase and classification phase.

During training phase, LevenbergMarquardt back propagation (LM) network training function is used that updates weight and bias values according to Levenberg-Marquardt optimization.

During classification phase, the extracted feature of image is taken as input and is transformed from input layer to output layer .Now classification can occur by selecting the category associated with the output unit that has the largest output value.

3. RESULTS

The proposed algorithm is now applied to the selected images and enhancement of image is done. After enhancement important features are extracted and required region of thyroid gland is extracted. Then feed forward neural network is used for thyroid segmentation of US images. In order to define the segmentation performance of proposed method some standardized parameters were evaluated like accuracy sensitivity, True positive rate, False positive rate etc. These are as follows.

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

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

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

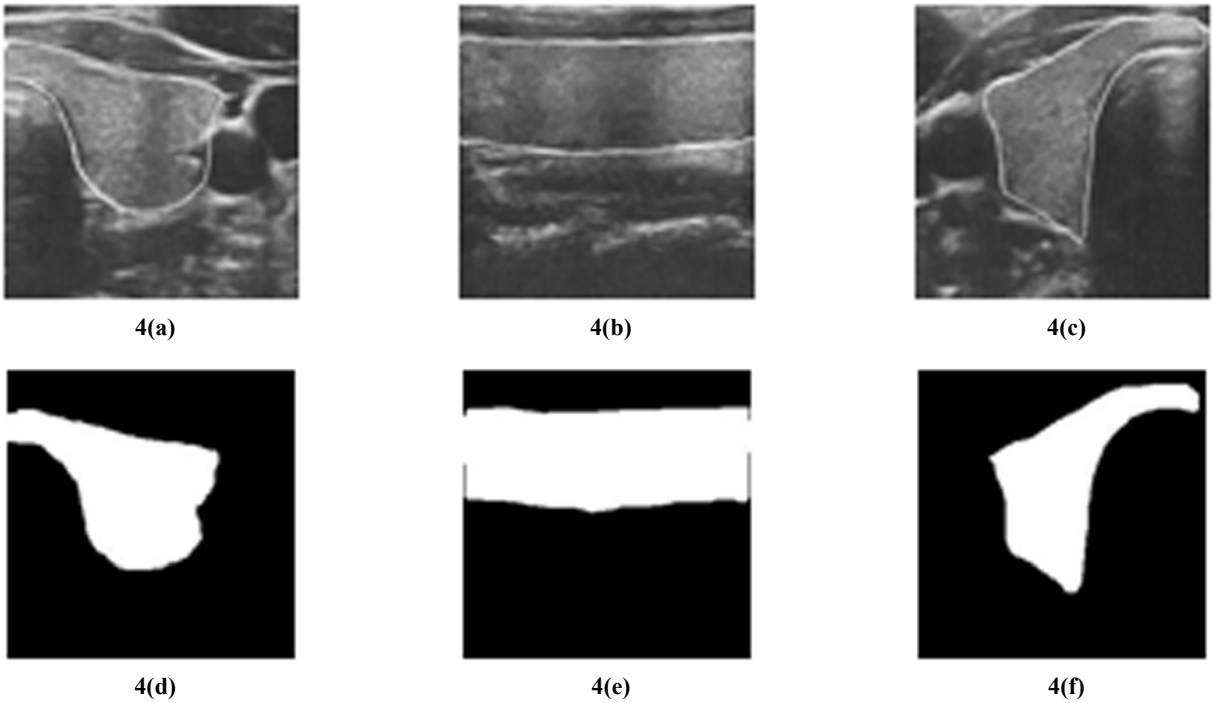
$$\text{TP rate} = \frac{TP}{TP + FN}$$

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

4. SEGMENTATION EFFICIENCY OF PROPOSED METHOD

Table 1

Us image	*F measure*	*Accuracy*	*Sensitivity*
IMAGE 1	98.95	97.30	97.82
IMAGE 2	98.76	97.36	97.62
IMAGE 3	97.88	98.20	97.75
Average	99.86	98.28	97.73



4(a) **4(b)** **4(c)**

4(d) **4(e)** **4(f)**

Figure 4: (a)-(c) Original ultrasound images,(d)-(f)segmented thyroid region using proposed method.

Experiments are done on few US images and results of some images are shown in fig. Fig (A)-(C) shows original US images.(D)-(F) shows segmented thyroid region using proposed method. Table Ishows the segmentation efficiency of proposed method.

4. DISCUSSIONSAND CONCLUSIONS

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. Fuzzy histogram algorithm is used for contrast enhancement in proposed method The proposed method gives better results than existing methods.

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