

Review of Segmentation of Thyroid Gland in Ultrasound Image using Neural Network

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ABSTARCT

The thyroid gland is highly vascular organ and it lies in the interior part of the neck just below the thyroid cartilage. In medical organization, there are many ways to detect the affected interior part of the thyroid gland like CT/MRI and ultrasound imaging. But CT/MRI are expensive techniques as compare to US images. But US images are blurred and consist of noise. In the existing method, to segment the thyroid gland in US images feed forward neural network techniques can be used. In the proposed method, we can improve the US images a new technique will be used.

Keywords

Feed Forward Neural Network, Feature Extraction, Image Processing, Thyroid Segmentation, Ultrasound images.

1. INTRODUCTION

Digital Image Processing is a wide area which includes large number of sub-areas further but fundamentally it is a single block in which image or a video is an input and output is either an image or video or set of parameters associated with an image. It is vastly used in medical imaging processing which helps radiologists for diagnosis of problem which manually consumes lot of time, so it saves time & comparatively less laborious. [1] Medical Imaging Analysis plays important role to detect different kinds of human diseases. [2] With technology advancements, computerized diagnosis becomes an active research area and provides an accurate judgements. Basic Principle of computerized diagnosis is an image processing which includes image acquisition, image pre-processing, image segmentation etc according to requirements.

If there should arise an occurrence of medicinal picture transforming different methods are there to diagnose the human body like CT Scans, MRI, X-beams, OCT, US and so on. US (Ultrasound) is the most broadly utilized tool [3] on the grounds that it has number of focal points over different systems like non-obtrusiveness, minimal effort, and short obtaining times [1]. Also, Ultrasound Images have the capacity to give prompt data and different vital attributes & they doesn't includes ionizing radiations. [4] But Ultrasound pictures contain dot clamor notwithstanding grain noise. [1] Noise is the consequence

of blunders which can corrupt the nature of an image. In request to improve the nature of picture or to make the picture commotion free picture upgrade is necessary. Various separating routines are there to upgrade the picture like AWM (Adaptive Weighted Median Filter) [1], anisotropic dispersion model [5] and so forth.

Thyroid Gland is a butterfly molded organ & comprises of two cone lobes. It fits in with the endocrine framework & found in the neck simply front of the larynx. It serves to control the emission of the thyroid hormone which directs the

human body temperature furthermore significantly influences the youth intelligence, growth and also grown-up metabolism. [6] The undesirable development of cells on the thyroid structures a mass of tissue called as thyroid nodules. [7] Nodules are only a disorders. Out of which the vast majority of the thyroid knobs are kindhearted & some may cause growth or malignant. We can likewise say that thyroid knobs are robust or cystic bumps framed in the thyroid organ which may get brought about because of different sorts of thyroid disorders. [3] The danger of building up a substantial thyroid knob in a lifetime goes between 5% & 10% while half of individuals with single nodules. [4]

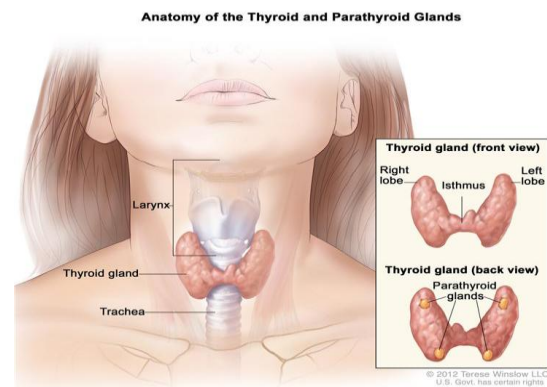


Figure 1. Thyroid Gland [14]

Picture division is the procedure of parceling a computerized picture into numerous fragments or sets of pixels otherwise called super pixels. [8] It is utilized for finding the articles and limits in pictures like lines, bends, and so forth. Motivation behind division is to adjust the picture representation into the structure which is more important & simple to examine.

Resultant division picture incorporates set of fragments that can conceal the complete picture all in all, or we can say that it is a situated of forms (sketching out) taken out from the picture. When it is connected to countless like if there should arise an occurrence of restorative imaging, after division of a picture the subsequent shapes (blueprints) can get used to create 3D reproductions by utilizing obliged calculations. Pixels are comparable in connection of a few properties like power, shading, surface etc & neighboring districts are altogether diverse regarding the same characteristics. [8]

Image segmentation is applicable in various areas like:-

- Machine Vision
- Medical Imaging for locating tumors and other pathologies, Surgery planning, Measure tissue volumes, Diagnosis, study of anatomical structure etc.

- Object Detection such as face detection & locate objects in satellite images (roads, forests, crops, etc.)
- Recognition Tasks such as Face recognition, Fingerprint recognition, iris recognition etc.
- Traffic Control Systems.

Various Image segmentation methods are given as follows:-

- Thresholding
- Clustering methods
- Compression based methods
- Histogram based methods
- Edge Detection
- Optimization Algorithms
- Region growing methods & Graph portioning methods.

A counterfeit neural system is a gathering of interconnected hubs like the immense system of neurons in a cerebrum. Every roundabout hub speaks to a manufactured neuron and a bolt speaks to an association from the yield of one neuron to the data of an alternate neuron as demonstrated below.[9] Basically neural system has three layers i.e. data layer, concealed layer & yield layer. These layers speak with each other more than an expansive number of weighted associations

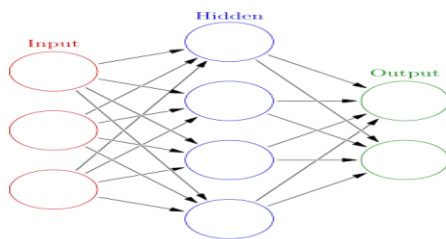


Figure 2 Neural Networks [15]

In machine learning, fake neural systems (ANNs) are a group of factual learning calculations inspired by organic neural systems (Central sensory systems like mind) & used to gauge the capacities that can rely on upon countless and are by and large unknown[9]. By and large, they are introduced as interconnected neurons to figure values from inputs & fulfilled of machine adapting and example distinction.

There is no single formal meaning of manufactured neural system. However, a class of factual models might regularly be called "Neural" in the event that they comprise of sets of versatile weights & are fit for assessing non-direct capacities. Versatile weights are association qualities between neurons, which get actuated amid forecast and in addition preparing stage.

Typically neural network is defined by following three parameters

1. Interconnection pattern between the different neuron layers.
2. Learning process to update the weights of the interconnection.
3. Activation function to convert weighted input of neuron into an output.

Neural Network includes following applications:-

- Function approximation or Regression analysis (time series prediction & modeling)
- Classification (pattern recognition, sequence recognition)
- Data processing (filtering, clustering)
- Robotics (directing manipulators)
- Control (vehicle control, process control, natural resources management)
- Decision making
- Financial applications like automated trading systems etc.[9]

Common types of Neural Network:-

- FFNN(Feed Forward Neural Network)
- FBNN (Feedback Neural Network)

2. RELATED WORK

In this part writing overview identified with past work and methodologies about thyroid division of ultrasound pictures is introduced. Different systems are there to diagnose the human body like CT Scans, MRI, X-beams, OCT, US and so forth .in the event of division the majority of the work is performed on ultrasound (US) pictures due to its favorable circumstances like non-intrusiveness, minimal effort, short securing times, capability to give quick information & they does not includes ionizing radiations.

In our writing review we have considered numerous exploration approaches. Our point is to study and break down the gimmick extraction, characterization & division approaches for fragmenting the thyroid organ to watch the outcomes.

Garg H.& Jindal A.[1] displayed a paper in which Feed-Forward Neural Network for division of thyroid organ ultrasound pictures has been talked about. With the end goal of division of US pictures, power of pixels and surface is taken as criteria and it is a crossover methodology. First and foremost they have done picture upgrade so as to uproot the spot clamor. A short time later different obliged gimmicks get removed to gauge the surface & to prepare the neural system. At that point creators actualized Feed-Forward Neural Network for power based grouping and their trial results demonstrate that neural system gives better results.

Chang CY. et al. [6]presented a paper in which thyroid organ division & volume estimation of thyroid has been presented. Firstly, Image Pre-preparing has been carried out to make the picture commotion stifled and peculiarities get extricated to prepare the neural system. At that point, Radial Basis Function (RBF) Neural Network has been connected to group the squares whether it is thyroid or non-thyroid organ territory. To recuperate the precise state of thyroid organ area, creator connected the district developing strategy. With the end goal of volume estimation of thyroid organ, they connected Particle Swarm Optimization (PSO) calculation. They contrasted Volume Estimation of Proposed Method and different strategies like standard GA.

Gopinath B. & Gupta B.R.[7] introduced a paper which includes the division and grouping of Papillary carcinoma & Medullary carcinoma cells in FNAB (Fine Needle Aspiration Biopsy) infinitesimal cytological pictures of thyroid knobs. They have utilized numerical morphology for picture division so as to expel the foundation recoloring data from infinitesimal pictures. At that point, Feature Extraction is

carried out by Discrete Wavelet Transform (DWT) and Gray Level Co-event Matrix (GLCM). For arrangement they have utilized k-Nearest Neighbor (kNN) classifier. Analytic exactness reported by the DWT & GLCM is 97.5% and 75.84% individually. Creators executed Majority voting guideline to enhance the symptomatic exactness of GLCM by 90%.

Savelonas M.A. et al.[4] proposed a novel Active Contour Model for exact outline of thyroid knobs of assorted shapes on the premise of their composition & reverberation -genicity in ultrasound pictures. Proposed model is named as JET (Joint Echogenicity Texture) which incorporates provincial picture force & factual surface ^{gimmick} conveyances or LBP disseminations by using Mumford-Shah utilitarian otherwise called negligible parcel issue. Chan-Vese Model additionally utilized as a part of definition of JET model so as to keep up the power data. Creator executed JET for dividing the US pictures containing hypoechoic, hyperechoic and isoechoic knobs. Outline Performance of JET is equivalent to VBAC model (Variable Background Active Contour) furthermore develops its ability from depiction of hypoechoic to isoechoic knobs furthermore adapts to the impediments of cross breed multiscale model. Downside of proposed model is that it is not generally ready to separate structures like greater veins from real knobs.

Helme A. et al.[10] proposed an application called thermography which non-obtrusively judgment the thyroid organ malady. In light of non-intrusive framework, a PC based model gadget was outlined which can recognize & show the relative varieties of skin temperature & can diagnose the hyperactivity inside the thyroid organ. They likewise exhibited a FEA (Finite Element Analysis) of thyroid knob to assess the temperature circulation in mix with model and to focus the obliged sensor determination. They have utilized Non-contact IR (infrared) thermocouple sensors & Data Acquisition (DAQ) framework which is tactile 518 card having 16 bit determination. Recreation results anticipated that a thermocouple temperature determination of 0.1 °C would be sufficient for tackling the issue. Downsides of the framework are that it includes variability in sensor skin separation, restricted determination & optical covering in center arrangement. Future degree includes the framework with remote connections between the quiet's position and specialist's office, use of fiber optics keeping in mind the end goal to center the infrared range for examining and to give better determination.

Lakovidis D. K. et al.[11] exhibited a paper for division of US pictures so as to depict thyroid knobs precisely. They actualized a methodology called GA-VBAC i.e. a blend of GA (Genetic Algorithm) & VBAC (Variable Background Active Contour model). VBAC uses variable foundation districts with a specific end goal to minimize the force inhomogeneity impacts in thyroid US pictures. They utilized GA to consequently & productively look the VBAC parameters without obliging any specialized abilities. Trial results demonstrate that GA-VBAC is a successful, proficient and very target framework for outline of thyroid in US pictures. As GA-VBAC acquired normal cover esteem 92.5% though specialists got 91.8%, so it is clear that GA-VBAC is skilled to acquire high outline precision relatively. Future work is to improve GA-VBAC by accelerating the preparation stage to make it practical for numerous US pictures & plan a

coordinated framework to consolidate heterogeneous data for judgment of thyroid knobs.

Maroulis D.E. et al.[12] introduced a paper on VBAC (Variable Active Contour Model) for outline of thyroid knobs in US pictures. They joins the profits of ACWE (Active Contour without Edges) with VBAC & dissimilar to excellent dynamic form models which are touchy if there should be an occurrence of power inhomogeneities, this proposed model likewise includes the variable foundation districts. At that point, they assessed VBAC & contrasted and ACWE display if there should be an occurrence of both engineered and additionally genuine US pictures. Trial results demonstrate that VBAC external performs ACWE when in homogeneity was considered. Likewise, its outlines of hypoechoic knobs are exact by 91% than that of ACWE in less cycles & it is similar to master radiologists as indicated by which it is plausible in clinical practice. VBAC met in 9.6% less cycles than ACWE & execution time is likewise speedier by 8.2%, as normal division time is 1min 33s for VBAC while for ACWE it is 1min 41 s.

Kollorz Eva N.K. et al.[13] exhibited a paper on volumetric evaluation of thyroid utilizing 3-D US imaging. They proposed a self-loader division approach for grouping & examination is carried out on the premise of the 3-D US information. Pictures get examined in 3-D then preprocessing keeping in mind the end goal to uproot spot commotion, sifting & division is carried out. Augmentation of Geodesic dynamic form level is examined in point of interest. They joined two anisotropic dispersion channels with level set based dissemination calculation. Affectability & Specificity of division was 75% & 97% individually. Mean Hausdorff separation is obliged under 3mm for clinical utilization.

Maroulis D.E. et al.[4] exhibited a paper on thyroid knob recognition in US pictures utilizing PC supported method that considers the in homogeneity of US pictures. They actualized VBAC includes variable subset of the picture as its experience which can change the shape to diminish the foundation in homogeneity impacts. Results get assessed by utilizing US pictures of 35 thyroid patients & demonstrates that VBAC (Variable Active Contour Model) gives quick joining and enhanced exactness similar to ACWE (Active Contour without Edges). As with VBAC they arrived at the meeting in 10% less calculation cycles than ACWE. Future work is to implant the textural gimmicks to watch the form advancement which empowers non hypo-echoic knobs recognition.

Keramidas E.G. et al.[14] introduced a paper in which they depicted TND (Thyroid Nodule Detector) which is a PC supported determination model for ultrasound pictures & features to identify the nodular tissue. This proposed technique incorporates four segments that considers novel commitments like TBD-2 calculation incorporates thyroid parenchyma for programmed meaning of ROI and combination of FLBP (Fuzzy Logic Binary Patterns) & FGLH (Fuzzy Gray Level Histogram). They examined the attainability of proposed system on genuine US pictures. Test results demonstrate that joining of FLBP & FGLH is more powerful relative to different systems. They additionally demonstrated that TND framework can get connected clinically. Precision in thyroid knob location has been assessed to surpass 95%. Future extension is to improve the TND with the assistance of modern programmed systems like GA & suitable shape approaches for outline of distinguished knobs.

3. PROBLEM FORMULATION

- 1.Existing Techniques are not always capable of distinguishing structures such as bigger blood vessels from actual nodules.
- 2.Existing segmentation techniques generally results in broken edges.
- 3.Existing techniques suffers from limited resolution & boundary leakage problem.
4. Existing techniques suffers from problem of official overlap during focus alignment.
5. Existing techniques are device dependent as they require different set of parameters for the segmentation if they get
6. acquired from different ultrasound devices.

4. METHODOLOGY

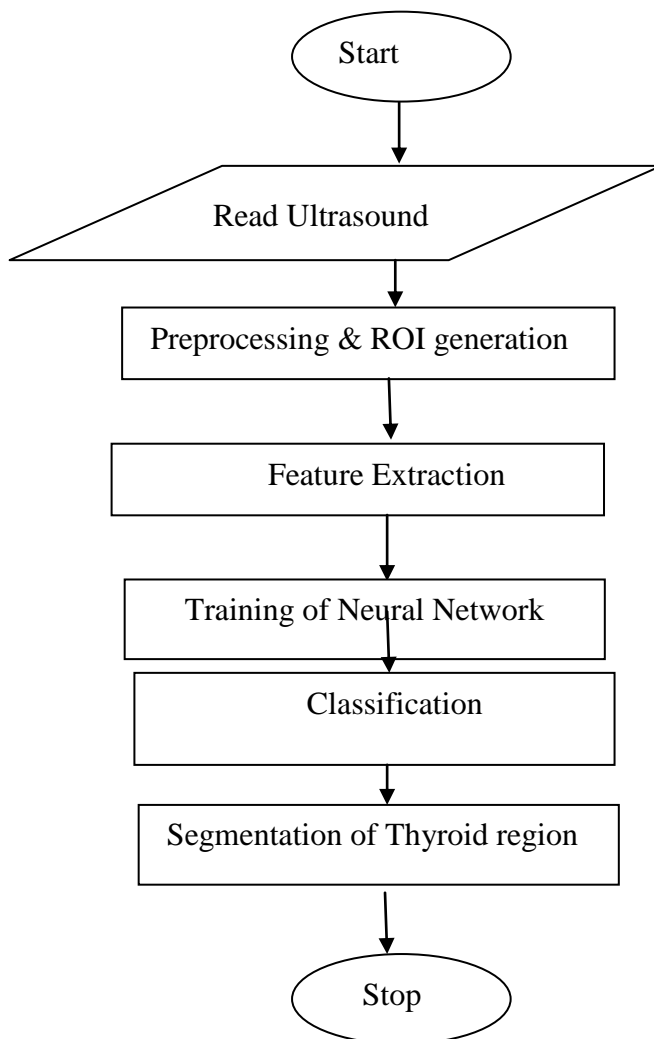


Figure3. Thyroid Segmentation steps

5. DISCUSSION

For the evaluation of proposed technique we have used MATLAB Simulation 2012a version and platform were installed at window 8.1 processor version. The proposed algorithm is now applied to the images in the data set and the required region of thyroid gland is extracted. Various experiments were performed to show the ability of the proposed method. The evaluated parameters were used Accuracy, Specificity, Sensitivity, False Negative Rate and False Positive Rate. The five measuring indices are defined as follows:

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

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

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

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

$$\text{FP Rate} = 1 - \frac{TN}{TN+FP}$$

We will compare all parameters with existing results by using our proposed techniques.

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