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Thyroid Segmentation and Volume Estimation Using CT Images

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ABSTRACT: Pathology of thyroid gland is determined by physicians with its volume as a significant indicator.For this thyroid area segmentation and volume estimation are necessary steps. Most physicians use CT images even if the volume of thyroid gland is determined using Ultrasound images, for precise evaluation of volume of thyroid gland. In this paper a Linear Vector Quantization neural network (LVQNN) with a pre-processing procedure and initial segmentation using cellular automata(CA) is proposed for thyroid segmentation and volume estimation using computerized tomography (CT) images.

KEYWORDS: Computerized Tomography images, Linear Vector Quantization Neural Network (LVQNN) computer-aided diagnosis, ultrasound (US), Cellular Automata (CA).

I. INTRODUCTION

The thyroid is a small gland, shaped something like a butterfly. It is located in the lower front part of the neck, just below the voice box and surrounds trachea. The thyroid produces hormones that are carried in the blood to every tissue in the body. It helps regulate metabolism, or how the body turns food into energy.It participates in these processes by producing thyroid hormones. But very less or excessive amount of these hormones causes various thyroid disorders. So usually by assessing thyroid gland volume physicians diagnose thyroid disorders.

For the evaluation and management of thyroid pathologies a precise estimation of the size of thyroid gland is a very useful tool. For example if a patient has hyperthyroidism, the size of his thyroid gland increases. But the size of the thyroid gland of patients with hypothyroidism decreases. Therefore in initial screening the size of thyroid gland is an important assessment parameter.

Medical image processing is a very important application of digital image processing, which deals with images of human body for the study of normal anatomy and physiology. Many medical imaging methods such as magnetic resonance imaging (MRI), computerized tomography (CT) and Ultrasound (US) images are applied to the diagnosis of different diseases with the help of medical analysis procedures. With respect to other usual medical procedures, they give painless but strong methods to find the internal structures and operations of human body.

In the diagnosis of thyroid diseases, US and CT are most common imaging technologies used.US is inexpensive, painless, easy to perform, widely available and does not contain any ionizing radiation. But this technology has disadvantages such as echo disturbance and noise, which makes the diagnosis difficult. so for more clear visualization CT images, are used. CT gives detailed picture of human body's muscle tissue, organs; soft tissues compared to US images.

Analyzing features and calculating the thyroid volume from a large number of CT images is difficult and time consuming task. Therefore Computer –Aided diagnosis of CT images is needed to classifying different thyroid disorders segmenting and evaluating the volume of thyroid gland for improving the reliability and decrease invasive procedures such

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as biopsy and fine Needle Aspiration (FNA) [1].Nowadays various machine learning techniques such as neural networks, genetic algorithms are widely used in medical image processing. These techniques can be applied to CAD systems to increase the performance of diagnosis of medical images [2]. Segmentation is the process dividing an image into regions with similar properties such as gray level, color, texture, brightness, and contrast. The role of segmentation is to subdivide the objects in an image.

Chen applied fractal analysis combined with a probabilistic neural network to describe the coarseness of liver tissues and classify CT liver regions into hepatoma or hemagoema[3]. Lee developed a multi module contextual neural network to perform the segmentation of abdominal CT images by taking the contextual information of each pixel into consideration [4]. Spatial fuzzy rules describing the location relationship of organs were then applied to the results for the identification of abdominal organs from a series of CT images [4].

For recurrent nasal papilloma detection, spatio-temporal neural networks have been developed to characterize the time evolution time evolution properties of lesions after the injection of an administrative material [5]. A Shape Cognitron neural network was developed for describing the shape features of micro calcifications from mammograms for malignant and benign tumour classification. A support vector machine (SVM)-based feature selection scheme was developed for selecting the features of stomach endoscopy images for gastric histology classification [6]. All of the above methods combined image analysis and learning algorithms to handle ambiguity and variation.

Most commonly used segmentation methods are include active contours (snakes), Level Sets, intelligent scissors, Graph cut. For active contours and Level Sets, the user initializes the boundary near the desired contour and the algorithm moves the boundary to a local minimum determined by energy functional [7]. This approach requires that the user solve two optimization problems: setting the impact of the terms in the functional, and placing the initial boundary such that the results settle into a desirable minimum [8]. Intelligent scissors connect-the-dots between user-placed boundary points, but either image noise or inaccurate placement of those points can generate inaccurate segmentations [9]. Graph cut uses graph-based operations to separate user-placed “seeds” so as to satisfy the max-flow/min-cut theorem, but demonstrates a bias toward small segmentations and is inherently a two-label approach [10].

This paper proposes a system that applies Linear Vector Quantization Neural Network to segment thyroid gland. A pre-processing step is done before the segmentation. It extracts the region of interest from the input CT image. This step separates the thyroid region from non-thyroid glands. In segmentation a basic segmentation is done using cellular automata. This result in a segmented thyroid region. This region is used to train the LVQ network .Three slices from each patient is considered. And after training the network is used to further classify the segmented region into thyroid and non-thyroid. After extracting the refined thyroid region area is measured from each slice. Then volume of the segmented thyroid gland is calculated. Figure 1 shows two thyroid regions [11].

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Figure 1. CT Image (thyroid regions are outlined in red) [11]

This paper is organized as follows. Section II contains the procedures used in this paper. Proposed algorithm includes steps such as pre-processing, segmentation and volume estimation. Section III discuss about the experiments and results obtained. Finally section IV contains conclusions.

II .THE PROPOSED ALGORITHM

This section contains the proposed segmentation and volume estimation of thyroid gland from CT images. There are three main steps, which are as follows: A) pre-processing; B) segmentation using LVQ neural network; C) volume estimation.Figure.2.shows the flow chart of proposed algorithm.

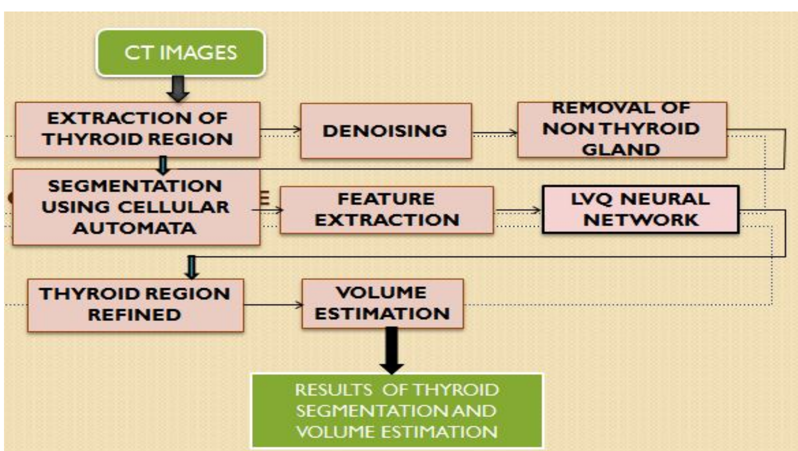

Figure 2.Flow chart of the proposed algorithm

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A.Preprocessing

Pre-processing is an important step in any image processing algorithm. The purpose of this step is to enhance the image data by eliminating unwanted noise or by improving some specific features that is relevant to particular applications. In this paper the purpose of pre-processing procedure to remove maximum possible non thyroid regions which interfere with further processing .This section includes extraction of thyroid region, filtering and removal of non-thyroid glands.

1) Extraction of Thyroid region

Processing correct part of input image helps to reduce unwanted area from the input image. This reduces computational cost and time. Normally thyroid gland surround trachea and situated below the neck. So thyroid region is extracted by first locating the trachea, since it is a homogeneous region with intensity 0[11].So after binarizing and edge detection, the input image is considered as a window of size 120 x 240 as trachea as its centre.

2*) Filtering*

An important factor that affects the image quality is noise. So noise removal is an important step in pre-processing in image processing to get important details from input images. In this paper a median filter is used to reduce the noise content in input CT images. Here a 3 x 3 window size median filter is used.

3) Removal of non-thyroid gland

Main aim of this step is to eliminate the non- thyroid glands with same intensity as that of thyroid gland. This procedure includes a k-means clustering method which will separate the ROI into three groups according to the intensity values. This will result in a group with high intensity value which contains both thyroid and non-thyroid glands. Then a region filling method is used to fill the holes and a erosion operation with a circular structuring element is used to remove the small parts. Then based on the anatomical features such as circularity, non-thyroid glands are removed.

B. Thyroid segmentation

Segmentation is an important procedure used in medical image processing for improving the quality of analysis of medical images during clinical diagnosis. This section includes segmentation using cellular automata, feature extraction, segmentation using LVQNN.

1) Segmentation using cellular automata

A cellular automaton is basically a computer algorithm that is discrete in space and time and operates on a lattice of cells [12]. Since it was first proposed by Von Neumann and Ulam [12], Cellular Automata has attracted researchers from various fields in both physical and social sciences because of its simplicity, and potential in modelling complex systems [13].Each individual cell is in a specific state and changes synchronously depending on the states of some neighbours as determined by a local update rule [13]. They are parallel, local and homogeneous, since the state of any cell depends only on the states of the local neighbours at the previous time step and the update rules are same for every cell.

The proposed cellular automata based segmentation method uses continuous state cellular automata to interactively label images using user supplied seeds. The cells are corresponding to image pixels, and the feature vector is RGB or gray scale intensities [14].

2) Feature extraction and segmentation using LVQNN

Feature extraction is used to compute quantitative measurements to best describe the characteristics of targets for differentiation. Texture details and pixel intensity are two common features used in medical images with no color details. The main features extracted are a) first order statistical features b) texture features c) Statistical feature matrix .Extracted features are useful in the training of LVQNN for segmentation.

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Vector Quantization is a technique that exploits the underlying structure of input vectors for the purpose of data compression. An input space is divided in a number of distinct regions and for each region a reconstruction (representative) is defined. When the quantizer is presented with a new input vector, the region in which the vector lies is first determined, and is then represented by the reproduction vector for this region.LVQNN is mainly used for classification. Here it is used for classifying thyroid region from CT images. The inputs to the LVQNN are the 8 features (energy, entropy, homogeneity, LE_variance, EL_variance, SL_variance, EE_variance, and dissimilarity) extracted from each block[15]. The inputs of each LVQNN can be written in a vector form as:

$$Y_i=[y_1,y_2,\ldots\ldots\ldots y_n,\ldots\ldots\ldots y_8] \quad \textbf{(1)}$$

where $\mathbf{y}_n$ is the *n*-th feature of the *i*-th block. Since each LVQNN is used to classify the image blocks as thyroid or non-thyroid, the weight vector can be written as [15]:

$$T_j=[t_{j1},t_{j2},\ldots\ldots\ldots t_{j8}] \quad \textbf{(2)}$$

where j = 1, 2 represent the thyroid and non-thyroid classes, respectively.

The LVQ algorithm proceeds as follows:

Suppose that the weight vector **Tj** is the closest to the input vector $\mathbf{y}_i$. Let C_{Tj} and C_{yi} denote the class labels associated with $\mathbf{T}_j$ and $\mathbf{y}_i$ respectively. Then the weight i vector $\mathbf{T}_j$ is adjusted as follows:

1) If $C_{Tj} = C_{yi}$ then

$$\mathbf{T}_j(n+1)= \mathbf{T}_j(n)+a_n[\mathbf{y}_i- \mathbf{T}_j(n)] \quad (3)$$

Where $0< a_n <1$

2) If $C_{Tj} \neq C_{yi}$ then

$$\mathbf{T}_j(n+1)= \mathbf{T}_j(n)-a_n y_i- \mathbf{T}_j(n)] \quad (4)$$

The other weight vectors are not modified. It is desirable for the learning constant a_n to decrease monotonically with time n. For example a_n could be initially 0.1 and decrease linearly with n. After several passes through the input data the Voronoi vectors typically converge at which point the training is complete. After training the LVQNN separates thyroid and non-thyroid blocks. For each thyroid block, the number of thyroid blocks was calculated in its 8-nearest neighbours [16]. If the number is smaller than four, the block is reassigned to non-thyroid glands [16].

C) Volume estimation

In this paper three slices of each patient is used to measure volume. Area of thyroid gland is calculated in each slice. And in CT scanning the interstice distance is also measured and used for further calculation. After finding the total area volume of thyroid gland is calculated using the interslice distance. Once the thyroid area is obtained, the thyroid volume can be estimated using:

$$\text{Thyroid Volume}=\sum^N \text{Area}(i) \times b \times D \quad (5)$$

where N denotes the total number of slices, and 'b' denotes the resolution factor of a pixel to the real space (equal to 1/484 in this paper; that is, 484 pixels are sampled in a area of 1 cm^2). D denotes distance between slices [16].

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III. EXPERIMENTAL RESULT

In the experiments 10 CT images of patients are collected. Three slices of each patient is considered. After preprocessing thyroid non thyroid area are separated. Then initial segmentation using cellular automata based seeded segmentation is done. And features are extracted from the segmented thyroid region. Then training LVQNN using the extracted features is carried out. Next area of refined thyroid region is measured from each slice. And then using the area from three slices and interslice distance, volume of the thyroid gland is calculated. Results shows better accuracy compared to the existing system.

IV. CONCLUSION

Most physicians use CT images even if the volume of thyroid gland is determined using Ultrasound images, for precise evaluation of volume of thyroid gland. In this paper a linear Vector Quantization neural network (LVQNN) with a pre-processing procedure with cellular automata based seeded segmentation method is proposed for segmentation and volume estimation of thyroid gland using computerized tomography (CT) images. Experiments shows that the proposed method segments the thyroid region effectively and volume is calculated more accurately than the existing system.

REFERENCES

[1] H.Zaidi,"Organ Volume Estimation using SPECT",IEEE Transactions on Nuclear Science,Vol 43.No 3,June 1996.

[2] E.-L. Chen, P.-C. Chung, C.-L. Chen, H.-M. Tsai, and C.-I. Chang, "An automaticdiagnostic system for CT liver image classification," IEEE Trans. Biomed. Eng., vol. 45, no. 6, June 1998.

[3] N. Archip and P.-J. Erard, "A knowledge-based approach to automatic detection of the spinal cord in CT images," IEEE Trans. Med. Imag., vol. 21, no. 12, pp. 1504–1516, 2002.

[4] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, 2002.

[5] S. K. Lee, P.-C. Chung, C. I. Chang, C.-S. Lo, T. Lee, B. C. Hsu, and C. W. Yang, "Classification of clustered microcalcifications using a shape cognitron neural network," Neural Netw., vol. 16, pp. 121–132, 2003.

[6] C.-C. Lee, P.-C. Chung, and H.-M. Tsai, "Identifying multiple abdominal organs from CT images series using a multimodule contextual neural network and spatial fuzzy rules," IEEE Trans. Inform. Technol. Biomed., vol. 7, no. 3, Sept. 2003.

[7]M. Kass, A. Witkin, and D. Terzopoulos, "Snakes: active contour models," International Journal of Computer Vision, vol. 1, no. 4, pp. 321–331, 1988.

[8] D. Cremers, M. Rousson, and R. Deriche, "A review of statistical approaches to level set segmentation: integrating color, texture, motion and shape," International Journal of Computer Vision, vol. 72, no. 2, pp. 195–215, 2007.

[9]E. N. Mortensen and W. A. Barrett, "Interactive segmentation with intelligent scissors," Graphical Models and Image Processing, vol. 60, no. 5, pp. 349–384, 1998.

[10]Y. Boykov and V. Kolmogorov, "An experimental comparison of min-cut/max-flow algorithms for energy minimization in vision," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 26, no. 9, pp. 1124–1137, 2004

[11] Chuan-Yu Chang and Yong-Cheng Hong National Yunlin University of Science & Technology, TAIWAN Pau-Choo Chung, National Cheng Kung University, TAIWAN Chin-Hsiao Tseng, National Taiwan University College of Medicine, TAIWAN," A Neural Network for Thyroid Segmentation and Volume Estimation in CT Images", November 2011 | IEEE Computational Intelligence Magazine.

[12] N. Ganguly, B. K. Sikdar, A. Deutsch, G. Canright, and P. P. Chaudhuri, "A survey on cellular automata Centre for high performance computing", Dresden Univ. Technol., Dresden, Germany, Tech. Rep., 2003.

[13] A. Popovici and D. Popovici, "Cellular automata in image processing," in Proc. 15th Int. Symp. Math. Theory Networks Syst., 2002, pp. 34–44.

[14] G. Nyirenda, et al., "Automated segmentation of tumour changes intemporal PET-CT data," IEEE. I. S. Biomed. Imaging., pp. 1699-1702,2012.

[15] C.-R. Huang, P.-C. Chung, B.-S. Sheu, H.-J. Kuo, and M. Popper, "Helicobacter pylori related gastric histology classification using support vector machine based feature selection," IEEE Trans. Inform. Technol. Biomed., vol. 12, no. 4, pp. 523–531, July 2008.

[16]Chuan-Yu Chang∗, Senior Member, IEEE, Yue-Fong Lei, Chin-Hsiao Tseng, and Shyang-Rong Shih," Thyroid Segmentation and Volume Estimation in Ultrasound Images", IEEE Ttransactions on biomedical engineering, vol. 57, no. 6, june 2010.