**First Review Document**

**Detection and Classification of Thyroid Diseases Using Ultrasound Images Through Deep learning technique**

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**Abstract:** The thyroid gland produces hormones that regulate your body's metabolism. There are various disorders that can arise when your thyroid secretes too much hormone. The shape and size of the thyroid gland changes when it is affected making thyroid segmentation essential in the diagnosis of thyroid related diseases. The existing systems use image-based features to characterize the thyroid tissue by direction working on the image pixels and focus on algorithms which use techniques such as edge detection, thresholding, region splitting and merging, watershed segmentation resulting in a low SNR and resolution. Deep learning plays a decisive role within the method of illness prediction and this paper handles the analysis and classification models that area unit getting used within the thyroid illness based on the information gathered from the dataset taken from UCI repository. It is important to ensure a decent knowledge base that can be entrenched and used as a hybrid model in solving complex learning tasks, such as in medical diagnosis and prognostic tasks. In this project we have proposed different machine learning and deep learning techniques for the detection of thyroid diseases. In the proposed system, we are using K-means clustering for segmentation, Convolutional neural network to train and test and model which would help in classification as well as the localization of the disease part in the ultrasound image of the thyroid gland.

**Key Words**: Thyroid gland, Thyroid diseases, CNN.

**Introduction:** The thyroid is a butterfly shaped gland consisting of two lobes, the right lobe and the left lobe is located on the lower front neck. Thyroid diseases can affect anyone: men, women and children, but they are more common in women, and become more common with age. The thyroid gland is a small butterfly-shaped organ that is found in the neck just in front of voice box. It makes the thyroid hormones, T3 and T4, which acts as chemical messengers, travelling through blood stream to all the cells and tissues in the body. These thyroid hormones control the speed at which your body works, which is also called your body’s ‘Metabolism’. They therefore affect your heartbeat, energy levels, digestion, body temperature, and even how to think and feel. Malfunctioning of the thyroid results in a disease such as hyperthyroidism when too much hormones are produced, hypothyroidism when not enough hormones are produced, Hashimoto's disease, Graves' disease, goiter, and thyroid nodules. These diseases are common throughout the world and it has been estimated that over 42 million people i.e, every third person in India are affected by these diseases. These diseases are most likely to affect women of child bearing age and they have the potential to complicate pregnancy by causing postpartum bleeding, preeclampsia, placental abruption and in some cases even a miscarriage.

The first test for a thyroid abnormality is an ultrasound. An ultrasound is a primary test in which high-frequency sound waves are bounced off tissues and with the help of echoes a picture is generated known as sonogram. The thyroid gland resembles in appearance for multiple diseases and intense analysis needs to be done to accurately determine the disease. A medical expert refers to an ultrasound image to make a diagnosis about the patient's condition. However, due to the poor clarity and low contrast of ultrasound images, it is difficult to analyze the minute details which play a key role in the identification of the condition. Due to this, the medical expert has to prescribe a variety of blood tests to pinpoint the exact condition.

The current software-based solutions for the problem are primitive in nature and lack in terms of accuracy and range of diseases that can be identified. Due to this, doctors have to manually examine the results of the system and the diagnosis based on their subjective knowledge. Our project aims to solve this issue by developing a system that classifies the 2D ultrasound images of the thyroid gland using the concepts of image processing, machine learning and deep learning to determine if the patient is suffering from hyperthyroidism, hypothyroidism, thyroiditis or thyroid nodules.

**Objective:**

● To develop a system that can be implemented and used for quick and accurate diagnosis of thyroid diseases from an ultrasound image which can be used by medical experts.

● To develop a system that accurately segments the thyroid region from the surrounding tissues and displays a clear image that is convenient for the medical expert to determine its shape and deformities.

● To develop a system that shows the location of the deformities present in the thyroid tissue for the medical expert to refer to.

● To design a system that is easily scalable and deployable in various platforms and environments.

● To develop a system with optimal time and space complexity in order for it to generate quick results and be portable.

● To develop a system that abides by the ethical, health, and safety requirements.

**Problem Statement:**

Early diagnosis plays a major role in treating these diseases and it is vital to have a process that is quick and accurate. In order to determine whether or not the thyroid is affected, an ultrasound sound of the neck is examined. Ultrasounds have poor contrast and a high amount of speckle noises thus making it hard for the doctors or machines to clearly examine the thyroid for a change in its shape or size. This therefore results in a second ultrasound or other tests to confirm the abnormalities. This brings the need for a solution that can speed up the diagnosis process so that the patient can be treated before the condition gets worse.

**Literature review:**

Texture Analysis of Ultrasound Medical Images for Diagnosis of Thyroid Nodule Using Support Vector Machine (2020)

**Authors**: Shrikant D. Kale, Krushil M. Punwatkar

**Summary**: In this paper thyroid texture analysis is done using matlab. In this paper, gray level co-occurrence matrix (GLCM) is used as the texture characterization technique. The 10 GLCM features are selected for feature extraction & GLCM matrix is calculated for four different orientations & different pixel distance from 1 to 15. The extracted features are classified using SVM classifier with linear kernel for diagnosis of thyroid nodule malignancy risk.

**Dataset used**: The total 85 thyroid ultrasound images were used which contains total 48 cancerous and 37 non-cancerous nodules was selected in the database. These thyroid images are available in the image gallery of Wilmington Endocrinology PA on the website. The image size of 546 × 410, with 24-bit depth size, true color image, format of images are JPEG.

**Future work**: It is suggested to propose other preprocessing techniques and feature extraction for nodule texture analysis.

Deep learning based classification of ultrasound images for thyroid nodules: a large scale of pilot study (2019)

**Author**: Qing Guan, Yunjun Wang, Jiajun Du, Yu Qin, Hongtao Lu, Jun Xiang, Fen Wang

**Summary**: To explore the ability of the deep learning network Inception-v3 to differentiate between papillary thyroid carcinomas (PTCs) and benign nodules in ultrasound images. There were 1,162 benign nodules in the training group and 190 benign nodules in the test group. A margin size of 50 pixels and an input size of 384×384 showed the best outcome after training, and these parameters were selected for the test group. In the test group, the sensitivity and specificity for Inception-v3 were 93.3% (195/209) and 87.4% (166/190), respectively. Inception-v3 was trained and tested to crop the margin of the images of nodules and provide a differential diagnosis. The sizes and sonographic features of nodules were further analyzed to identify the factors that may influence diagnostic efficiency. Inception-v3 displayed the highest accuracy for 0.5–1.0 cm nodules. The accuracy differed according to the margin description (P=0.024). Taller nodules were more accurately diagnosed than were wider nodules (P=0.015).

**Dataset Used**: A total of 2,836 thyroid ultrasound images from 2,235 patients were divided into a training dataset and a test dataset.

Classification of Thyroid Ultrasound Standard Plane Images using ResNet-18 Networks (2019)

**Authors**: Minghui Guo, Yongzhao Du

**Summary**: The thyroid ultrasound standard plane (TUSP) classification is quite essential for the ultrasound diagnosis of thyroid disease. In this paper, They applied the ResNet-18 model to TUSP images classification successfully and compares it with other classical convolutional neural network models. The test set experimental results show that the 18-layer CNN model ResNet has a good performance for automatic classification of TUSP images, and the accuracy of TUSP images classification reaches 83.88%. CNN consists of an input layer, convolution layers, pooling layers, fully connected layers, and an output layer. The CNN consists of multiple convolution layers and pooled layers to implement a deeper network generally, and the fully connected layer can also use a multi-layered structure. The typical CNN models include ResNet, MobileNet, InceptionV3, Xception, AlexNet, LeNet, ZF\_Net and so on.

**Dataset Used**: 4,509 TUSP images collected from the hospital's real data are randomly divided into 3,386 sheets as the training set and 1,123 sheets as the test set.

**Future Study**: The automatic classification method of TUSP images based on deep learning has great application prospects in clinical, which deserves further study.

Automated thyroid nodule detection from ultrasound imaging using deep convolutional neural networks (2020)

**Authors**: Fatemeh Abdolali, Jeevesh Kapur, Jacob L. Jaremko, Michelle Noga, Abhilash R. Hareendranathan, Kumaradevan Punithakumar.

**Summary**: proposed a novel deep neural network architecture with carefully designed loss function regularization, and network hyperparameters to perform nodule detection without complex postprocessing refinement steps. CNN-based approaches such as fast R-CNN, Faster R-CNN and Mask R-CNN have achieved increasing success in object detection tasks. Mask R-CNN is the most recent CNN architecture for object detection. In this study, They have presented a novel framework for fully-automated thyroid nodule detection which can facilitate analysis of thyroid ultrasound scans. Accurate and automatic thyroid nodule diagnosis is a crucial step in detecting cancer and in reducing diagnosis time, and bias from clinicians. They included modifying the conventional Mask R-CNN loss function, tailoring transfer learning and data augmentation strategies to adapt the model to thyroid nodule detection task. The mean average precision for the proposed method, Mask R-CNN, Faster R-CNN and conventional Mask R-CNN are 0.82, 0.74 and 0.78, respectively. The proposed Mask R-CNN achieved highly accurate detection results despite the large variations in the ultrasound data and outperformed Faster R-CNN and conventional Mask R-CNN.

**Dataset used**: The local training and testing datasets consist of 2461 and 820 ultrasound frames acquired from 60 and 20 patients with a high degree of variability, respectively.

Classification of Thyroid nodules in ultrasound images using deep model based transfer learning and hybrid features (2017)

**Authors**: Tianjiao Liu, Shuaining Xie, Jing Yu, Lijuan Niu, Weidong Sun

**Summary**: convolution neural networks (CNNs) is used as feature extraction method for ultrasound images. CNN model trained with a massive natural dataset is transferred to the ultrasound image domain, to generate semantic deep features and handle the small sample problem. Then, combined those deep features with conventional features such as Histogram of Oriented Gradient (HOG) and Local Binary Patterns (LBP) together, to form a hybrid feature space. use a ImageNet pre-trained ConvNets to extract features and combine them with hand crafted features. SVM is used for nodule classification. In this paper, a feature extraction method for ultrasound images is presented to classify the thyroid nodules into benign and malignant. The comparison results shown that, our proposed hybrid method outperformed both the pre-trained CNN model and the traditional single-type feature method with the accuracy of 93.1%.

**Dataset Used**: Real world 1037 images taken from the Cancer Hospital of Chinese Academy of Medical Sciences, which are clinically verified. 1037 thyroid nodule ultrasound images, including 651 benign images and 386 malignant images.

**Future Work**: planning to complete further tuning of the CNN, and improve classification accuracy especially for the malignant nodules.

Ultrasound image analysis using deep learning algorithm for the diagnosis of thyroid nodules (2019)

**Authors**: Junho Song , Young Jun Chai, Hiroo Masuoka, Sun-Won Park, Su-jin Kim, June Young Choi, Hyoun-Joong Kong, Kyu Eun Lee, Joongseek Lee, Nojun Kwak, Ka Hee Yi, Akira Miyauchi

**Summary**: Fine needle aspiration (FNA) (type of biopsy procedure) is the procedure of choice for evaluating thyroid nodules. It is indicated for nodules >2 cm, even in cases of very low suspicion of malignancy. FNA has associated risks and expenses. In this paper, image analysis model using a deep learning algorithm was developed and evaluated if the algorithm could predict thyroid nodules with benign FNA results. Transfer learning method using the Inception-v3 model is used to classify benign and malignant nodules. Inception-v3 model architecture consists of the following layers which are pretrained, and contain information that can discriminate between images: a stem layer, 3 Inception-A layers, 5 Inception-B layers, 2 Inception-B layer, a pooling layer, a dropout layer, a fully connected layer, and a softmax layer. e. The diagnostic performance of the algorithm was promising with the accuracy of 94%.

**Dataset Used**: 1358 (670 benign, 688 malignant) thyroid nodule images were collected from SMG-SNU Boramae Medical Center, Seoul, Korea in TIFF format. Then the nodules on the images were cropped into squares (299 \* 299 pixel).

Thyroid nodules classification and diagnosis in ultrasound images using fine-tuning deep convolutional neural network (2017)

**Authors**: Olfa Moussa, Hajer Khachnaoui, Ramzi Guetari, Nawres Khlifa

**Summary**: In this paper, fine-tuning approach based on deep learning using a Convolutional Neural Network model named resNet50 is used to classify and detection of thyroid in US images. ResNet-50 (50 layers) holds 16 blocks, each of them includes a convolutional layer. Residual block consists of three layers in this order: 1 × 1 convolution − 3 × 3 convolution − 1 × 1 convolution. ResNet uses 7 × 7 convolution with stride 2 to down sample the input by the order of 2 as well as the pooling layer. The fine-tuning is the process of adapting the pretrained weights of a CNN to different data sets through the use of the backpropagation. It got the accuracy of 97.33% while VGG-19 model had 81.83% which suggest the proposed approach improves the accuracy of the classification of thyroid nodules and outperformed the VGG-19 model.

**Data Used**: Two public database were used DDTI (Digital Database Thyroid Image) and Ultrasoundcases.info. DDTI is a thyroid ultrasound image database performed by two experts in 299 patients with thyroid disorders, containing 451 thyroid images with the size 560 × 360, including 376 malignant images and 75 benign images. The images were extracted from thyroid ultrasound video sequences captured with TOSHIBA Nemio 30 and TOSHIBA Nemio MX Ultrasound devices.

**Demerits:** the present study was not able to classify the thyroid nodules into all classes of the different TI-RADS scores and it was restricted in only two classes (benign and probably malignant).

**Future Work**: will continue further tuning on the proposed DCNN in order to improve accuracy specifically for the benign nodules.

**Conclusion:**

The shape and size of the thyroid gland changes with it is affected making thyroid segmentation essential in the diagnosis of thyroid related diseases. Hence, we aim to develop a system that focuses on characterization of thyroid texture in an ultrasound image using Deep learning techniques. In the proposed system, we are using K-means clustering for segmentation, Convolutional neural network to train and test and model which would help in classification as well as the localization of the disease part in the ultrasound image of the thyroid gland.

**Reference:**

1. Shrikant D. Kale, Krushil M. Punwatkar, “Texture Analysis of Ultrasound Medical Images for Diagnosis of Thyroid Nodule Using Support Vector Machine”, IJCSMC.
2. K. Shankar, S.Lakshmanaprabu, Deepak Gupta, “Optimal feature- Based multi-kernel SVM approach for thyroid disease classification”, Springer, 2018
3. Qing Guan, Yunjun Wang, Jiajun Du, Yu Qin, Hongtao Lu, Jun Xiang, Fen Wang, Deep learning based classification of ultrasound images for thyroid nodules: a large scale of pilot study, 2019
4. D. China, A. Illanes, P. Poudel, M. Friebe, P. Mitra, and D. Sheet “Anatomical structure segmentation in ultrasound volumes using cross frame belief propagating iterative random walk”, 2019
5. Kunwar Suryaveer singh, Defeng Wang, Anil Tejbhan, “ Feasibility Study of Texture Analysis Using Ultrasound Shear Wave Elastography to Predict Malignancy in Thyroid Nodules”, ELSEVIER, 2016
6. Jianning Chi, Ekta Walia, Paul Babyn, Jimmy Wang, Gary Groot and Mark Eramian, “Thyroid Nodule Classification in Ultrasound Images by Fine-Tuning Deep Convolutional Neural Network”, 2017
7. Minghui Guo, Yongzhao Du, Classification of Thyroid Ultrasound Standard Plane Images using ResNet-18 Networks, 2020
8. Fatemeh Abdolali, Jeevesh Kapur, Jacob L. Jaremko, Michelle Noga, Abhilash R. Hareendranathan, Kumaradevan Punithakumar, Automated thyroid nodule detection from ultrasound imaging using deep convolutional neural networks, 2020.
9. Tianjiao Liu, Shuaining Xie, Jing Yu, Lijuan Niu, Weidong Sun, Classification of Thyroid nodules in ultrasound images using deep model based transfer learning and hybrid features, 2017.
10. Olfa Moussa, Hajer Khachnaoui, Ramzi Guetari, Nawres Khlifa, Thyroid nodules classification and diagnosis in ultrasound images using fine-tuning deep convolutional neural network, 2018.