# Machine and Deep Learning Techniques for Cancer Regions Detection in Thyroid Ultrasound Images

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**Abstract:** The endocrine system is responsible for controlling and regulating all of the body's major activities and functions. It controls child development, adult physical function, and the process of reproduction. This is why complete recovery and society's survival are more likely with an early, precise diagnosis. The gland's abnormal cells give rise to tumour areas. These locations are separated into benign and malignant. Malignant tumour in thyroid glands is more hazardous than benign tumour. In this work, tumour sites in thyroid pictures were identified using machine learning and deep learning algorithms in two separate ways. The strategy allows for the use of NN and SVM classification methods to identify tumors with the aid of computers. It consists of two different techniques for locating tumors. In the first method, thyroid images are preprocessed, and then some features are obtained. In the second suggested technique, the source thyroid pictures are registered using geometric modifications, and then the pixels in the changed image are improved using histogram equalization. Spatial domain pixel of the enhanced image is subsequently transformed into multi domain pixels by means of the Gabor algorithm. In the end, the effectiveness and precision of these two classifiers are evaluated and compared.

**Key words**: Thyroid tumors, Thyroid hormones, Endocrine gland

## INTRODUCTION

The thyroid is the organ with the largest endocrine gland. Additionally, it is a significant global public health issue. This is why early, accurate diagnosis can increase the chances of total recovery and survival for society. Therefore, reducing morbidity and mortality requires early thyroid prediction. The risk of malignancy is approximately 10% in individuals with thyroid nodules, and it is between 5% and 13% in patients with incidentalomas found via ultrasonography, CT, or MRI [6]. TSH is a common diagnostic and laboratory tool that is utilised in percentage of hormones to investigate thyroid. Thyroid is situated beneath the thyroid cartilage on the front of the neck. Thyroid hormones, which are produced by the gland, control metabolic rate. The body's energy and temperature are controlled by thyroid hormones. Thyroid disorders can cause the thyroid to produce too much thyroid hormone, which is known as an overactive thyroid, or too little thyroid hormone, which is known as an underactive thyroid, which causes thyroid nodules and goitre. An endocrine gland system that emerges from a bodily cavity is the thyroid gland. Its little gland, which measures 28 grammas and is situated in the neck behind the laryngeal voice box, is modest. T4 and triiodothyronine are secreted by the gland (T3). The level of calcium in the blood is regulated by this hormone [19].

The brain's hypothalamus initiates the hormone-secretion process. It is the area of the brain where TRH, which is secreted and travels to the pituitary gland, is produced. Following this, thyroid gland is stimulated to release its hormone, thyroxin (T4), triiodothyronine, by the pituitary gland, which then begins to emit Thyroid-Stimulating Hormone (TSH) (T3). Iodine is a component of these hormones; hence iodine content is necessary for their production. All patients underwent a whole or partial thyroidectomy and a central compartment neck dissection after being evaluated for cervical lymph node metastases [13]. As seen in the illustration in figure1, located near the front of the neck and have a shape of a butterfly.

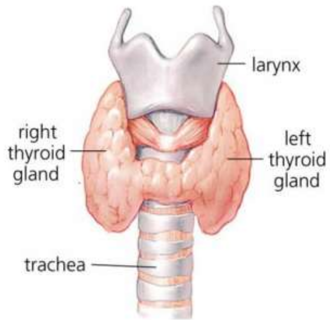


Figure1 Thyroid Gland

Both hypothyroidism and hyperthyroidism have a variety of causes. Hyperthyroidism is the overproduction of thyroid hormones, which causes the body to burn through more energy more quickly. Hypothyroidism, on the other hand, is characterized by lower hormone production and lower energy expenditure than usual. Thyroid disease currently affects 42 million people in India, with more people in the West of the world suffering from the condition. People of all ages can have thyroid deficiencies, which are more common in women than in males. Numerous histological and clinical variables have been linked to a poor prognosis for thyroid cancer patients as of late [2].

Both hypothyroidism and hyperthyroidism frequently result in thyroid goiter. Both deficiency illnesses cause goiter, which is the swelling of the thyroid gland. In rare cases, goiter can develop into benign and cancerous nodules. It is very typical for the thyroid to have many levels; a small percentage of these nodules progress to thyroid cancer. Iodized salt consumption has led to a decline in thyroid goiter in recent years. Thyroid cancer deaths are extremely rare; however the number of people affected by thyroid cancer has been rising by 6% year. Since thyroid cancer has become more common over the past few decades, effective thyroid cancer care has gained significant attention [16].Iodine plays a crucial role in both the T3 and T4 molecules and is a necessary component of the thyroid's function. Thyroid hormones cross the cell membrane like other steroid hormones and attach to intracellular receptors, which affect DNA transcription associated with basal metabolism.

Regulation hormones from the pituitary and hypothalamus serve as feedback mechanisms to regulate T4 and T3 production from the thyroid gland. Thyrotropin Releasing Hormone (TRH) is released in response to stimuli to the hypothalamus, such as heat, cold, and hunger. Thyroid-Stimulating Hormone (TSH) causes the production of thyroxine and triiodothyronine by attaching to TSH Receptor (TSHR). On the other side, a negative feedback loop caused by increasing blood levels of T3 and T4 inhibits the generation of TSH. An important tumour marker for post-operative monitoring is TG, which is typically secreted into the blood by differentiated thyroid carcinoma. The parafollicular cells, often known as C cells, are responsible for calcitonin production. The metabolism of calcium and phosphorus is connected to the actions of calcitonin. Since individuals with Medullary Thyroid Carcinoma (MTC) frequently have high levels of calcitonin, this condition is diagnosed by using calcitonin as a marker. Although thyroid nodules are becoming more often discovered during neck imaging tests, only a tiny percentage of these lesions ultimately turn out to be cancerous [9].

The principal thyroid tumour forms identified by the WHO classification are shown in Figure 2. Follicular Thyroid Adenoma (FTA), which develops from the thyroid's follicular epithelium, is the most prevalent kind of tumour. FTA is an encapsulated solitary tumour that typically arises in multiples, unlike nonneoplastic thyroid nodules. FTA is categorized as benign, and the absence of vascular and capsular invasion is necessary for the diagnosis. The below figure2 depicts different types of Thyroid tumors.

A typical Follicular Thyroid Adenoma (AFTA) and Hurthle Cell Adenoma are two more kinds of follicular malignancies (HTA). Adenomas with high levels of cellularity, an erratic pattern of development against the capsule, and elevated mitotic activity are classified as having AFTA. More than 75% of the cells in HTA, also known as an oxyphilic cell adenoma, are eosinophilic and have a lot of mitochondria. Well-differentiated thyroid cancer (WDTC), Poorly-differentiated thyroid cancer (PDTC), and anaplastic thyroid cancer (ATC) are the three broad categories used to describe malignant thyroid tumors. Patients with WDTC typically have better prognoses than those with PDTC or ATC. Nearly 80% of thyroid cancers are papillary thyroid carcinomas (PTC), which typically metastasis to the cervical lymph nodes [7]. PTC commonly enters lymph nodes and arteries. The prognosis for papillary thyroid cancer is often favourable, and its death rate is less than 10% [15].

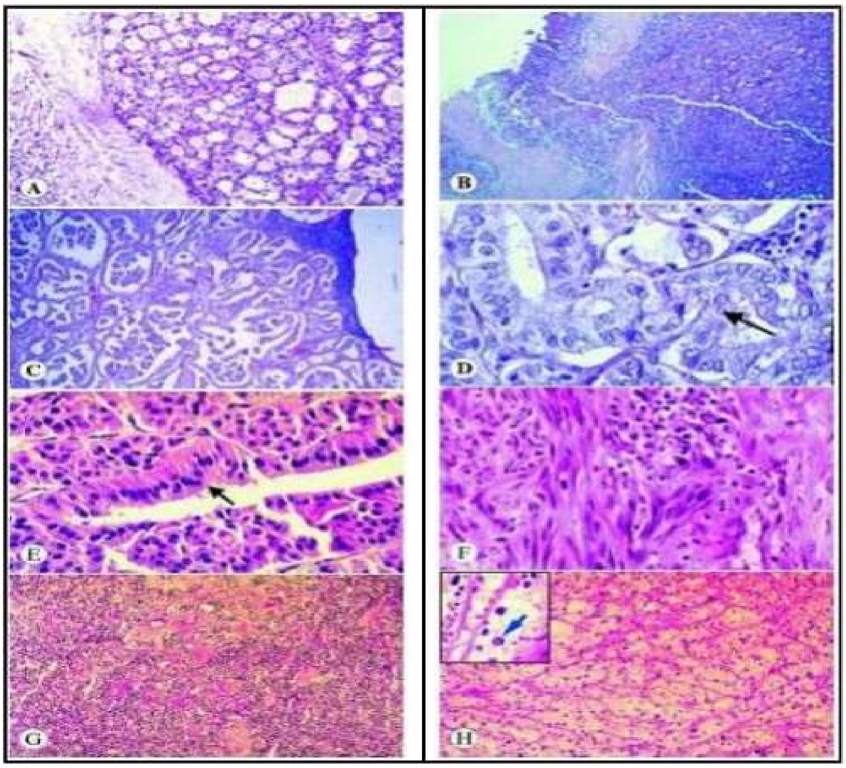

**Figure2 Types of Thyroid Tumors**

The second most prevalent form thyroid cancer is FTC which accounts for 10% of all cases. Hurthle cell thyroid carcinoma commonly referred to as oxyphillic or oncocytic carcinoma is a subtype of FTC that contains more than 75% oxyphilic cells. After hematogenous spread, FTC metastases are identified in the lungs and bones. Medullary thyroid cancers (MTC) are about 3% of thyroid malignancies and developed from parafollicular cells that produce calcitonin. 20% of patients experience distant metastasis, which subsequently spreads to the liver, lung, and skeleton. It is commonly accepted that the capacity of metastatic thyroid lesions to concentrate radioactive iodine (RAI) denotes a more differentiated phenotype [27].PDTC is a rare type of thyroid cancer, accounting for up to 7% of all thyroid cancer.

The most serious sort of thyroid tumors is anaplastic thyroid cancers (ATC), which are a subtype of thyroid cancer. Even while it only affects a very small percentage of individuals (1%–2%), it can be deadly because there is little that can be done to prevent it once the condition has begun. The incidence of thyroid cancer is impacted by a number of variables, including gender, race, and region. Statistics from around the world reveal that women are more frequently impacted than men. Every year, thyroid cancer affects 1.2 to 2.6 males and 2.0 to 3.8 women per 100,000 people. The two-fold higher prevalence in Iceland and Hawaii as compared to other North European nations, Canada, the United States, and Israel, serves as an illustration of the geographic variance. Additionally, thyroid cancer is more prevalent among several ethnic groups, including Caucasian men and women and Chinese males, Filipino women in Hawaii, and women.

For the evaluation of thyroid nodules, ultrasonography is crucial. When it comes to the diagnosis of thyroid nodules, ultrasonography is not very accurate [28]. Diagnostic precision ranges from 74% to 82% [29]. To get a picture of the thyroid, high frequency sound waves are used. Thyroid Nuclear Scans Today, nuclear medicine is employed to detect a number of disorders. According to the lymph node division performed after surgery, all lymph nodes assessed on the CT scans were associated with the pathological findings and split into two groups: metastasis group and non-metastasis group [5]. Digital Tomography (CT) Thyroid issues can also be diagnosed using computed tomography. Under the circumstances, a senior radiologist also reinterpreted neck CT images [10]. Scan with magnetic resonance imaging (MRI) when it comes to capturing pictures of soft tissues, magnetic resonance imaging (MRI) is quite helpful. Since the thyroid is a soft tissue, thyroid problems can also be diagnosed using an MRI. Radioactive iodine is not utilised in a PET scan (positron emission tomography). Positron-emitting radioisotopes are used in the imaging technique known as PET [14]. The extent of thyroid cancer can be determined with a PET scan, which doesn't include radioactive iodine. Chest X-rays have been used to assess the severity of thyroid disease in the lungs or other organs. It is primarily used to find lung follicular thyroid carcinoma. In cases of follicular thyroid cancer, therapeutic lymph node dissection is the only procedure carried out.

## Literature Review

The thyroid gland controls the body's mental, physical, and reproductive processes. Disorders either result in the gland working inefficiently by secreting fewer hormones (hypothyroidism) or improperly high levels of hormone (hyperthyroidism). It produces the hormones needed to control heart rate, blood pressure, body temperature, and weight, and it is situated at the base of the throat [24]. The interaction of so many variables makes it possible to anticipate the outcome by analysing the various individual data using computer, statistical, and mathematical models. 4-7% of the general population has clinically detectable thyroid nodules in areas with adequate iodine intake. Thyroid nodules can be caused by benign or malignant tumors, thyroiditis or goiter, as well as a number of non-cancerous disorders. [23] To split and categorize thyroid nodules using ultrasound images, have developed border descriptors. The evaluation of the experimental outcomes uses the receiver operating characteristic (ROC).

The body's pituitary gland is in charge of making thyroid hormones. When the blood level of thyroid hormone is high, the pituitary gland reduces the production of TRH and TSH while increasing the quantity of TSH to bring the blood level of thyroid hormone back to normal. Since there are no issues with this regulatory mechanism, hypothyroidism and hyperthyroidism are only brought on by issues with the thyroid gland. As a result, the pituitary gland regulates the over- and underproduction of thyroid hormones. In patients with thyroid carcinoma, CT showed respectable diagnostic performance in the pre- and postoperative identification of metastatic cervical lymph nodes [12].

[17] Have developed an automated system that can identify the thyroid glands boundaries, locate nodules inside the gland, divide them into distinct groups, and categorize thyroid nodules according to their likelihood of developing cancer. Here, several features from ultrasound images are retrieved. In order to classify the data, the textural and geometric features are extracted and employed with pattern recognition software. Receiver Operating Characteristics are used to assess the categorization performance (ROC).Between 1984 and 1993, the Indian Council of Medical Research gathered information on more than 0.3 million patients. These statistics were gathered by the National Cancer Registry Programme (NCRP), of which 5614 cases—3617 women and the remaining men—were thyroid-related. In the states of Andhra, Chennai, Mumbai, Delhi, Trivandrum, and Chandigarh, the NCRP conducted this survey. The frequency of thyroid cancer was predicted to be 1 in 100,000 for men and 1.8 in 100,000 for women, according to the stated survey. The two regions with the highest thyroid cancer incidence rates were Andhra and Trivandrum.

According to epidemiological research, a number of internal and environmental factors can affect a person's chance of acquiring thyroid cancer. Iodine shortage, nutrition, radiation exposure, sex hormone exposure, age, and gender are further determining factors. Goiter is a common complication of compensatory thyroid growth in people with dietary iodine insufficiency. Numerous biochemical and genetic processes are linked to the development of thyroid cancers. To categories thyroid gland blocks [4] have suggested a radial basis function neural network. Calculate the thyroid glands volume after separating it from non-thyroid components. It is feasible to determine whether the thyroid is normal or pathological based on its volume. If the volume is greater than the expected range, the thyroid is not functioning normally. The suggested method successfully partitions the thyroid region and computes the volume of each thyroid region, according to experimental results. The outcome is compared to the thyroid value provided by the skilled radiologist.

[20] Presented the current state of primary thyroid lymphoma (PTL), not a common clinical condition that is typically characterized by a neck mass that is rapidly expanding and causing pressure symptoms. Relevant publications from PubMed that were published up to June 2017 were chosen for the review in order to get new details of PTL with a focus on diagnostic and distinct therapeutic treatment.

Thyroid carcinoma makes up more than 90% of all endocrine malignancies while being relatively rare, accounting for only 1% of all cancers. The thyroid gland has a number of roles, including controlling calcium and supporting basic metabolism. Nodules on the thyroid are typically benign. From non-neoplastic illnesses like goiter or thyroiditis to neoplastic nodules that might be benign or malignant, thyroid nodules represent a variety of various thyroid disorders. Adenomas and goiters can occasionally coexist with hyper- or hypothyroidism. From the slow-growing papillary micro-carcinoma, which poses little risk to life, to the uncommon anaplastic carcinoma, which is highly aggressive and associated with substantial morbidity and death, thyroid carcinomas are a diverse collection of malignancies. According to a survey conducted between 2007 and 2011, there are 12.9 new instances of thyroid cancer per one lakh women and men per year. Thyroid cancer is more common and affects 3-4% of all cancer patients in India. There isn't enough evidence available, though, to determine the prevalence and prognosis of this condition in relation to genetic mutation. [3] Have put up a proposed automated thyroid volume estimation and segmentation system. To reduce the noise that exists in the CT pictures, preprocessing is first used. The comparability of the grey values of the pixels in the thyroid and non-thyroid areas is the primary issue addressed in this research. This is accomplished by using the intensity values and texture properties. The thyroid is identified in this case using modified region growth. To categorize the thyroid and non-thyroid tissues, Progressive Learning Vector Quantization Neural Network (PLVQNN) is then applied. Network is trained using the data from the middle slice. The suggested method effectively segments and calculates the thyroid's volume.

[26] This study looked at the site-specific cancer risks brought on by hyper- or hypothyroidism. The authors conducted a comprehensive evaluation of observational studies in MEDLINE and the COCHRANE collection that reported correlations between hyperthyroidism or hypothyroidism and subsequent cancer incidence. When a patient is diagnosed with a thyroid nodule, the Fine Needle Aspiration Biopsy (FNAB) is the initial diagnostic procedure carried out to ascertain the lesion's malignancy. Since malignant nodules are rather uncommon, the cytological investigation by FNAB typically reveals the nodule(s) to be benign, such as colloid goiter or thyroiditis. However, FNAB cannot be utilised to differentiate between benign and malignant forms of follicular tumors, unlike some types of thyroid cancer such as PTC and ATC. [11] Have put out the TND (Thyroid Nodule Detector) Computer-Aided-Diagnosis (CAD) system for the identification of thyroid nodules in thyroid ultrasound (US) images and movies obtained during thyroid US tests. This approach first applies preprocessing to improve the image. Once the nodules have been located, features including intensity and textural properties are retrieved. After that, classification and post-processing techniques are used to enhance the outcome. For classification, K-Nearest Neighbors (K-NN) and the SVM are employed. Additionally, the ATBD-2 technology, which reduces boundary identification error, is recommended for accurate thyroid lobe border detection. [18] Aim of this study was to analyse sonographic imaging data from clinical ultrasounds in order to apply deep CNN models to increase the diagnostic precision for thyroid cancer. On the training

set obtained from the Tianjin Cancer Hospital, the researchers created and trained the DCNN model. The algorithm was quite effective at locating thyroid cancer patients. The model's sensitivity and specificity were both 84 and 9%, respectively.

[25] This review discusses the causes of the rising prevalence and takes into account environmental, patient- and clinician-driven, and environmental effects. Critical reviews were conducted on articles that addressed the reasons for the rise in incidence. Thyroid disease risk awareness, thyroid cancer screening, and diagnosis have all increased as a result of a complex interaction of environmental, medical, and social influences.[1] Have suggested two tools and an algorithmic segmentation method for segmenting thyroid US pictures. Their approach can be used for thyroid US and CT scans of the lungs. Two tools are used for segmentation purposes. The segmentation functionality of the tools is compared in a chart. As a result, a useful algorithm for locating thyroid nodules is created.

Unlike an MRI scan, an ultrasonic scan generates sound waves rather than radiation, therefore they are safe. [8] Proposed a new technique for evaluating an ultrasound image of a cancerous thyroid nodule. The method that was suggested was limited to four categories which are pre-processing, segmentation, feature extraction and classification. For categorization, a Support Vector Machine (SVM) is employed. This is accomplished by utilising the co-presence of grey levels through the extraction of features. Precision, affectivity, and specificity were used to assess the results, and the scientists found that the SVM classifier is progressed to an ANN to discriminate between benign and malignant tumors.

[25] Comparing the two machine learning methods for thyroid illness diagnosis. RBF and PNN are examples of applied machine learning algorithms. Collection of thyroid data is from the UCI repository. The prediction with the best accuracy, 99.5%, was made. Our approach helps to categories thyroid disease, solve the classification issue, and save the patients who have been diagnosed with insufficiency. It also helps to transform the traditional analysis of thyroid disease into a decision-aid tool.

## Methodology

The production of thyroid hormones requires the thyroid nodule, a major organ in the human body. Much of the inner-body functionality is regulated by this hormone. It will control human metabolism and slow down ageing. The right lobe, left lobe, and trachea are the components of the thyroid gland in humans. The thyroid gland is located in the trachea in humans. Due to the effects of numerous genes on the human body, aberrant cells either arise internally or outside in the thyroid gland. These cancer cells quickly influence the close cells and also disrupt the normal operations of the healthy cells in the area around the malignancy.

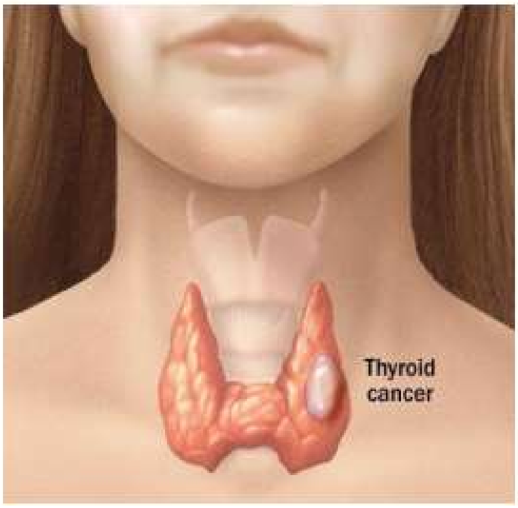


**Figure 3 Thyroid Cancer**

It is challenging to find a tumour or other abnormalities in the thyroid gland in humans. Currently, blood tests, thyroid gland sample testing, and image processing techniques are employed to identify aberrant thyroid gland regions. Image processing is one of the current approaches that is known for being both easy to use and effective for finding and locating thyroid gland tumour aberrant locations. In this study, an ultrasonic imaging technique is employed to identify aberrant thyroid image regions. The ultrasonic scanner scans the thyroid gland in its entirety, and the resulting image is then further processed on a computer using a variety of image processing techniques. The algorithms for identifying the problematic spots in scanned thyroid pictures use soft computing techniques.

The thyroid ultrasound image is transformed into a fixed-width, fixed-height image with 128*128 pixels. The below figure4 depicts the detection classification system. Additionally, it converts every pixel in the ultra-sound thyroid image into a grayscale pixel to speed up the execution mechanism. Using the increased performance of the CANFES classification framework, a tumour location in a thyroid ultra sound picture is recognized and segmented. Enhancement, Gabor transform, and CANFES classification are the three primary components of the proposed system. Feature extraction procedure and a tumour segmentation method are used for training. The pixels in ultrasound thyroid image are enhanced for improving the classification accuracy of the thyroid tumor segmentation system. Histogram equalization technique [30] is applied on the low resolution thyroid image in order to enhance the internal regions in thyroid image.

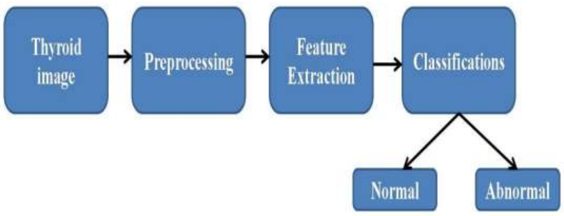


Figure 4 Thyroid cancer detection and classification system

The thyroid ultrasound image is displayed in spatial mode. This means that every pixel in the ultrasound image of the thyroid belongs to the spatial domain and cannot be divided or altered for further processing. Therefore, it is necessary to translate the pixels from the spatial domain into the multiclass pixel format. To prepare the thyroid picture for further processing, the spatial domain pixels are transformed using the Gabor transformation. The characteristics of thyroid images are utilised to distinguish between normal thyroid images and thyroid images with aberrant tumors. For the purpose of detecting tumors, derivative and discrete wavelet transform (DWT) features are extracted.

Each pixel in the multiclass thyroid image after Gabor transformation belongs to a different orientation. Using the pixel differences with regard to different orientations, the aberrant patterns in thyroid images can be identified. Four different degrees of orientation are utilised in this chapter: "0 degree," "45 degree," "90 degree," and "135 degrees."

Applying 2D-DWT will yield the breakdown characteristics from the multiclass Gabor transformed thyroid image. For the decomposed coefficients low frequency and high frequency sub bands, are presented. The high frequency sub bands reflect the pixel fluctuations with respect to horizontal orientation, vertical orientation, and diagonal orientation, while the low frequency sub band approximates the pixel variations in the Gabor processed thyroid image. The decomposed coefficients from the multi-class thyroid picture after Gabor transformation are used as an input feature set in the classification algorithm. The retrieved characteristics from the thyroid picture are optimized using the GA approach.

Step 1: Choose chromosomes 1 and 2 to optimize the retrieved feature set.

Step 2: Apply crossover between the chromosomes 1 and 2 with characteristics.

Step 3: Apply the mutation process to chromosomes that have crossed across.

Step 4: Calculate the Euclidean distance between two chromosomes

Step 5: Remove the features from the other chromosome and fix the chromosome with the smallest possible Euclidean distances.

Step 6: Up until the end of the final feature in the feature matrix, repeat steps 2 through 6.

The final chromosome's features are identified as optimized features, and they serve as input for the classification algorithm.

Both the derived derivative feature and the decomposed DWT feature are four square pixels in size. Given that the matrix has eight elements overall, these properties are integrated. These matrix coefficients are designated as feature vectors and supplied as input to the classification algorithm. As a classification algorithm, CANFES classifier can be utilised. The final chromosome's features are identified as optimized features, and they serve as input for the classification algorithm. The recovered feature set from the matrix coefficients is fed into the proposed CANFES classification architecture, which has a single input and single output layer (each with a single neuron). It also comprises five hidden layers, each of which has 10 neurons that are distributed among the hidden levels according to a weighting factor.

The final chromosome's features are identified as optimized features, and they serve as input for the classification algorithm. The training input is created by properly training both normal and pathological ultra sound thyroid images as well as well-known images from open access datasets or renowned radiologist from medical facilities. In this chapter, the training input is created using the MATLAB simulator's "cafes" command and the output pattern is created using the "evalfis" command. If the output pattern has a value of "0," the thyroid picture is abnormal; if it has a value of "1," the thyroid image is normal. The final chromosome's features are identified as optimized features, and they serve as input for the classification algorithm. Additionally, in classified ultra sound thyroid pictures, morphological functions such morphological "open" and "close" are used to extract the tumour regions. The thyroid ultrasound image is preprocessed to make it a set size of 128*128 pixels for its width and height. Additionally, it converts every pixel in the ultra-sound thyroid image into a grayscale pixel to speed up the execution mechanism.

**Result and Analysis**

The following equations show how the sensitivity, specificity, accuracy, and classification rate of the ultra sound thyroid tumour detection and classification system are evaluated.

$$Sensitivity = TP/(TP + FN)$$

$$Specificity = TN/(TN + FP)$$

$$Accuracy = (TP + TN)/(TP + FP + TN + FN)$$

Where TP and TN stand for the number of correctly identified cancer and non-cancer pixel in an abnormal thyroid imaging, respectively. False Positive (FP) and False Negative (FN) pixels are those that were incorrectly identified as cancer and non-cancer, respectively.

$$Classificationrate = \frac{\text{Properly detected ultra sound thyroid images}}{\text{Total number of ultra sound thyroid images}} * 100\%$$

Where TP and TN stand for the number of correctly identified cancer and non-cancer pixel in an abnormal thyroid imaging, respectively. False Positive (FP) and False Negative (FN) pixels are those that were incorrectly identified as cancer and non-cancer, respectively. The morphological segmentation strategy is used to segment the tumour regions in thyroid pictures, and the simulation results are contrasted with those obtained using other traditional segmentation techniques. The proposed tumour segmentation method employed in this chapter has 99.8% specificity, 99.1% accuracy, and 97.7% sensitivity. The suggested region-growing method for tumour segmentation achieves 87.1% sensitivity, 88.7% specificity, and 88.9% accuracy. The proposed tumour segmentation method achieves 85.9% sensitivity using the Watershed segmentation method, 88.1% of specificity and 89.8% of accuracy.

## CONCLUSION

This study looks into how to spot cancerous areas in thyroid ultrasound imaging. The thyroid ultrasound image's pixels have been improved to increase the thyroid tumour segmentation system's classification accuracy. The interior parts of the thyroid picture are enhanced using the histogram equalization approach on the poor resolution thyroid image. To prepare the thyroid picture for further processing, the spatial domain pixels are transformed using the Gabor transformation. The characteristics of thyroid images are utilised to distinguish between normal thyroid images and thyroid images with aberrant tumors. For the purpose of detecting tumors, derivative and discrete wavelet transform (DWT) features are extracted. The classification algorithm utilised is CANFES classifier. The ultrasound thyroid picture belongs to an abnormal pattern sets are distinguished from ultrasound thyroid images belongs to a normal pattern sets by this classification technique. Because Gabor transformation was used to analyse the collected feature set, the method has higher sensitivity, specificity, and accuracy than other traditional methods.

## REFERENCES

1. Aggarwal, P., Vig, R., Bhadoria, S., & Dethe, C. G. (2011). Role of segmentation in medical imaging: A comparative study. International Journal of Computer Applications, 29(1), 54-61.

2. Akkas, B. E., Demirel, B. B., & Vural, G. U. (2014). Prognostic factors affecting disease-specific survival in patients with recurrent and/or metastatic differentiated thyroid carcinoma detected by positron emission tomography/computed tomography. Thyroid, 24(2), 287-295.

3. Chang, C. Y., Hong, Y. C., & Tseng, C. H. (2011). A neural network for thyroid segmentation and volume estimation in CT images. IEEE Computational Intelligence Magazine, 6(4), 43-55.

4. Chang, C. Y., Lei, Y. F., Tseng, C. H., & Shih, S. R. (2010). Thyroid segmentation and volume estimation in ultrasound images. IEEE transactions on biomedical engineering, 57(6), 1348-1357.

5. Cho, S. J., Suh, C. H., Baek, J. H., Chung, S. R., Choi, Y. J., & Lee, J. H. (2019). Diagnostic performance of CT in detection of metastatic cervical lymph nodes in patients with thyroid cancer: a systematic review and meta-analysis. European radiology, 29(9), 4635-4647.

6. Durante, C., Grani, G., Lamartina, L., Filetti, S., Mandel, S. J., & Cooper, D. S. (2018). The diagnosis and management of thyroid nodules: a review. Jama, 319(9), 914-924.

7. Eun, N. L., Son, E. J., Kim, J. A., Gweon, H. M., Kang, J. H., & Youk, J. H. (2018). Comparison of the diagnostic performances of ultrasonography, CT and fine needle aspiration cytology for the prediction of lymph node metastasis in

patients with lymph node dissection of papillary thyroid carcinoma: a retrospective cohort study. International Journal of Surgery, 51, 145-150.

8. Gireesha, H. M., & Nanda, S. (2014). Thyroid nodule segmentation and classification in ultrasound images. International Journal of Engineering Research and Technology.

9. Grani, G., Lamartina, L., Cantisani, V., Maranghi, M., Lucia, P., & Durante, C. (2018). Inter observer agreement of various thyroid imaging reporting and data systems. Endocrine connections, 7(1), 1-7

10. Kang, J. H., Jung, D. W., Pak, K. J., Kim, I. J., Kim, H. J., Cho, J. K., ... & Lee, B. J. (2018). Prognostic implication of fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography in patients with recurrent papillary thyroid cancer. Head & Neck, 40(1), 94-102.

11. Keramidas, E. G., Maroulis, D., & Iakovidis, D. K. (2012). TND: a thyroid nodule detection system for analysis of ultrasound images and videos. Journal of medical systems, 36(3), 1271-1281.

12. Kim, D. W., Yoon, H. M., Lee, J. Y., Kim, J. H., Jung, A. Y., Lee, J. S., & Cho, Y. A. (2018). Diagnostic performance of CT for pediatric patients with suspected appendicitis in various clinical settings: a systematic review and meta-analysis. Emergency radiology, 25(6), 627-637.

13. Land, C. E., Kwon, D., Hoffman, F. O., Moroz, B., Drozdovitch, V., Bouville, A., ... & Simon, S. L. (2015). Accounting for shared and unshared dosimetric uncertainties in the dose response for ultrasound-detected thyroid nodules after exposure to radioactive fallout. Radiation research, 183(2), 159-173.

14. Leboulleux, S., Schroeder, P. R., Schlumberger, M., & Ladenson, P. W. (2007). The role of PET in follow-up of patients treated for differentiated epithelial thyroid cancers. Nature Clinical Practice Endocrinology & Metabolism, 3(2), 112-121.

15. Lee, D. H., Kang, W. J., Seo, H. S., Kim, E., Kim, J. H., Son, K. R., & Na, D. G. (2009). Detection of metastatic cervical lymph nodes in recurrent papillary thyroid carcinoma: computed tomography versus positron emission tomography-computed tomography. Journal of computer assisted tomography, 33(5), 805-810.

16. Lee, Y., Kim, J. H., Baek, J. H., Jung, S. L., Park, S. W., Kim, J., ... & Na, D. G. (2018). Value of CT added to ultrasonography for the diagnosis of lymph node metastasis in patients with thyroid cancer. Head & neck, 40(10), 2137-2148

17. Legakis, I., Savelonas, M. A., Maroulis, D., & Iakovidis, D. K. (2011). Computer-based nodule malignancy risk assessment in thyroid ultrasound images. International Journal of Computers and Applications, 33(1), 29-35.

18. Ming, X., Cheng, X., Tian, C., Li, W., Wang, R., Qian, C., & Zeng, X. (2022). Evaluation of condylar osseous changes using a wireless detector with proton

density–weighted imaging sequences. Quantitative Imaging In Medicine and Surgery.

19. Mugasa, H., Dua, S., Koh, J. E., Hagiwara, Y., Lih, O. S., Madla, C., ... & Acharya, U. R. (2020). An adaptive feature extraction model for classification of thyroid lesions in ultrasound images. Pattern Recognition Letters, 131, 463-473.

20. Pavlidis, E. T., & Pavlidis, T. E. (2019). A review of primary thyroid lymphoma: molecular factors, diagnosis and management. Journal of Investigative Surgery, 32(2), 137-142.

21. Rouhani, M., & Mansouri, K. (2009, April). Comparison of several ANN architectures on the Thyroid diseases grades diagnosis. In 2009 International Association of Computer Science and Information Technology-Spring Conference (pp. 526-528). IEEE.

22. Savelonas, M. A., Maroulis, D. E., Iakovidis, D. K., & Dimitropoulos, N. (2008, August). Computer-aided malignancy risk assessment of nodules in thyroid US images utilizing boundary descriptors. In 2008 Panhellenic Conference on Informatics (pp. 157-160). IEEE.

23. Savelonas, M., Maroulis, D., & Sangriotis, M. (2009). A computer-aided system for malignancy risk assessment of nodules in thyroid US images based on boundary features. Computer methods and programs in biomedicine, 96(1), 25-32.

24. Sudarshan, V. K., Mookiah, M. R. K., Acharya, U. R., Chandran, V., Molinari, F., Fujita, H., & Ng, K. H. (2016). Application of wavelet techniques for cancer diagnosis using ultrasound images: a review. Computers in biology and medicine, 69, 97-111.

25. Tarantino, U., Iolascon, G., Cianferotti, L., Masi, L., Marcucci, G., Giusti, F., ... & Brandi, M. L. (2017). Clinical guidelines for the prevention and treatment of osteoporosis: summary statements and recommendations from the Italian Society for Orthopaedics and Traumatology. Journal of Orthopaedics and Traumatology, 18(1), 3-36.

26. Tran, T. V. T. (2021). Association Between Thyroid Dysfunction and Breast Cancer Risk Among Adult Women (Doctoral dissertation, Université Paris-Saclay).

27. Wang, W., Larson, S. M., Fazzari, M., Tickoo, S. K., Kolbert, K., Sgouros, G., ... & Robbins, R. J. (2000). Prognostic value of [18F] fluorodeoxyglucose positron emission tomographic scanning in patients with thyroid cancer. The Journal of Clinical Endocrinology & Metabolism, 85(3), 1107-1113.

28. Yu, Q., Jiang, T., Zhou, A., Zhang, L., Zhang, C., & Xu, P. (2017). Computer-aided diagnosis of malignant or benign thyroid nodes based on ultrasound images. European Archives of Oto-rhino-laryngology, 274(7), 2891-2897.

29. Zhang, Y. (2019). Classification and diagnosis of thyroid carcinoma using reinforcement residual network with visual attention mechanisms in ultrasound images. Journal of Medical Systems, 43(11), 1-9.

30. Zhuang, L., & Guan, Y. (2017). Image enhancement via subimage histogram equalization based on mean and variance. Computational intelligence and neuroscience, 2017.