A COMPARITIVE STUDY OF THYROID DISEASE DETECTION USING MACHINE LEARNING – A PAPER REVIEW

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ABSTRACT: ***Thyroid problems are a common endocrine disorder affecting a significant portion of the population worldwide. Early detection and accurate diagnosis of thyroid abnormalities are crucial for effective treatment and management of patients. The detection process involves collecting blood samples to know the percentage of hormones (TSH, T3 and T4). In recent years, medical image processing techniques combined with Machine Learning (ML) algorithms have emerged as a promising approach to improve thyroid problem detection and diagnosis. The use of Machine Learning (ML) in thyroid detection processing has received huge interest in latest years due to its attainable to enhance the accuracy and effectiveness of thyroid ailment diagnosis. The thyroid gland performs an essential position in regulating metabolism, and abnormalities in its shape or feature can lead to a number of thyroid disorders. ML algorithms utilized to clinical imaging data, such as ultrasound or thyroid scintigraphy scans, provide the possibility to beautify the detection and classification of thyroid abnormalities.***

Keywords: Thyroid, SVM, ANN, KNN and CNN

I.INTRODUCTION:

Thyroid hormones produced by the thyroid gland help regulation of the body’s metabolism. Abnormalities of thyroid function are usually related to production of too little thyroid hormone (hypothyroidism) or production of too much thyroid hormone (hyperthyroidism). Diagnosing a thyroid ailment generally, includes an aggregate of clinical records evaluation, bodily examination, blood assessments to measure thyroid hormone levels, and imaging assessments such as ultrasound or thyroid scans. In some cases, a fine-needle aspiration biopsy may additionally be carried out to consider suspicious thyroid nodules for cancer.

Treatment preferences for thyroid ailment rely on the particular circumstance and its severity. Hypothyroidism is commonly managed with artificial thyroid hormone substitute medication. Hyperthyroidism might also be handled with medicines to decrease hormone production, radioactive iodine remedy to break extra thyroid tissue, or in some cases, surgical treatment to put off phase or all of the thyroid gland. Thyroid nodules and thyroid most cancers may also require surgical elimination of the affected tissue, accompanied by means of extra redress as necessary.

Various ML methods in thyroid detection methods automatically detects and assess using ultrasound

images. The massive dataset of annotated thyroid pictures to instruct and consider ML models. The dataset consists of various cases, consisting

of everyday thyroid glands, thyroid nodules and thyroid cancers.

(a)

(b)

Fig. (1) (a) The Longitudinal thyroid nodules. (b) The transverse thyroid nodules.

The Figure (1) shows the ultra sound images of thyroid nodules [2]. Generally, the raw ultrasound images contained a lot of irrelevant information, e.g., patient's ID and name, acquisition parameters, and screen background. The required images are delineated and masked to produce a cropped square image. After that the digital medical images are converted into high-dimensional data extract high-dimensional feature data in order to meet the clinical needs. The extracted features included gray-scale histograms, intensity difference, GLCM, Gabor and wavelet based statistical feature. After feature extraction, ML algorithms are applied for feature selection, dimension reduction and classification task, respectively. The images should be pre-processed such as noise reduction, picture resizing, normalization, and filtering to optimize for the ML models. And then the extraction has to be done for inclusive of size, shape, texture, and pixel intensity, the usage of superior photo processing algorithms. These facets are used to signify the special traits of special thyroid abnormalities [3].

II. Thyroid Detection Methods:

a. Convolutional Neural Network in Thyroid detection:

The images are preprocessed to enhance relevant features and standardize them for input to the CNN. Preprocessing techniques may involve resizing the images, normalizing pixel values, and applying filters to reduce noise or enhance contrast. Convolutional Neural Networks (CNNs) can detect thyroid abnormalities in medical images by leveraging their ability to learn hierarchical features from the data. The process typically involves collecting a large number of labeled images, including both normal and abnormal thyroid cases. The images may be in the form of ultrasound scans, CT scans, or other medical imaging modalities.

The CNN (Convolutional Neural Network) deep-learning framework typically consists of several design components and layers. The system takes multiple input channels, which can include various types of medical imaging data related to the thyroid gland. These may include ultrasound images, fine-needle aspiration biopsy (FNAB) images, or other relevant data types. The input data is passed through convolutional layers, which extract relevant features from the input images. These layers consist of filters that perform convolutions across the input data, capturing local patterns and features at different spatial scales. The extracted features from different input channels are combined using fusion techniques. This can involve concatenation, element-wise operations, or other fusion methods to integrate the information from multiple channels. The fused features are further processed through additional convolutional layers. These layers help capture more complex and abstract features, learning hierarchical representations of the input data. Periodic pooling layers may be inserted to down sample the feature maps, reducing spatial dimensions while retaining the most salient features. Common pooling techniques include max pooling or average pooling. The pooled feature maps are flattened and connected to fully connected layers. These layers serve as the final classification layers and map the learned features to the desired output classes (normal or abnormal thyroid). The final layer of the network typically consists of one or more neurons, depending on the number of output classes. Activation functions such as SoftMax may be applied to provide class probabilities or binary classifications.

The deep-learning framework is trained using labelled data, typically with a loss function such as categorical cross-entropy or binary cross-entropy. Backpropagation and optimization algorithms, such as stochastic gradient descent (SGD) or Adam, are used to update the network weights and optimize the model's performance. The trained model is evaluated using a separate validation dataset to assess its performance in terms of accuracy, sensitivity, specificity, and other relevant metrics. This step helps in tuning hyperparameters and ensuring the model generalizes well to unseen data.

The multi-input deep-learning network, which follows the feed-forward convolutional neural network (CNN) structure [5]. The architecture, shown in Fig. 2 consists of two identical branches in structure.

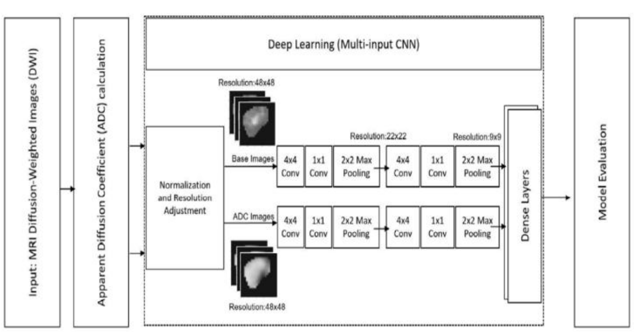

Fig. 2. Schematic diagram of our proposed CAD system that shows the design and the layers of the multi-input CNN deep-learning framework.

The CAD system with CNN generated kernels are governed by the fusion of base images and ADC images of the training samples during the forward-propagation and backward-propagation of the neural network. The compression id done with the use of 1 × 1 conv layer. The DC image and the base image is given to the respective branch for the accurate analysis

The convolution layers is constructed from 4 × 4 conv with 32 filters and 4 × 4 kernel size, 1x1 conv with 16 filters and 1 × 1 kernel size), pooling block (2 × 2 pool size, maximum value pooling). Each branch has two convolution blocks before being concatenated into the dense fully-connected layers (2 layers). Those layers are one hidden layer of 10 neuron with ReLU activation function [5], and one output layer y is observed during forward propagation, yi is the label of the sample, and wi is the weight of each training sample. We

b. Support Vector Machine:

Support Vector Machines [15] is used for the detection of thyroid detection and classification. The ultrasound images typically have high dimensional data and large number of extracted features and SVM can effectively handle and find an optimal hyperplane that separates the classes in the high-dimensional feature space. Also SVM can be used for the non-linear relationships between features and labels through the use of kernel functions. By transforming the input data into a higher-dimensional feature space, SVM can find non-linear decision boundaries that better separate the classes. This flexibility allows SVM to capture complex patterns and relationships in the data, which can be beneficial in thyroid detection where the boundaries between normal and abnormal cases might not be linear.

SVM is less prone to overfitting such as decision trees or neural networks. It achieves this by maximizing the margin, i.e., the distance between the decision boundary and the training samples of both classes. A wider margin helps in generalizing better to unseen data, reducing the risk of overfitting. SVM is more reliable and less dependent on data ordering by formulating the optimization problem as a convex optimization, ensuring that the solution is globally optimal. Also, SVM provides good interpretability which helps the detection of thyroid abnormalities accurately.

c. KNN Method:

KNN is a straightforward and instance-based algorithm, which means it does not require an explicit training phase. The model stores the training instances and their associated class labels directly. This can be advantageous when dealing with dynamic or evolving datasets, as KNN can readily adapt to new instances without retraining the entire model. KNN can capture non-linear relationships in the data without explicitly modeling them. By considering the k nearest neighbors, the algorithm can find decision boundaries that are not constrained to linear separability. This can be useful in thyroid detection, where the boundaries between normal and abnormal cases may exhibit non-linear patterns. KNN provides interpretability in terms of classifying an instance based on its closest neighbors. The class label assigned to a test instance is determined by the majority vote of the neighboring instances. This transparency can help in understanding the reasoning behind the classification decisions and provide insights into the factors influencing thyroid detection. KNN primarily involves computing distances between test instances and the stored training instances. As long as the number of training instances is

Technique	**Accuracy**	**Advantages**	**Disadvantages**
Artificial Neural Network (ANN)	85 -90%	Ability to learn complex patterns and relationships. Can handle non-linear relationships	Requires a large amount of labelled data for training. May overfit with insufficient data
K-Nearest Neighbours (KNN)	75-80%	Simple and intuitive algorithm. No explicit training phase is required. Non-linearity handling	Computationally expensive during inference. Struggles with high-dimensional feature spaces. Sensitive to imbalanced data
Convolutional Neural Network (CNN)	90-95%	Automatic feature learning. Can capture complex patterns.	Requires a large amount of labelled data for training. Computationally demanding.
Support Vector Machine (SVM)	80-85%	Powerful in separating data using hyperplanes. Effective with limited training data and Suitable for high-dimensional feature spaces	Sensitivity to kernel and hyperparameter. Can be computationally demanding.

manageable, the computational cost during inference can be relatively low. This can be advantageous when working with smaller datasets or when computational resources are limited.

d. ANN:

Designing of Artificial Neural Networks (ANNs) [8] are commonly used for analyzing medical images to classify thyroid cases as normal or abnormal. This algorithm ensures that the dataset is diverse, representative, and of sufficient size for training and evaluation. The dataset id divided into various classes such as training, validation, and testing sets. The training set is used to train the ANN, the validation set helps in monitoring the model's performance during training and tuning hyperparameters, and the testing set is used for the final evaluation of the trained model. The labeled dataset is trained using ANN and during training, the network learns to map the input thyroid images to the correct class labels (normal or abnormal). The weights and biases of the network are adjusted

iteratively using optimization algorithms (e.g., stochastic gradient descent) to minimize the difference between the predicted and actual labels. [6] [4].

The optimization is done for hyper parameters which includes adjusting parameters such as the learning rate, regularization techniques, the number of layers, the number of neurons per layer, activation functions, and dropout rates. Hyperparameter tuning can be performed using techniques like grid search, random search, or more advanced methods like Bayesian optimization.

Table -1: Comparison of different ML techniques for thyroid detection

III. CONCLUSION

In this paper different types of ML techniques were discussed and compared. All these techniques can be used in many medical image analysis and applications. In medical images these techniques can be used to detect various thyroid levels. The accuracy of these algorithms can be improved by using larger datasets and more sophisticated training methods. These algorithms can be used to develop new diagnostic tools and treatments for thyroid diseases.

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