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Thyroid Nodule Detection Using Deep Learning Strategies

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Abstract:

Detection of thyroid nodule is an important part in medical imaging because they occur more often and can be of any form from benign to malignant. If we detect the thyroid nodules in the beginning stages itself we can provide better treatment for the patient. The proposed model helps in thyroid nodules detection by using Convolutional Neural Network(CNN) and classifies thyroid nodules into functional, malignant and benign categories. First step involves loading and preprocessing the pictures dataset. These pictures contain various types of thyroid images collected from various medical imaging methods like ultrasound scanning reports. The images are shrunked, grayscaled and labelled based on file keyword names similar to real world diagnosis classification of medical photographs.The dataset is divided mainly into the training set and the testing set so that model is developed using the training data can be checked for it's performance by extracting patterns from the testing data. During training, maintaining the consistency in pixel values between photos , data normalization keeps features of any image occupying the center stage. The CNN model is constructed using layers with an aim to identify complex patterns in image. Maxpooling layers are useful in extracting main features, where convolutional layers are used to find spatial patterns. Dense layers formed afterwards helps to develop the intricate representations which are required for a precise classification. After the model architecture is defined, the annotated photos are used to train the model architecture. By using the optimizer "Adam" and the "Categorical cross entropy loss function", the model gets trained with the ten epochs which improve the models performance. It is very useful since it helps the doctors to quickly determine the precise type of thyroid nodules, therefore planning early diagnosis and therapy planning for the patient. This helps in speeding up the decision making by improving classification process , resulting prompt patient interventions. These type of automated methods also scale medical diagnostics which is helpful in providing services to large population round the globe by reaching out to the places with limited special healthcare.

***Keywords*—Prediction,Keras,Tensorflow**

I. INTRODUCTION

Thyroid nodules impact a huge portion of the worlds population, posing a serious risk in the medicine field[1]. The nature of the thyroid gland growths varies greatly from benign to cancer possibly. To ensure prompt interventions , guiding medical decisions , and reduce the risk of undetected cancers is directly proportional to the accurate identification and classification of those nodules[3].

Diagnosis of thyroid nodule in conventional clinic centers is made by image modalities such as fine-needle aspiration(FNA) biopsies and ultrasound images. These techniques work very well but to get precise interpretations , lot of manual labor personnel who are medically trained are required[2]. Additionally, there could be inconsistencies and diagnostic errors due to the subjects present in manual interpretation, which may cause therapeutic delays or unnecessary interventions[4].To handle these types of obstacles, the plan is to use an automated software system that can accurately and efficiently classify thyroid nodules in the medical photographs with the help of ML techniques, and CNN[5]. Main goal is to develop a model that can differentiate the thyroid nodules into different groups like benign, malignant, functional by using CNN with deep learning techniques to replicate and improve medical professionals diagnostic abilities. Motivation for doing this project is the urgent need required for optimizing and expedite the thyroid nodule diagnosis. The study aims to automate the difficult task of identifying the nodules based on the given visual patterns and attributes by using the capabilities of machine learning and neural networks[8].

Workflow of the project contains multiple important phases, starting with data pre treatment methods. These methods include noise reduction, image normalization, grayscale conversion, and annotization of images based on recognized features. The CNN architecture is later developed and trained using complex design designs, like layer selection, activation functions, and optimization methods, all of which are made to guarantee the model's effectiveness in nodule classification[4].The paper mentions the rigorous validation of the model through various testing on many datasets that can recreate real-world conditions encountered in clinical process. The goal of validation process is to find the model's accuracy, robustness and generalizability, these are the important requirements for the model's real-world usage in clinical situations. The importance of this initiative is far more than its technical difficulties to introduce it's usage in healthcare delivery[10].

There are many conclusions for the effective deployment of the automated thyroid nodule classification system. It has the capacity to speedup the diagnosis workflow, facilitate quick decisions about the therapy and eventually improve patient outcomes. Furthermore, this research's goal is to support fair healthcare providence by expanding the access to modern diagnostic tools, which could benefit weak patients even without the access to professional medical care[3].Additionally, with increased access to scientific diagnostic technologies, this research aims to provide fair healthcare services and help vulnerable people who couldn't have the access to quality medical treatment.This study involves the usage of high-end machine learning techniques with medical imaging to make an automated system that can quickly and effectively classify the thyroid nodules. The initiative aims to enhance patient care and healthcare accessibility, going beyond the technological innovation.This aligns with the longer objectives of advancing the medical diagnoses and improving global health outcomes.

II. LITERATURE SURVEY

Wenfeng et al[1] proposed a framework “Multicascade CNN Framework”.In clinical technique Thyroid ultrasound images are used to predict the type of nodule.In present technology doctors could detect the nodules by understanding the context features,it requires lot of clinical research by studying the hundreds and thousands of the thyroid nodule cases.By using the proposed framework it exploits the information of nodules.This framework is uses large number of thyroid ultrasound images.Here there are two stages of deep CNN is used for detecting and recognizing the thyroid nodules.After primary detection they are sent to CNN for fine- grained thyroid recognition.

Yinghui et al[5] proposed and algorithm with combination of the SocMax Algorithm and the L2 Regularization techniques.This work takes the ultrasound Images which consists of both the benign and malignant type of thyroid nodules.By using the above techniques it prevents the over-fitting.To improve the prediction model combination of CNN and the RNN are used.This study introduces the development of the forecasting systems, system feasibility analysis.It describes the prediction of the thyroid nodule.It results in high prediction accuracy.

Yongfeng et al[4] proposed an algorithm named as “Radiomics Based Method”.Many methods were introduced using IOT so it detects the nodules.It can be classified into mainly two classes.Generally, CNN with deep learning methods achieved the high performance in medical analysis.This work compares the radiomics performance based on the methods of DL.In this algorithm, it consists of extracting the high throughput values with 302-dimensional features for pre-processed images.A model is developed based on the deep learning and testing done by VGG16 model by fine-tuning.It totally consists of the 3120 images.It achieves better performance using the deep learning based methods. Danilo et al[8] uses DenseNet(Densely connected convolutional Network). They use computer vision methods and the different methods in AI. By using these techniques it formulate the diagnosis of a given image.They increase the perfomance of the CAD systems which avoids some procedures like fine-needle aspiration.It mainly focuses upon the multimodal data which is introduced by the thyroid ultrasonographic images and acts as the CAD to classify the benign and malignant nodules.It is ensembled by different networks like ImageNET,ResNET etc..In conlusion, it achieves high performance metrics in thyroid nodule classification task.

Xiangqiong et al[2] proposed and Cache Track approach.To get the accurate results and detect the thyroid nodules is a challenging task.It is a crucial step to detect the benign and the malignant nodules in the CAD systems.Many methods perform the excellent results on the static frames.To make more naturally they have developed a well-designed framework which are suitable for thyroid nodule detection in the ultrasound vedios.Cache-Track approach exploits the relation between the vedio frames.It reduces the labor work by tracking and monitoring the surrounding tissues.In conclusion this approach gives the balancing accuracy and the speed.

Jintao Lu et al[10] proposed an online class activation mapping (CAM) mechanism for classifying the thyroid nodules using thyroid ultrasound images by making the network learn discriminative features, called CAM attention network. The network is guided to find more relevant features of nodule by introducing a convolution module.To ensure accurate results from the convolution module, Generative adversarial network (GAN) is used. The further practice of the module captures more relevant features between malignant,benign thyroid nodules.

Van T. Manh et al[7] introduced a Multi-attribute attention network(MAA-Net), is a deep learning framework.It is mainly used in the clinical process. This model concludes the malignant nodule based on the similar features and learns to predict nobular attributes. Customized attention is generated using multi-attention scheme to increase performance of the tasks and diagnosis. Additionally, MAA-Net is used for the guidance of training. Results proved that this proposed system showed higher performance than other methods and predictions are done accurately.

III. PROPOSED METHODOLOGY

SYSTEM ARCHITECTURE

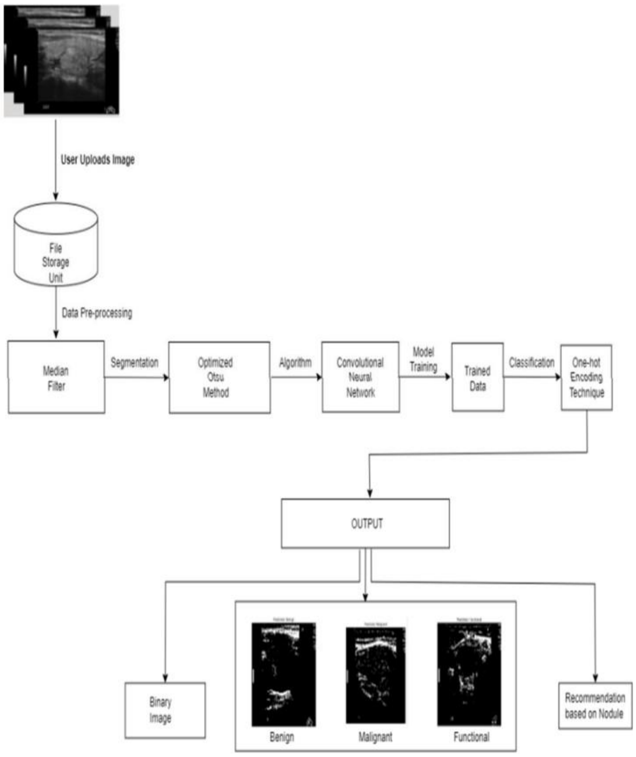

Fig1.Proposed System Architecture

In this section we shall discuss about the methodology of the proposed model.

At the intial phase we need to import all the modules.Tensorflow is one of the open-source machine learning library which is employed through the Keras API and then to create and train the Convolutional Neural Network for the classification of image tasks.It provides the strong and user friendly interface through Keras API.It is used for the construction of the neural network architectures.

From Tensorflow we can import the Sequential model which is used for the organizing the layers sequentially and different layers like ‘Conv2D’,’MaxPooling2D’,’Flatten’ and ‘Dense’ are used for building the CNN.’to_categorical’, is one of the function which is used to convert the catrgorical labels into the suitable formats and these are mainly used for training the neural networks.Essentially,Tensorflow provides the necessary tools and used to design,construct and efficiently used for the image classification tasks.

Here Median filtering is done so that it reaches the expected results.

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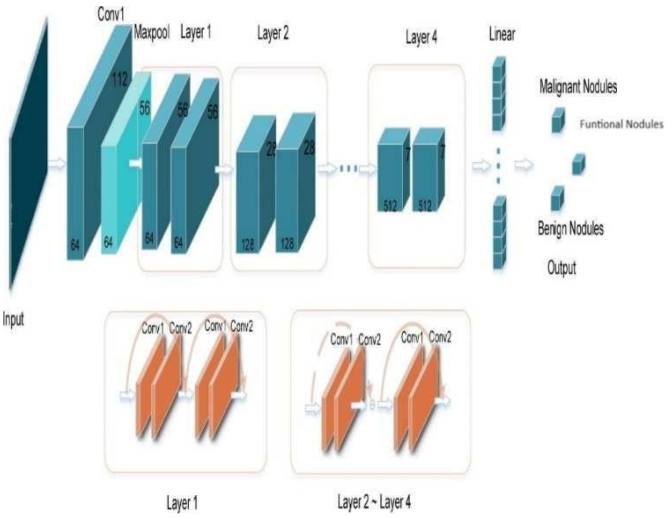

Fig2.Working of CNN model

CNN model is created using the Sequential API which is known as the 'Keras'.It consists of the different layers in which it is mainly designed for the preprocessing of the images.MaxPooling2D layers reduces the dimensions and it extracts only main features.Flatten layer is used to flatten the output and dense layers are the fully connected layers which performs the classification based on the learned features.These are the primary ones which are used in this project.

IV. EXPERIMENTAL DESIGN

Dataset Information-The dataset consists of combination of types of thyroid nodules.It consists of Benign,Malignant and Functional Nodules.

Thyroid images are to be loaded in which these images are to be preprocessed.It considers all the files in the directory and by using the OpenCV it resizes to the common size(128x128)pixels and they are converted into the grayscale.There are mainly 'Benign','Malignant','Functional' nodules are assigned with the numerical labels as 0,1 and 2.

Data splitting is one of the crucial step which is used to divide the dataset into the training data and the test data.Here we use 'train_test_split(images,labels,test_size=0.2,random_state=42)'.It divides the images and labels into the training and the testing subsets.

Normalization is one of the data preprocessing technique in which the image values ranges from 0 to 1.Reshaping of the images is done using the CNN input structure which is of the form(128x128x1 for grayscale images).Using the 'to_categorical' it assigns the labels where there 3 different classe namely benign,malignant and functional nodules.

Model Creation is the major role , we use CNN model in which there are different layers such as 'Conv2D','MaxPooling2D','Flatten' and 'Dense' are used for builiding the CNN architecture.After successful creation of the model compilation process is done in which the adam optimizer is used and the categorical_crossentropy is used to measure the loss and different metrics are used to evaluate the model.Model need to be trained by using the 'model.fit' in which takes the parameters as the train_images,train_labels,epochs=10 and the batch size is taken as 32.It uses the some portion of data to validate while training.

Evaluation of the model is done by testing the trained

In the existing model it only predicts the whether the thyroid is

Algorithm:

Step-1:Collect a dataset with different thyroid images in which it consists of benign,malignant and functional nodule images.
Step-2:Upload dataset to the Google Drive folder or any other directory.To verify print the folder name after loading.
Step-3:Use the Google Collab or the python environment in which the installation of Tensorflow is successful.
Step-4:Build the Convolutional Neural Network model in which it considers different ultrasound images and by using 'MaxPooling2D' it extracts the important or relevant features.
Step-5:Compile the model and train the model by using 'model.fit'.
Step-6:After training the model evaluate it.
Step-7:User can upload 'n' number of images as a test data .Test data is predicted using the trained model .Segmentation of the nodule is obtained by applying threshold values on the considered images.Model prediction is done on the segmented nodule and the model predicts whether it is benign or malignant or functional nodule.
Step-8: Binary image is obtained by adjusting the threshold values
Step-9:Recommendations are given based on the predicted class of the test data.
Step-10:If model predicts incorrectly on the test data then go to step-5 by training the model again else result the output. his proposed model results binary image,predicted image,recommendation based on the nodule detected.

V. EVALUATION METRICS

A. Precision-The ratio of the number of correctly predicted observations to the total number of positive observations. Such type of metric is known as "Precision".

$$\text{Precision}=\frac{Tp}{(Tp+Fp)} \quad (1)$$

B. Recall-The ratio of the number of correctly predicted positive observations to the total actual positive values.Such type of metric is known as "Recall".

$$\text{Recall}=\frac{\text{Tp}}{(\text{Tp+Fn})} \quad (2)$$

C. F1-score-It is the combination of both the precision and the recall. Such type of metric is known as "F1-score".

$$\text{F1-score}=\frac{2(\text{Recall}*\text{Precision})}{\text{Recall+Precision}} \quad (3)$$

D. Support-It refers to the total number of actual occurences of each and every class in the dataset. Such type of metric is known as "Support".

V. RESULTS & DISCUSSION

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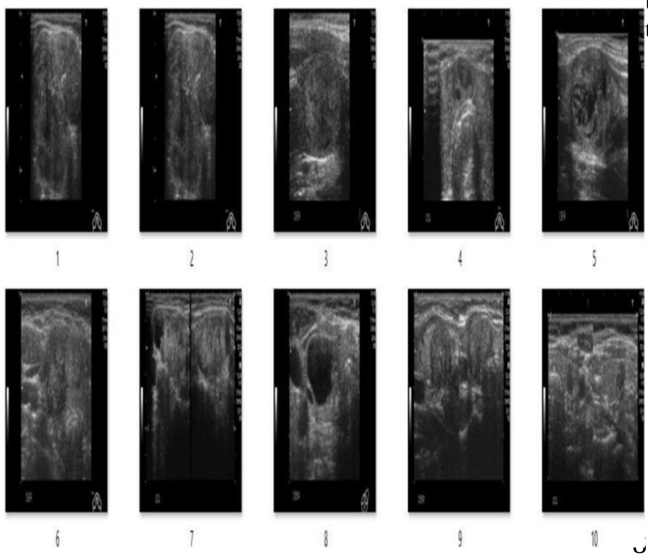

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EXISTING SYSTEM RESULTS

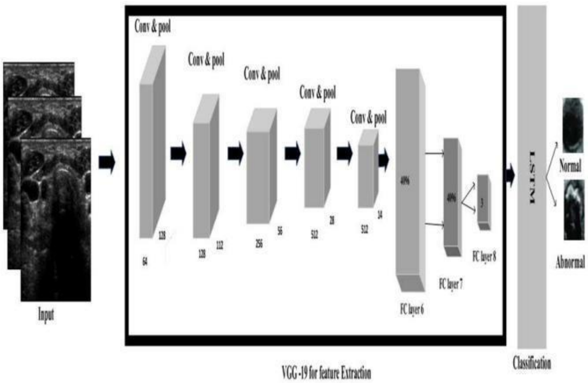
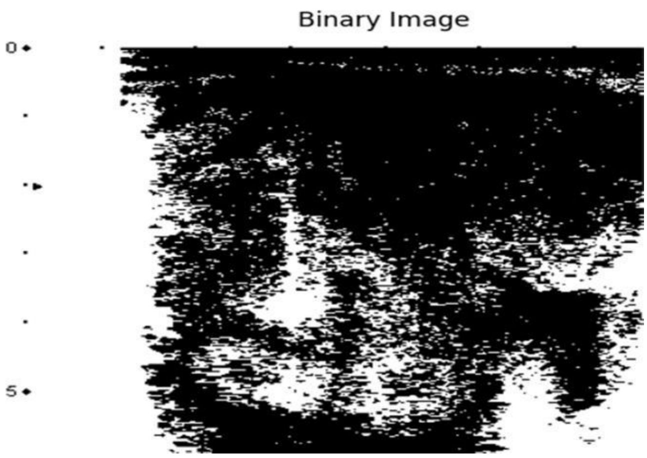


Fig4.Existing Model Results

This process is not detecting the type of thyroid nodule .In order to overcome this we introduced a proposed system.

PROPOSED SYSTEM RESULTS

A. Benign Nodule: These nodules are not more harmful(non-cancerous)



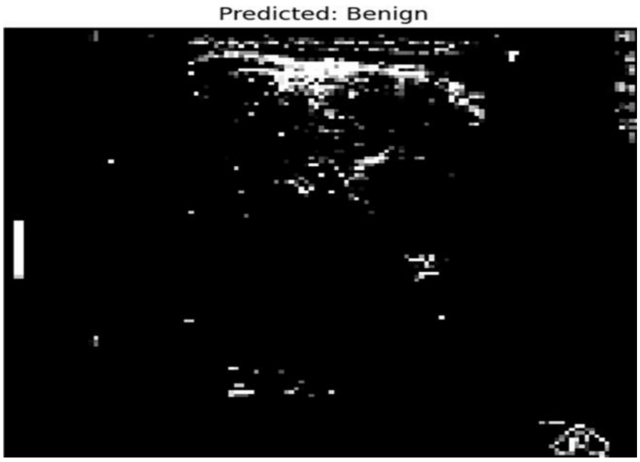
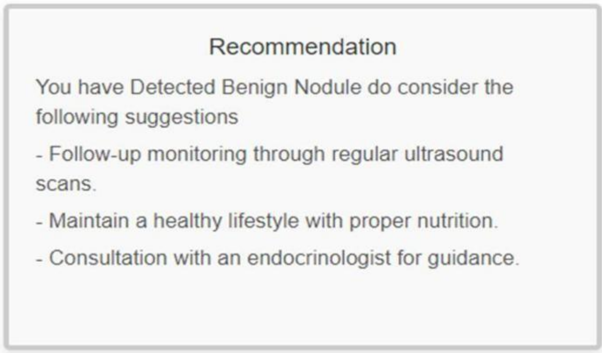
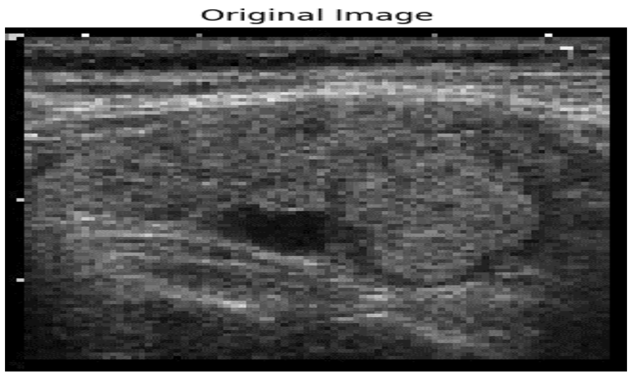
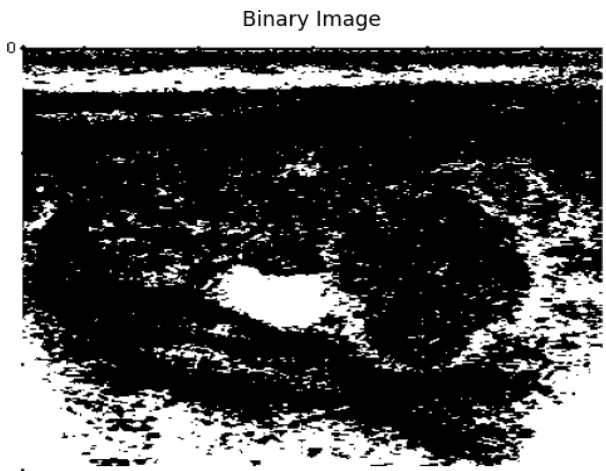


Fig5.Benign Nodule



B. Malignant Nodule: These nodules are harmful when compared to the Benign Nodules





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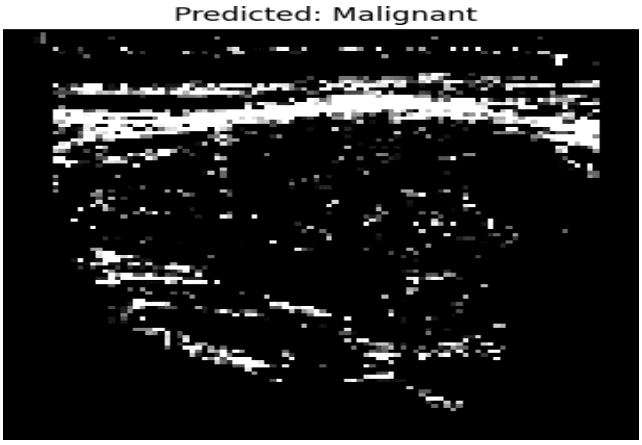


Fig6. Malignant Nodule

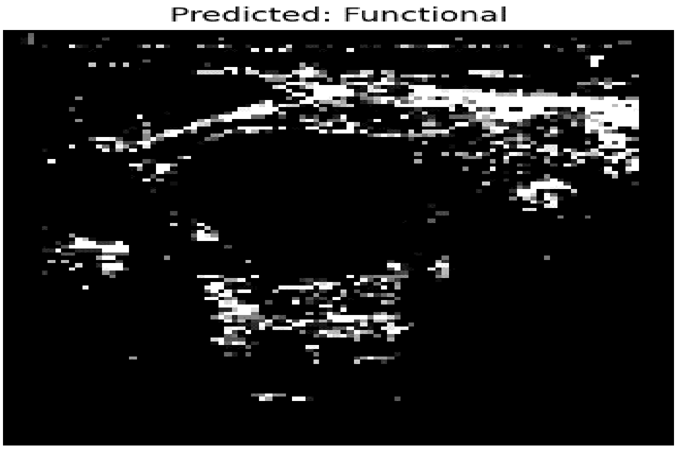
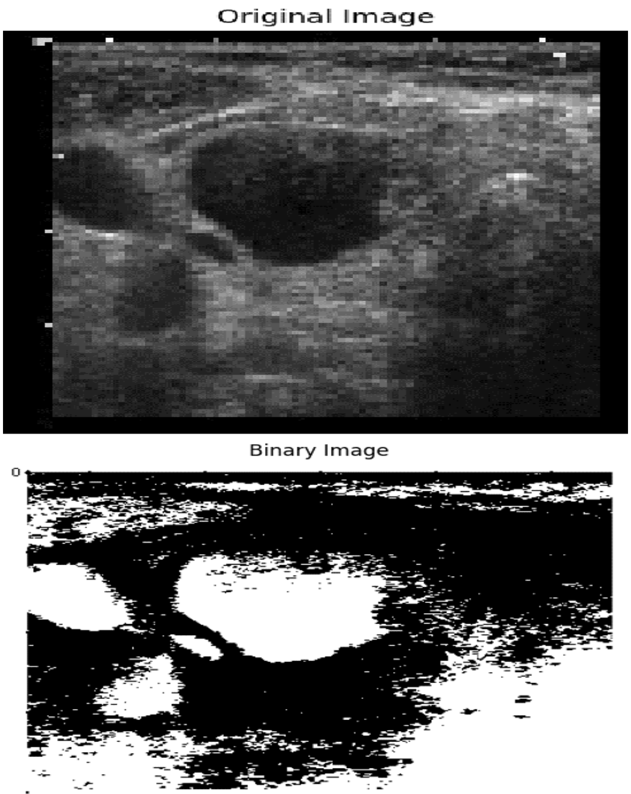
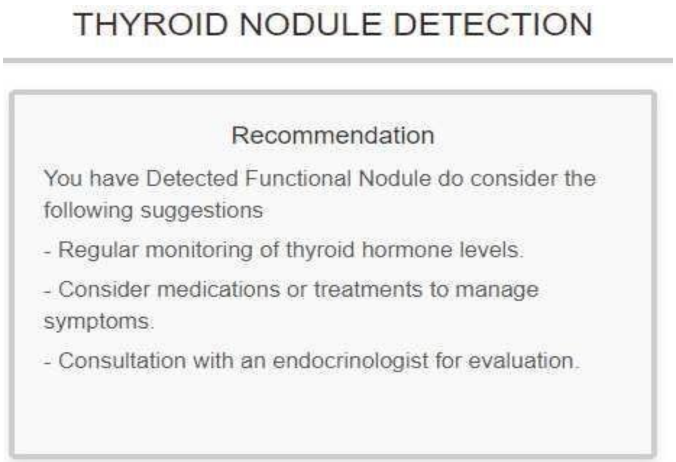


Fig7. Functional Nodule

C. **Functional Nodule**-It has the ability to produce hormones without the intervention of human body.





GRAPHS

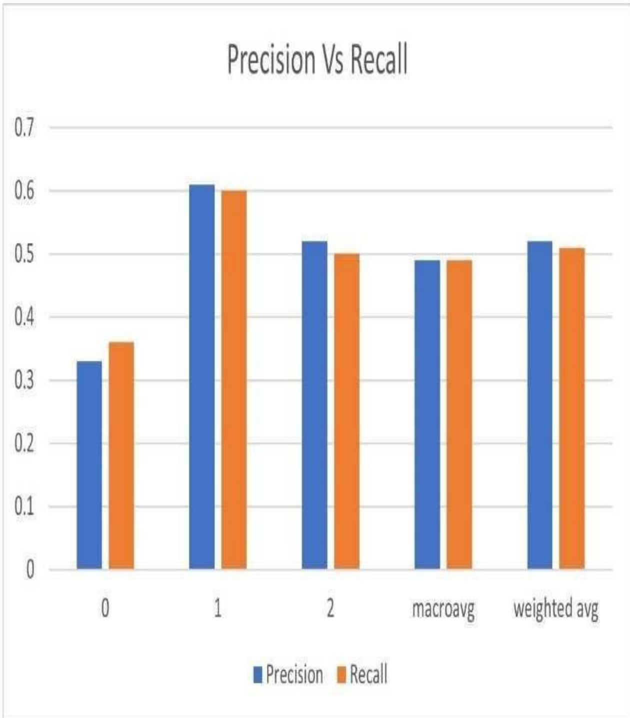


Fig8.Comparision of Precision and Recall Values

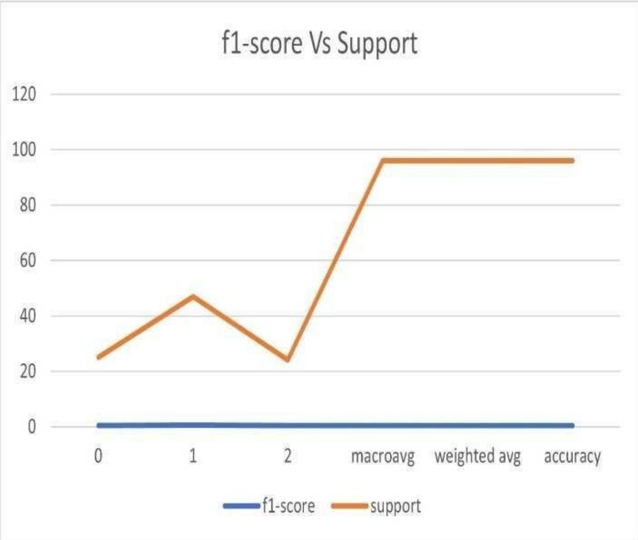


Fig9.Comparision of f1-score and Support Values

Fig10.Comparision of Precision and Support Values

VI. CONCLUSION

It provides a robust pipeline for the classification of the thyroid images.It splits the dataset into two parts training data and the test data.It normalizes and reshapes the thyroid images in which it fits to the model of CNN.Using the Tensorflow framework and Keras API the architecture of CNN is constructed and then the model is trained using the 'Adam' optimizer and its performance can be measured by the evaluation metrics.In addition,it allows users to perform interactively by uploading 'n' images for classification.These images are considered and by using the trained model it predicts the class.Overall,it not only focuses on development of the model and but also it provides an interactive surface to classify the images and mostly helpful to the medical professionals in diagnostic scenarios. Recommandations play a key role to reduce the risk to some extent after nodule detection.In this work we have introduced a recommendation to the detected nodule.

FUTURE SCOPE

As a future scope we would like to develop a mobile application and make the user more-friendly and interactive.In this present technology mobile usage is becoming vast,so building up an mobile application on classification of thyroid nodule is needed.

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