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

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Introduction

The thyroid gland in the human body is responsible for producing and regulating the metabolism of the body and hence is a very important gland in our body and thus requires high care and nurturing. 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. Malfunctioning of the thyroid results in a disease such as hyper-thyroidism when too much hormones are produced, hypothyroidism when not enough hormones are produced, Hashimoto's disease, goiter and thyroid nodules.

Motivation

Around 42 million people in India suffered from various Thyroid diseases in 2019.Further the analysis of the thyroid gland which is mostly image based and based on the subjective knowledge of the radiologists. This requires an **automated system to classify** the thyroid ultrasound images to the various texture classes and this texture class further can be used to detect the various thyroid diseases.

SCOPE of the Project

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.

Methodology

The project typically takes 2D ultrasound images of the thyroid gland, segments the thyroid region separately using the K-means clustering algorithm and then classifies the ultrasound image on the basis of the disease that it is affected by.

The classification is done using the Deep learning algorithm; Convolutional Neural Networks (CNNs) are designed to map image data(or 2D multidimensional data)to an output variable(1 dimensional data). We classify the image into malignant or benign.

Along with the classification of disease, the system also performs localization of abnormal regions i.e identifies the location of the deformities present in the image of the thyroid tissue by marking a rectangular boundary over that region.

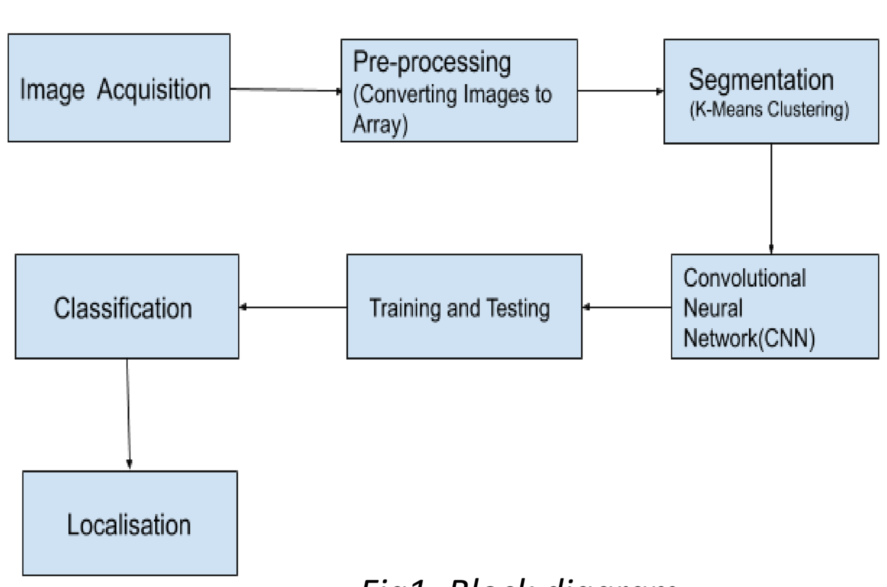


Fig1: Block diagram

Fig2: Thyroid disease classification – Flow Diagram

We obtained 480 ultrasound images of the thyroid gland. The images are in 2D form and are grayscale images. The dataset taken from Nepalgunj Medical College & Teaching Hospital and Lumbini Medical College & Teaching Hospital of Nepal. The grayscale ultrasound images are then converted into an array form in order to perform operations on them. As all the images are of different dimensions, they are all converted to the same dimension. The thyroid region from the ultrasound images is then segmented using K-means clustering. K-means clustering is a type of unsupervised learning, which is used when you have unlabeled data (i.e., data without defined categories or groups). The centroids of the K clusters, which can be used to label new data.

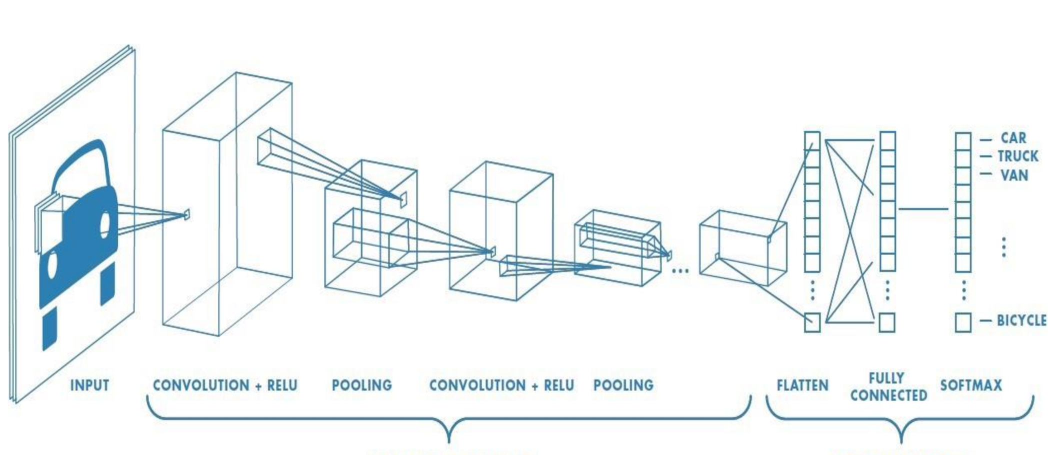


Fig3: CNN Workflow

Image Source: www.towardsdatascience.com

The images are then classified according to the thyroid condition using Deep learning algorithms. For this purpose, the dataset is split into two; training and testing data(80% and 20%). After classifying the thyroid diseases using Ultrasound images, we localize the region in which the abnormalities of the thyroid gland are found by drawing a boundary box over the abnormality.

Results

We collect the real world dataset from hospitals and pre-processed the data. K-means clustering is used for the segmentation of images. Then we create CNN model (Keras sequential) and got the accuracy around 86 percent. After that we detect the abnormalities of thyroid glands through localization of image. That's how, we can objectify the abnormal area of thyroid gland and classify them into benign and malignant.

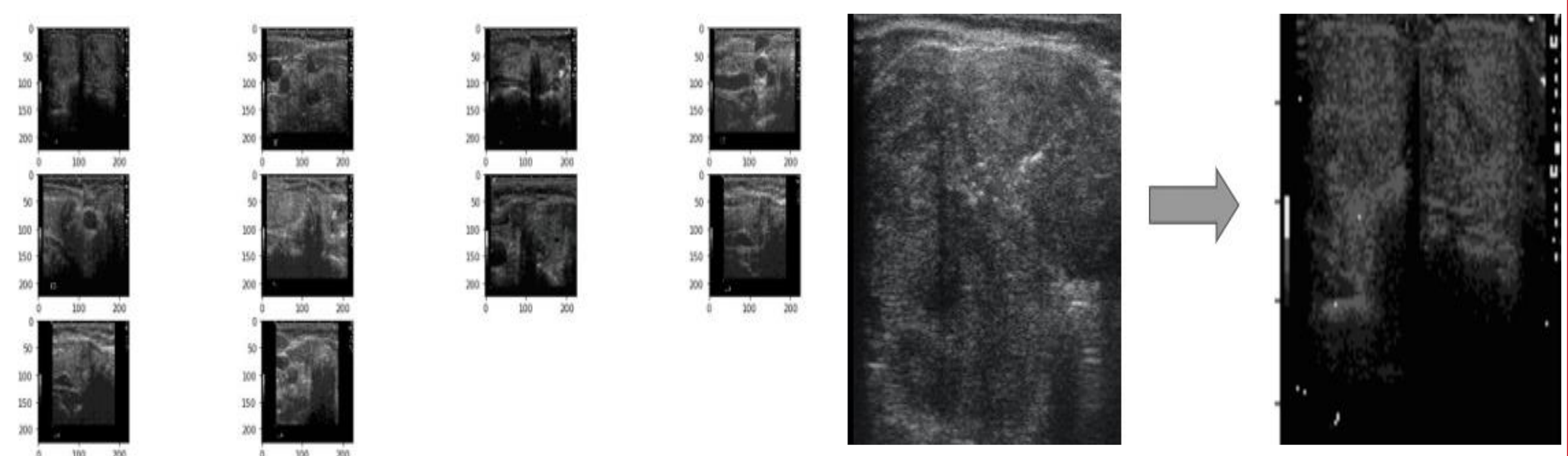


Fig4: Segmented Image Dataset

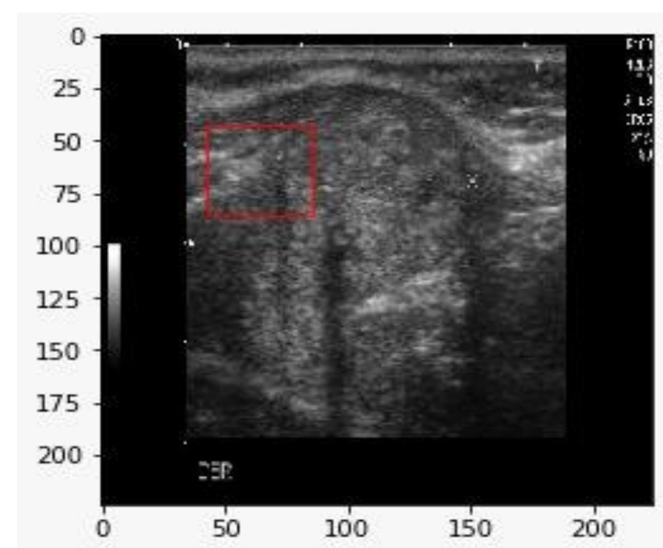
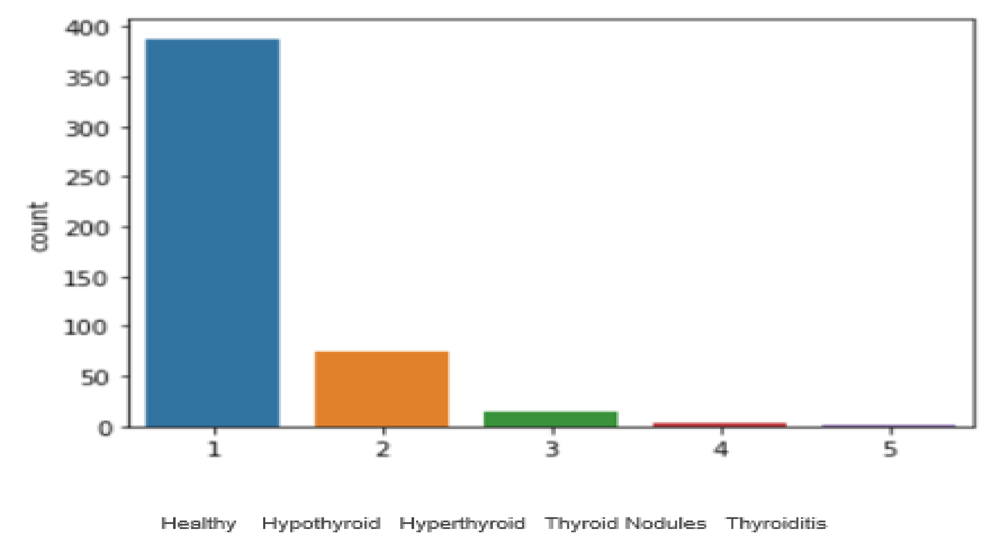


Fig5: Localization



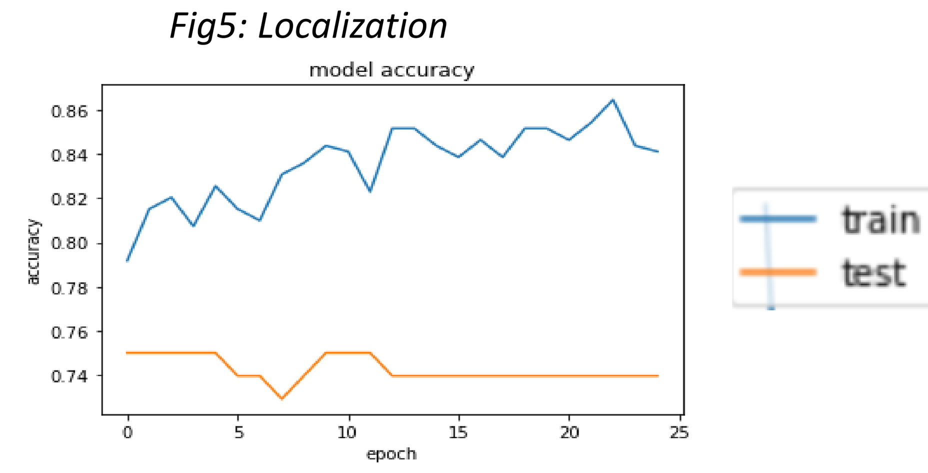


Fig7: Training accuracy vs Validation Accuracy

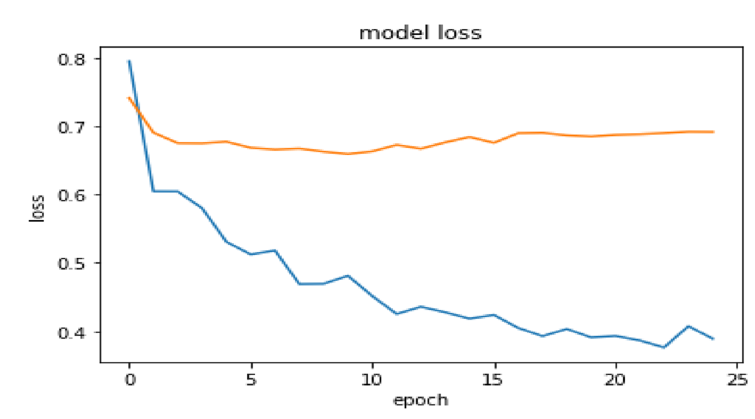


Fig8: Training Loss vs Validation Loss

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 224, 224, 32)	896
conv2d_1 (Conv2D)	(None, 224, 224, 32)	9248
max_pooling2d (MaxPooling2D)	(None, 112, 112, 32)	0
dropout (Dropout)	(None, 112, 112, 32)	0
conv2d_2 (Conv2D)	(None, 112, 112, 64)	18496
conv2d_3 (Conv2D)	(None, 112, 112, 64)	36928
max_pooling2d_1 (MaxPooling2D)	(None, 56, 56, 64)	0
dropout_1 (Dropout)	(None, 56, 56, 64)	0
flatten (Flatten)	(None, 200704)	0
dense (Dense)	(None, 128)	25690240
dropout_2 (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 5)	645

Total params: 25,756,453
Trainable params: 25,756,453
Non-trainable params: 0

Fig9: applied layers to CNN model and activation functions among other things

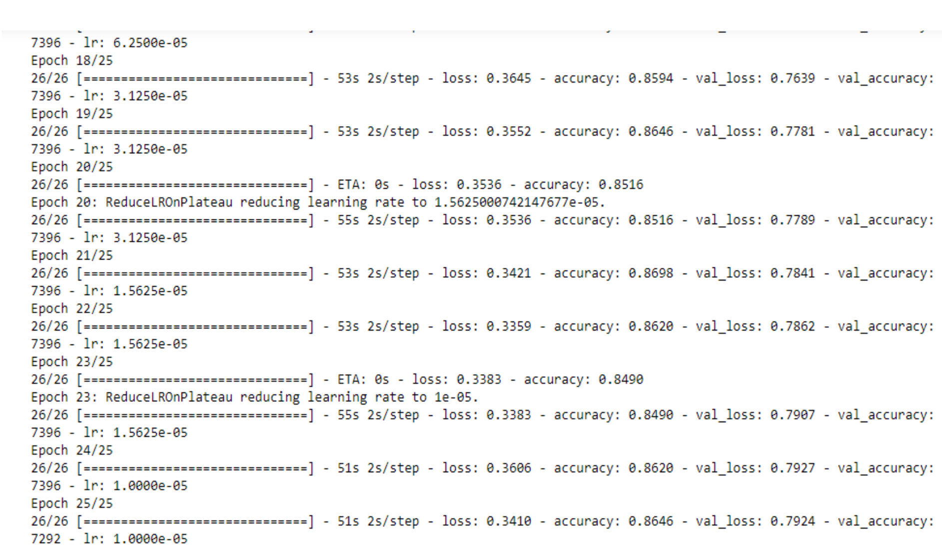


Fig10: Training and Testing on Samples and the time required, epoch and accuracy and losses

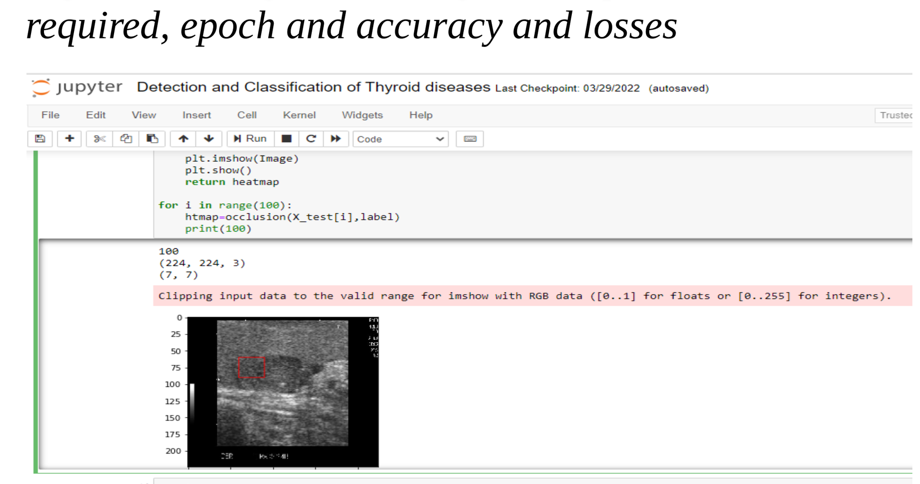


Fig11: Predicted thyroid disease of our model

Conclusion

We have developed a model that detects the disease that is affecting the thyroid from 2D ultrasound images using the k-means clustering algorithm for the image segmentation and the convolution neural networks algorithm for the disease classification. The results obtained show that the system is classifying the diseases efficiently with an accuracy of 86%. The system has also been successful in performing satisfactory segmentation of the thyroid region from the background despite the poor resolution of the ultrasound images. The localization of the abnormalities has also been achieved by the system. In the future, the accuracy can be improved by using ultrasound images of a higher resolution and including more parameters.

References

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