A PROJECT REPORT

on

OVARIAN CYST DETECTION USING MOBILENETV2

Submitted to

KIIT Deemed to be University

In Partial Fulfilment of the Requirement for the Award of

BACHELOR'S DEGREE IN
COMPUTER SCIENCE AND ENGINEERING

BY

Architaa Swain	21053360
Swapnil Das	21051521
Medha	21052334

UNDER THE GUIDANCE OF
DR. SAURABH BILGAIYAN

SCHOOL OF COMPUTER ENGINEERING
KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY
BHUBANESWAR, ODISHA - 751024

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KIIT Deemed to be University

School of Computer Engineering

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CERTIFICATE

This is certify that the project entitled

OVARIAN CYST DETECTION USING MOBILENETV2

submitted by

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Medha	21052334

is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Computer Science & Engineering OR Information Technology) at KIIT Deemed to be university, Bhubaneswar. This work is done during year 2022-2023, under our guidance.

Date: 22/04/2024

DR.SAURABH BILGAIYAN

Project Guide

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We are profoundly grateful to **DR. SAURABH BILGAIYAN** of **School Of Computer Science And Engineering** for his expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to its completion.

Architaa Swain
Swapnil Das
Medha

ABSTRACT

Ovarian cysts are basically fluid-filled sacs which develop inside the ovaries being the part of the reproductive system of females. The ovaries are responsible for producing eggs and hormones like estrogen and progesterone and ultrasound images are required for accurate detection. Recent studies explore the implementation of deep learning algorithms for improving the accuracy and efficiency and also there is ongoing reasearch on implementation of non-invasive imaging techniques for early detection of ovarian cysts. To generate more accurate results a fuzzy inference based MobileNetV2 model is implemented which helped in detecting if the cyst had less chance, medium chance or more chance using the ultrasound images. The training phase involved data augmentation and model training with Adam optimizer. Synthetic image generator is implemented to refine a clear view of different synthetic images from the original images. Image data generator and Normalization using keras library in python enhances data augmentation leading to more accurate results. Overall the model achieved an accuracy of 97% on the test data set.

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Chapter 1

Introduction

Ovarian cyst detection is defined as the understanding of risk factors and symptoms associated with these fluid-filled sacs which develop on or within inside the ovaries. These risk factors involves hormonal imbalances especially which are associated with menstrual cycle or conditions like polycystic ovaries syndrome (PCOS) [1] and endometriosis which is associated with the condition where there exists a tissue which is same as the line growing outside the [2] uterus. The ovarian cysts is formed due to various specific reasons. The most common types of ovarian cysts is referred to as functional cysts which develop as a part of the menstrual cycle. The woman's ovaries release an egg during each month or a period of 28 days is known as ovulation. After ovulation the follicles which released the egg may endure and fill it with fluid which later on becomes a follicular cyst. Other types of ovarian cysts included are cancer cyst, chocolate cyst, cystadenoma cyst, dermoid cyst, normal cyst, pelvic infection, polycystic ovaries [3,4]. These are formed due to conditions such as endometriosis, polycystic ovary syndrome (PCOS) or from abnormal cell growth. It is generally suggested that to detect these types of ovarian cysts Machine learning and Deep learning models are implemented. Some of the ovarian cysts don't cause any symptoms as they are periodically checked either by routine pelvic exams or imaging studies.

One of the major symptom is stomach bloating depending on the size of the ovarian cyst. Types of ovarian cysts is referred to as functional cysts which develop as a part of the menstrual cycle [5]. The woman's ovaries release an egg during each month or a period of 28 days is known as ovulation. After ovulation the follicles which released the egg may endure and fill it with fluid which later on becomes a follicular cyst. Other types of ovarian cysts included are cancer cyst, chocolate cyst, cystadenoma cyst, dermoid cyst, normal cyst, pelvic infection, polycystic ovaries. These are formed due to conditions such as endometriosis, polycystic ovary syndrome (PCOS) or from abnormal cell growth. It is generally suggested that to detect these types of ovarian cysts Machine learning and Deep learning models are implemented [6,7].Some of the ovarian cysts don't cause any symptoms as they are periodically checked either by routine pelvic exams or imaging studies.

The usual size of ovarian cyst found in women is 10-25mm but in some cases [8,9] it may grow larger in certain unusual conditions such as changes in menstrual cycle patterns and the nature of the contents of the cyst which help gynaecologists to suggest only if treatment is needed. Early recognition of ovarian cysts [10] and initiation of treatment during the early phase result in improved consequences contrasted to late diagnosis [11,12] and subsequent etiological analysis. The image dataset consisting of the ultrasound images of different ovarian cysts namely cancer cyst, chocolate cyst, cystadenoma cyst, dermoid cyst, follicular cyst, pelvic infection and polycystic ovaries [13] are used in detection using fuzzy inference based MobileNetV2 model which resulted in 97% accuracy and also synthetic images of the original ultrasound images are also generated. Lives of the patients can be cured through early diagnosis [14] and detection of Ovarian cysts. Ultrasound images have been proved cruical for precise detection [15,16], prompting the utilization of fuzzy inference based MobileNetV2 model. The model seeks to detect cysts [17,18,19] with accurate results enabling timely interventions and treatment strategies. Implementing techniques such as data augmentation, model training [20] with Adam optimizer and synthetic data generation helps in generating accurate results.

Chapter 2

Related Works

As large number of patients are suffering with cyst, a lot of work have been carried out on Cyst detection in the field of medical science. The classification of 8 ovarian cysts using fuzzy controlled Covolutional Neural Network model has been used to detect the cyst [2] where 320 images were used for training sets and 12o images were used for testing set athe test data after sucessful detection resulted in an accuracy of 98.37%.

The study of automatic detection of follicles using best division [3] and classification. Cystic, Polycystic and Normal uterus are the three classifications which have been used for classification [4]. In another research [6] a model incorporating Logistic Regression, Support Vector Machine and K-Nearest Neighbour is used to differentiate between PCOS [1] and normal ovaries. Preprocessing of images such as grayscaling, histogram, equilization, invert picture, cleansing of data was used to give better image inputs to segmentation stage. The model used in the detection classified the input images into groups consisting of polycystic and non-polycystic ovaries and accuracy of 98% is generated from the merged classifier.

Another reasearch contrasted the necessity of artificial intelligence in the field of health care focussing on the identification of PCOS [7]. Pearson correlation is used to select features and implement different algorithms like SVM , random forest classifier and XG boost. C.Narmatha utilized HHO (Harris Hawk Optimization) in DQN (Deep Q-Network) to identify the ovarian cysts consisting of 87 images. Image preprocessing is utilized using Weiner filter for noise removal from dataset. Another research used VGG-16 deep learning [9] network to detect ovarian cyst using ultrasound images. The Visual Geometry Group-16 model utilized kernel filters of size 3x3 with three layers fully connected. 80 images are utilized with 80 images of ovarian cysts for training and also 40 images of both normal and ovarian cyst is used for testing resulting in an accuracy of 92.11%. In another research R.Benazir Begam utilized CNN (Convolutional Neural Network) [10] which categorizes the cysts into dermoid cyst, hemorrhagic cyst and endiometrioma cyst. Dataset consisting of 80 images are utilized for successful cyst detection and the accuracy resulted in 94% after segmentation.

Overall all the above related works used deep learning technique and Ml algorithms like SVM, K-NN and more to detect different types of ovarian cyst. Most of the works used convolutional neural network model to classify the training and testing images with accurate results.

Chapter 3

Methodology

Preprocessed images are used to detect 8 types of ovarian cysts using fuzzy inference based MobileNetV2 network. Feature extraction is implemented by appending the images in a 1-D array and also synthetic images has been generated from the original images. Data augmentation and training the model using Adam optimizer helps in generating more accurate results. 75% of the data has been trained and these trained image dataset are used to evaluate the MobileNetV2 model after implementing the fuzzy rules using the fuzzy inference system and performing data augmentation using the trained images.
25% of the image dataset is tested for making predictions after sucessful evaluation and data augmentation using image data generator. The Figure 1.0 shows the entire process in which the ovarian cysts have been detected.

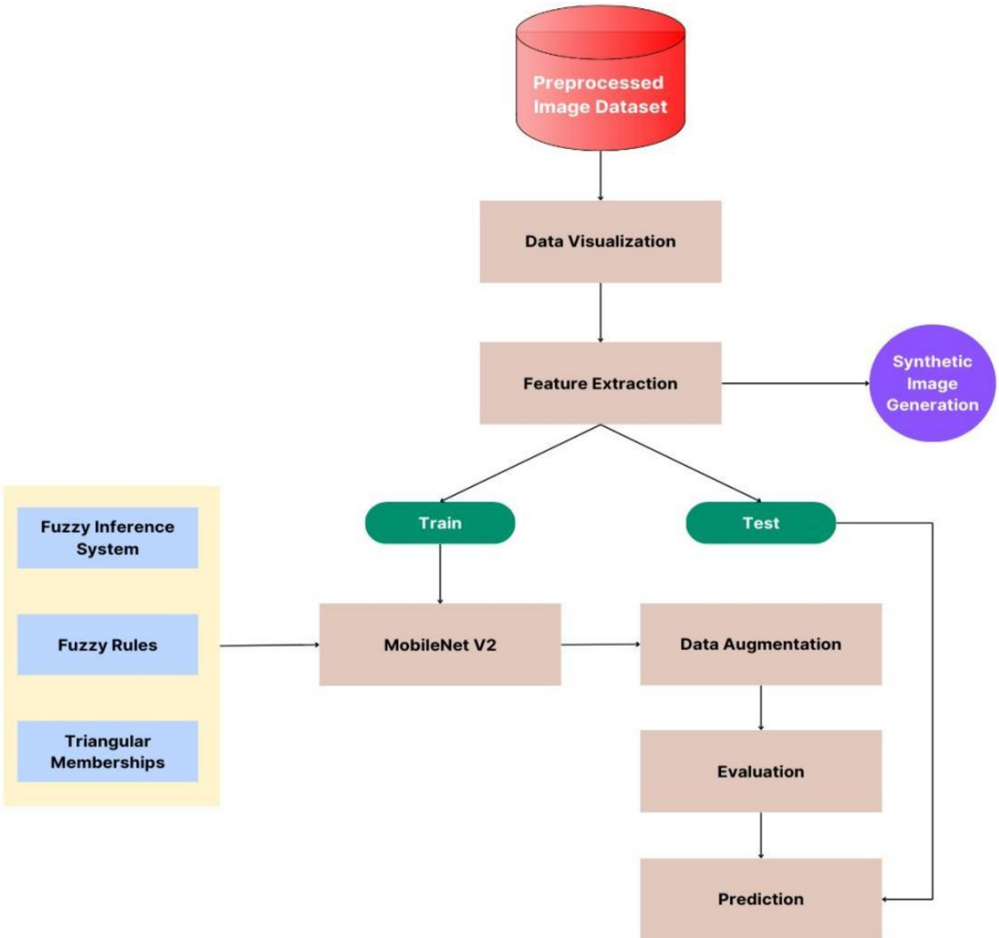

Figure 1. Ovarian Cyst Classification Model

3.1 Dataset Selection

Ultrasound images are used for as the high frequency waves helps in generating real time images producing more accurate results. The images are selected based on the ultrasound of 8 types of ovarian cyst namely cancer cyst, chocolate cyst, cystadenoma cyst, dermoid cyst, follicular cyst, normal cyst, pelvic infection and polycystic ovaries [2]. Each image has been labelled in the format as 1,1,1,1 , 1,1,1,2 and so on where the first integer indicates length, the second integer indicates width, the third as shape and at last the intensity(length, width, shape, intensity). The ultrasound images helps us to detect the occurance of a specified cyst.

Table 1

Sl no.	Cyst types	Number of images
1.	Cancer cyst	40
2.	Chocolate cyst	21
3.	Cystadenoma cyst	36
4.	Dermoid cyst	36
5.	Follicular cyst	30
6.	Normal cyst	36
7.	Pelvic infection	36
8.	Polycystic ovaries	30
Total training images : 200 Total testing images : 65		

The dataset comprises of 265 ultrasound images where 65 images are utilized for testing and the remaining 200 ultrasound images are utilized for training providing accurate results.

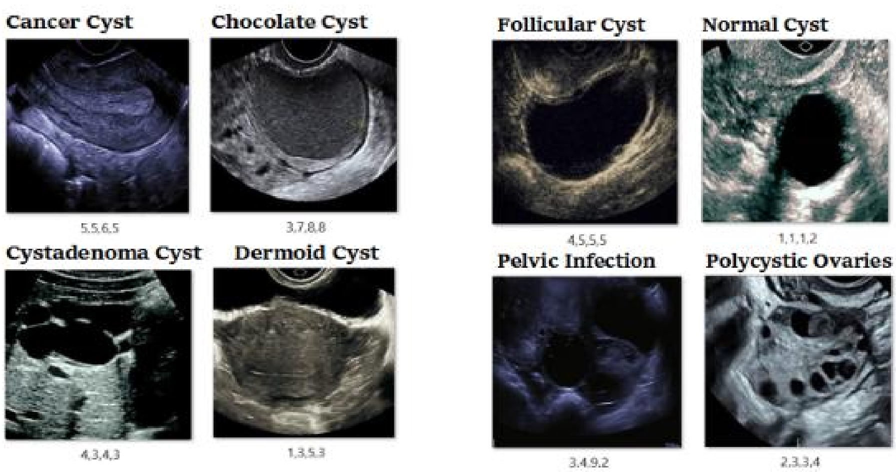

Figure 2. Ultrasound image dataset of ovarian cysts

3.2 Image Preprocessing

The images of size 140 x 140 pixels to enable faster image processing and the image datas are tranformed into a numpy array and divided by 255, which helps in normalizing the image pixel values by keeping it between the range 0 to 1. Image data generator from keras library in python is used for data augmentation techniques in order to avoid overfitting. Zero component analysis(ZCA) whitening is used, helping in increasing the proficiency of the algorithm.

3.3 Feature Extraction

The ultrasound images of ovarian cyst detection consists of several feature comprising shape, intensity, length and width and the number of pixels (140 x 140) along with 3 colour channels namely blue, green and red. Overall these features enables to generate accurate synthetic images and use of fuzzy based rules using these features enable to detemine if there is less chance, medium chance or more chance of cyst occurance and generates a triangular membership with the occurance.

3.4 Synthetic Data Generation

Synthetic data refers to the process of generating additional data or images involving the patterns and features of the original data. Pillow library has been used for the image processing. The synthetic image function enables iterations through the ultrasound images of the 8 types of cyst used and produces synthetic images of different filters and noise levels.It generates 6 synthetic images for each ultrasound images along with the filter which comprises of the colours namely red, green, white, cyan and yellow along with the noise levels as low intensity and moderate intensity noise. Each synthetic image has been generated at a size of 15x5 inches.

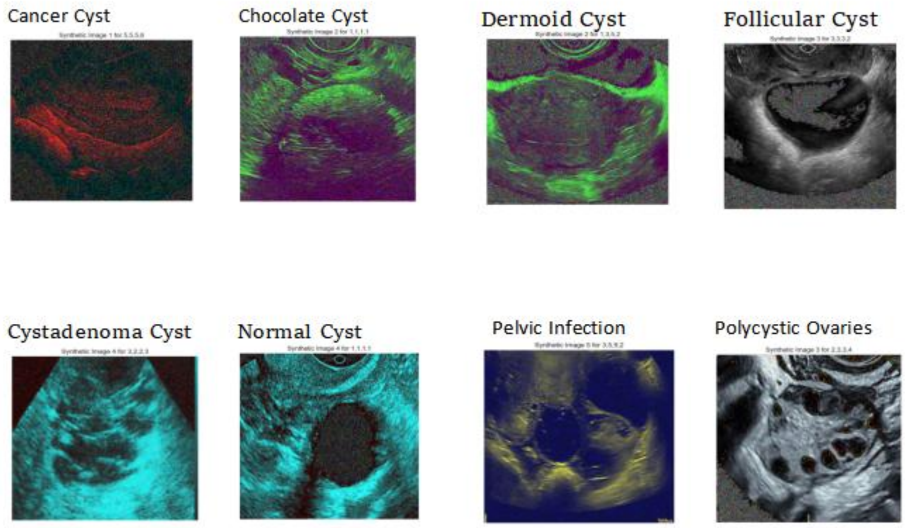

Figure 3. Synthetic images generated from the original ultrasound images

3.5 CNN in Keras

Deep learning is used for classifying images in order to establish a convolutional neural network(CNN). With the use of Keras library, establishing a CNN becomes quite simple. Convolutional neural network (CNN) makes sure to iterate through each ultrasound image [5] until all the pixels of those images have been analyzed. Convolutional neural netwok (CNN) is a neual network algorithm which is mostly suitable of classification and detection of images. CNN consists of several layers which comprises of pooling layers, fully connected layers and Convolutional layers.

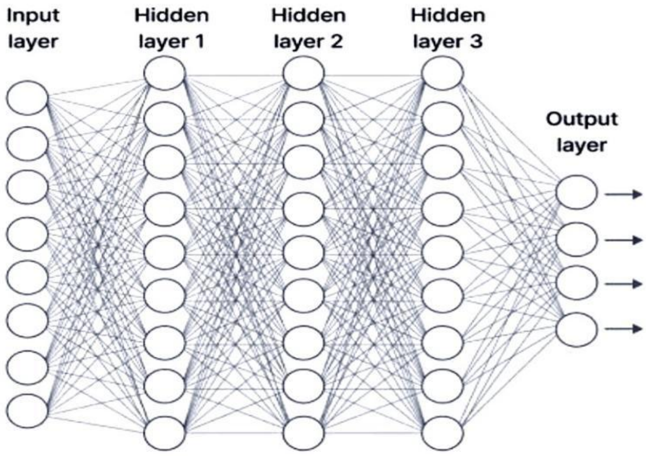

Figure 4. Proposed Convolutional Neural Network Architecture

3.6 MobileNetV2 Implementation Using CNN

MobileNetV2 is a portal CNN model which functions more efficiently on smaller datasets. The MobileNetV2 model includes the shape of ultrasound images of 140 x 140 pixels along with 3 colour channels (Red, Green and Blue) by creating a base and initializes the top layer as false which indicates that final top layer will not be included.

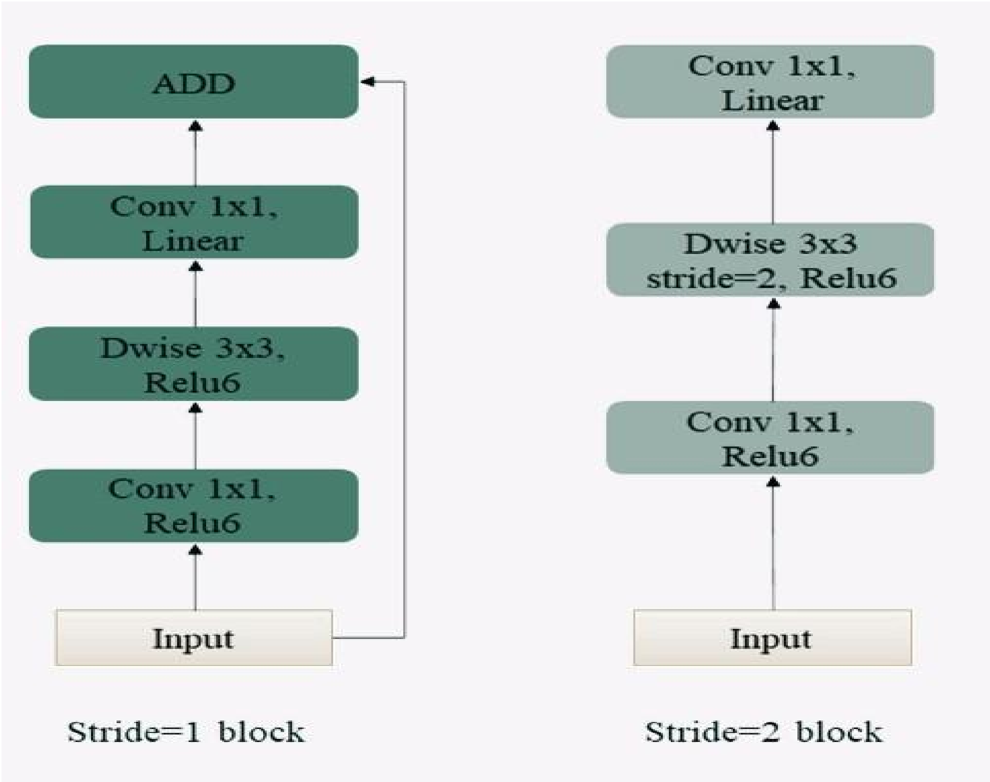

Figure 5. Proposed MobileNetV2 architecture

A Sequential model is created where the layers are non-trained and Global Average Pooling2D is included to decrease the spatial dimensions and helps in avoiding overfitting. MobileNetV2 adds a dense layer consisting of 512 units along with ReLu (Rectified Linear Unit) as the activation function which will exchange the negative inputs with zeros and help in detecting and analyzing patterns. It also adds a dense layer with 8 units with activation function as softmax [5]. Here 8 indicates the 8 classes of cyst and softmax is used to convert the ouput to probability allocations as shown in figure 6.

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 mobilenetv2_1.00_224 (Func  (None, 5, 5, 1280)        2257984
 tional)

 global_average_pooling2d_1  (None, 1280)              0
  (GlobalAveragePooling2D)

 dense_2 (Dense)             (None, 512)               655872

 dense_3 (Dense)             (None, 8)                 4104

=================================================================
Total params: 2917960 (11.13 MB)
Trainable params: 659976 (2.52 MB)
Non-trainable params: 2257984 (8.61 MB)
_________________________________________________________________
```

Figure 6. Model Summary

3.7 Fuzzy Inference

The skfuzzy library in python is used for appyling the fuzzy inference rules and these rules determines whether is less,medium or more chance of occurance of cyst by analyzing the length, width, intensity and shape of different ultrasound images of cysts and at last generates a triangular membership with reference to the occurance of cyst. The regular expression(re) is used to extract the numeric image names from the cyst directories and checks if it matches with the correct format of image names as the first one indicating length followed by width, shape and intensity. The figure 7 below shows a triangular membership with respect to occurance. The input values which are received after extraction are used in the fuzzy inference system. Triangular membership result obtained from one of the cysts is shown in Figure 7.

```
 Cancer Cyst

Fuzzy Inference Result for 1,1,1,1.jpg
Predicted Occurrence: Less chance
```

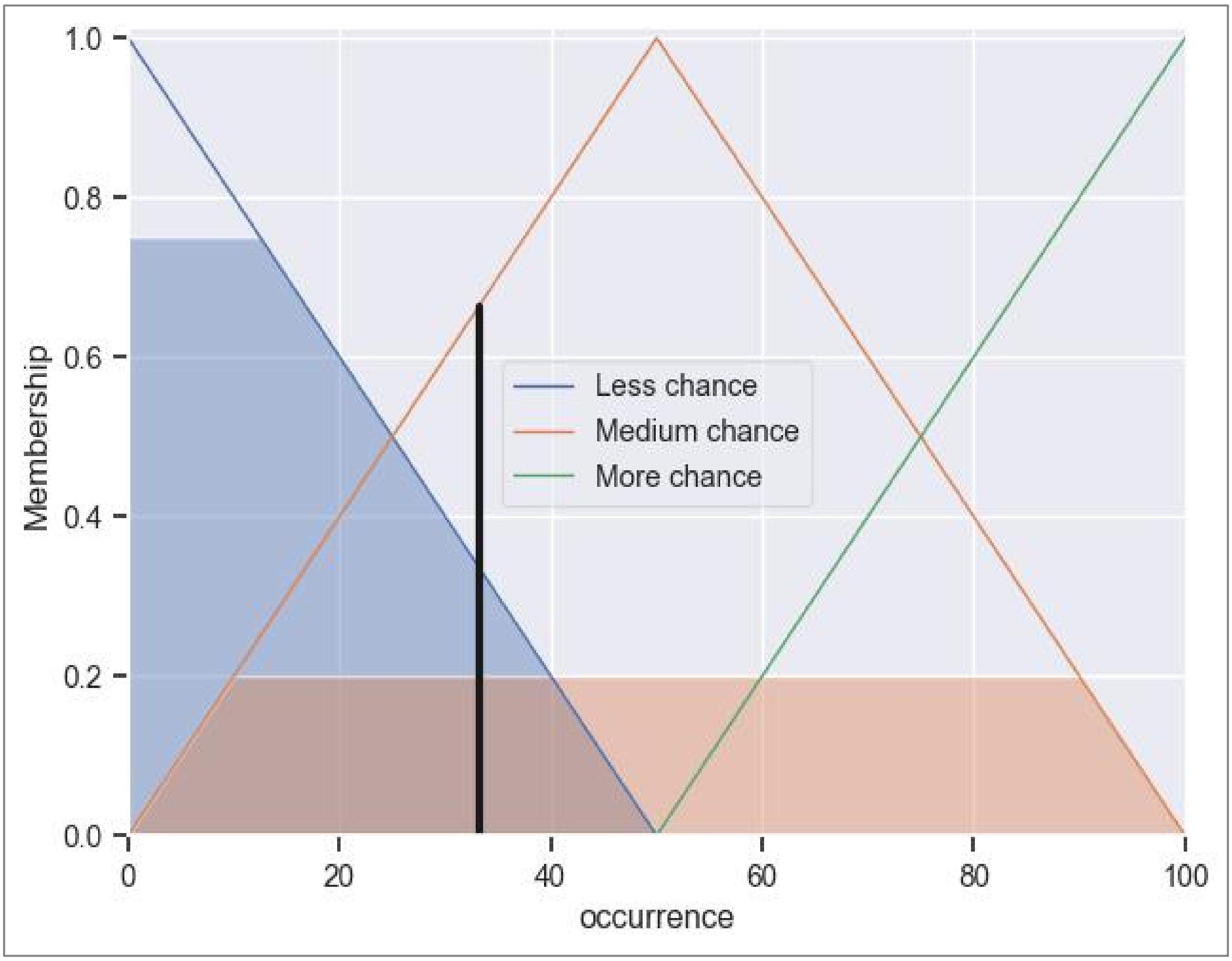

Figure 7. Triangular membership result obtained from Fuzzy inference rule

Chapter 4

Results and Discussions

MobileNetV2 compilation takes place by considering 3 parameters namely optimizer, loss function and metrices. Adaptive Movement Estimation(Adam) optimizer helps in adjusting the learning rate during the training process and also generated the best configuration. The loss function determines how well the model is performing and the difference between the predicted cyst labels and true cyst labels generates how accurate the model is. Ovarian cyst detection is basically multi-classified as it involves the classification of 8 different types of cyst and so categorical crossentropy is used as the targets are one-hot encoded.

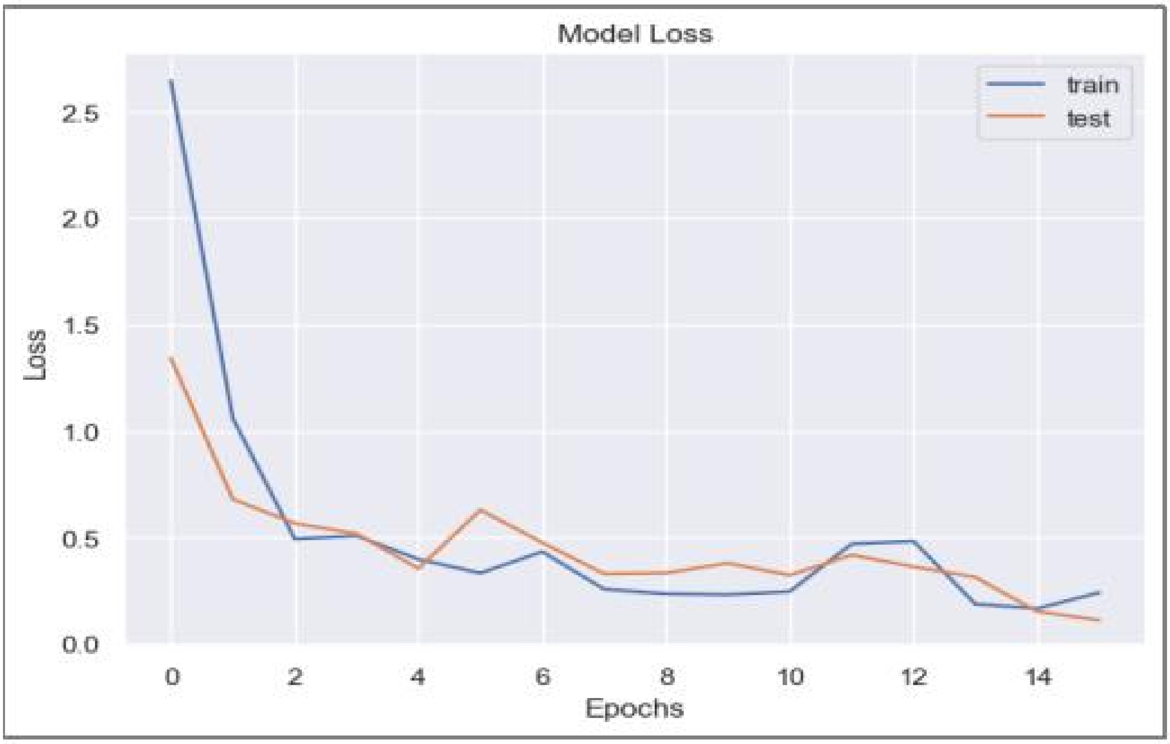

Figure 8 Model Loss after evaluation

Accuracy is commonly used metric for mutli-classification and at last it generates the accuracy percentage of the model. Basically metrices checks the progress of the model and determines if the model is working correctly. After the training of different layers of the MobileNetV2 model that led to the successful generation of loss, accuracy and value of the metrices, the History() approach is used to display the accuracy results and the loss that occurred from the epoches as shown in Figure 8 and 9.

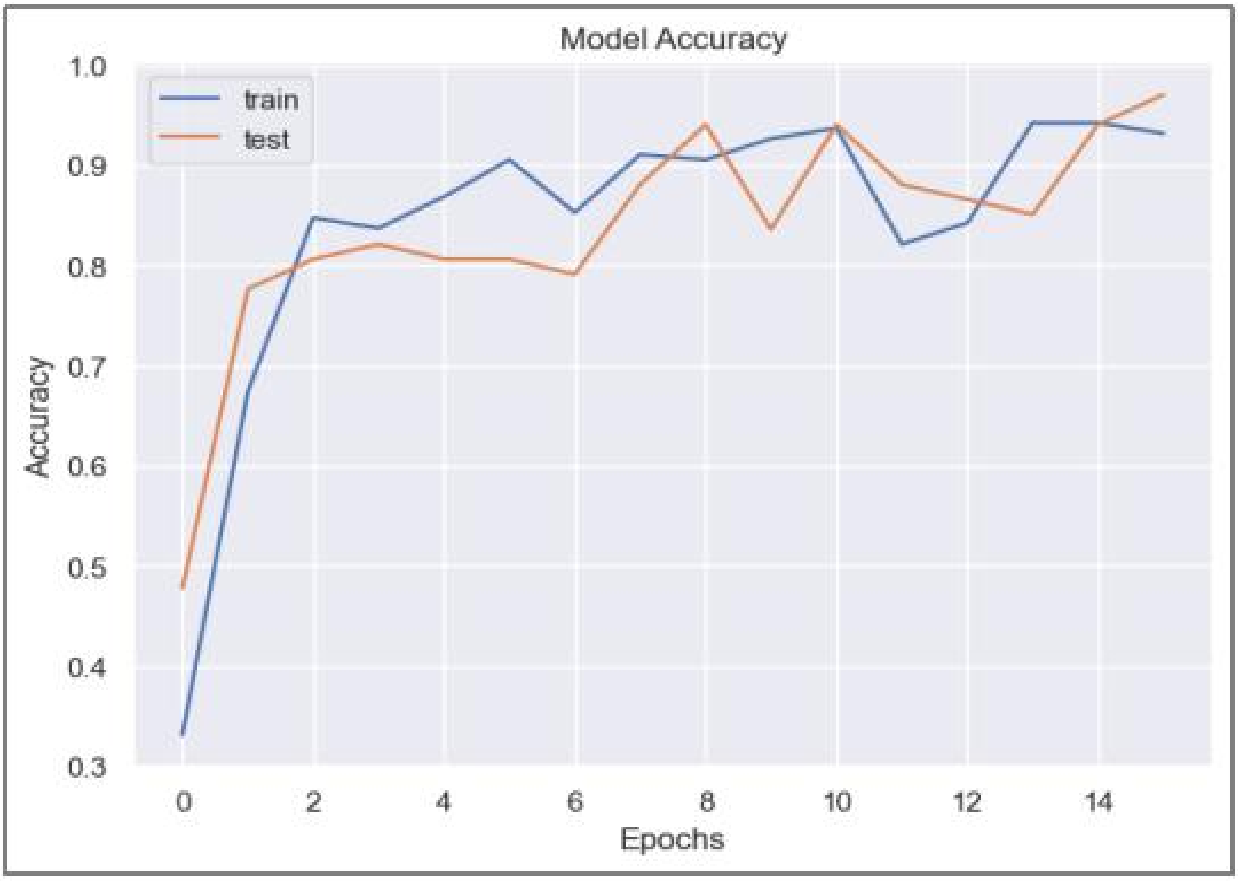

Figure 9 Model Accuracy after evaluation

Confusion matrix is a type of matrix which is used to determine and evaluate the performance of a model. It comprises of the parameters: TN(True Negative), TP(True Positive), FN(False Negative) and FP(False Positive). Implemention is done using a heatmap which takes the predicted values on the test data [2]. The Sequential colour ranging from purple to red is applied to the confusion matrix. It makes sure to accept numeric values for evaluating the performance and takes the classes of cysts on both the x axis and y axis of the matrix. The figure 10 display the confusion matrix.

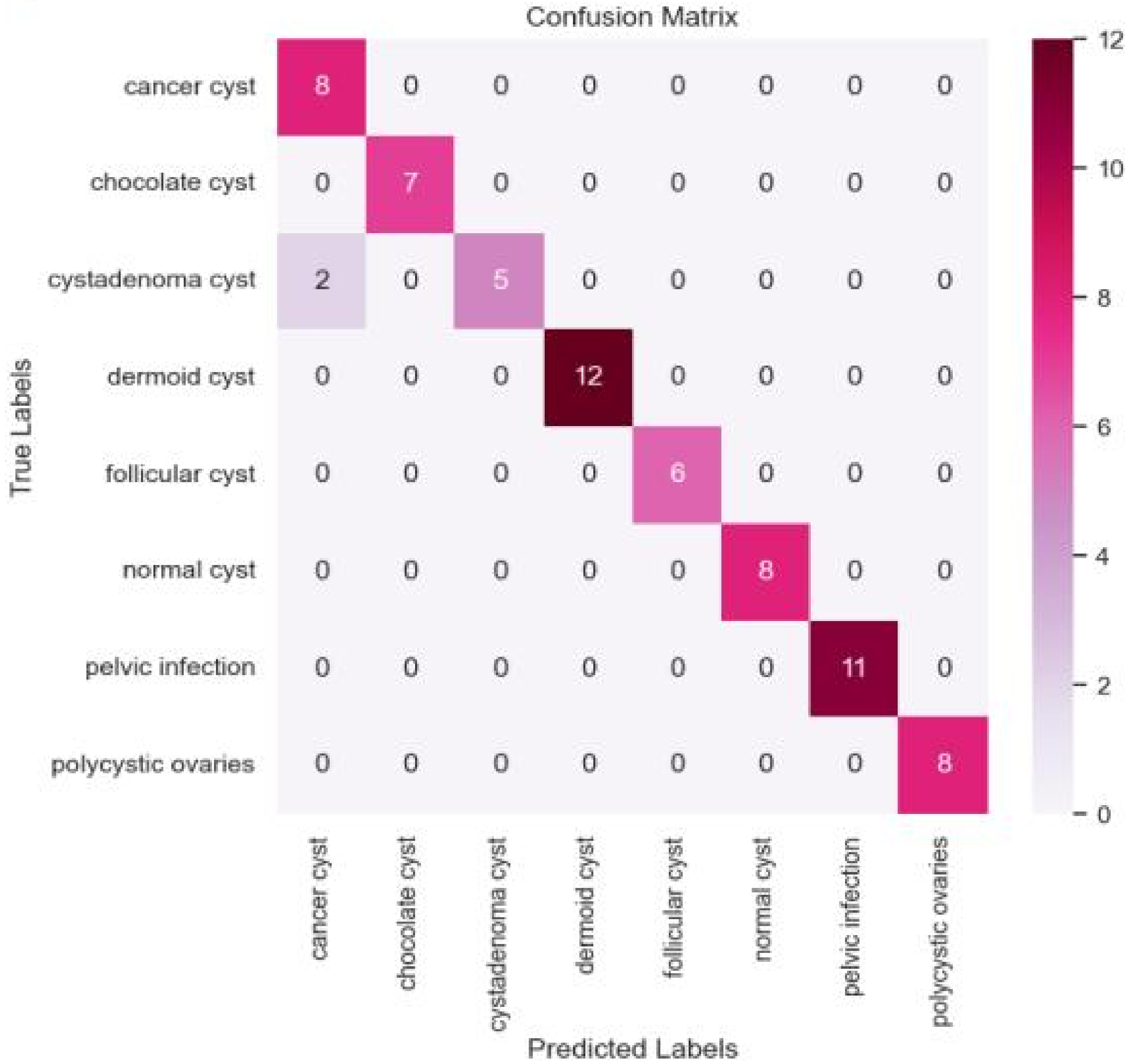

Figure 10 Confusion Matrix for different types of cyst

Classification report comprises of the parameters precision, recall, f1-score and support. These metrices together help in determining the accuracy of model by deeply analyzing the 8 types of cysts. The accuracy is actually determined by taking the true classes and predicted classes into account.

Precision indicates the number of positive predictions generated are correct as shown in figure 2.0.

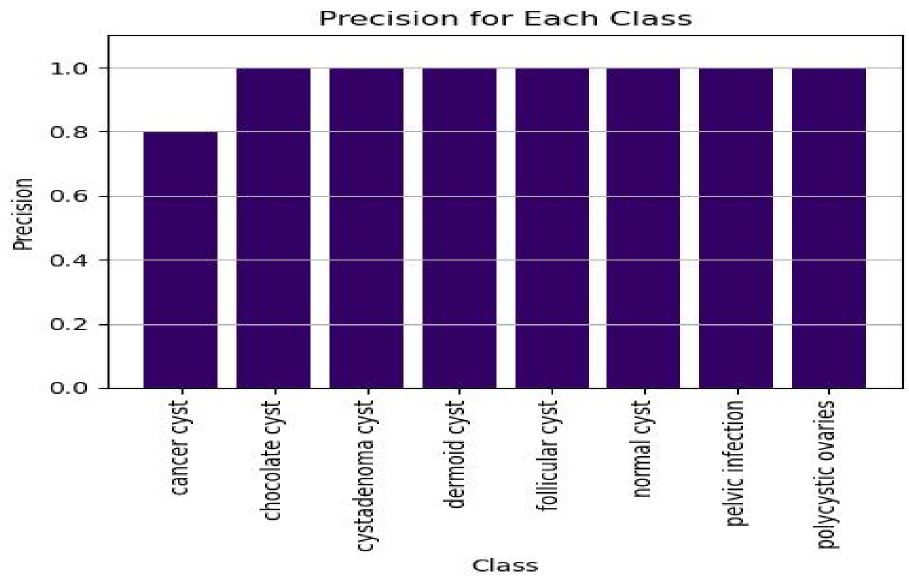

Figure 11 Precision score for all cysts

Recall indicates the overall positive scenarios in the data and provides the information about how well the model can identify the instances within the image dataset.

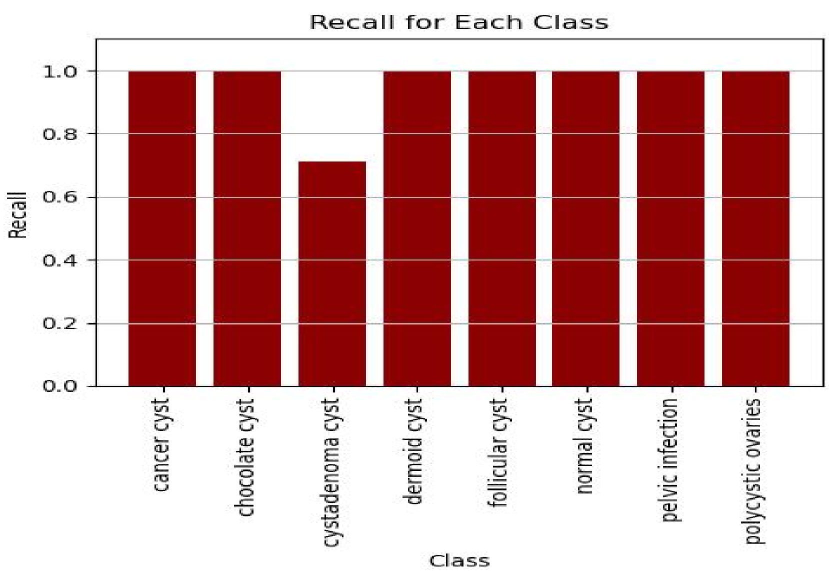

Figure 12 Recall score for all cysts

F1 score represents the reciprocal average of precision and recall. The support metrice comprises of the number of actual classes in he image data set. The support metrice is highest for the dermoid cyst and the macro average has been obtained as 97% for precision metrice, 96% for recall metrice and 97% for the f1-score.

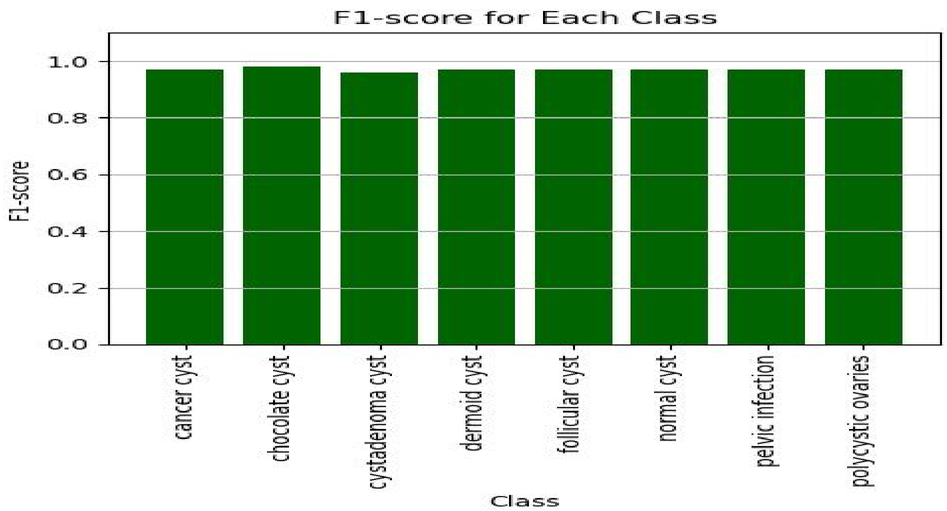

Figure 13 F1- score for all cysts

The weighted average has been obtained as 98% for precision metrice, 97% for recall metrice and 97% for the f1-score. By determining these metrices, the accuracy of the model is generated as 97% by deeply analyzing the results obtained from testing the data of the 8 types of cysts. The accuracy obtained represents the effectiveness obtained by determining the model's predictions. The figure 1.8 displays the classification report.

```
Classification Report:
                    precision    recall  f1-score   support

       cancer cyst       0.80      1.00      0.89         8
    chocolate cyst       1.00      1.00      1.00         7
  cystadenoma cyst       1.00      0.71      0.83         7
      dermoid cyst       1.00      1.00      1.00        12
    follicular cyst       1.00      1.00      1.00         6
       normal cyst       1.00      1.00      1.00         8
  pelvic infection       1.00      1.00      1.00        11
polycystic ovaries       1.00      1.00      1.00         8

          accuracy                           0.97        67
         macro avg       0.97      0.96      0.97        67
      weighted avg       0.98      0.97      0.97        67


The accuracy of the model is 97%
```

Figure 14 Classification report

Chapter 5

Conclusion

The implementation of ultrasound images and advanced deep learning techniques using fuzzy inference based MobileNetV2 demonstrated an efficient approach towards early detection of ovarian cysts. The model showcases robust performance by accurately detecting the cysts based on their likelihood. Implementation of techniques such as data augmentation, use of Adam optimizer helped in improving patient outcomes and health care by facilitating timely treatment and interventions. Overall the model emphasized the importance of innovative methodologies to enhance the accurate outcomes of cyst detection.

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Contribution

Medha (Roll no:2102334) contributed to analysing related works (chapter 2), methodolgy (chapter 3) which included designing the classification model, Dataset selection (3.1), image preprocessing (3.2), feature extraction (3.3) to generate accurate synthetic images of pixels 140x140 .

Swapnil Das (Roll no:21051521) contributed to generation of synthetic images from the original image dataset(3.4), selection of most suitable model for generating the accuracy i.e. MobileNetV2 model using CNN (3.5) , (3.6) and making use of fuzzy inference system (3.7) .

Architaa Swain (Roll no:21053360) contributed to Introduction (Chapter 1) which included the explanations about the different types of Ovarian cysts and their treatment process, Results and Discussions (chapter 4) which included generating the model loss and model accuracy, confusion matrix for different kinds of cysts, precision, recall, f1-score and Conclusion (chapter 5)

OVARIAN CYST DETECTION USING MOBILENETV2

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