Project Report on

Skin Cancer Detection Using Image Processing

Submitted in partial fulfillment of the requirements

of the degree Bachelor in Engineering

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Under the guidance of

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Certificate

This is to certify that the report of the project entitled

Skin Cancer Detection Using Image Processing

is a bonafide work of

Name of Student	Class	Roll No.
Vatsal Gada	BE 4	12
Jashil Mehta	BE 4	32
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submitted to the

UNIVERSITY OF MUMBAI

during semester VIII in partial fulfillment of the requirements for the award of the degree

Bachelor in Engineering

in

COMPUTER ENGINEERING.

(Mrs. Sarika Rane)
Guide

(Prof. Uday Bhave)
I/c Head of Department

(Dr. Bhavesh Patel)
Principal

Approval for Project Report for B. E. Semester VIII

This project report entitled SKIN CANCER DETECTION USING IMAGE PROCESSING by Vatsal Gada, Jashil Mehta and Rushi Shah is approved for semester VIII in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering.

Examiners

1._____

2._____

Guide

1._____

2._____

Date: 30/04/2022

Place: Chembur

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Name of Student	Class	Roll No.	Signature
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Date: 30/04/2022

Place: Chembur

Abstract

Skin cancer is found most commonly among fair skin. Skin cancer is found to be two types: Malignant Melanoma and Benign. Melanoma is one of the deadly and dangerous types of cancer. Melanoma can be cured if it is identified or diagnosed in the early stages and the treatment can be provided early, but if melanoma is identified in the last stages, it is possible that Melanoma can spread across deeper into the skin and also can affect other parts of the body, then it becomes very difficult to treat.

The diagnosis that is performed by the system will help to increase the speed and accuracy of the diagnosis. Computers will be able to extract some information, like asymmetry, color variation, and texture features, these minute parameters may not be recognized by the human naked eye. In our project, we use image processing techniques like image segmentation using K-means to differentiate the mole from the rest of the skin lesion. Then this skin lesion after some post-processing is used to build a model using EfficientNet. We use Adam optimizer along with the model and use default imagenet weights to train the model. We used an essential technique namely Test Time Augmentation which helps us increase the accuracy and diversity by feeding back augmented images several times. After achieving a desirable accuracy score, the entire project is concluded with various techniques to visualize the accuracy of the model. We use accuracy and loss graphs, accuracy score, confusion matrix, AUC and ROC curve and also print out actual vs predicted results.

Acknowledgement

We are thankful to our college Shah And Anchor Kutchhi Engineering College for considering our project and extending help at all stages needed during our work of collecting information regarding the project.

We are deeply indebted to our Principal, **Dr. Bhavesh Patel** and Head of Computer Department, **Prof. Uday Bhave** giving us this valuable opportunity to do this project. We express our hearty thanks to them for their assistance without which it would have been difficult in finishing this project synopsis and project review successfully.

It gives us immense pleasure to express our deep and sincere gratitude to our project guide **Prof. Sarika Rane** for her kind help and valuable advice during the development of the project synopsis and for her guidance and suggestions.

We convey our deep sense of gratitude to all teaching and non-teaching staff for their constant encouragement, support and selfless help throughout the project work. It is a great pleasure to acknowledge the help and suggestion, which we received from the Department of Computer Engineering.

We wish to express our profound thanks to all those who helped us in gathering information about the project. Our families too have provided moral support and encouragement several times

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Chapter 1

Introduction

Image processing is a technique where we apply an operation or an algorithm to a digital image in order to enhance an image or to gain some useful information from the image. It is a type of processing in which an image is the input and its characteristics are the output.

The main reason we use image processing in the healthcare field is that it can allow for an extensive study of the anatomy which can still be non-invasive. Many fields can benefit from replicating a 3D printed model of the patient's organs to study and treat. With advancements in image capturing and storing along with higher instantaneous compute power has made many medical advancements using image processing possible.

Other examples involve the Healthcare Industry where if we talk about Cancer, even in today's age of technological advancements, cancer can be fatal if we don't identify it at an early stage. Detecting cancerous cell(s) as quickly as possible can potentially save millions of lives. The shape of the cancerous cells plays a vital role in determining the severity of cancer which can be identified using image classification algorithms.

We attempt to create something similar, where we use image processing techniques to extract useful information and use that information to train an efficient model that can predict where a shown model is malignant or benign.

EfficientNets, as the name suggests are very much efficient computationally and also achieved state of art results with 80% accuracy on average.

Chapter 2

Literature Survey

Sr No.	Title	Author	Publication/ Year	Technology Used
1.	Skin Lesion Analysis Using Ensemble of CNN with Dermoscopic Images and Metadata	Sergey Milanteva, Vyacheslav Olyunina, Natalya Milantevaa , Ilya Bykova and Igor Bessmertny	Proceedings of the 12th Majorov International Conference on Software Engineering and Computer Systems, December 10–11, 2020, Online Saint Petersburg, Russia	➔ R2U-Net for segmentation ➔ EfficientNetB0-B7, SENet-154, ResNeXt-101 32x4d and Inception-ResNet-v2 to classify skin diseases. ➔ CNN
2.	An Efficient Classification of Benign and Malignant Tumors Implementing Various Deep Convolutional Neural Networks	Taki Hasan Rafi Mehadi Hassan	International Journal of Computer Science Engineering (IJCSE) Apr-Mar 2020	➔ Pre-trained deep learning models, namely as VGG19, ResNet50 and EfficientNetB0 ➔ CNN
3.	Convolutional Neural Network (CNN) for Automatic Skin Cancer Classification System	Yunendah Nur Fu'adah, NK Caecar Pratiwi, Muhammad, Adnan Pramudito, Nur Ibrahim	IOP Conf. Series: Materials Science and Engineering 982 (2020) 012005	➔ CNN ➔ Optimizers such as SGD,RMSprop, Adam and Nadam.

Software Requirements Specification

for

Skin Cancer Detection using Image Processing

Version 1.0 approved

Prepared by Vatsal Gada, Jashil Mehta, Rushi Shah

Shah and Anchor Kutchhi Engineering College

09/08/2021

Table of Contents

1. Introduction

1.1 Purpose

The main objective of this document is to illustrate the requirements of the project Skin Cancer Detection using Image Processing. The document gives the detailed description of the both functional and non-functional requirements proposed by the client.The main purpose of this project is to detect skin cancer in a more efficient and accurate manner using digital image processing techniques.This project describes the hardware and software interface requirements.

1.2 Document Conventions

- Convention for Main title
  - Font Face: Times New Roman
  - Font Style: Bold
  - Font Size: 18
- Convention for Sub title
  - Font Face: Times New Roman
  - Font Style: Bold
  - Font Size: 14
- Convention for body
  - Font Face: Times New Roman
  - Font Style: Normal
  - Font Size: 11

1.3 Intended Audience and Reading Suggestions

This document is intended for developers, project managers, testers. Start reading the document, beginning with the overview sections and proceeding through the sections that are most pertinent to each reader type.

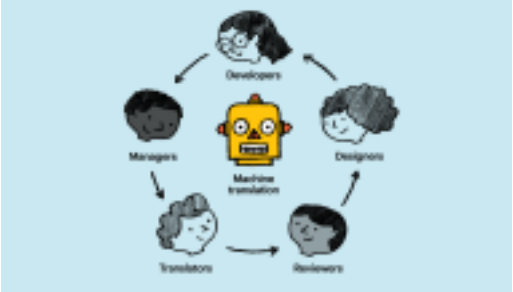


Fig 1. Audiences

1.4 Product Scope

The diagnosis that is performed by the system will help to increase the speed and accuracy of the diagnosis. Computers will be able to extract some information, like asymmetry, color variation, texture features, these minute parameters may not be recognized by the human naked eye.
Hence this diagnosis will be very helpful for a more accurate and quick detection of skin cancer.

1.5 References

https://arxiv.org/pdf/1908.03265v1.pdf

2. Overall Description

2.1 Product Perspective

The proposed model will predict whether the given image has a malignant or benign mole. It will perform image processing to optimize the image for the model and than the model will make the prediction

2.2 Product Functions

The product will apply 2D k means algorithm, create smooth boundaries using gaussian mean blur , perform otsu segmentation, shuffle and plot datasets, expand the dataset by using various tweaks, train the dataset on efficient B0 using the adam optimizer and plot the results and various visualizations of the same.

2.3 User Classes and Characteristics

All users will have the same level of access to the product. Anyone regardless of their technical expertise, educational level, or experience will be able to use the product

2.4 Operating Environment

The product will be a platform free, running on any capable python notebook online and so it will need an active internet connection at all times. It is supported through all modern browsers.

2.5 Design and Implementation Constraints

The model needs to be accurate enough to be used for medical diagnosis. That being said, this project is under development and should be used for research purposes only.

2.6 User Documentation

The User documentation will include:-

- Details of the entire image processing pipeline
- Easily quantifiable accuracy scores

2.7 Assumptions and Dependencies

Assumptions are:-

- The coding should be error free
- The cloud platform provider in this case Google should be up and running
- A fast and steady internet connection is required
- Access to the dataset

The dependencies are:-

- The end user should have a proper understanding of everything as this not supposed to be for average users
- The specific hardware and software due to which the product will be run on the basis of listing requirements and specification the project will be developed and run.

3. External Interface Requirements

3.1 User Interfaces

The product is a python notebook which will have properly labelled and segmented components. Finally the user will be able to understand the model better by analytics such as graphs and tables.

3.2 Hardware Interfaces

Processor: Dual Core CPU
Hard Disk: 16GB RAM:
Ram: 8GB or more

3.3 Software Interfaces

The model is developed using python 3
Interpreter : Any online interpreter will support for libraries
Language: Python

3.4 Communications Interfaces

The communication interfaces required are all included in web browsers. All requests made will be done using HTTPS as the entire project lies within the Google ecosystem and can be easily migrated.

4. System Features

This template illustrates organizing the functional requirements for the product by system features, the major services provided by the product. You may prefer to organize this section by use case, mode of operation, user class, object class, functional hierarchy, or combinations of these, whatever makes the most logical sense for your product

4.1 High Accuracy Prediction

4.1.1 Description and Priority

The model needs to predict the results accurately as they will be used for diagnosis or second diagnosis. This is the highest priority as other features can be added further according to the requirements but this remains the core functionality of the entire project.

4.1.2 Stimulus/Response Sequences

Whenever each part of the project is completed, the user is given a visual result of the action completed. Images are plotted whenever changes are visible.

4.1.3 Functional Requirements

REQ-1: Users should have access to the dataset
REQ-2: The model should have high accuracy
REQ-3: Users should have internet access throughout the process

5. Other Nonfunctional Requirements

5.1 Performance Requirements

The project shall be used by doctors/experts who are thorough with the system. Openness and clear understanding of all the functionalities is the main priority.

- The system should be well documented
- The system should be configurable on the fly

5.2 Safety Requirements

Alternative repos of the system should be placed for redundancy in the event that one crashes or misbehaves. On the go changes should be made only after proper backups

5.3 Security Requirements

The system should not have any access to patients data other than the image. The platform is just for detection using images and all other information should be avoided.

5.4 Software Quality Attributes

Availability: The software should be available at all times whenever internet access is there. Reliability: The prediction should be accurate and reliable.
Maintainability: The software should be maintained regularly and should use the latest technology to provide best results.
Testability: Multiple tests should be run to ensure accurate prediction and improve the quality of the model.

6. Other Requirements

The system uses various libraries and has codependency between the various versions. It is essential to regularly check the compatibility with the new versions with each other and ensure correct syntax is used.

Chapter 4

Project Scheduling and Planning

4.1 Gantt Chart

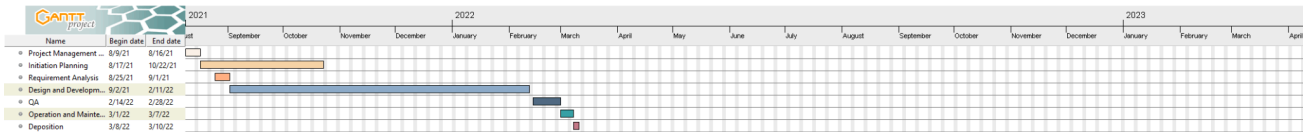


Fig 2. Gantt Chart Timeline

The following tasks will be divided amongst team members :

- **Vatsal Gada** - Developing and designing models, training and evaluating them to achieve a good performance.
- **Jashil Mehta** : Documentation, research of new techniques and literature review.
- **Rushi Shah** : Developing and designing models, training and evaluating them to achieve a good performance.

Chapter 5

Proposed System

5.1 Analysis/ Framework/ Algorithm

- Framework : pandas, tensorflow, numpy, keras
- Environment : Python 3
- Algorithms: CNN, Efficientnet, Adam
- Analysis: Accuracy scores, confusion matrix, receiver operating characteristic curve (ROC), Area under the curve (AUC)

5.2 Details of Hardware & Software

5.2.1 Hardware Requirements

- CPU : An Intel i5 CPU (64 bit processor)
- RAM : 8GB Recommended
- Disk Space : ~10GB for database
- GPU : Graphic card (2GB recommended)

5.2.2 Software Requirements

- Editor : Visual Studio Code with python extension, Colab, Jupyter Notebook
- Libraries Used : pandas, tensorflow, numpy, keras
- Environment : Python 3

5.3 Methodology

Problem Understanding: Traditionally biopsy and CT imaging are the only ways doctors can confirm whether the lesion is malignant or not, this project helps in making the process easier and make less false positives

Data Understanding: Data is mainly collected from ISIC - The International Skin Imaging Collaboration. This includes a few hundred images segmented into train and test set. In each of these we have images classified as benign and malignant. The images are available for open source use.

Data Preparation: The earlier part of the project focused heavily on Data Preparation. This included grayscale filter, Kmeans segmentation, cluster selection, Gaussian blur, OTSU segmentation and finally splitting of datasets.

Building Models:

We have used EfficientNet-b0 as our CNN model. EfficientNet-b0 is a convolutional neural network that is trained on a very vast dataset. Being trained on over 1000 images from the ImageNet database, this particular CNN is highly effective and efficient. It accurately classifies images into a 1000 object categories. The network has an image input size of 224-by-224.

To optimize the results achieved by the EfficientNet-b0, we've used Adam optimizer. Adam optimizer is basically a combination of 'gradient descent with momentum' algorithm and the 'RMSP' algorithm. It helped us improve our results and performance of the model.

Flow Chart

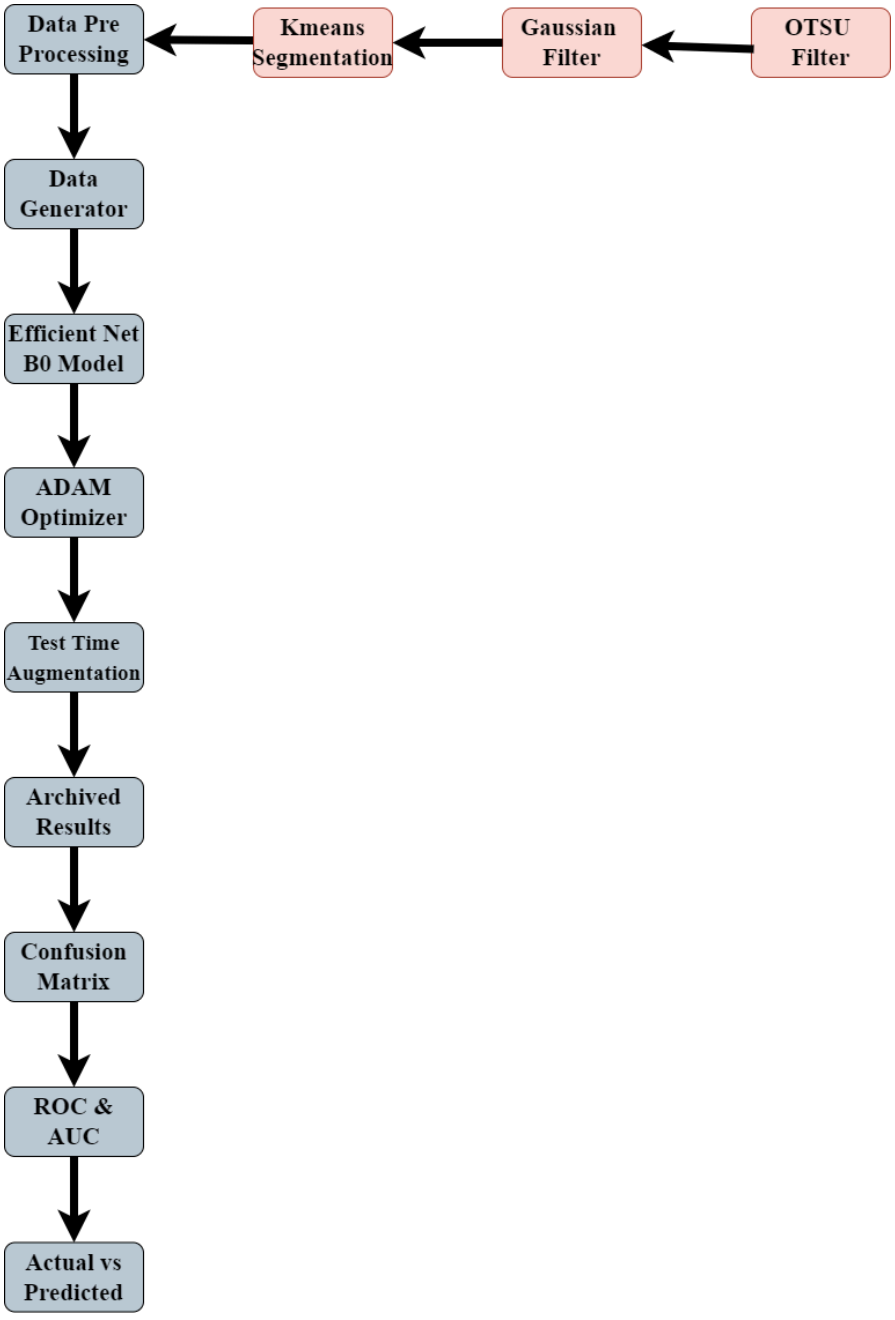


Fig 3. Flowchart

Implementation Details

Modules & Description

- Preprocessing

In this module, we preprocess the image obtained from the dataset. The image is initially converted from rgb to gray while resolving it to 224x224. The grey scale image is passed through a K-means algorithm where we extract the mole from the skin lesion. The segmented area is then passed through otsu segmentation for boundaries smoothening and gaussian filter to blur the edges. The final skin lesion is then overlapped on the original rgb image to get the rgb skin lesion. The images finally obtained after this are passed through Image Data Generator. It helps us increase the size of the dataset by skewing the images in various forms and also helps in adding variety to the image dataset

- Training

We then used Efficient B0 CNN and to improve on the results we used Adam optimizer. EfficientNet-b0 is a convolutional neural network that is trained on a very vast dataset. Being trained on over 1000 images from the ImageNet database, this particular CNN is highly effective and efficient. It accurately classifies images into a 1000 object categories. The network has an image input size of 224-by-224.
To optimize the results achieved by the EfficientNet-b0, we've used Adam optimizer. Adam optimizer is basically a combination of 'gradient descent with momentum' algorithm and the 'RMSP' algorithm. It helped us improve our results and performance of the model.

- Evaluation

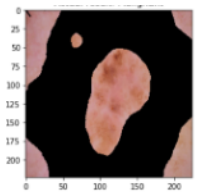
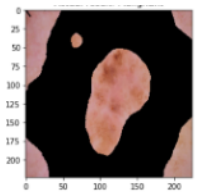
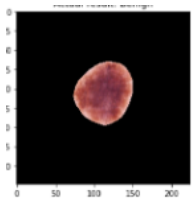
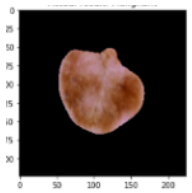
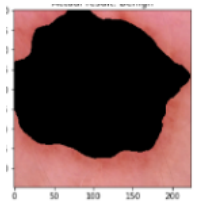
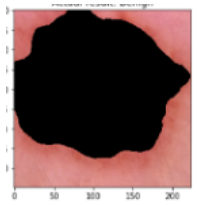
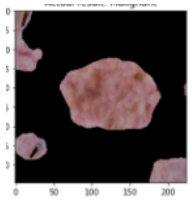
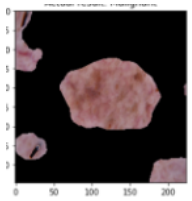
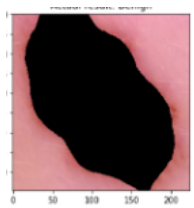
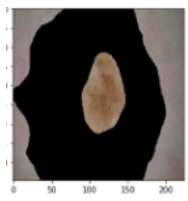
After the model is ready, we use several evaluation methods to guage the performance of the model. This includes accuracy

In the upcoming semester, we plan to increase the accuracy of the model even further. We intend on doing this by tweaking the preprocessing of datasets and adjusting and tweaking the parameters of the optimizer even more. If the accuracy of the model isn't satisfactory, we'll implement a rectified ADAM optimizer for more accurate parameters. After reaching satisfactory accuracy, we plan to visualise the results of the model. This will be done through Area under ROC curve, confusion matrix and add more if we find a better way to quantify the results.

Chapter 7

Testing

Table No. 1 - Test Cases

Test Case ID	Objective	Input	Expected Output	Actual Output	Result
T001	Is image Benign or Malignant		Malignant Image		The image generated is of Malignant Mole. (PASS)
T002	Is image Benign or Malignant		Benign Image		The image generated is of Malignant Mole (Failed)
T003	Is image Benign or Malignant		Benign Image		The image generated is of Benign Mole (PASS)
T004	Is image Benign or Malignant		Malignant Image		The image generated is of Malignant Mole (PASS)
T005	Is image Benign or Malignant		Benign Image		The image generated is of Malignant Mole (Failed)

Chapter 8

Results and Analysis

After a number of pre-processing techniques and modules being implemented, we finally achieved an accuracy score of 86%.

To understand our result better, we used various visualization techniques.

First being an accuracy and loss graph. These are graphs of accuracy/loss vs epochs. They displayed a change in accuracy/loss over time with epochs.

Accuracy graph initially started at 55% accuracy and then ended at 86%.

Loss graph initially started at 25% accuracy and then ended at 4%.

Next the Confusion Matrix showed a distribution of a total of 660 images, out of which 307 were true positives and another 263 were true negatives. A total of 90 images were involved in false positives and false negatives.

Further the ROC curve was a plot of true positive rate vs false positive rate. The Area under Curve equalled to a value of 0.865

Lastly we plot out actual vs predicted results along with an image of the pre-processed skin mole.

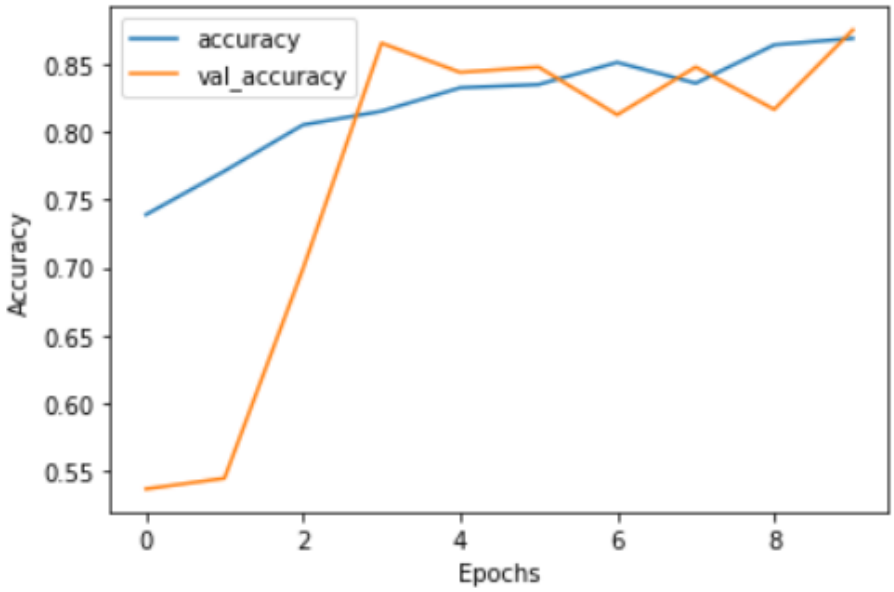


Fig4. Achieved Accuracy

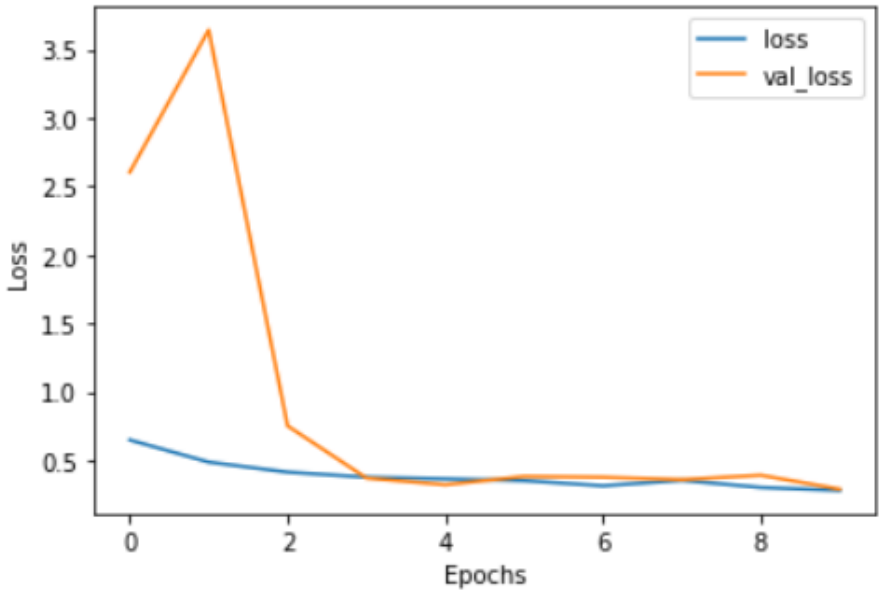


Fig 5. Achieved Loss

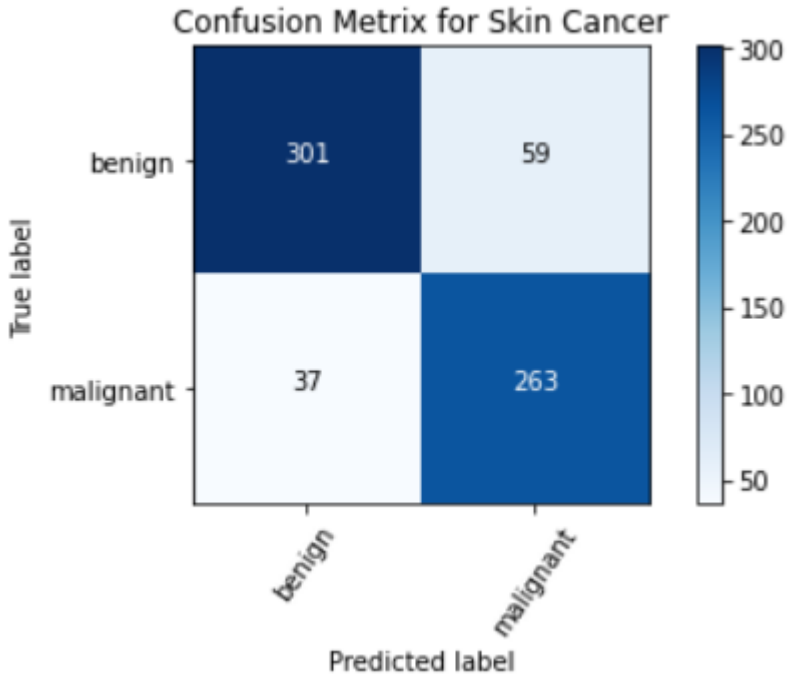


Fig 6. Confusion Matrix

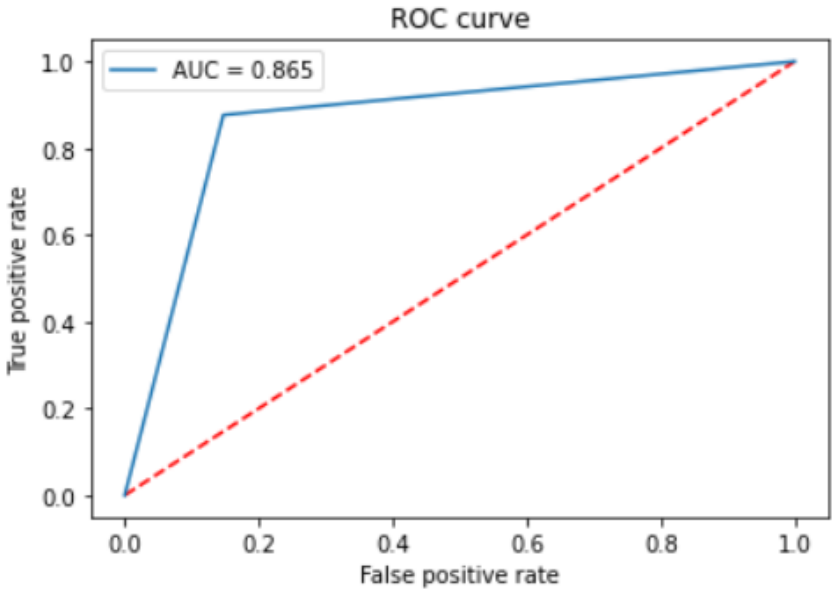


Fig8. AUC and ROC Curve

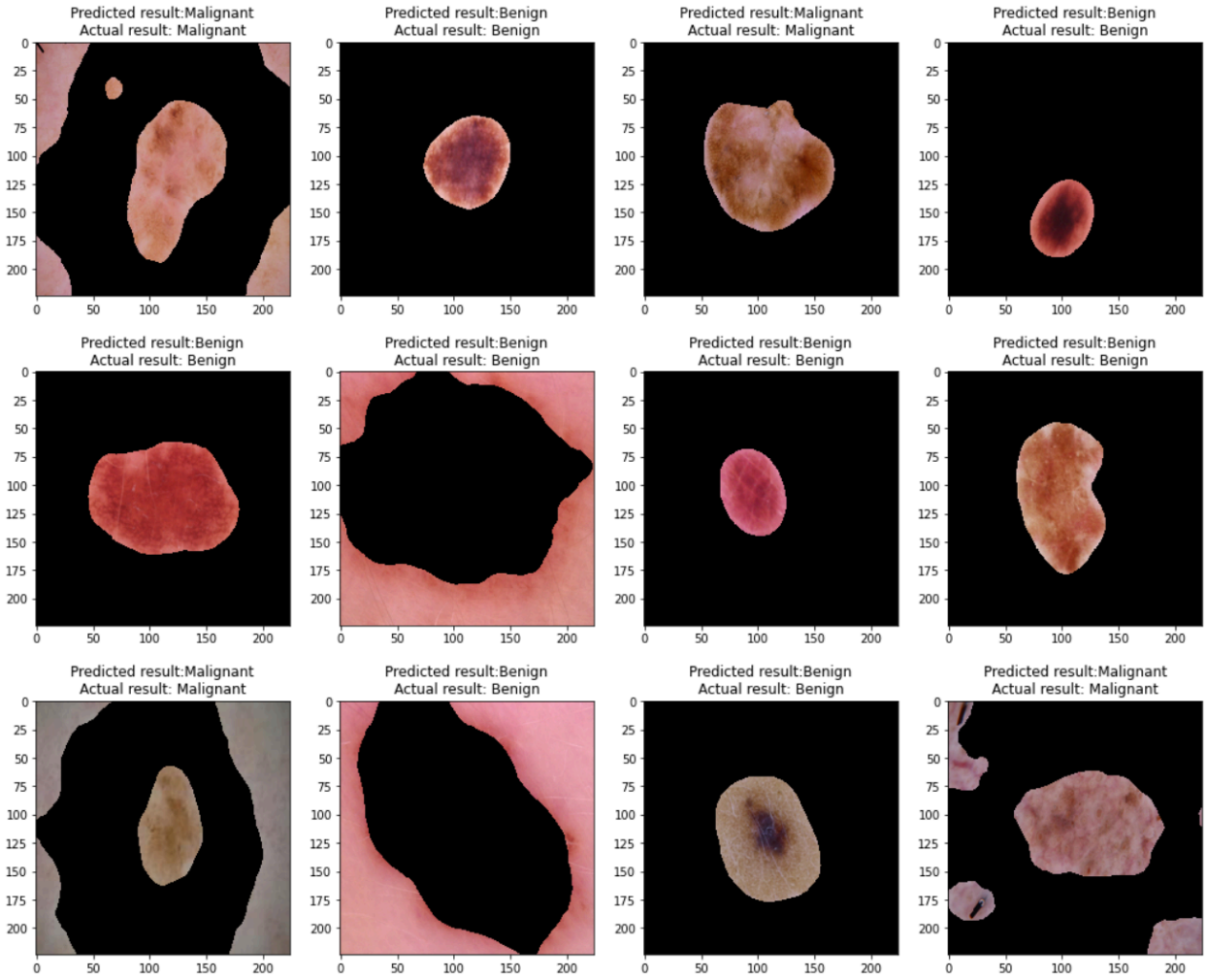


Fig7. Actual vs Predicted

Chapter 9

Conclusion and Future Scope

The aim of this project was to predict accurate results for skin cancer. After undergoing many pre-processing techniques, we were able to predict skin cancer with a good accuracy score. Early detection of skin cancer will prevent many consequences for a patient and this project aims to do that.

For future scope, we can tweak the parameters and make the accuracy even better.

Chapter 10

Bibliography

[1] Venkata Charan.Nagisetty , Arun Kumar , Machani Venkatesh , Dr. Ravi Kumar M.G , N.Pani Bhushan.International Journal of Advance Science and Technology(2020).Skin Cancer Detection Using Image Processing.

[2] Vijayalakshmi M M.International Journal of Trend in Scientific Research and Development (IJTSRD) (2019).Melanoma Skin Cancer Detection using Image Processing and Machine Learning.

[3] Shivangi Jaina, Vandana Jagtap, Nitin Pitsea.International Conference on Intelligent Computing, Communication & Convergence (ICCC-2015).Computer aided Melanoma skin cancer detection using Image Processing.

[4] Sergey Milanteva , Vyacheslav Olyunina , Natalya Milantevaa , Ilya Bykova and Igor Bessmertnya, "Skin Lesion Analysis Using Ensemble of CNN with Dermoscopic Images and Metadata" Proceedings of the 12th Majorov International Conference on Software Engineering and Computer Systems, December 10–11, 2020, Online Saint Petersburg, Russia
http://ceur-ws.org/Vol-2893/paper_5.pdf

[5]Taki Hasan Rafi, Mehadi Hassan, "An Efficient Classification of Benign and Malignant Tumors Implementing Various Deep Convolutional Neural Networks" Taki Hasan Rafi et al. / International Journal of Computer Science Engineering (IJCSE) ISSN : 2319-7323 Vol. 9 No. 2 Mar-Apr 2020
http://www.ijcse.net/docs/IJCSE20-09-02-013.pdf

[6] Yunendah Nur Fu'adah, NK Caecar Pratiwi , Muhammad Adnan Pramudito , Nur Ibrahim "Convolutional Neural Network (CNN) for Automatic Skin Cancer Classification System ". IOP Conf. Series: Materials Science and Engineering 982 (2020) 012005 doi:10.1088/1757-899X/982/1/012005
https://iopscience.iop.org/article/10.1088/1757-899X/982/1/012005/pdf