DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY"** is the bonafide of **"AARTHI K (19ECR001)**, **ARCHITHA K (19ECR012), DEEPANI P(19ECR022), DURGALAKSHMI M (19ECR034),"** who carried out the project work under our supervision. Certified further that to the best of our knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Diabetic retinopathy (DR) is a diabetes complication that affects the eye and can cause damagefrom mild vision problems to complete blindness. It has been observed that the eye fundus images showvarious kinds of color aberrations and irrelevant illuminations, which degrade the diagnostic analysis andmay hinder the results. In this research, we present a methodology to eliminate these unnecessary re ectanceproperties of the images using a novel image processing schema and a stacked deep learning technique forthe diagnosis. For the luminosity normalization of the image, the gray world color constancy algorithm isimplemented which does image desaturation and improves the overall image quality. The effectiveness of theproposed image enhancement technique is evaluated based on the peak signal to noise ratio (PSNR) and meansquared error (MSE) of the normalized image.

Three custom CNN model weights are fed on the top of a single meta-learner classier, which combinesthe most optimum weights of the three sub-neural networks to obtain superior metrics of evaluation androbust prediction results. The proposed stacked model reports an overall test accuracy of 97:92% (binaryclassication) and 87:45% (multiclass classication). Extensive experimental results in terms of accuracy,Fmeasure, sensitivity, specicity, recall and precision reveal proposedmethodology of illumination normaliz ation greatly facilitated the deep learning model and yields better results than various state-of-art techniques.

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CHAPTER 1

INTRODUCTION

1.1 Project Overview:

Diabetic retinopathy is a diabetes complication that refers to retinal changes thatoccur in patients with diabetes mellitus. Diabetic retinopathy can develop in anyone whohas type 1 or type 2 diabetes. Diabetic retinopathy is caused by damage to the small blood vessels of the light-sensitive tissue at the back of the eye called the retina and canlead to vision loss through several different pathways. It necessitates constant monitoring, and in the event of complications, it may shorten life expectancy. If it is not diagnosed and treated, it can blind you. The medication cannot be cured at this time. Diabetic retinopathy can be stopped or slowed down with treatment. Diabetes management may be used carefully to treat mild cases.

1.2 Project Overview:

Diabetic Retinopathy {DB) is a complication of diabetes that influences the eyes.Damage to blood vessels in the tissue of the retina, the back layer of the eye, typically causes it. Blurriness, floaters, dark or empty areas in the vision, and difficulty recognizingcolor blindness are some of the early symptoms. Diabetic retinopathy is one of the most common causes of sight loss among people of working age. You can have diabetic retinopathy and not know it. This is because it often has no symptoms in its early stages

1.3 Purpose:

The main purpose is it can control Blood sugar (glycemic control).Blood Pressure Control—BP of less than 140/80 mm Hg for a patient with diabetes. Lipid Lowering—lowering LDL cholesterol through lifestyle modification. This changes thecurvature of the lens, leading to changes in vision. However, once blood sugar levelsare controlled, usually the lens will return to its original shape and vision improves. Patients with diabetes who can better control their blood sugar levels will slow the onset and progression of diabetic retinopathy.

CHAPTER 2

2.1 Literature Survey:

It has 1200 images of the fundus and was divided into 580 images of normaland exudates for the project. The dataset has been divided into two parts for the CNN process : the training dataset and the testing dataset . On 50% of the training dataset, this method achieves accuracy greater than 90%, and the remaining 50% of the datasetis used for testing. The tests give an accuracy of about 85% accuracy on the dataset of 80000 images. Diabetic retinopathy results from the damage diabetes causes to the small blood vessels located in the retina. These damaged blood vessels can cause vision loss:

- Fluid can leak into the macula, the area of the retina responsible for clear central vision. Although small, the macula is the part of the retina that allows usto see colors and fine detail. The fluid causes the macula to swell, resulting in blurred vision.
- In an attempt to improve blood circulation in the retina, new blood vessels mayform on its surface. These fragile, abnormal blood vessels can leak blood into the back of the eye and block vision.

2.2 Existing Problem:

In this study, we have presented a systematic computational methodologyfor diabetic retinopathy and macular edema classification, and assessed its performance on a non-open dataset using five different diabetic retinopathy and macular edema classification systems. We have found that our deep learning model achieved comparableor better results with only a small fraction (< 1/4) of training set images than used recently by two other groups to obtain the state-of-the-art results in the non referable/referable diabetic retinopathy (NRDR/RDR) classification, with similar model architecture. We have also presented state-of-the-art results for classifying retinal images using the proposed international diabetic retinopathy classification system (PIRC), when measured with Cohen's quadratic-weighted kappa, using less than 2% of the images than previous state-of-the-art system. Our work also sets for the first time the baseline for classifying retinal images using the clinical scale of the proposed international macular edema classification system (PIMEC).

2.3 Reference:

Diabetes reduces life expectancy by five to 10 years. Premature cardiovascular disease is the most common cause of morbidity and mortality, but the microvascular complications specific to diabetes (box 1) are also contributory factors. Diabetes is the most common reason for renal replacement therapy worldwide, the most common cause of blindness in the under 65s, and the most common cause of non-traumatic amputation.With our current knowledge, most of these devastating events could be prevented or delayed, or their impact minimized. This review focuses on the prevention, early detection,and initial management of the vascular complications of diabetes in adults.

1. Marshall, S. M. & Flyybjerg, A. Prevention and early detection of vascular complications of diabetes. *bmi.* **333**(7566), 475–480 (2006).

http://www.adcis.net/en/Download-Third-Party/Messidor.html.

2. Medical Research Act, https://www.finlex.fi/en/laki/kaannokset/1999/en19990488_20100794.pdf

2.4 Problem Statement Solution:

In medical field, diagnosis of diseases competently carried out by using the image processing. Therefore, that to retrieve the relevant data from the amalgamation of resulting image is too difficult. Here the segmentation technique is very useful by semi- supervised learning then the result can be tuned by using Deep Learning Neural Network. Deep neural networks have been investigated in learning latent representations of medical images, yet most of the studies limit their approach in a single supervised convolutional neural network (CNN), which usually rely heavily on a large scale annotateddataset for training. To learn image representations with less supervision involved, this problem can be solved using a deep CNN architecture that can be trained with only binaryimage pair information. Some researchers evaluated the learned image representations on a task of content-based medical image retrieval using a publicly available multiclass diabetic retinopathy fundus image dataset. The problem can be solved using deep CNN which requires much less supervision for training.

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 IDEATION & BRAINSTROMING:

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. A principal difference between ideationand brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity. Brainstorming is usually conducted by getting a group of people together to come up with either general new ideas or ideas for solving a specific problem or dealing with a specific situation.

For example, a major corporation that recently learned it is the object of a major lawsuit may want to gather together top executives for a brainstorming session onhow to publicly respond to the lawsuit being filed. Participants in a brainstorming sessionare encouraged to freely toss out whatever ideas may occur to them. The thinking is that

by generating a large number of ideas, the brainstorming group is likely to come up with a suitable solution for whatever issue they are addressing. The lines between ideation and brainstorming have become a bit more blurred with the development of several brainstorming software programs, such as Bright idea and Idea wake. These software programs are designed to encourage employees of companies to generate new ideas forimproving the companies' operations and, ultimately, bottom-line profitability.

3.3 Proposed Solution:

A **problem statement** is a concise description of an issue to be addressed or a condition to be improved upon. It identifies the gap between the current (problem) state and desired(goal) state of a process or product. The first condition of solving a problem is understanding the problem, which can be done by way of a problem statemen

Idea solution is a progressive, state of the art information technology. we have a proventrack record of customer satisfaction with our clients, ranging from residential client tosmall business to mid size corporations and government offices and agencies.

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The purpose of this study is to test the relationship of perceived value, service quality andcustomer expectation with customer satisfaction. This study uses questionnaire method to collect data from the respondents.

3.4 PROBLEM SOLUTION FIT:

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. The Problem-Solution Fit canvas is based on the principles of LeanStartup, LUM (Lazy User Model) and User Experience design. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what wouldwork and why. It is a template to help identify solutions with higher chances of solution adoption, reduce time spent on testing and get a better overview of the current situation. My goal was to create a tool that translates a problem into a solution, taking into account customer behavior and the context around it. None of the existing canvases or frameworks were giving me an overview and insight into the real customer situation duringhis/her decision-making process. With this template you will be able to take important information into consideration at an earlier stage and look at problem solving in depth. Itincreases your chances of finding problem-solution and product-market fit.

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Deep learning	DL refers to methods learning the mathematical representation of the latent and intrinsic relations of the data in an automatic manner. Unlike traditional machine learning methods, deep learning ones require much less human guidance, since they are not
FR-2	Neural network	The simplest form of a neural network refers toan Artificial Neural Network (ANN), which consists of 3 layers of neurons, one input layer, one hidden layer and an output layer
FR-3	Traditional CNN	Convolutional Neural Networks (CNN), which unlike shallow neural networks accept 2D arrays as their input, were inspired by human vision and their concept is based on a fundamental mathematical operation, namely “convolution”
FR-4	Transfer learning	Training a deep neural network is very demanding in terms of computational resources and data required. The world’s largest object detection database,

	Attention modules	It is well known that human vision and perception relies on attention mechanisms to focus on specific parts of ascene or an object instead of processing the whole scene at once.
	Generative Adversarial	Generative Adversarial Networks Finally, another important class of convolutional neural networks regards the Generative Adversarial Network (GAN).

4.2 Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

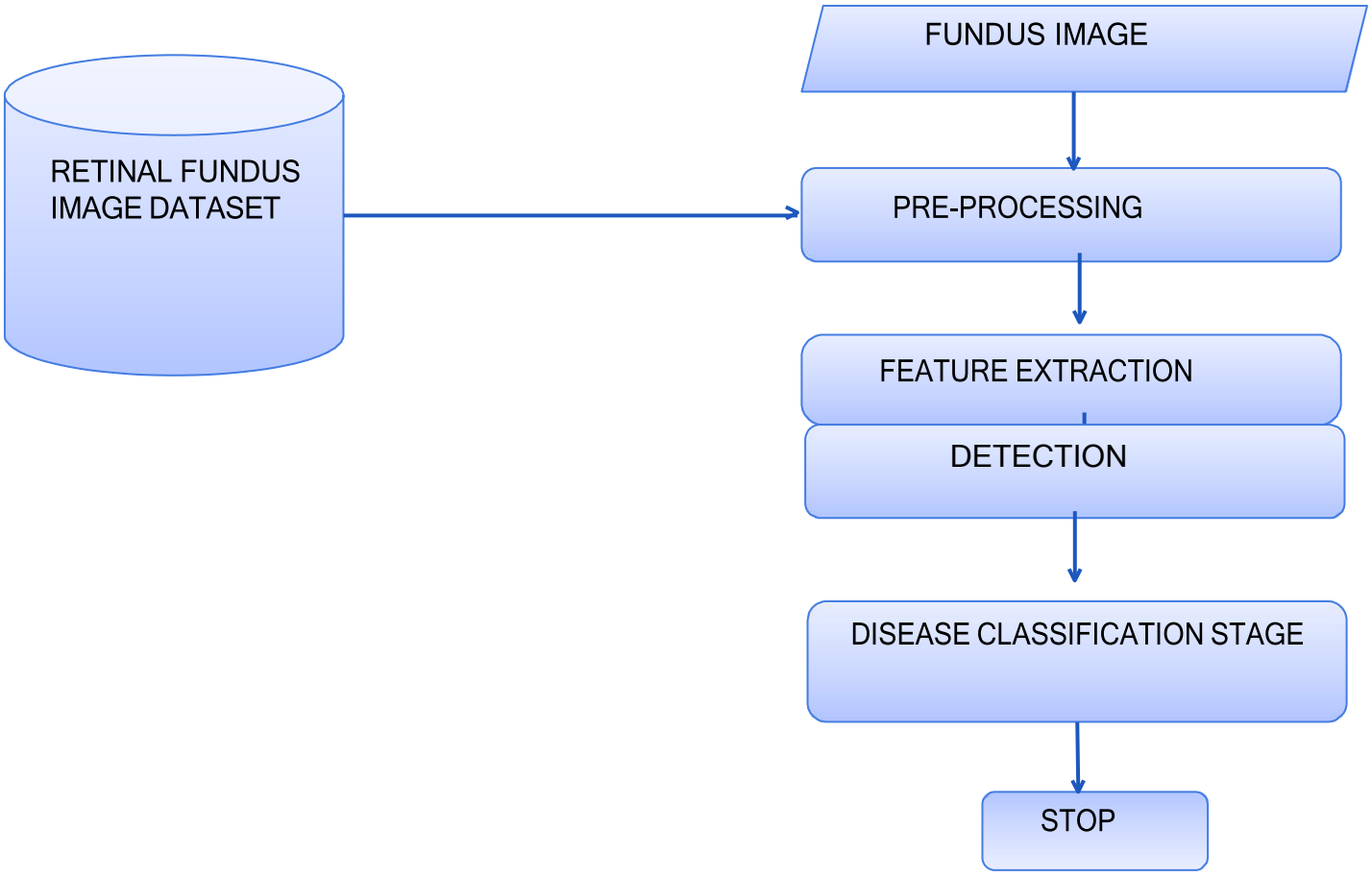
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	
NFR-2	**Security**	To protect sensitive data, you may consider developing nonfunctional security features. For example, professionals at healthcare facilities use secure databases to store patients' medical records. The security on their databases may include firewalls to prevent unauthorized access.
NFR-3	**Reliability**	Technology that is highly reliable functions with the same or similar efficiency after extensive use.
NFR-4	**Performance**	Performance are classified into different types such as (a) response time, (b) throughput (number of operations performed per second)
NFR-5	**Availability**	Availability is defined as the Percentage of time that the system is up and running correctly
NFR-6	**Scalability**	Scalability is for large number of users or quantities of data

CHAPTER 5

PROJECT DESIGN

5.1 Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flowswithin a system. A neat and clear DFD the right amount of the systemrequirement graphically. It shows how data enters and leaves the system, what changesthe information, and where data is stored.



5.2 Solution & Technical Architecture

5.3 Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions.Its goals are to:

1. Find the best tech solution to solve existing business problems.
2. Describe the structure, characteristics, behaviour, and other aspects ofthe software to project stakeholders.
3. Define features, development phases, and solution requirements.
4. Provide specifications according to which the solution is defined, managed, and delivered.

Technologies needed for Minimum Viable Product deployment

Software technologies required for the systematic development and deployment of theproject are:

a. HTML/CSS/JavaScript/bootstrap-Front End Development

b. Python

c. TensorFlow

d. Image processing Basics

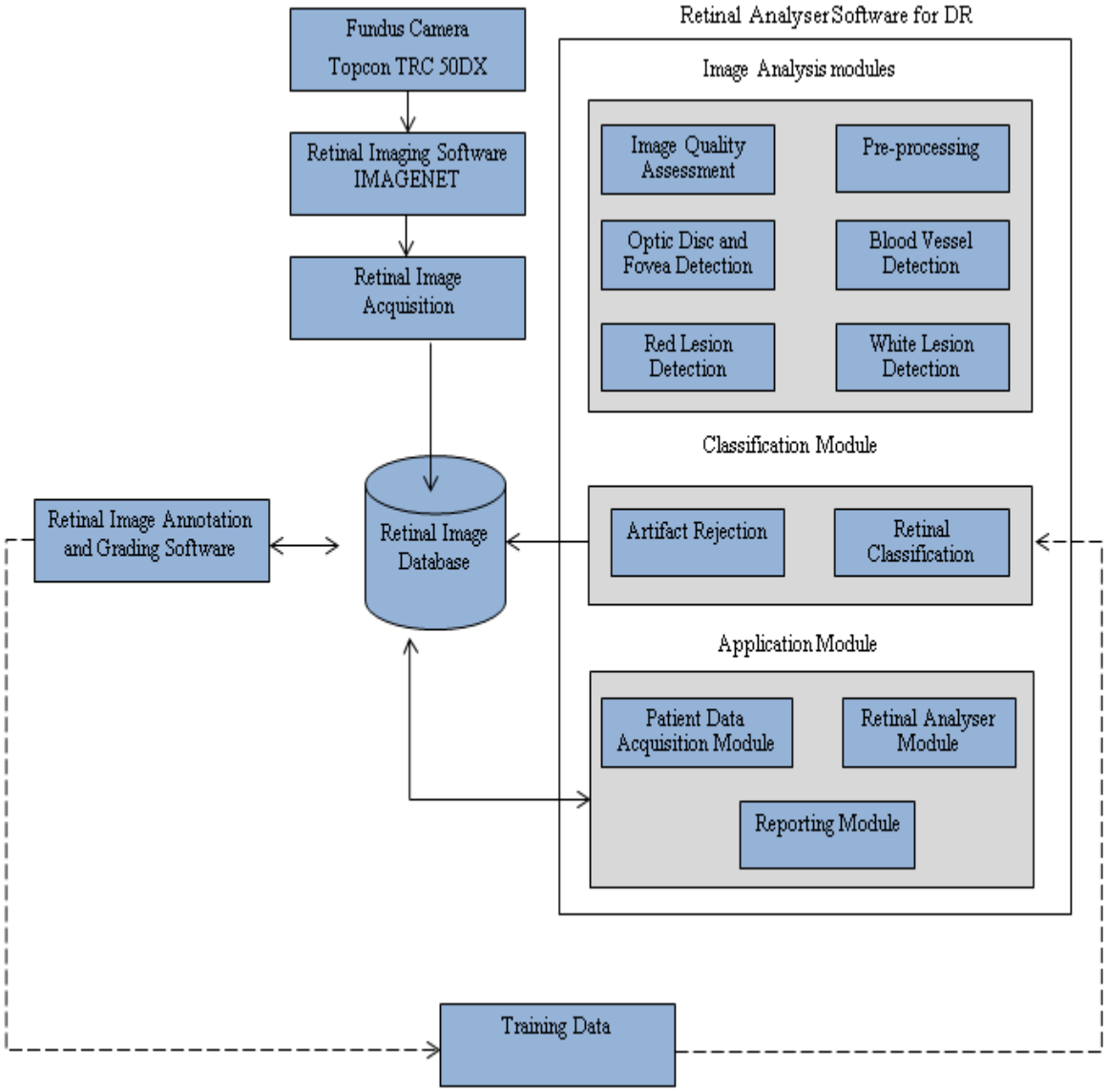
e. Flask-Backend Development

f. Git & GitHub-project Management

g. IBM Cloud-Hosting

h. IBM Watson-Training the Deep Learning Model

SOLUTION- ARCHITECTURE DIAGRAM:



REFERENCE: https://images.app.goo.gl/6XA1KC3pkJqKrcAP9

5.4 USER STORIES

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can Check whether I have Retinopathy or not by uploading the image of myeye by entering details.	I can upload or take image.	High	Sprint-1
	Screeningmethod	USN-2	As a user, I can find the method more efficient and accurate.	It prevents the chances of unwanted infections in the patient's eye	High	Sprint-1
		USN-3	As a user, I can use it With minimal physical interaction with the device.	I can take the device to the residence of patients if They are Unable to Visit the Hospital/clinic.	High	Sprint-2

	Physical feature	USN-4	As a user, I can find it portable and light weight.	I can Perform the screening procedu -re Without any fear and Hesitation.	Low	Sprint-2
	safety	USN-5	As a user, I can be safe as the detection Method is free from radiations.	Pain due to testing is the major fear factor that prevents the patients from visiting the hospital.	High	Sprint-4
Custom er (Diabetic Patient)	Testing	USN-6	As a user, I can undergo testing without any Fear of pain as this method is pain-free.	Pain due to testing is the major fear factor that prevents the patients from visiting the hospital.	Medi um	Sprint-2
		USN-7	As a user, I will be comfortable asit requires minimum/no Human involvement.	The screening is carried out using a computer robot Along with the Aid of AI technology.	Low	Sprint-4

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
	Results	USN-8	As a user, I can rely on the results without any suspicion.	The technique is almost 100% efficient as it involves Modern techniques incorporat -ed with Machine Learning	High	Sprint-3
		USN-9	As a user, I can benefit from the result as it will help me know whether treatment is necessary or not.	It can prevent me from vision loss.	High	Sprint-1
		USN-10	As a user, I can get the results on the spot immediately after the screening process.	It prevents further delay in the treatment process.	Low	Sprint-4

Customer (Public Sector/Private Sector)	Cost Efficiency	USN-11	As a user, I can reach many people suffering from Diabetes.	Diabetic patients are more vulnerable to Diabetic Retinopathy.	Medium	Sprint-1
		USN-12	As a user, I can create awareness among diabetic patients to undergo frequent screening.	As the technique isof low cost, patients will find it very useful.	Low	Sprint-3
	Results	USN-13	As a user, I can complete the screening process within minutes for a single patient.	The random results generated by the device saves time.	High	Sprint-2

CHAPTER 6

PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNINGAND ESTIMATION

SPRINT	USER STORY / TASK	STORYPOINTS	PRIORITY	TEAM MEMBERS
Sprint - l	Get the dataset	3	High	Aarthi K
	Explore the data	2	Medium	Architha k
	Data Pre-Processing	3	High	Deepani P
	Prepare trainingand testing data	3	High	Durgalakshmi M
Sprint - ll	Create the model	3	High	Aarthi K
	Train the model	3	High	Architha K
	Test the model	3	High	Deepani P
Sprint - lll	Improve the model	2	Medium	Durgalakshmi M
	Setup a database tostore input images	2	Medium	Aarthi K
Sprint - IV	Build the resultspage	3	High	Architha K

	Save the model	3	High	Deepani P
	Build the Home Page	3	High	Durgalakshmi M
	Integrate the model with the application	3	High	Aarthi K Architha K
	Test the application	3	High	Deepani P Durgalakshmi M

6.2 SPRINT DELIVERY SCHEDULE

SPRINT	TOTAL STORY POINTS	DURATION	SPRINT START DATE	SPRINT END DATE (PLANNED)	STORY POINTSCOMPLETED(AS ON PLANNEDDATE)	SPRINT RELEASE DATE (ACTUAL)
Sprint - I	11	6 Days	24 Oct 2022	29 Oct 2022	11	29 Oct 2022
Sprint - II	9	6 Days	31 Oct 2022	05 Nov 2022	9	05 Nov 2022
Sprint - III	10	6 Days	07 Oct 2022	12 Nov 2022	10	12 Nov 2022
Sprint - IV	9	6 Days	14 Nov 2022	19 Nov 2022	9	19 Nov 2022

CHAPTER 7
CODING AND SOLUTIONING

```
imagesize = [299, 299]
trainpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/training"
testpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing"
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
train_datagen = ImageDataGenerator(rescale =1./255,shear_range = 0.2,zoom_range = 0.2,horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set = train_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/training",target_size = (299, 299),batch_size = 32,class_mode = "categorical")
test_set = test_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing",target_size = (299, 299),batch_size = 32,class_mode="categorical")
xception = Xception(input_shape =imagesize + [3], weights = 'imagenet', include_top = False)
for layer in xception.layers:
  layer.trainable = False
x = Flatten()(xception.output)
prediction = Dense(5, activation='softmax')(x)
model = Model(inputs=xception.input, outputs=prediction)
model.summary()
model.compile(
    loss='categorical_crossentropy',
    optimizer='adam',
    metrics=['accuracy']
)
r=model.fit_generator(
    training_set,
     validation_data=test_set,
     epochs=30,
     steps_per_epoch=len(training_set)//32,
     validation_steps=len(test_set)//32)
model.save('updated-xception-diabetic-retinopathy.h5')

import numpy as np
import os
from tensorflow import keras
from keras import models
from keras.models import load_model
from keras.preprocessing import image
from keras.applications.inception_v3 import preprocess_input
import requests
from flask import Flask, request, render_template, redirect, url_for
from cloudant.client import Cloudant
model = load_model(r"updated-xception-diabetic-retinopathy.h5")
app = Flask(__name__)
client = Cloudant.iam('9f458f39-44d8-46bd-bf8b-eb02c85f223c-bluemix',
                      '39FqlWsnZs_xCT-eEqB2Pim6rLghPbsDdd4h3wWcrwZo', connect=True)
# Create a database using an initialized client
my_database = client.create_database('my_db')
if my_database.exists():
    print("Database '{0}' successfully created.".format('my_db'))
# default home page or route
```

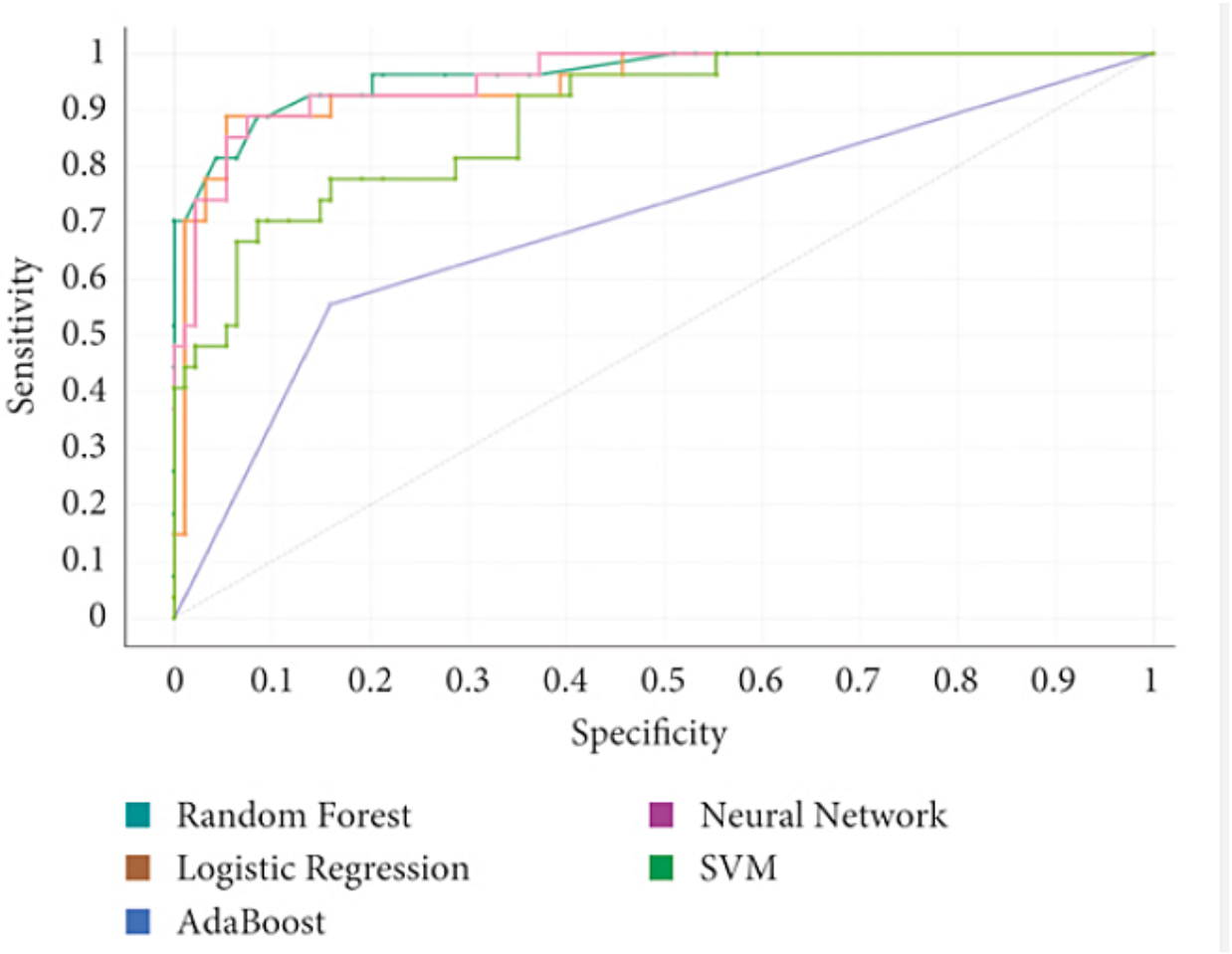
CHAPTER 8
TESTING

8.1 TEST CASES:

Test case ID	Feature Type	Component	Test Scenario	Expected Result	Actual Result	Status
HP_TC_001	UI	Home Page	Verify UI elements in the Home Page	The Home page must be displayed properly	Working as expected	PASS
HP_TC_002	UI	Home Page	Check if the UI elements are displayed properly in different screen sizes	The Home page must be displayed properly in all sizes	The UI is not displayed properly in screen size 2560 x 1801 and 768 x 630	FAIL
HP_TC_003	Functional	Home Page	Check if user can upload their file	The input image should be uploaded to the application successfully	Working as expected	PASS
HP_TC_004	Functional	Home Page	Check if user cannot upload unsupported files	The application should not allow user to select a non image file	User is able to upload any file	FAIL
HP_TC_005	Functional	Home Page	Check if the page redirects to the result page once the input is given	The page should redirect to the results page	Working as expected	PASS

BE_TC_001	Functional	Backend	Check if all the routes are working properly	All the routes should properly work	Working as expected	PASS
M_TC_001	Functional	Model	Check if the model can handle various image sizes	The model should rescale the image and predict the results	Working as expected	PASS
M_TC_002	Functional	Model	Check if the model predicts the digit	The model should predict the number	Working as expected	PASS
M_TC_003	Functional	Model	Check if the model can handle complex input image	The model should predict the number in the complex image	The model fails to identify the digit since the model is not built to handle such data	FAIL
RP_TC_001	UI	Result Page	Verify UI elements in the Result Page	The Result page must be displayed properly	Working as expected	PASS
RP_TC_002	UI	Result Page	Check if the input image is displayed properly	The input image should be displayed properly	The size of the input image exceeds the display container	FAIL
RP_TC_004	UI	Result Page	Check if the other predictions are displayed properly	The other predictions should be displayed properly	Working as expected	PASS

CHAPTER 9
PERFORMANCE TESTING:



CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

i. Reduces manual work

ii. More accurate than average human

iii. Capable of handling a lot of data

iv. Can be used anywhere from any device

DISADVANTAGES

v. Cannot handle complex data

vi. All the data must be in digital format

vii. Requires a high performance server for faster predictions

viii. Prone to occasional errors

CHAPTER 11

CONCLUSION

Diabetic retinopathy is a serious complication of diabetes mellitus, leading to progressive damage and even blindness of the retina. Its early detection and treatment is important in order to prevent its deterioration and the retina's damage. The interest in applying deep learning in detecting diabetic retinopathy has increased during the past years and as several DL systems evolve and become integrated into the clinical practice, they will enable the clinicians to treat the patients in need more effectively and efficiently. This article presents the current state of research regarding the application of deep learning in diagnosing diabetic retinopathy. Although deep learning has paved the way formore accurate diagnosis and treatment, further improvements are still necessary regarding performance, interpretability and trustworthiness fromophthalmologists.

CHAPTER 12

FUTURE SCOPE

This project is far from complete and there is a lot of room for improvement.Some of the improvements that can be made to this project as follows:

- Add support to detect from digits multiple images andsave the results
- Add support to detect multiple digits
- Improve model to detect digits from complex images
- Add support to different languages to help users from all overthe world.

This project has endless potential and can always be enhanced to become better .Implementing this concept in the real world will benefit several industries and reduce the workload on many workers, enhancing overall work efficiency.

APPENDIX

SOURCE CODE:

INDEX.HTML

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <body>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="predict"style="color: aliceblue;">Prediction</a>
            </li>
          </ul>
        </div>
      </nav>
      <div class="d-flex justify-content-center">
        <img src="C:/Users/Nivetha Anandhan/diabetic/upload/index.jpg">
        </div>
  </body>
</html>
```

REGISTER.HTML:

```
<!-- <!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;

        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <form action="{{url_for('register')}}" method="post" >
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">DR Register</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
      <form class="form-inline" method ="POST">
      <div class="container" style="width: 600px; height: 600px;">
```

```
43            <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
44          </li>
45          <li class="nav-item">
46            <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
47          </li>
48        </ul>
49      </div>
50    </nav>
51    <br><br>
52    <form class="form-inline" method ="POST">
53    <div class="container" style="width: 600px; height: 600px;">
54      <div class="mb-3 d-flex justify-content-center"><script src="https://cdn.lordicon.com/xdjxvujz.js"></script>
55          <lord-icon
56             src="https://cdn.lordicon.com/elkhjhci.json"
57             trigger="hover"
58             style="width:200px;height:200px">
59          </lord-icon></div>
60          <div class="mb-3">
61            <input type="text" class="form-control" id="exampleInputName" name = "name" aria-describedby="nameHelp" placeholder="Enter Name">
62          </div>
63          <div class="mb-3">
64            <input type="email" class="form-control" id="exampleInputEmail1" name="emailid" aria-describedby="emailHelp" placeholder="Enter Mail ID">
65          </div>
66          <div class="mb-3">
67            <input type="number" class="form-control" id="exampleInputNumber1" name="num" aria-describedby="numberHelp" placeholder="Enter Mobile number">
68          </div>
69          <div class="mb-3">
70            <input type="password" class="form-control" id="exampleInputPassword1" name="pass" placeholder="Enter Password">
71          </div>
72          <div class="mb-3">
73          <button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;">Register</button>
74        </div>
75        <div class="mb-3 d-flex justify-content-center">
76          <a href="login" class="nav-link"> Already Registered: Login Here</a>
77      </div>
78      {{pred}}
79      </div>
80    </form>
81  </body>
82 </html> -->
```

LOGIN.HTML:

```html
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;

        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <form action="",method='POST'>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">DR Register</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
            </li>
          </ul>
        </div>
    </nav>
    <br><br>
    <form class="form-inline">
    <div class="container" style="width: 600px; height: 600px;">
      <div class="mb-3 d-flex justify-content-center"><script src="https://cdn.lordicon.com/xdjxvujz.js"></script>
          <lord-icon
             src="https://cdn.lordicon.com/elkhjhci.json"
             trigger="hover"
             style="width:200px;height:200px">
          </lord-icon></div>

          <div class="mb-3">
              <input type="email" class="form-control" id="exampleInputEmail1" name="mail" aria-describedby="emailHelp" placeholder="Enter Registered Mail ID">
            </div>
            <div class="mb-3">
              <input type="password" class="form-control" id="exampleInputPassword1" name="pass" placeholder="Enter Password">
            </div>
            <div class="mb-3">
            <a href="prediction" class="btn btn-lg btn-dark">Login </a>
          </div>
    </div>
  </form>
 </body>
</html>
```

PREDICTION.HTML:

```html
<!DOCTYPE html>
<html lang="en">

<head>
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <!-- CSS only -->
  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css" rel="stylesheet"
    integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT" crossorigin="anonymous" />
  <!-- JavaScript Bundle with Popper -->
  <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
    integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"></script>
  <style>
    #navbarRight {
      margin-left: auto;
      padding-right: 10px;
    }

    .navbar-brand {
      padding-left: 15px;
    }

    .row {
      width: 90%;
    }
  </style>
  <title>DR Predcition</title>
</head>

<body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
    </div>
    <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
      <ul class="navbar-nav mr-auto text-center" id="navbarRight">
        <li class="nav-item active">
          <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
        </li>
        <li class="nav-item">
          <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>
        </li>
      </ul>
    </div>
```

```html
      </ul>
    </div>
  </nav>
  <br><br>
  <div class="container justify-content-center" style="width:400px">
    <form>
    <label for="formFileLg" class="form-label">Upload Image</label>
    <input class="form-control form-control-lg" id="formFileLg" type="file" />
    <br>
    <a class="nav-link" href="p_result" class="btn btn-dark">submit</a>
    <div class="d-flex justify-content-center">
      <div class="row d-flex display-3 justify-content-center">
          Diabetic retinopathy classification is:
          <br><br>
    </form>
  </div>
  <br><br><br>
  <div>
      {{prediction}}
      <img src="C:/Users/Nivetha Anandhan/diabetic/upload/prediction.jpg">
```

LOGOUT.HTML:

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <body>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
      <div class="d-flex justify-content-center">
        <div class="row d-flex display-3 justify-content-center">
            Successfully Logged Out!
            <br><br>
            <a href="login" class="btn btn-lg btn-dark">Login for more Information</a>
              </div>
        </div>
  </body>
```

APPLICATION:

```python
imagesize = [299, 299]
trainpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/training"
testpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing"
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
train_datagen = ImageDataGenerator(rescale =1./255,shear_range = 0.2,zoom_range = 0.2,horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set = train_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/training",target_size = (299, 299),batch_size = 32,class_mode = "categorical")
test_set = test_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing",target_size = (299, 299),batch_size = 32,class_mode="categorical")
xception = Xception(input_shape =imagesize + [3], weights = 'imagenet', include_top = False)
for layer in xception.layers:
  layer.trainable = False
x = Flatten()(xception.output)
prediction = Dense(5, activation='softmax')(x)
model = Model(inputs=xception.input, outputs=prediction)
model.summary()
model.compile(
    loss='categorical_crossentropy',
    optimizer='adam',
    metrics=['accuracy']
)
r=model.fit_generator(
    training_set,
     validation_data=test_set,
     epochs=30,
     steps_per_epoch=len(training_set)//32,
     validation_steps=len(test_set)//32)
model.save('updated-xception-diabetic-retinopathy.h5')

import numpy as np
import os
from tensorflow import keras
from keras import models
from keras.models import load_model
from keras.preprocessing import image
from keras.applications.inception_v3 import preprocess_input
import requests
from flask import Flask, request, render_template, redirect, url_for
from cloudant.client import Cloudant
model = load_model(r"updated-xception-diabetic-retinopathy.h5")
app = Flask(__name__)
client = Cloudant.iam('9f458f39-44d8-46bd-bf8b-eb02c85f223c-bluemix',
                      '39FqLWsnZs_xCT-eEqB2Pim6rLghPbsDdd4h3wWcrwZo', connect=True)
# Create a database using an initialized client
my_database = client.create_database('my_db')
if my_database.exists():
    print("Database '{0}' successfully created.".format('my_db'))
# default home page or route
    @app.route('/')
    def index():
        return render_template('index.html')

    @app.route('/index')
    def home():
        return render_template("index.html")

    @app.route('/register',methods=["GET","POST"])
    def register():
        if request.method == "POST":
            name =  request.form.get("name")
            mail = request.form.get("emailid")
            mobile = request.form.get("num")
            pswd = request.form.get("pass")
            data = {
                'name': name,
                'mail': mail,
                'mobile': mobile,
                'psw': pswd
            }
            print(data)
            query = {'mail': {'$eq': data['mail']}}
            docs = my_database.get_query_result(query)
            print(docs)
            print(len(docs.all()))
            if (len(docs.all()) == 0):
                url = my_database.create_document(data)
                return render_template("register.html", pred=" Registration Successful , please login using your details ")
            else:
                return render_template('register.html', pred=" You are already a member , please login using your details ")
        else:
            return render_template('register.html')


    @app.route('/Login', methods=['GET','POST'])
    def login():
        if request.method == "POST":
            user = request.form.get('name')
            passw = request.form.get('pass')
            print(user, passw)
            query = {'_id': {'$eq': user}}
            docs = my_database.get_query_result(query)
            print(docs)
            print(len(docs.all()))
            if (len(docs.all()) == 0):
                return render_template('login.html', pred="The username is not found.")
            else:
                if ((user == docs[0][0]['_id'] and passw == docs[0][0]['pswd'])):
                    return redirect(url_for('prediction'))
                else:
                    print('Invalid User')
        else:
            return render_template('login.html')
```

```
        return render_template('login.html')

@app.route('/logout')
def logout():
    return render_template('logout.html')

@app.route("/predict")
def predict():
    return render_template("prediction.html")

@app.route('/result', methods=["GET", "POST"])
def res():
    if request.method == "POST":
        f = request.files['image']
        basepath = os.path.dirname(__file__)
        filepath = os.path.join(basepath, 'uploads', f.filename)
        f.save(filepath)
        img = image.load_img(filepath, target_size=(299, 299))
        x = image.img_to_array(img)
        x = np.expand_dims(x, axis=0)
        img_data = preprocess_input(x)
        prediction = np.argmax(model.predict(img_data), axis=1)
        index = [' No Diabetic Retinopathy ', ' Mild DR ',
                 ' Moderate DR ', ' Severe DR ', ' Proliferative DR ']
        result = str(index[prediction[0]])
        print(result)
    return render_template('prediction.html', prediction==result)

if __name__ == "__main__":
    app.run(debug=False)
```

GITHUB LINK:

https:/ github.com/IBM-EPBL/IBM-Project-PNT2022TMID22755