DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

A PROJECT REPORT

Submitted by

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ANNA UNIVERSITY....CHENNAI-600 025

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1. INTRODUCTION

.1.1 PROJECT OVERVIEW

Diabetic Retinopathy(DR) is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision. If it is not deected , it can lead to blindness Unfortunately. DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time, effort and cost consuming and prone to misdiagnosis unlike computer aided diagnosis systems.

Transfer learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. We used Transfer Learning techniques like Inception V3, Resnet50, Xception V3 that are more widely used as a transfer learning method in medical image analysis and they are effective.

1.2 Purpose

The manual diagnosis process of DR retina fundus images by ophthalmologists is time. effort and cost consuming and prone to misdiagnosis unlike computer aided diagnosis systems. DR early detection and treatment can significantly reduce the risk of vision loss. AI can save the manual effort and cost and also have more accuracy than human experts, thus improving value of service.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

DR is a disease caused by uncontrolled chronic diabetes and it can cause complete blindness if noy treated. Therefore early medical diagnosis and medical cure is essential to prevent the severe side effects of DR. Manual detection of DR by ophthalmologist take plenty of time and patient need to suffer a lot at this time. An automated system can help to detect DR and we can easily followup treatment to avoid further effects to the eye.

This system proposes a machine learning method for extracting three features like exudates, hemorrhages and micro aneurysms. And the classifications using c

2.2 REFERENCES

1. FAHMAN SAEED, MUHAMMAD HUSSAIN, AND HATIM A. ABOALSAMH "Automatic Diabetic Retinopathy Diagnosis Using Adaptive Fine-Tuned Convolutional Neural Network" IEEE Access Vol. 9, pp. 41344- 41359, March 19, 2021.

DESCRIPTION:

The manual screening of colour fundus images to detect DR at early stage is expensive and time consuming.

2. MOHAMED M. ABDELSALAM AND M. A. ZAHRAN "A Novel Approach of Diabetic Retinopathy Early Detection Based on Multifractal Geometry Analysis for OCTA Macular Images Using Support Vector Machine" IEEE Access Vol. 9, pp. 22844-22858, February 9, 2021.

DESCRIPTION

Analyzing the Macular optical coherence tomography angiography (OCTA) images for diagnosing early non proliferate diabetic retinopathy (NPDR0. Using a supervised machine as a Support Vector Machine (SVM) algorithms to automate the diagnosis process.

2.3 PROBLEM STATEMENT

Diabetes mellitus is a chronic disease where blood glucose level tends to increase due to the lack or inability of the pancreas to secrete sufficient blood insulin. Adverse effects of Diabetes on human organs especially eyes. Here one of the complicated disease termed as DR under the age of 50 years. The severe DR stage will affect the total retina of the eye. Detecting DR is a complicated issue in an initial stage.

I3. IDEATATION & PROPOSED SOLUTION
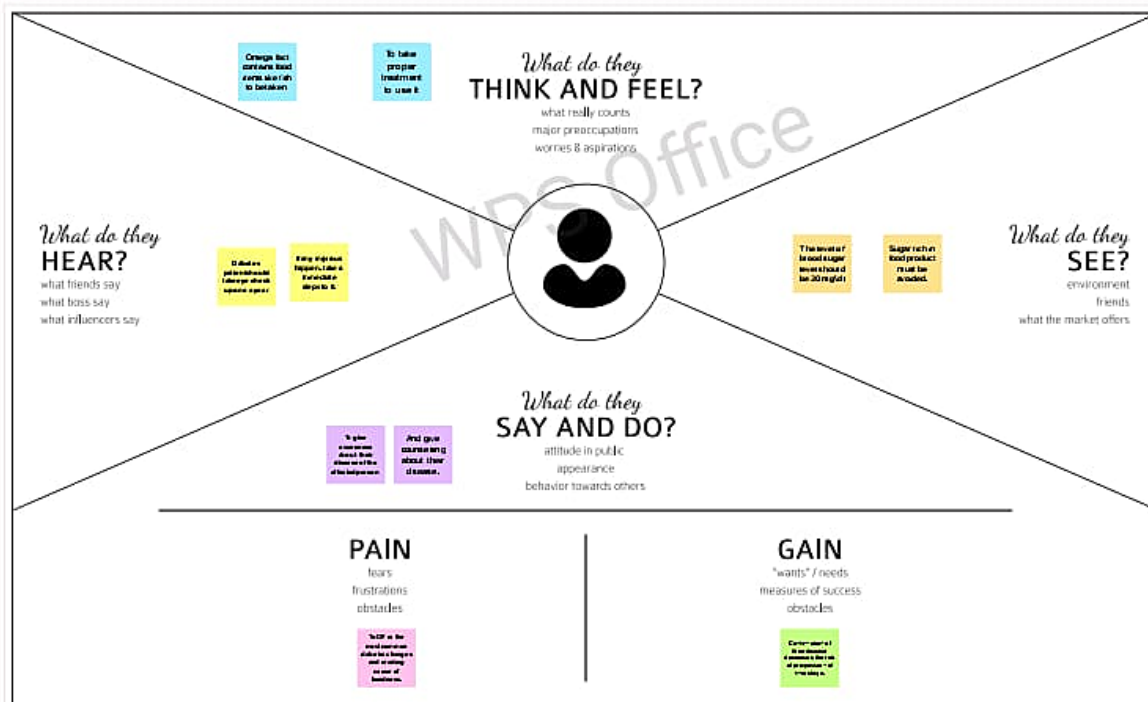
3.1 EMPATHY MAP CANVAS
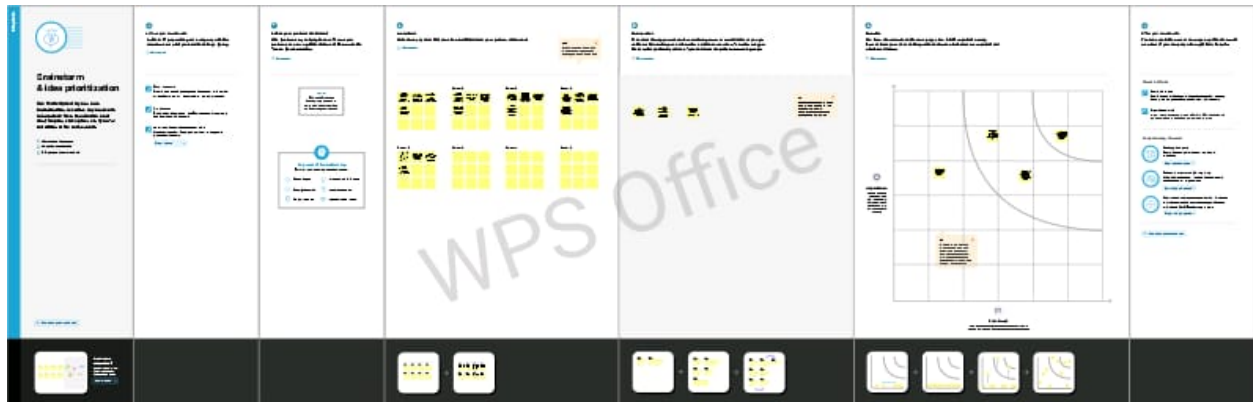
3.3 PROPOSED SOLUTION

Project Design Phase-I
Proposed Solution Template

Date	19 September 2022
Team ID	PNT2022TMID50773
Project Name	Project - Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy.
Maximum Marks	2 Marks

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Diabetic Mellitus is a chronic disease where blood glucose level tends to increase due to the lack or inability of the pancreas to secrete sufficient blood insulin.Adverse effects of diabetes on human organs especially eyes.Here one of the complicated disease termed as Diabetic Retinopathy, that can cause severe injury and it leads to vision loss.
2.	Idea / Solution description	To detect the Diabetic Retinopathy in early stage to avoid these eye injuries and vision loss.
3.	Novelty / Uniqueness	From this detection strategy of Deep Learning platform, It is more secure and safe in the detection procedure. It is fast and accurate in their results.
4.	Social Impact / Customer Satisfaction	Many of the people can gaining this by getting warning and a large prevention from the vision loss of Diabetic Retinopathy.
5.	Business Model (Revenue Model)	It increase the efficiency by detecting it in a early stage of the disease.
6.	Scalability of the Solution	It can be lead to a long term solution for all diabetes disease in the medical field.

Problem-Solution fit canvas 2.0

Purpose / Vision

	1. CUSTOMER SEGMENT(S) — CS	6. CUSTOMER CONSTRAINTS — CC	5. AVAILABLE SOLUTIONS — AS	
Define CS, fit into CC	Who is your customer? i.e. working parents of 0-5 y.o. kids	What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.	Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking.	**Explore AS, differentiate**
	Patients are suffered from Diabetic Retinopathy(DR).	Requirements needed for the customer constraints of budjet and related devices.	Early detection of Diabetic Retinopathy in early stage leads to prevent from the vision loss.	

	2. JOBS-TO-BE-DONE / PROBLEMS — J&P	9. PROBLEM ROOT CAUSE — RC	7. BEHAVIOUR — BE	
Focus on J&P, tap into BE, understand RC	Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.	What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.	What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work. (i.e. Greenpeace)	**Focus on J&P, tap into BE, understand RC**
	Detect the diabetes in early stage. Earlier detection of diabetic retinopathy using various types machine learning techniques.	Improper checking and maintenance in their reular eye checkups No attention in their health care.	Asking a existing solution for the DR suffered patients. Get counselling from the DR clinicians.	

	3. TRIGGERS — TR	10. YOUR SOLUTION — SL	8. CHANNELS of BEHAVIOUR — CH	
Identify strong TR & EM	What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news. Word of mouth and social media. Asking a doctor for advice.	If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits with the customer limitations, solves a problem and matches customer behaviour. Making their health care perfectly. Made a regular checkup.	8.1 ONLINE What kind of actions do customers take online? Extract online channels from #7 Could search for the related social medias in online	**Extract online & offline CH of BE**
	4. EMOTIONS: BEFORE / AFTER — EM How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design. It can leads to blurred vision in their eyes. Finally leads to blindness.		8.2 OFFLINE What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. Ask a healthy counselling fron the neighbours.	

★ AMALTAMA

4. **REQUIREMENT ANALYSIS**
     4.1 FUNCTIONAL REQUIREMENT
     4.2 NON FUNCTIONAL REQUIREMENT

Project Design Phase-II
Solution Requirements
(Functional & Non-functional)

Date	03 October 2022
Team ID	PNT2022TMID50773
Project Name	Deep learning Fundus image analysis for early detection of diabetic Retinopathy
Maximum Marks	4 Marks

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Identifying and selecting dataset	The appropriate dataset to enhance the model's performance is necessary to select.
FR-2	Invitation and information	Invite the full cohort for screening, supplying information tailored appropriately for different groups To enable informed choice to participate.
FR-3	Training	It is required to import the libraries needed for training the model.
FR-4	Diagnosis	Diagnose true cases and identify the false positives.
FR-5	Testing	Conduct screening tests with different data to test if the model is trained well to predict the medical condition.
FR-6	Reporting	Report the outcomes to identify false negatives and improve effectiveness of the screening program.
FR-7	Intervention/Treatment/Followup	The testing of the model helps us to identify the appropriate treatment.

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Users with basic understanding of the medical condition and computer knowledge can operate the system. User friendly interface that can be accessed with ease by users.
NFR-2	Security	Deep learning AI can be more precise around sensitive organs and tissues, reduce blood loss, risk of infection, and pain during detection.
NFR-3	Reliability	There is a chance of hardware failure or false positives when the testing data is more different

5. PROJECT DESIGN PHASE
5.1 DATA FLOW DIAGRAM

Project Design Phase-II
Data Flow Diagram & User Stories

Date	07 November 2022
Team ID	PNT2022TMID50773
Project Name	Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy
Maximum Marks	4 Marks

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a graphical or visual representation using a standardized set of symbols and notations to describe a business's operations through data movement. They are often elements of a formal methodology such as structured system analysis and design method.

Training Image → Preprocessing

Feature Extraction → Classification → Normal

Test Image

Classification → DR

DR → Internal and External Features

Internal and External Features → Analysis Risk Factor

Analysis Risk Factor → Make Decision
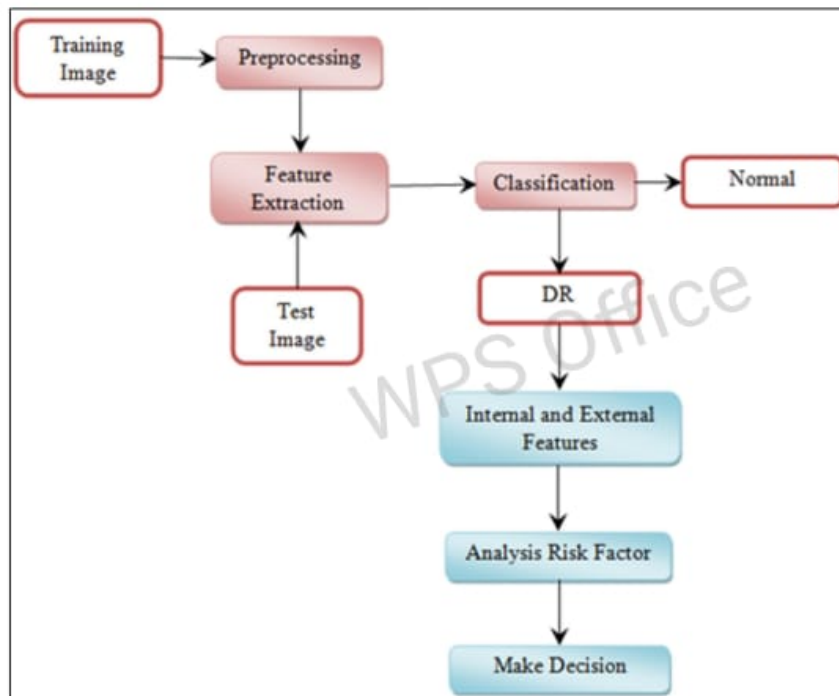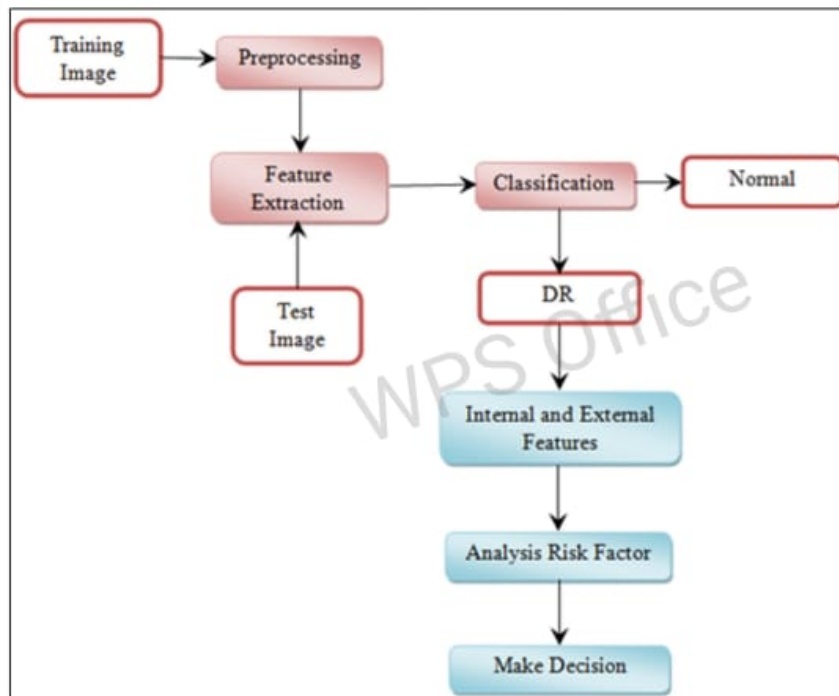
USER STORIES

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 This project, eye drops placed in your eyes (dilate) treatment a better view inside your eyes.	I can upload or take image.	High	Sprint-1
	Physical feature	USN-2	As a user, I can use it with minimal physical interaction with the corresponding device.	I can take the device to the residence of patients if they are unable to visit hospital.	High	Sprint-2
		USN-3	The feature extraction method more efficient and accurate.	It prevents the chances of unwanted infections in the patient's eye	High	Sprint-1
	Screening method	USN-4	I can find it portable and easy to use.	I can perform the screening procedure without any fear and hesitation.	Low	Sprint-2

|	Safety	USN-5	I should be safe as the detection method is free from radiations.	Pain during the testing is the major fear factor that prevents the patients from visiting the hospital.	High	Sprint-4
	Testing	USN-6	The undergo testing without any fear of pain as this method is pain free.	Pain during the testing is the major fear factor that prevents the patients from visiting the hospital.	Medium	Sprint -2
		USN-7	I will be comfortable as it requires minimum/ no human involvement.	The screening is carried out using a computer robot along with the aid of AI technology.	Low	Sprint-4
Common User	Dashboard	USN -8	I receive the severity of the retinopathy.	The severity of the disease should be categorized.	Medium	Sprint-2
	Results	USN-9	I can rely on the results without any suspicion.	The technique is almost 100% efficient as it involves modern techniques incorporated with Machine Learning and Deep learning.	High	Sprint-3
		USN-10	I get the 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-11	I can get the results immediately after the screening process.	It prevents further delay in the right treatment process.	Low	Sprint-4
Customer (Public sector/ Private sector)	Cost efficiency	USN-12	I can reach many people suffering from diabetes.	Diabetic patients are more vulnerable to diabetic retinopathy	Medium	Sprint-1
		USN-13	I can create awareness among diabetic patients to undergo frequent screenings.	As the technique is low cost, patients will find it very useful.	Low	Sprint-3

5.2 SOLUTION ARCHITECTURE
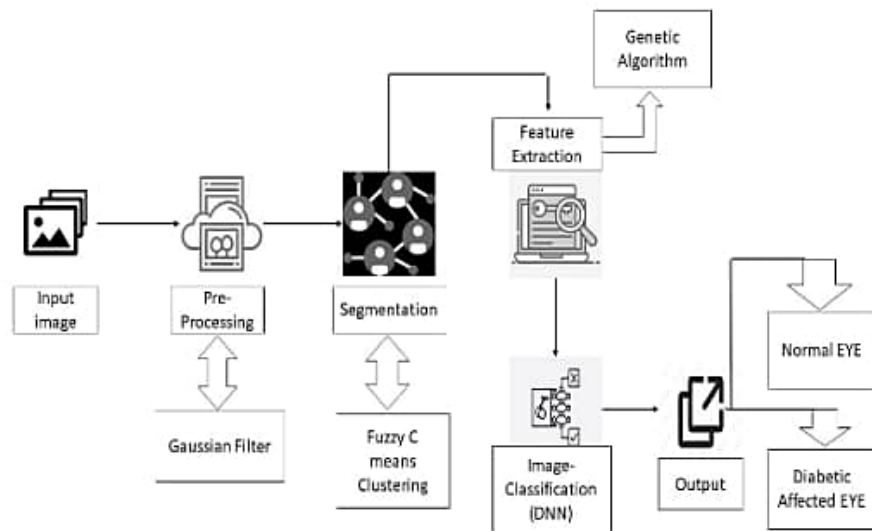
Figure 1: Solution Architecture for the deep learning fundus image analysis

Technical Architecture

Project phase-II Technology architecture:

Date	11 November 2022
Team ID	PNT2022TMID50773
Project Name	Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy
Maximum Marks	4 Marks

Technical Architecture:

1. The Deliverable shall include the architectural diagram as below and the information as per the table1 &

table 2.

2. It could explain the basic components and the technical solution for it to solve by the technical

architecture..

3. It involves the development of a technical blueprint with regard to the arrangement, interaction, and interdependence of all elements so that system-relevant requirements are met.
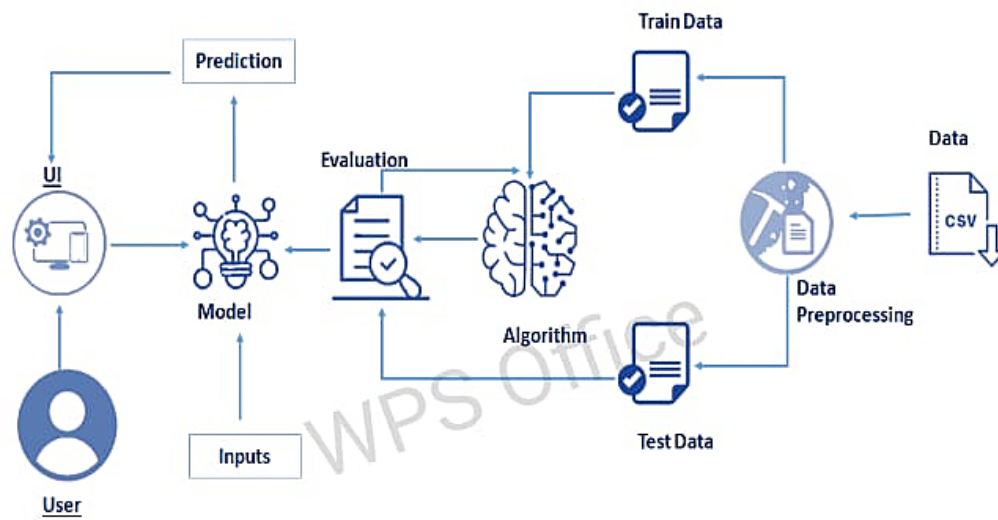
Table:1 Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI etc.,	CSS, JavaScript,
2.	Application Logics	Logic for each and every process in the application	Python, JavaScript.
3.	Cloud database	Database service on cloud	IBM Cloudant.
4.	API	Used to call the functions in order to access the execution in another framework	Python Flask , NodeJS (if needed).
5.	Deep Learning Model	The model is developed to predict the rainfall using ML algorithms	Sklearn, DL Algorithms.
6.	Data Pre-processing and Analysis	The available data is formatted or converted into the format which will be suitable for the ML model	Matplotlib, Tensorflow, opencv.
7.	External API	API to fetch FUNDUS Image from Kaggle	Google's Kaggle API

Table:2 Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Backend Framework, Non-structured Database.	Python Flask / NodesJS, IBM Cloudant.
2.	Security Implementations	Email Verification and authentication using JSON object by comparing the data exists in database.	Encryptions, Direct verification using Backend Framework.
3.	Scalable Architecture	To ensure that enough resource is allocated on the hosting platform to keep up with demand	IBM Cloud Kubernetes Service.
4.	Availability	The website will be made available by hosting it in cloud hosting platforms	IBM cloud hosting.
5.	Performance	Multiple prediction requests should be handled simultaneously without affecting the speed and accuracy of prediction	Load Balancers and Distributed servers.

6. PROJECT PLANNING AND SCHEDULING

Project Planning Phase

(Sprint Delivery plan)

Date	14 November 2022
Team ID	PNT2022TMID50773
Project Name	Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy.
Maximum Marks	8 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

To create sprint delivery plan schedule.

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email or phone number and password, and confirming my password.	10	High	Sindhu Abirami

Sprint-1	DashBoard	USN-2	As a user, I will Redirect to the dashboard after registration which shows the importance of DR.	10	Medium	Vaishnavi & Sushma
Sprint-2	Login	USN-3	As a user, I can log into the application by entering Login credentials.	5	High	Vanitha & Lingeshwari
Sprint-2	Upload Images	USN-4	As a user, I should be able to upload the image of eye Retina.	10	High	Sindhu Abirami & Vanitha

Sprint							
Sprint-2	Dashboard	USN-5	As a user, based on my requirement I can navigate through the dashboard.	5	Medium	Sushma & Vaishnavi
Sprint-3	Train the model	Task 1	As a developer, the dataset will be uploaded and trained by developed algorithm.	20	High	Lingeshwari & Vanitha
Sprint-4	Testing & Evaluation	Task 2	As a developer, we tested the trained model using the provided dataset and model will be evaluated for accurate results.	10	High	Sindhu Abirami & Vaishnavi
Sprint-4	Display predictedresult	USN-6	As a user, I can view the predicted result in the dashboard.	10	High	Vanitha & Sushma

Project Tracker, Velocity & Burn down Chart: (4 Marks)

Sprint	Total story point	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022

7. **CODING AND SOLUTIINING (Explain the features added in the project along with code)**
   7.1 Feature

```
1   imagesize = [299, 299]
2   trainpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/training"
3   testpath = r"C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing"
4   from tensorflow.keras.layers import Dense, Flatten, Input
5   from tensorflow.keras.models import Model
6   from tensorflow.keras.preprocessing import image
7   from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
8   from tensorflow.keras.applications.xception import Xception, preprocess_input
9   from glob import glob
10  import numpy as np
11  import matplotlib.pyplot as plt
12  train_datagen = ImageDataGenerator(rescale =1./255,shear_range = 0.2,zoom_range = 0.2,horizontal_flip = True)
13  test_datagen = ImageDataGenerator(rescale = 1./255)
14  training_set = train_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/training",target_size = (299, 299),batch_size = 32,class_mode = "categorical")
15  test_set = test_datagen.flow_from_directory("C:/Users/Nivetha Anandhan/diabetic/preprocessed/testing",target_size = (299, 299),batch_size = 32,class_mode="categorical")
16  xception = Xception(input_shape =imagesize + [3], weights = 'imagenet', include_top = False)
17  for layer in xception.layers:
18      layer.trainable = False
19  x = Flatten()(xception.output)
20  prediction = Dense(5, activation='softmax')(x)
21  model = Model(inputs=xception.input, outputs=prediction)
22  model.summary()
23  model.compile(
24      loss='categorical_crossentropy',
25      optimizer='adam',
26      metrics=['accuracy']
27  )
28  r=model.fit_generator(
29      training_set,
30      validation_data=test_set,
31      epochs=30,
32      steps_per_epoch=len(training_set)//32,
33      validation_steps=len(test_set)//32)
34  model.save('updated-xception-diabetic-retinopathy.h5')
35
36  import numpy as np
37  import os
38  from tensorflow import keras
39  from keras import models
40  from keras.models import load_model
41  from keras.preprocessing import image
42  from keras.applications.inception_v3 import preprocess_input
43  import requests
44  from flask import Flask, request, render_template, redirect, url_for
45  from cloudant.client import Cloudant
46  model = load_model(r"updated-xception-diabetic-retinopathy.h5")
47  app = Flask(__name__)
48  client = Cloudant.iam('9f458f39-44d8-46bd-bf8b-eb02c85f223c-bluemix',
49                        '39FqLWsnZs_xCT-eEqB2Pim6rLghPbsDdd4h3wWcrwZo', connect=True)
50  # Create a database using an initialized client
51  my_database = client.create_database('my_db')
52  if my_database.exists():
53      print("Database '{0}' successfully created.".format('my_db'))
54  # default home page or route
```

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	All sixe must be d	working as expected	PASS

|			page.			
HP_TC_002	UI	Home page	check verify the elementse displayed properly	The home pages must be displayed properl.	The UI is not displayed properly in screen size 2560*1801 and 768*630	FAIL
HP_TC_003	UI	Home page	check if user can upload their file.	The input image should be uploaded to the application successfully.	working as expected	PASS
BE-TC-001	Functional	Backend	check if all the routes are	The model should be	working as expected	PASS

			working properly	rescale the image and project the results		
M_TC_0 01	Function al	Backend	check if the model can handle various image sizes.	The model should rescale image and predict the results	working as expect ed	PASS
M_T002	Function al	model	check if the model predicts the digit	The model should predict the number	working as expect ed	PASS
M-TC-003	Function al	Model	check if the model can handle complex	The model should predict in the complex	The model fails to identify the digit since	FAIL

			input images	images	the model is not built to handle it.	
RP-TC-001	UI	Result page	verify is the UI element 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 exceed the display contents	PASS
RP-TC-003	UI	Result page	check if the other ;predictions are displayed ed	the other predictions should be display	working as expected	PASS

			properly	ed properly		

PERFORMANCE TESTING

Random Forest   Neural Network
Logistic Regression   SVM
AdaBoost
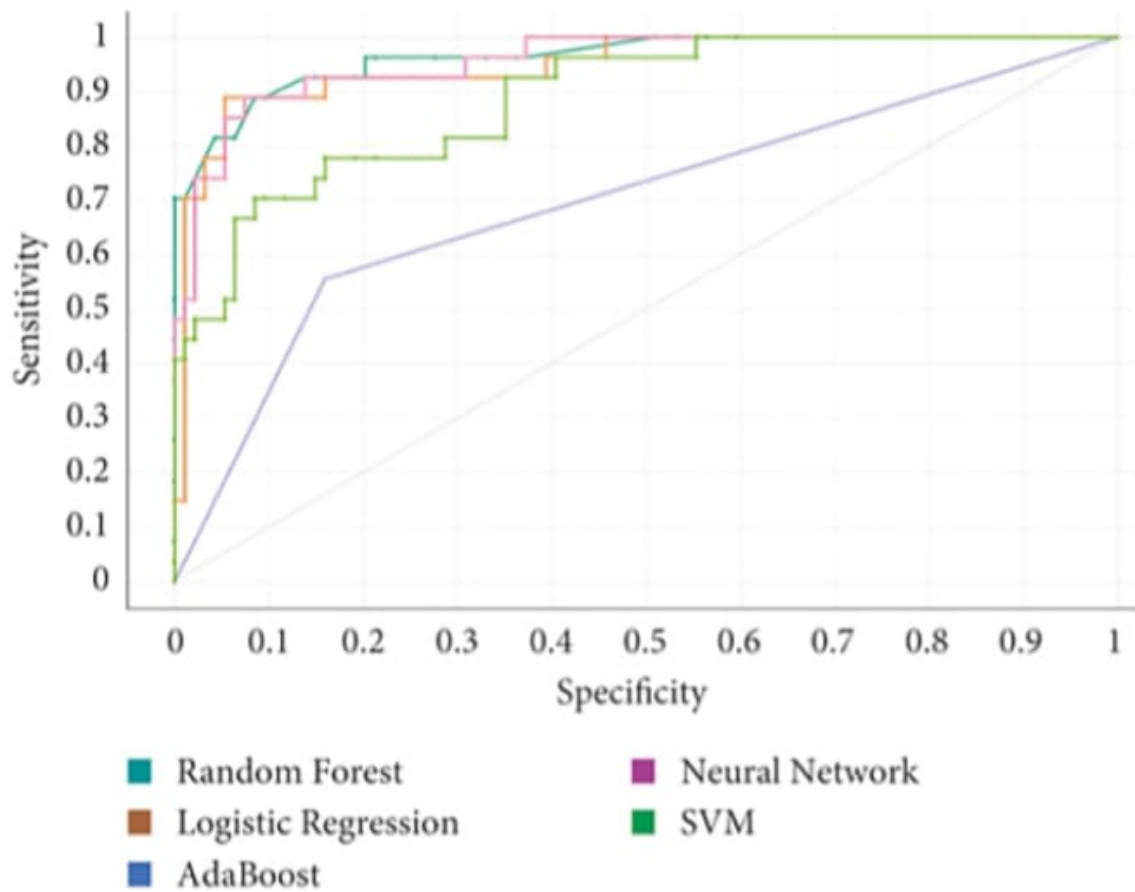
10 .Advantages and Disadvantages:

ADVANTAGES:

1. Reduce manual word
2. More accurate than average human
3. capable of handling a lot of data

DISADVANTAGES

5. cannot handle complex data

6. All the data must be in digit.

7. Pronw to occasional errors.

```html
1   <!DOCTYPE html>
2   <html lang="en">
3     <head>
4       <meta charset="UTF-8" />
5       <meta http-equiv="X-UA-Compatible" content="IE=edge" />
6       <meta name="viewport" content="width=device-width, initial-scale=1.0" />
7       <!-- CSS only -->
8       <link
9         href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
10        rel="stylesheet"
11        integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
12        crossorigin="anonymous"
13      />
14      <!-- JavaScript Bundle with Popper -->
15      <script
16        src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
17        integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NmikvbZLHgTPOOmMi466C8"
18        crossorigin="anonymous"
19      ></script>
20      <style>
21        #navbarRight {
22          margin-left: auto;
23          padding-right:10px;
24        }
25        .navbar-brand{
26          padding-left:15px;
27        }
28      </style>
29      <title>DR Predcition</title>
30    </head>
31    <body>
32      <nav class="navbar navbar-expand-lg navbar-light bg-dark">
33        <div>
34          <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
35        </div>
36        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
37          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
38            <li class="nav-item active">
39              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
40            </li>
41            <li class="nav-item">
42              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
43            </li>
44            <li class="nav-item">
45              <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
46            </li>
47            <li class="nav-item">
48              <a class="nav-link" href="predict"style="color: aliceblue;">Prediction</a>
49            </li>
50          </ul>
51        </div>
52      </nav>
53      <div class="d-flex justify-content-center">
54        <img src="C:/Users/Nivetha Anandhan/diabetic/upload/index.jpg">
55      </div>
56    </body>
57  </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-uIOknCvxWWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIMI7NnikvbZlHgTPOOmMi466C8"
      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;">
```

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
@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:
```

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 inn order to prevent its deterioration and the retinas damage. The interest in applying deep learning in detecting diabetic retinno;pathy has increased during the ;past years and as several DL systems evolve to treat the patents in need more effectively and efficiently.

12. FUTURE SCOPE

- Add support to detect from digits multiple images and save the results.
- Add support to detect multiple digits.
- Improve model to detect digits from complex images.