Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy

IBM-Project-2665-1658480813

NALAIYA THIRAN PROJECT BASED LEARNING ON PROFESSIONAL READINESS FOR INNOVATION, EMPLOYMENT AND ENTREPRENEURSHIP

A PROJECT REPORT

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CONTENTS

1. INTRODUCTION

1.1 Project overview:

A person’s vision is their ability to view and interpret the world around them.A side effect of diabetes that damages the eyes is called diabetic retinopathy. The light-sensitive tissue in the rear of the eye's blood vessels called retina gets damaged.

Initially with no symptoms or with slight visual issues, diabetic retinopathy can affect vision. Blindness, though, may result from it. Type 1 or type 2 diabetics are both susceptible to the problem developing. The risk of developing this eye issue increases with the duration of having diabetes and the degree of blood sugar control one has. Diabetic retinopathy is best diagnosed with a comprehensive dilated eye exam. A dye is then injected into an arm vein after the eyes have been dilated. Pictures are then taken when the dye passes through the blood vessels in the eyes. Blood vessels that are closed, damaged, or leaking might be located on the photographs.

1.2 Purpose

The prevalence of diabetic retinopathy (DR) in urban and rural India was calculated using a systematic review and meta-analysis. The overall, rural, and urban prevalences were calculated using a random-effects model. In urban regions, diabetic retinopathy was prevalent (17.44%), but in rural areas, it was only 14.0%. The total prevalence is 16.10%, with the 40–49 age range accounting for the bulk of cases. Urbanization and the rising incidence of diabetes in rural regions highlight the need for equitable eye care. The field of retinal imaging has advanced significantly over the past 160 years and is now a cornerstone of the clinical treatment and management of patients with both retinal and systemic illnesses. Fundus photography is frequently employed for the population-based, widespread identification of glaucoma, age-related macular degeneration, and diabetic retinopathy.

2. LITERATURE SURVEY

2.1 Existing Work

- **Early detection of diabetic retinopathy**

This paper attempts to describe all studies focused on the development of subclinical DR biomarkers and how they may be implemented for routine clinical use and to explore the possible perspectives for detection of subclinical DR.

- **AI-Based Automatic Detection and Classification of Diabetic Retinopathy Using U-Net and Deep Learning**

Here they suggest a two-stage novel approach for automated DR classification in this research. Due to the low fraction of positive instances in the asymmetric Optic Disk (OD) and blood vessels (BV) detection system, preprocessing and data augmentation techniques are used to enhance the image quality and quantity. The first step uses two independent U-Net models for OD (optic disc) and BV (blood vessel) segmentation. In the second stage, the symmetric hybrid CNN-SVD model was created after preprocessing to extract and choose the most discriminant features following OD and BV extraction using Inception-V3 based on transfer learning, and detects DR by recognizing retinal biomarkers

- **Referable diabetic retinopathy identification from eye fundus images with weighted path for convolutional neural network**

In this paper they propose a new strategy, which applies multiple weighted paths into convolutional neural networks, called the WP-CNN, motivated by ensemble learning. In WP-CNN, multiple path weight coefficients are optimised by back propagation, and the output features are averaged for redundancy reduction and fast convergence.

- **A Novel Way to Detect Hard Exudates Using Dynamic Thresholding Technique in Digital Retinal Fundus Image**

Here they have applied median filtering onto the input image directly if it is in grayscale, otherwise we have to convert the input image into grayscale before applying median filtering. In the next step they have subtracted the median filtered image from the input image (grayscale) and have found that the optic disk is eliminated after the subtraction operation, which often has almost similar intensity as that of the hard exudates.Finally image addition is performed in between input image (grayscale) and thresholded image.

● **Fundus image lesion detection algorithm for diabetic retinopathy screening**

This paper proposes a single framework for automatic lesion detection that can be used for quick screening-based disease diagnosis. It consists of four steps: luminosity and contrast enhancement, removal of extracted blood vessels and optic disc (OD), lesion detection and classification based on lesions.The proposed algorithm is analysed using the publically available datasets and evaluated using the metrics of specificity, sensitivity and accuracy.

● **Low-complexity computer-aided diagnosis for diabetic retinopathy**

Convolutional neural networks (CNNs) have been developed for the analysis of fundus pictures and have proven to be more effective than other methods in tasks requiring detection and classification. The four stages of DR—normal retinas, NPDR, severe NPDR, and PDR—are detected and classified using colour fundus images in this chapter. This classification is done without the use of previous image processing or data augmentation techniques, giving ophthalmologists the tools they need to more accurately diagnose the condition and track its progression.

● **An Approach to Detecting Diabetic Retinopathy Based on Integrated Shallow Convolutional Neural Network**

In this paper, performance integration and multi-scale shallow CNNs are used to classify retinal images in order to identify diabetic retinopathy early on. The experiments reveal that the performance integration model outperforms other integration models in terms of accuracy. When compared, the suggested approach to existing approaches, it also performs well on small datasets in terms of classification effect and efficiency.

● **Survey on recent developments in automatic detection of diabetic retinopathy**

The primary purpose of this research study includes availability of publically available DR datasets, diabetic retinopathy detection methods (retinal feature extraction), diagnose the normal retinal and abnormal retinal features using recently proposed CAD systems, DR detection algorithms performance evaluation and future research in the field of DR. This survey study uses certain techniques to detect diabetic retinopathy and thoroughly evaluate performance. It does so within the framework of approximately 150 research articles and the collected retinal dataset.

● **A survey on active learning and human-in-the-loop deep learning for medical image analysis**

This review explores the potential role of humans in the design and implementation of deep learning-

enabled diagnostic applications, with an emphasis on methods that will preserve a considerable level of end-user involvement. Due to the fact that working in the medical field is safety-critical, we anticipate that research in the area of human-in-the-loop computing will become more and more significant, Practical considerations. Four key areas that are considered vital for deep learning in the clinical practice are active learning, interaction with model outputs, future prospective and unanswered questions.

2.2. References

1. Early detection of diabetic retinopathy, Hamid Safi, Sare Safi, Ali Hafezi-Moghadam, Hamid Ahmadieh, Survey of Ophthalmology, Volume 63, Issue 5, 2018, Pages 601-608, ISSN 0039-6257

2. AI-Based Automatic Detection and Classification of Diabetic Retinopathy Using U-Net and Deep Learning, Bilal, Anas & Zhu, Liucun & Deng, Anan & Lu, Huihui & Wu, Ning, (2022) Symmetry.

3. Referable diabetic retinopathy identification from eye fundus images with weighted path for convolutional neural network, Yi-Peng Liu, Zhanqing Li, Cong Xu, Jing Li, Ronghua Liang, Artificial Intelligence in Medicine, Volume 99, 2019, 101694, ISSN 0933-3657

4. A Novel Way to Detect Hard Exudates Using Dynamic Thresholding Technique in Digital Retinal Fundus Image, Banerjee, Sreeparna & Kayal, Diptoneel. (2015), INTERNATIONAL JOURNAL OF COMPUTERS & TECHNOLOGY.

5. Fundus image lesion detection algorithm for diabetic retinopathy screening, Kanimozhi, J., Vasuki, P. & Roomi, S.M.M, Springer, J Ambient Intell Human Comput 12, 7407–7416 (2021).

6. Low-complexity computer-aided diagnosis for diabetic retinopathy, Mohamed Shaban, Ali H. Mahmoud, Ahmed Shalaby, Mohammed Ghazal, Harpal Sandhu, Ayman El-Baz,In Computer-Assisted Diagnosis,Diabetes and Retinopathy, Elsevier, 2020, Pages 133-149

7.An Approach to Detecting Diabetic Retinopathy Based on Integrated Shallow Convolutional Neural Networks, Chen, Wanghu & Yang, Bo & Li, Jing & Wang, Jianwu. (2020), IEEE Access.

8. Survey on recent developments in automatic detection of diabetic retinopathy, A. Bilal, G. Sun, S. Mazhar, Journal Français d'Ophtalmologie, Volume 44, Issue 3, 2021, Pages 420-440.

9.A survey on active learning and human-in-the-loop deep learning for medical image analysis, Samuel Budd, Emma C. Robinson, Bernhard Kainz, Medical Image Analysis, Volume 71, 2021, 102062.

2.3. Problem Statement Definition

Diabetic Retinopathy is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision.Diabetes is a globally prevalent disease that can cause visible microvascular complications such as diabetic retinopathy and macular edema in the human eye retina, the images of which are today used for manual disease screening and diagnosis. If it is not detected early, it can lead to blindness. This labor-intensive task could greatly benefit from automatic detection using deep learning techniques. This project focuses on detecting such underlying lesions that could potentially result in blindness. This deep learning system could increase the cost-effectiveness of screening and diagnosis, while attaining higher than recommended performance.

3. IDEATION & PROPOSED SOLUTION

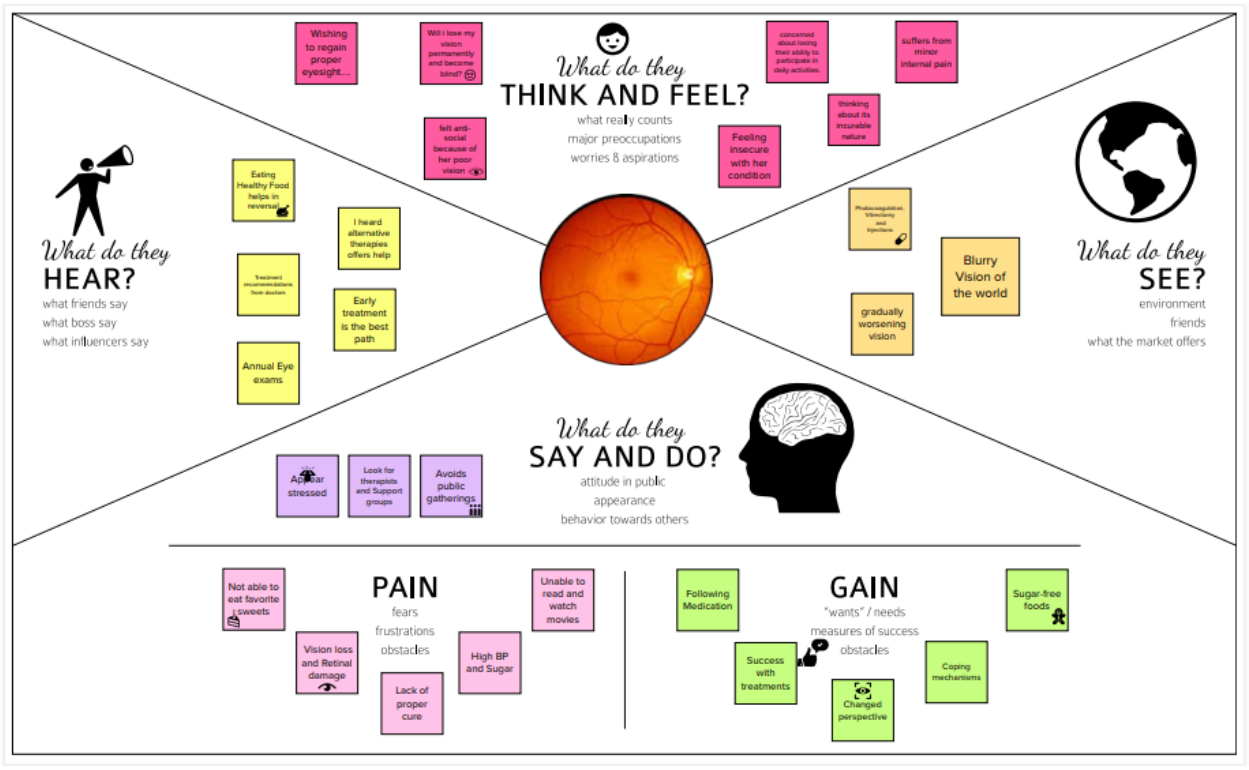
3.1 Empathy Map Canvas

1. An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers. Much like a user persona, an empathy map can represent a group of users, such as a customer segment. The empathy map was originally created by Dave Gray and has gained much popularity within the agile community.

2. An empathy map is an effective visualization template that helps analyse the behaviour and emotions of customers and users. Empathy maps not only detect the behaviours but highlight possible mediums for brands to communicate with their customers in a better way.

3. Empathy maps can also be used to collect data directly from the users. Used alongside user interviews, survey answers, etc., you can also have a user fill in an empathy map themselves. This often reveals aspects of the user that may have remained unsaid or not thought of.

4. Each of the four quadrants comprises a category that helps us delve into the mind of the user. The four empathy map quadrants look at what the user says, thinks, feels, and does.



3.2 Ideation & Brainstorming

3.3 Proposed Solution

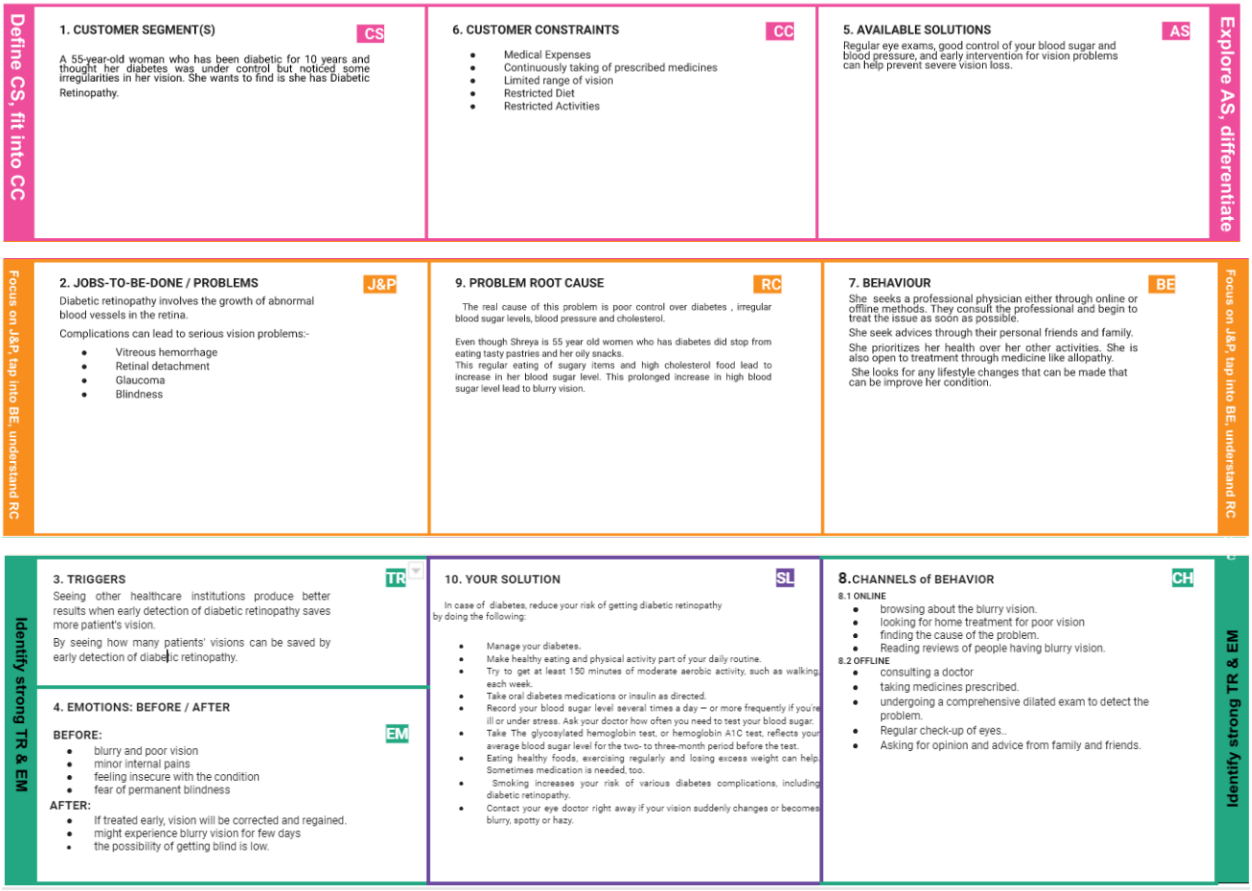
Proposed Solution Template:

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

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Diabetic Retinopathy is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision. If it is not detected early, it can lead to blindness. This project focuses on detecting such underlying lesions that could potentially result in blindness.
2.	Idea / Solution description	Diabetes is a globally prevalent disease that can cause visible microvascular complications such as diabetic retinopathy and macular edema in the human eye retina, the images of which are today used for manual disease screening and diagnosis. This labor-intensive task could greatly benefit from automatic detection using deep learning techniques. This deep learning system could increase the cost-effectiveness of screening and diagnosis, while attaining higher than recommended performance.
3.	Novelty / Uniqueness	The deep learning system identifies referable diabetic retinopathy comparably or better than presented in the previous studies, we try to use different screening and clinical grading systems for diabetic retinopathy and macular edema classification for accurately classifying images according to clinical five-grade diabetic retinopathy. We also present what preprocessing and regularization steps to the images need to be done for the good functionality of the deep learning system and investigate systematically how the size with a much smaller number of images used in training affects its performance.

4.	Social Impact / Customer Satisfaction	The development of Diabetic Retinopathy (DR) initiates at least seven years before type 2 diabetes is diagnosed clinically, hence early detection in a patient is vital. By identifying patients with retinopathy at the time of Diabetic mellitus diagnosis , loss of their vision is prevented. This project aids in making prompt assessments of patients diagnosed with DM2 and hence saving many people's vision.
5.	Business Model (Revenue Model)	Deep learning neural networks mimic the decision-making processes of the human brain by making a series of calculations to reach a conclusion and it can analyse massive datasets far faster than a human. Embedding Deep Learning across your business has the power to enhance differentiation and competitiveness, increase productivity, influence retention, and even change the course of disease. Integrating this model in hospitals will increase the rate of patients which will automatically increase the organization's revenue.Detecting the problem early for a patient increases the trust and the connection with hospital which leads to a good bond between patients and the hospital.
6.	Scalability of the Solution	The system offers a better solution for diabetic retinopathy and can be detected at an early stage. The system, developed using deep learning technology that can be implemented on a large scale. It is more adaptable to new images and datasets because it was built with a versatile dataset. Thus, this system can be used to detect diabetic retinopathy early in real-time for new variations.

3.4 Problem Solution fit



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	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/Follow up	The testing of the model helps us to identify the appropriate treatment.

4.2 Non-functional Requirements:

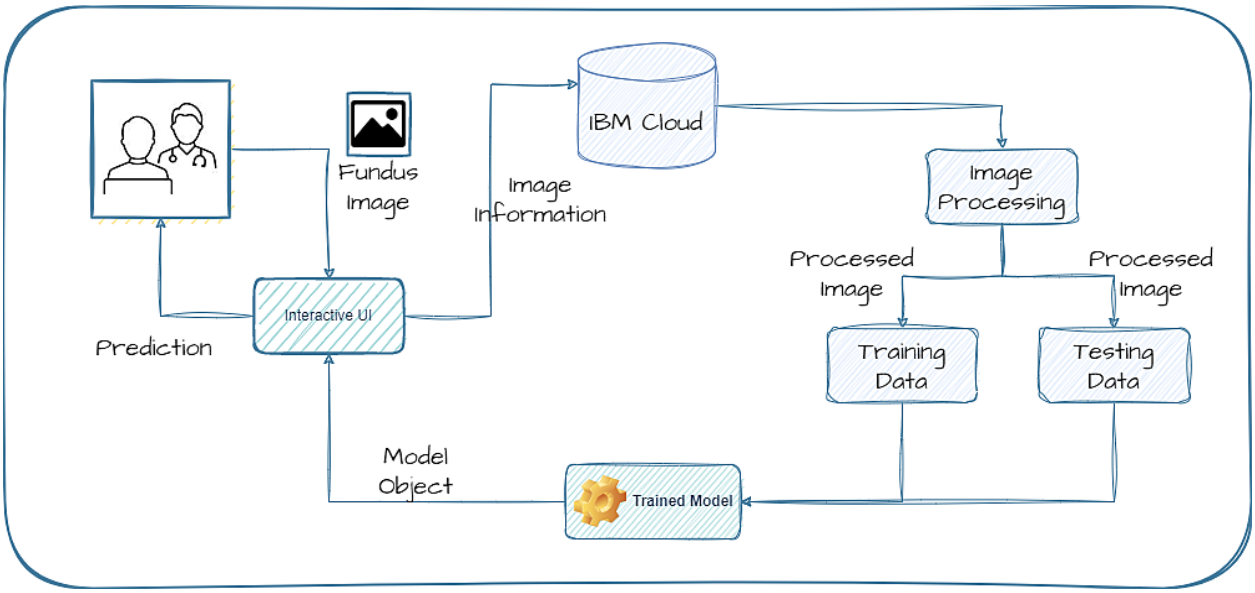
Following are the non-functional requirements of the proposed solution.

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 than the training dataset. Permission granted only by the administrator of the system.
NFR-4	**Performance**	If the system update fails or bugs in the code even though the system can rollback to its initial state. The performance of the model is meant to give speedy results for the patients.
NFR-5	**Availability**	The treatment should be available at low cost so that everyone with DR can find it beneficial.
NFR-6	**Scalability**	By processing more datasets for the reference of DR detection.

5. PROJECT DESIGN

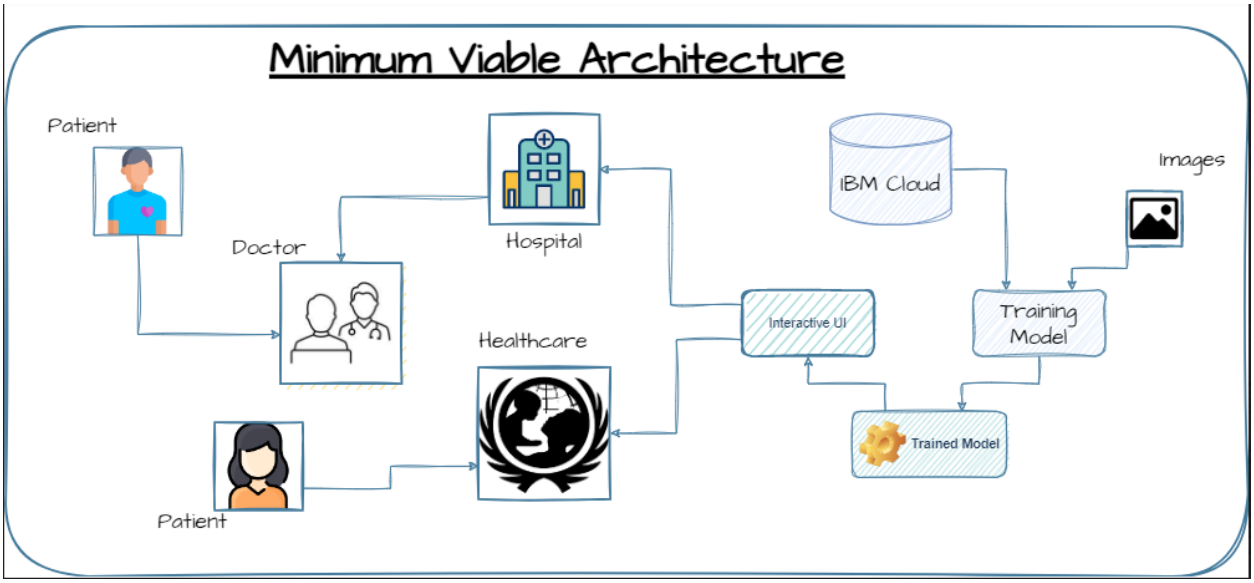
5.1. Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

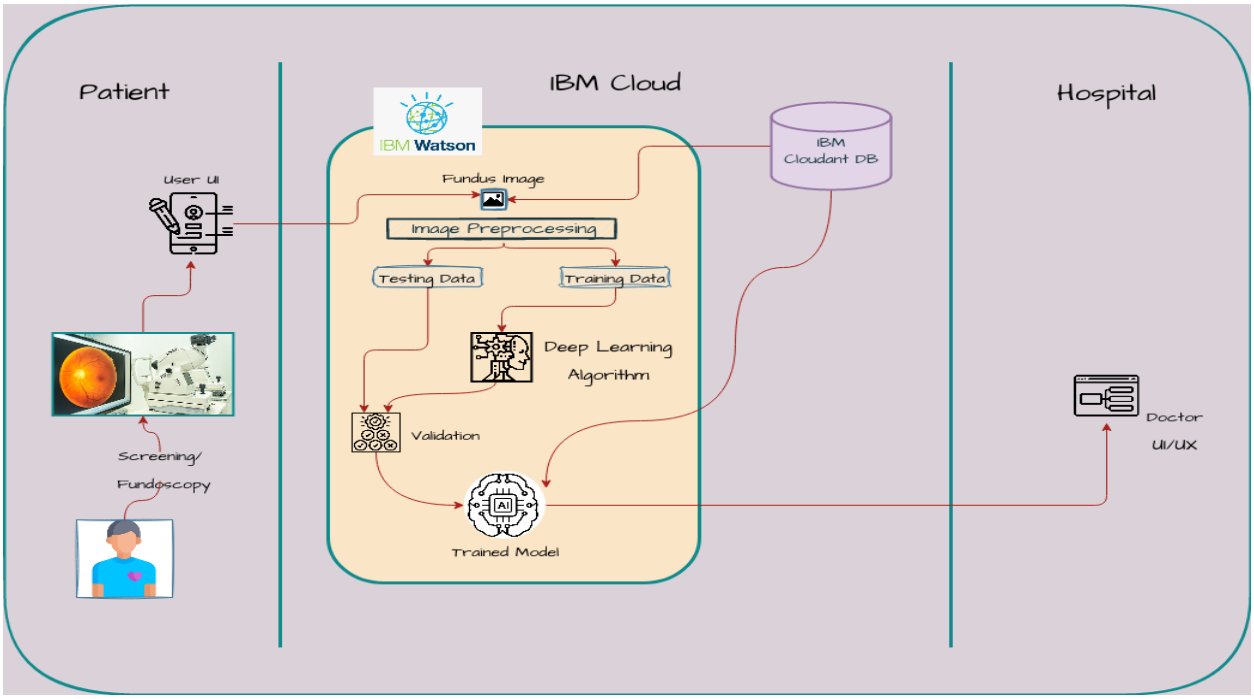


5.2 Solution and Technical Architecture

Solution Architecture:



Technical Architecture:



5.3 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 register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register and access the dashboard with Gmail Login	Medium	Sprint-1

	Login	USN-5	As a user, I can log into the application by entering email & password	I can login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-6	As a user, I can navigate through various sections of the application.	I can navigate the sections of the application	High	Sprint-2
Customer (Web user)	Registration	USN-1	As a user, I can register for the application by entering, password, and confirming my password	I can access my account/ dashboard	High	Sprint-1
Customer Care Executive		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can review confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register and access the dashboard with Gmail	Medium	Sprint-1

				Login		
	Login	USN-5	As a user, I can log onto the application by entering email & password	I can login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-6	As a user, I can navigate through sections of the applications	I can navigate the sections of the applications	High	Sprint-2
Administrator	Login	USN-1	As a administrator, I can log into the application by entering email and password	I can Login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-2	As an administrator, I can navigate through various sections of the application	I can navigate the sections of the application	High	Sprint-2
		USN-3	As an administrator, I can update data in database	I can update all data in the database.	High	Sprint-3

		USN-4	As an administrator, I can view all stages of the product	I can view and review all stages of the product	High	Sprint-3
		USN-5	As an administrator, I can add or remove user	I can add or remove an user from the application	Medium	Sprint-3

6. Project Planning & Scheduling

6.1.Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data collection	Task-1	To build a Deep learning Model which begins with the process of splitting data into training and testing set.	4	Medium	Kishore Kumar

Sprint-1	Data preprocessing	Task-2	We import the required libraries for preprocessing. We instantiate the ImageDataGenerator class to configure and augment different types of image data.	5	Low	Shrinitha S & Sai Anchana S A
Sprint-1	Data Preprocessing	Task-3	Application of the ImgaeDataGenerator to the Train and Test Set.	7	Medium	Rasmia Rahamathullah & Shankar N
Sprint-1	Building Homepage	USN-1	As a user, she will be given a brief description in the homepage.	4	Low	Rasmia Rahamathullah
Sprint-2	Feature Extraction	Task-4	Build a CNN Model and only use it as a feature extraction by freezing the convolution blocks.	8	High	Sai Anchana S A & Shrinitha S
Sprint-2	Building the layers	Task-5	Adding of dense layers with the aid of Keras. Addition of Optimizer, choosing loss function and the Metrics.	7	High	Kishore Kumar & Rasmia Rahamathullah
Sprint-2	Train, Save,Test	Task-6	To train the model with the configured neural network and save the model. Test the built model against the testing dataset.	3	High	Sai Anchana S A
Sprint-2	Building Registration Page	USN-2	As a user, she will be able to register for the application.	2	Low	Shankar N
Sprint-3	Create Service Instance	Task-7	Configure the location of resources, such as web server, and Cloud Storage for an application	7	High	Shankar N & Kishore Kumar

Sprint-3	Configuring credentials and creating DB	Task-8	Define the credentials that are required to access the services offered by IBM Cloudant and add users to access the DB.	6	High	Shrinitha S & Sai Anchana S A
Sprint-3	Create Tables in DB	Task-9	Structure the required tables with necessary attributes in Cloudant DB.	4	Medium	Shrinitha S & Rasmia Rahmathullah
Sprint-3	Building Login Page	USN-3	As a user, she will be able to login using her credentials.	3	Low	Sai Anchana S A
Sprint-4	Building prediction page	USN-4	As a user, she will be able to receive the diagnosis on her diabetic retinopathy.	2	Medium	Shrinitha S
Sprint-4	Building Logout Page	USN-5	As a user, she will be able to logout of her account in this page.	2	Medium	Kishore Kumar
Sprint-4	Build python code	Task-9	Import the libraries and Initialise the necessary modules	1	Medium	Sai Anchana S A
Sprint-4		Task-10	Use the database using initiated client and rendering HTML pages	2	Medium	Shrinitha S
Sprint-4		Task-11	Configuring the registration, login pages and validating the credentials.	2	Medium	Shankar N
Sprint-4		Task-12	Showcasing the model's prediction on UI.	1	High	Rasmia Rahamathullah
Sprint-4	Run the application.	Task-13	Run the application in the anaconda prompt to check the application.	2	High	Kishore Kumar

Sprint-4		Task-14	In the homepage, after logging on using credentials, upload the image to predict the diagnosis on diabetic retinopathy.	5	High	Shankar N & Rasmia Rahamathullah
Sprint-4	Train Model On IBM	Task-15	train the model on IBM and integrate it with the flask Application.	3	High	Shankar N

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	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
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	5 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA

JIRA has categorized reports in four levels, which are −

6.1. Agile

6.2. Issue Analysis

6.3. Forecast & Management

6.4. Others

VELOCITY: SPRINT - 1

Sprint duration = 5 days

Velocity of team = 20 points

Average Velocity (AV) = $\frac{\text{Velocity}}{\text{Sprint duration}}$

AV = 20/5 = 4

Average Velocity = 4

VELOCITY: Sprint 1 - 4

Sprint duration = 20 days

Velocity of team = 80 points

Average Velocity (AV) = $\frac{\text{Velocity}}{\text{Sprint duration}}$

AV = 80/20 = 4

Total Average Velocity = 4

7. CODING & SOLUTIONING

7.1 Feature 1

```
! pip install -q kaggle

from google.colab import files

files.upload()
# ! mkdir ~/.kaggle
! cp kaggle.json ~/.kaggle/
! chmod 600 ~/.kaggle/kaggle.json
!kaggle datasets download -d arbethi/diabetic-retinopathy-level-detection
!unzip diabetic-retinopathy-level-detection.zip
from google.colab import drive
drive.mount('/content/drive')
imagesize= [299,299]
trainpath= r"/content/preprocessed dataset/preprocessed dataset/training"
testpath= r"/content/preprocessed dataset/preprocessed dataset/testing"
from keras.preprocessing.image import ImageDataGenerator
train_datagen = ImageDataGenerator(rescale = 1./255,
                                   shear_range = 0.2,
                                   zoom_range  = 0.2,
                                   horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1.255)
train_set=train_datagen.flow_from_directory('/content/preprocessed
dataset/preprocessed dataset/training',
                                            target_size=(299,299),
                                            batch_size=64,
                                            class_mode= 'categorical')
test_set=test_datagen.flow_from_directory('/content/preprocessed
dataset/preprocessed dataset/testing',
                                            target_size=(299,299),
                                            batch_size=64,
                                            class_mode='categorical')
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 пр
import matplotlib.pyplot as plt
xception = Xception(input_shape=imagesize + [3], weights= 'imagenet'
,include_top=False)
for layer in xception.layers:
  layer.trainable=False
xception.summary()
x=Flatten()(xception.output)
x=Dense(128, activation='relu')(x)
x=Dense(86, activation='softplus')(x)
x=Dense(64, activation='relu')(x)
x=Dense(32, activation='relu')(x)
x=Dense(16, activation='relu')(x)
pred=Dense(5,activation='softmax')(x)
model=Model(inputs=xception.input,outputs=pred)
model.summary()
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['a
ccuracy'])
r=model.fit(train_set,validation_data=test_set,epochs=40,steps_per_epoch=le
n(train_set)//32,validation_steps=len(test_set)//32)
model.save('first-model.h5')
print("Model Saved!!")
import matplotlib.pyplot as plt
plt.plot(r.history['accuracy'])
plt.plot(r.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```

```
plt.plot(r.history['loss'])
plt.plot(r.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
import pickle
fl='ibm1.pkl'
pickle.dump(model, open(fl ,'wb'))
```

7.2 Feature 2

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">
                    <link rel="stylesheet" type= "text/css" href= "{{ url_for('static',filename='s
                    <title>DR</title>

                </head>
                <body>
                    <nav>
                        <div class="topnav">
                            <span>Diabetic Retinopathy Classification</span>
                            <div>
                                <a href="/registration.html">Register</a>
                                <a href="/login.html">Login</a>
                                <a href="/index">Home</a>
                            </div>

                          </div>
                    </nav>
                    <div class="home-page">
                        <div class="form">
                            <img src="{{ url_for('static',filename='images/Diabetic-Retina.jpg')}}
```

```
    alt="Italian Trulli">
            <h3>PROBLEM</h3>
            <p>Diabetic Retinopathy is a common complication of diabetes mellitus,
            <h3>SOLUTION</h3>
            <p>Diabetes is a globally prevalent disease that can cause visible mic
diabetic retinopathy early in real-time for new variations</p>
        </div>
    </div>




</body>
</html>
```

Login.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">
  <title>DR | Login</title>
  <link rel="stylesheet" href="{{ url_for('static',filename='styles/login.css')}}"
</head>
<body>
  <div class="login-page">
  <div class="form">
    <form class="login-form" action="/login-validate" method="post">
      <h2>Login</h2>
      <input type="email" name="uid "placeholder="enter email id" required/>
      <input type="password" name="passwd" placeholder="enter password" required/>
      <button type="submit">login</button>
      <p class="message">Not registered? <a href="./registration.html">Create an
account</a></p>
      <span>{{status}}</span>
    </form>
  </div>
</div>
```

```
    </body>
    </html>
```

Prediction.html:

```
<!DOCTYPEh
tml>
<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">
    <link rel="stylesheet" href="{{ url_for('static',filename='styles/homepage.css')}}
    <title>DR | Prediction</title>

</head>
<body>
    <nav>
        <div class="topnav">
            <span>Diabetic Retinopathy Classification</span>
            <div>
                <a href="login.html">Logout</a>
                {% if session.name %}
                <strong style="float: right;
                                color: #f2f2f2;
                                text-align: center;
                                padding: 14px 16px;
                                font-size: 17px;
                                position: relative;
                                text-transform: capitalize;">
                    {{session.name}}
                </strong>
                <i class="fa-solid fa-user" style="float: right;
                                color: #f2f2f2;
                                padding: 14px 16px;
                                font-size: 17px;
                                position: relative;"> </i>
                {% endif %}
            </div>

          </div>
    </nav>
    <div class="predict-page">
        <form  class="form"  action="/get-prediction" method="post"  enctype="multipa
data">
```

```
            <img src="{{ url_for('static',filename='images/prediction.jpeg')}}"
    alt="Italian Trulli">
             <input type="file" name="image" placeholder="upload your Retinopathy Ima
required/>
             <button type="submit">Predict</button>
            <span>{{prediction}}</span>
        </form>
    </div>




</body>
<script src="https://kit.fontawesome.com/d294cf5192.js" crossorigin="anonymous"></scr
</html>
```

8. TESTING

8.1 Test Cases

- The home page and the result page is tested .It is working well without issues.
- The login page was tested for functionality .
- The Accuracy of the prediction of the level of retinotharapy.

8.2 User Acceptance Testing

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	1	1	1	5	8
Duplicate	0	1	0	0	1
External	0	1	0	1	2
Fixed	1	1	1	1	4
Not Reproduced	0	1	0	0	1
Skipped	0	0	0	1	1
Won't Fix	0	0	0	1	1
Totals	2	5	2	9	19

Test Case Analysis

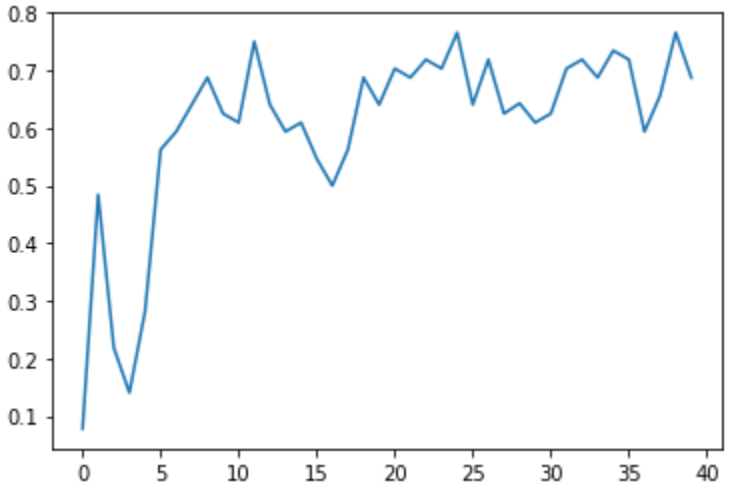
This report shows the number of test cases that have passed, failed, and untested.

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	1	0	0	7
Client Application	8	0	0	8
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	4	0	0	4
Final Report Output	5	0	0	5
Version Control	2	0	0	2

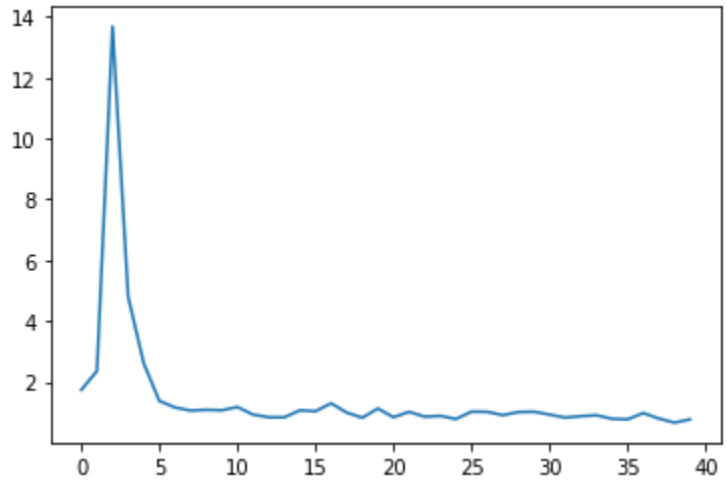
9. RESULTS

9.1 Performance metrics

Accuracy:



Loss:



Confusion Matrix:

```
array([[361,   0,   0,   0,   0],
       [ 74,   0,   0,   0,   0],
       [200,   0,   0,   0,   0],
       [ 39,   0,   0,   0,   0],
       [ 60,   0,   0,   0,   0]])
```

R2 Score:

```
-0.756175066713825
```

Accuracy Score:

```
0.49182561307901906
```

Classification Report:

	precision	recall	f1-score	support
0	0.49	1.00	0.66	361
1	0.00	0.00	0.00	74
2	0.00	0.00	0.00	200
3	0.00	0.00	0.00	39
4	0.00	0.00	0.00	60
accuracy			0.49	734
macro avg	0.10	0.20	0.13	734
weighted avg	0.24	0.49	0.32	734

10. ADVANTAGES AND DISADVANTAGES

Advantages :

- The project that we have worked on is an advanced machine learning based project that uses the knowledge of so many previous cases of diabetic retinopathy to accurately identify the early stages of this disease.
- Such early detection of this disease greatly benefits the lives of so many.
- By being able to identify such diseases beforehand could save the lives of many and drastically decrease the error in identifying them.
- They act as such good guidance to the doctors that work in this field.

Disadvantages:

- The model still has room for improvement in ways such as, the accuracy of the model could be improved.
- The model still can't be completely trusted without the assistance of a physician.

11. CONCLUSION

The aim of this project is to aid medical professionals in the feild of diagnostics of diabetic retinopathy. We have worked with a well defined dataset that has various parameters and attributes recorded. We have used that dataset to train our model that helps us in predicting the disease. The purpose of machine learning in found when it is applied in real time and significantly helps in changing people's lives. Yet we still believe that there is always some room for improvement. We could work with a more accurate and rich dataset which could improve the accuracy of the model.

12. FUTURE SCOPE

Improving the model efficiency and creating an additional interface for the interation between users , hospital and doctor.

13. APPENDIX

Github link: https://github.com/IBM-EPBL/IBM-Project-2665-1658480813/tree/main/

Demo link: https://drive.google.com/file/d/1nD6X35jsTLst7uQ1jhLyGUlf5oAdB7Jc/view?usp=share_link