Ai Platform for Collaborative Management of Congenital Cataract

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SESSION 2017-2021

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A DISSERTATION SUBMITTED AS A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

DEPARTMENT OF COMPUTER SCIENCES

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UNDERTAKEN

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Dated: _____ Dated: _____

FINAL APPROVAL

Certified that we have read this project report submitted by Mr. Zuhaib Khan and Mr. Hafiz M. Saqib Naveed and it is, in our judgment, of sufficient standard to warrant its acceptance by the Department of Computer Science, COMSATS University Islamabad, Attock Campus, for the BSCS degree.

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DEDICATION

Every challenging work needs sufficient efforts and guidance of elders. By the grace of Allah Almighty, We dedicate our humble efforts to our Loving Parents and Teachers who helped us in every phase of life and trusted us no matter what.

ACKNOWLEDGEMENT

In the name of ALLAH, the Most Merciful, the Most Beneficent.

Our utter praises to ALLAH Almighty who bestowed us with the knowledge and dedication that led us to the successful completion of our project. We also pray that may ALLAH provide us more better ways to serve His mankind.

We would also like to thank our parents for their love and guidance in whatever we pursue. They are the ultimate role models. We are grateful to all of those with whom we have had the pleasure to work during this and other related projects. Also highly indebted to our teachers and mentors who provided us extensive personal and professional guidance and taught us a great deal about this project and computer science in general.

PROJECT BRIEF

PROJECT NAME	AI PLATFORM FOR COLLABORATIVE MANAGEMENT OF CONGENITAL CATARACTS
ORGANIZATION NAME	COMSATS UNIVERSITY ISLAMABAD, ATTOCK CAMPUS
OBJECTIVE	IDENTIFICATION OF DISEASE
UNDERTAKEN BY	HAFIZ M.SAQIB & ZUHAIB KHAN
SUPERVISED BY	MAM TAHIRA SADAF LECTURER Dr. KHALID MEHMOOD HEAD OF DEPARTMENT COMPUTER SCIENCE CUI, ATK
STARTED ON	01-05-2020
COMPLETED ON	23-05-2021
COMPUTER USED	HP ELITEBOOK & HP PAVILION
SOURCE LANGUAGE	HTML, CSS, JAVASCRIPT, NODE.JS, VUE.JS PHP
OPERATING SYSTEM	WINDOWS AND LINUX
TOOLS USED	VS CODE, POSTMAN, PYCHARM, SPYDER, GOGGLE COLLAB, HEROKU, FIGMA, Vue.js, TOOLS, GIT, GITHUB, AWS S3

ABSTRACT

Using Artificial Intelligence for the identification of a rare eye disease called Congenital Cataract (CC). The specialized clinics for rare diseases like Cataracts can be hard to find especially in remote areas, particularly in underdeveloped countries like Pakistan, leaving a large proportion of patients with inadequate care. Hence the coverage of such specialized clinics is dispersed, and their coverage is insufficient. Therefore, using AI agent supported by deep learning and convolutional neural network CNN for identifying Congenital Cataract. Additionally, providing the web-based application for the collaboration of hospitals.

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Chapter 1

Introduction

1 Introduction

Congenital Cataracts (CC) is a disease that is present mostly in newborn babies and may also develop later, eyes become opaque causing blurry vision or vision loss. In some cases, if a Congenital Cataract is left untreated, or if treated too late. It can cause permanent vision loss. Experts suggest that the best time for the treatment of CC in a child is between the age of 6 weeks and 3 months and if delayed it can cause permanent blindness [3].

As in the remote areas the specialized clinics are scattered, and the coverage is insufficient. It is hard to find specialized clinics, which leaves a large portion of patients untreated or with inadequate care. That is where the AI-based congenital cataract identifier comes in. With the assistance of deep learning and convolutional neural networks determining the disease, which will reduce the cost and time. Also integrating this AI agent with a web application so that the multiple hospitals can collaborate.

Specialized clinics for rare diseases are geographically scattered, tremendously expensive, and have weak connections, so incorrect and mistaken diagnoses are common among rare diseases, which can be life-threatening.

Furthermore, the CC identifier will reduce the cost and time. Thus, making it affordable.

1.1 Brief

Congenital Cataracts (CC) is a disease that is present mostly in newborn babies and may also develop later, eyes become opaque causing blurry vision or vision loss. In some cases, if a Congenital Cataract is left untreated, or if treated too late. It can cause permanent vision loss.

As in the remote areas the specialized clinics are scattered, and the coverage is insufficient. It is hard to find specialized clinics, which leaves a large portion of patients untreated or with inadequate care. That is where the AI-based congenital cataract identifier comes in. With the assistance of deep learning and convolutional neural networks determining the disease, risk stratification, and treatment suggestions, which will reduce the cost and time. Also integrating this AI agent with a web application so that the multiple hospitals can collaborate.

Specialized clinics for rare diseases are geographically scattered, tremendously expensive, and have weak connections, so incorrect and mistaken diagnoses are common among rare diseases, which can be life-threatening.

1.2 Relevance to Course Modules

The project is designed with the recent knowledge obtained from the courses which are in the process of the degree of BCS. Following are the details of the relation of our project with core concepts of some subjects:

- **Artificial Intelligence/Machine Learning**

  We studied the course of Artificial Intelligence and Machine Learning which helps us in the basic methodology and implementation of our project. The core concepts of Neural Networks, Deep Learning, Convolutional Neural Networks (CNN) consists of training data, testing, identification, evaluation, and giving suggestions that are valuable for the completion of our project.

- **Web Technologies**

  To make the interaction of the patient with the system and to get the samples the web application is developed. It consists of the basic of the system to collect the image of the patient eyes. However, the authority will be with the admin who is maintaining all the systems.

- **Database Systems I**

  To interact with our system, users have to register in the web app through his/her username and a valid password. Once the user is registered, information will store in the database. Now, whenever the user wants to log in, his/her credentials are validated through the database.

- **Software Engineering**

This Software engineering course helps in understanding the system architecture by using diagrams which include use-cases, activity diagrams, sequence diagrams, and data flow diagrams to understand the flow of the system. Further, it helps in choosing the software development lifecycles that fit with our project to start, organize, and manage our project.

1.3 Project Background

- Using Artificial Intelligence (AI) to assist in the medical field. AI holds great promise in creating computational expert medical robots with all abilities and containing diagnostic accuracy. Congenital Cataracts (CC) is a rare disease that causes irreversible loss of vision. Therefore, the AI agent comes in to assist in computationally detecting the disease. Ai agent involving the functions to identify the patients from a dataset. Further, creating an AI-based congenital cataract identifier to assist in determining the disease. Using Implementations of deep learning and convolutional neural networks. Through the integration of AI agents with a web application so that multiple hospitals can collaborate with a web application. Below are the examples of some of the affected patients are shown in Fig. 1.1.

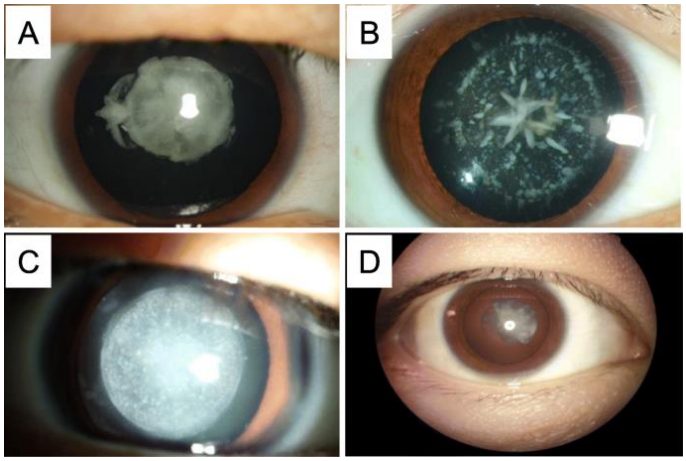

Figure: 1.3.1: Different samples of Cataracts

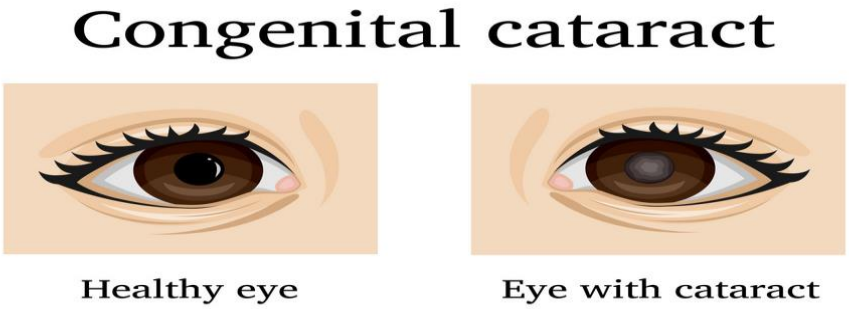

Figure 1.3.2: Difference between Normal and Defected eye

1.4 Literature Review

The specialized clinics for rare diseases like CC are scattered and not easy to find in remote areas. With the help of AI an attractive alternative which can help in medical purpose to improve efficiency and reduce the costs for the medical process.AI have many applications in the medical field, thus AI can assist us in identifying Congenital Cataract[1].

Following is a system developed and being used in the world:

1.4.1 CC-Cruiser

This CC-Cruiser system is developed in china used a convolutional neural network (CNN) and based on the way neurons are organized in the brain region that deals with vision. The system also wants to check if neural networks could help in addressing rare diseases which affect about 10 percent of the world population. The system focuses on identifying congenital cataracts. Research suggested that convolutional neural networks are good for scanning data to recognize images. The results compared with the real-life doctor's ophthalmologists and neural network look at 50 cases. The neural networks performed as well as the doctors and identified all the patients[9].

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1.5 Analysis from Literature Review

It is observed from the literature review that a system is needed to provide disease identification due to remote areas and less availability of specialized clinics in Pakistan. The concept of our project is to developed Ai based congenital cataract identifier to assist in identifying the disease through an integrated web application. The samples of the patient will be collected through the web application and provided to the AI agent working as an ophthalmic evaluator using deep learning and CNN. In the future, based on the data provided suggestions for the treatment will be given through web application.

1.6 Methodology and Software Lifecycle for This Project

The Software development Lifecycle helps us in developing our project. For continuous testing and checking for errors. We use Evolutionary Model for the development of our project This model is a combination of both iterative and incremental approaches. The requirements might change in development so we can evolve with the change using this model. Hence the core system requirements are understood, and remaining extensions can be added later.

The evolutionary model is used for the development of this project. The evolutionary model is a combination of both an iterative and incremental approach to software development. Since the requirement often change as the development proceed so, this model enables the software system to evolve with the changing requirements. Here the core product or system requirements are well understood, and details and extensions are added later [4].

1.6.1 Rationale behind Selected Methodology

The evolutionary model is an interactive software development strategy because it adopts a cyclic approach that enables project delivery in incremental. As the requirements will be known so we will work on the set of requirements, then test, identify, and evaluates the further requirement according to the need. This model releases a limited version of the product at each cycle, and it allows the developer to maintain the product and react accordingly.

Chapter 2

Problem Definition

2 Problem Definition

In this chapter, we will discuss the problem statement, followed by the deliverables and solution provided by our project.

2.1 Problem Statement

Specialized clinics are not easily available in a remote country like Pakistan. Rare diseases which require special treatment remain untreated due to insufficient availability of the treatment and proper identification of the disease with better accuracy[2]. Identifying the disease can also be not missed by the human eye due to human error. Congenital Cataract is a typical rare disease that mostly in newborn babies and causes blurry vision or vision loss. Therefore, missed, or wrong diagnoses or false treatment decisions are common among rare disease patients. These factors are contrary to computational medicine especially in a country with a large population such as Pakistan. Although some systems are available internationally that helps in the goals of precision medicine but not in Pakistan.

2.2 Deliverables and Development Requirements

Requirements are an important part of software development. Before starting a project, requirements are gathered, to formulate and manage the designing phase.

2.2.1 Deliverable Requirements

Developing a platform that uses AI to perform collaborative management of Congenital Cataracts. Clinics for Congenital Cataracts are not easily available therefore, the patient can use our system from anywhere using our collaborative web application. Resources will be reduced by using our system. The patient can interact with our web application and give his/her samples to the AI agent the samples of the patient's eye will be tested, and the disease will be identified using an Ai-based identifier using deep learning and convolutional neural network algorithm.

2.2.2 Development Requirements

Following are the software requirements:

- **OS Requirements:** Windows 7, Windows XP, Windows 8, Windows 8.1, Windows 10.
- **DBMS Requirements**: My SQL.
- **Other Requirements:** For Mockups and presentations we use MS Word, MS PowerPoint.

Chapter 3

Requirement Analysis

3 Requirements Analysis

Requirement Analysis is the process of defining the expectations of the users for an application that is to be built or modified. It involves all the tasks that are conducted to identify the need of a user. [5] So, in this chapter, we will discuss the interaction of actor user and server with the proposed system, and the functional and non-functional requirements of our system. We will create use case diagrams and detailed descriptions of those use cases to show the flow of our project.

3.1 Use Case Diagram(s)

A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can help provide a high-level view of the system. They provide a simplified and graphical representation of what the system must do. [6]

3.1.1 Use Case Diagram (User)

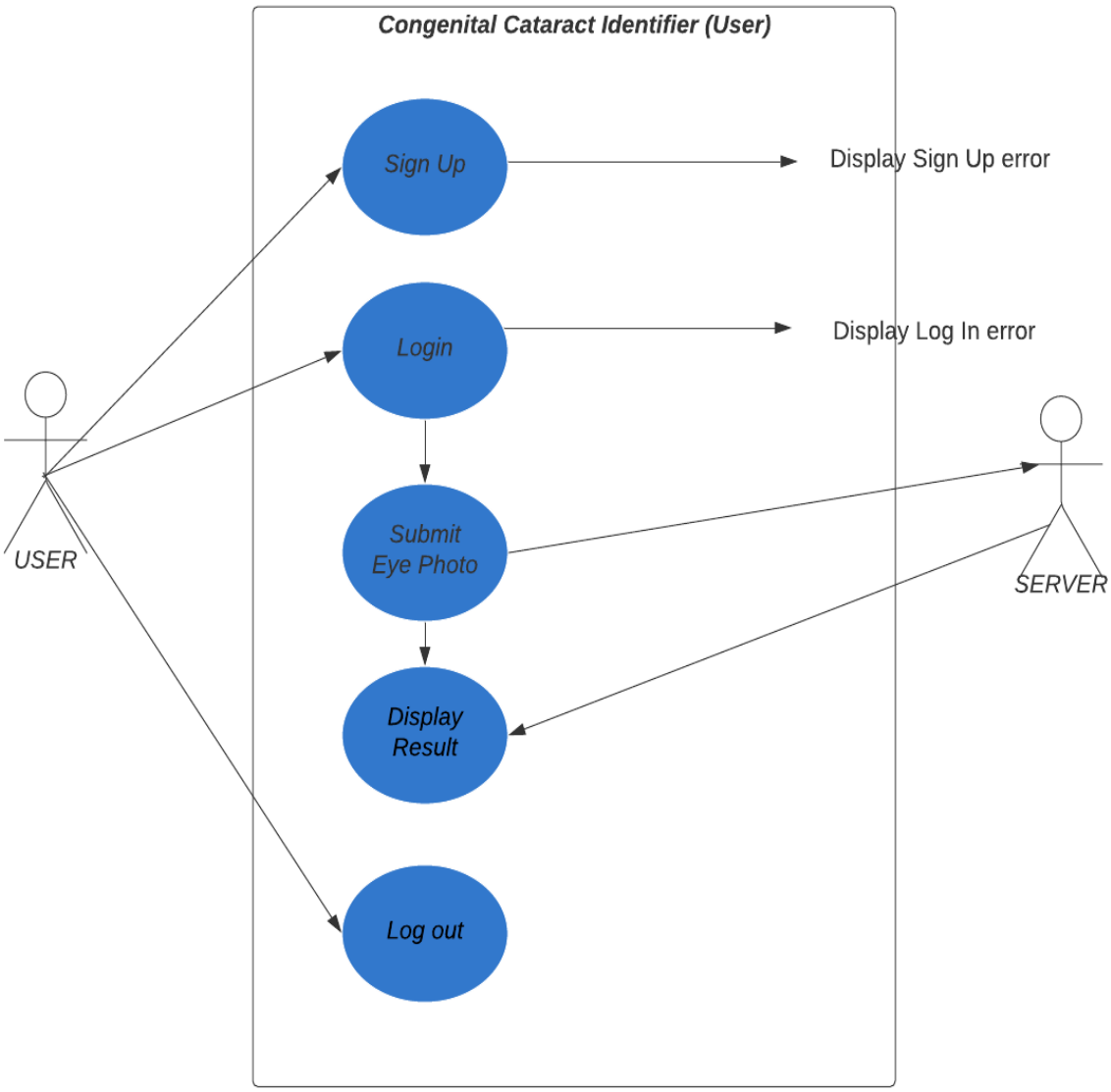

Figure 3. 1.1: Use case Diagram 1

3.1.2 Use Case Diagram (Application Server)

The Use case diagram for the application server is shown below.

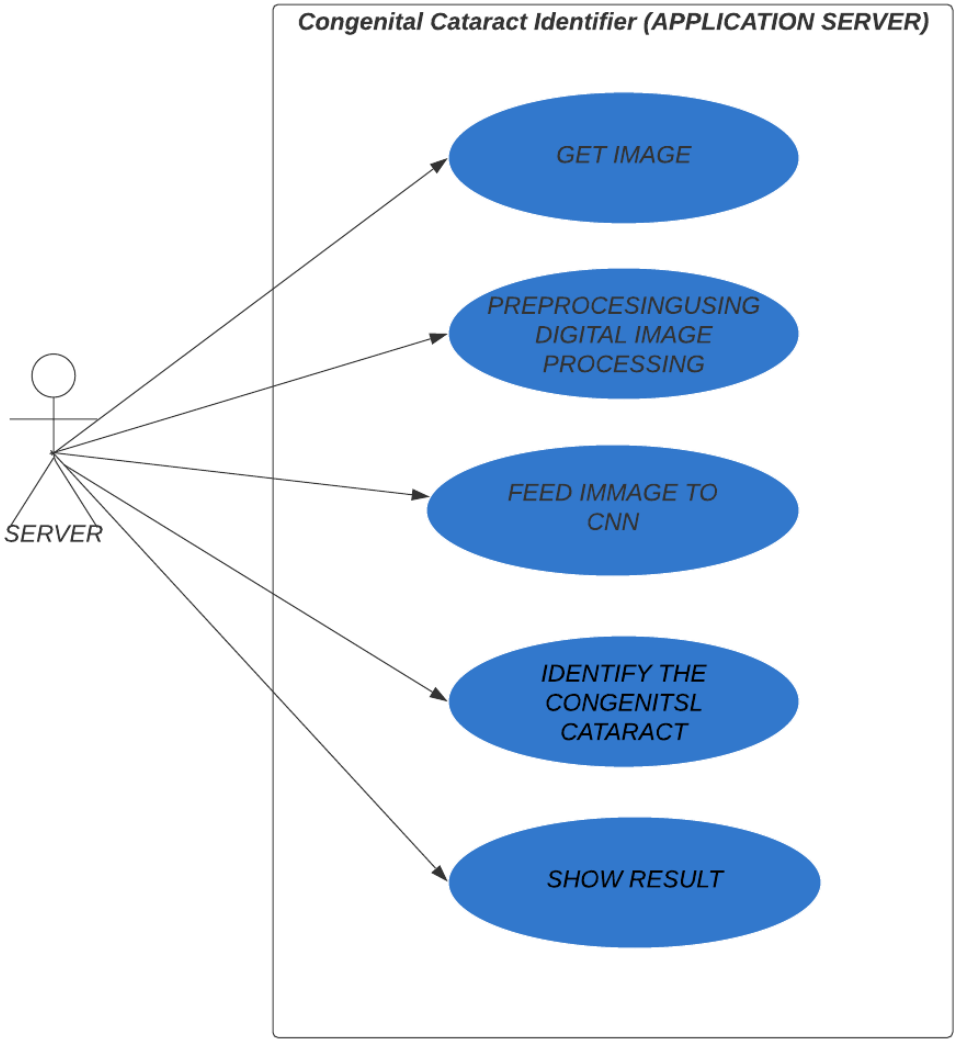

Figure 3. 1.2: Use case Diagram 2

3.2 Detailed Use Case

3.2.1 UC-01 Sign up

Table 3.2. 1: Sign up.

Use Case Name	Sign up (Creating a user account)
Priority	Essential
Actor	Patient
Trigger	User wants to give samples
Basic Path	Home page->Sign in Page->Sign up Page
Alternative Path	None
Precondition	User does not have an account
Postcondition	Users sign up successful
Exception Paths	None

When the patient wants to give a sample, he/she must have to sign up for our web application. First, if the user account does not exist then it will move to the sign up otherwise it will allow the user the login in order to use the system.

3.2.2 UC-02 User Login

Table 3.2.2: User Login

Use Case Name	User Login
Priority	Essential
Actor	Patient
Trigger	application opens and if the user is not sign in

Precondition	Signed out.
Basic Path	Home page -> Sign in
Alternative Path	None
Postcondition	The user will be able to use the application. It will redirect them to the collecting samples page.
Exception Paths	None

Once the user signs in its user will be directed to the homepage to give details and samples can be given. Sign-in is very essential because it only allows authentic users to use the system.

3.2.3 UC-3 Display of login error.

Table 3.2. 2: Display of login error

Use Case Name	Login error displayed
Priority	Essential
Actor	User (Patient)
Trigger	User-Triggered
Precondition	Entered password is incorrect
Basic Path	Home page -> login
Alternative Path	None
Postcondition	Correct credentials allow the user to log in
Exception Paths	None

The user cannot sign in if the password is incorrect the system will show an error message to the user so that the user can correct it and use the application.

3.2.4 UC 4 Submit Eye Photo

Table 3.2. 3: Submit Eye Photo

Use Case Name	Submit Eye Photo
Priority	Essential
Actor	User
Trigger	User-Triggered
Precondition	User(Patient) Wants to give eye photo
Basic Path	Home page -> Sign in-> CC Identifier
Alternative Path	None
Postcondition	Photos received
Exception Paths	None

3.2.5 UC-05 Display Results

Table 3.2. 4: Display Results

Use Case Name	Display Results
Priority	Essential
Actor	User (Patient)
Trigger	User-triggered
Precondition	Samples is ready to send to server
Basic Path	Home page -> Sign in-> CC identifier
Alternative Path	None

Postcondition	The result will be displayed
Exception Paths	None

3.2.6 UC-06 User Logout

Table 3.2. 5: User Logout

Use Case Name	User Logout
Priority	Essential
Actor	User
Trigger	User-Triggered
Precondition	User logout
Basic Path	Home page -> Sign in->CC Identifier-> Logout ->Home page
Alternative Path	None
Postcondition	Logout succeeded
Exception Paths	None

Detailed use case (Application Server)

3.2.7 UC-07 Get Image

Table 3.2. 6: Get Image.

Use Case Name	Get Image
Priority	Essential
Actor	Server
Trigger	Self-triggered by the system

Precondition	System gets samples
Alternative Path	None
Postcondition	Samples receive by the server
Exception Paths	None

CC identifier gets the image from the user to respond to the given samples.

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3.2.8 UC-08 Pre-Processing using Digital Image Processing

Table 3.2.8: Pre-Processing Using Digital Image Processing

Use Case Name	Processing Using Image Processing
Priority	Essential
Actor	Server
Trigger	Self-triggered by the System
Precondition	Samples receive at the server
Alternative Path	None
Postcondition	Pre-processed Sample photos
Exception Paths	None

CC identifier is used to identify the disease with the affected area. For this purpose, photos are pre-processed using Image processing techniques.

3.2.9 UC-09 Feed Image to CNN

Table 3.2.9: Feed Image to CNN

Use Case Name	Feed Image to CNN

Priority	Essential
Actor	Server
Trigger	Self-triggered by the system
Precondition	Pre-processed photos
Alternative Path	None
Postcondition	Image will be fed to CNN
Exception Paths	None

After pre-processing they are then fed the image to CNN for further processing identifying the disease.

3.2.10 UC-10 Identify the Congenital Cataract

Table 3.2.10: Identify the Congenital Cataract

Use Case Name	Identify the Congenital Cataract
Priority	Essential
Actor	Server
Trigger	Self-triggered by the System
Precondition	Identification of disease
Alternative Path	None
Postcondition	Congenital Cataract identified
Exception Paths	None

3.2.11 UC-11 Show Results

Table 3.2.11 Show Results

Use Case Name	Show Results
Priority	Essential
Actor	Server
Trigger	Self-triggered by the System
Precondition	Congenital Cataract identified
Alternative Path	None
Postcondition	Result will be showed
Exception Paths	None

3.3 Functional Requirements

Functional requirements are those requirements that our system must do.

3.3.1 Signup

Table 3.3. 1: Signup

Name	signup
Summary	This function is needed for new users
Rationale	Registered user can access the web application
Requirement	Valid username and password to access the web application. Without sign-up, the system cannot be used.

3.3.2 Login

Table 3.3. 2: login

Name	Login

Summary	Function is for registered users
Rationale	Registered user can access the web application
Requirement	Valid username and password to access the web application. Once user registered their selves than they can use the web application to give samples.

3.3.3 Submitting Image

Table 3.3. 3: Submitting Image.

Name	Submitting Image
Summary	A function is used for the user(patient). It provides the interface to the user in which the user can give the image of the eye.
Rationale	User wants to give an Image.
Requirement	If the user wants to get the result so the image must be submitted.

3.3.4 Get Image

Table 3.3. 4: Get Image.

Name	Get Image

Summary	This function will get the image on the server which will be processed further for identification.
Rationale	User wants to get results
Requirement	User needs treatment from the system

3.3.5 Pre-processing using digital Image processing.

Table 3.3. 5: Pre-processing using digital image processing.

Name	Pre-processing using digital image processing
Summary	Image is sent from the user side to the server for pre-processing, which will process the image.
Rationale	Image processing will be performed
Requirement	This function will process the image for identification of Congenital Cataract

3.3.6 Feed the image to CNN.

Table 3.3. 6: Feed the image to CNN.

Name	Feed the Image to CNN
Summary	The image will be feed to CNN to further process the image to detect cataracts.
Rationale	User wants to get results
Requirement	User needs a result for the disease

3.3.7 Identify the Congenital Cataract

Table 3.3. 7: Identify the Congenital Cataract

Name	Identify the Congenital Cataract
Summary	CC identifier will identify the cataract in the image
Rationale	User wants to get the result
Requirement	System wants to find the cataract on the image. System is ready to detect cataract

3.3.8 Display Results

Table 3.3. 8: Display Results

Name	Display Results
Summary	This function provides the appropriate results corresponding to the image given. So, the result display to the user
Rationale	User wants result for their problem
Requirement	Function provides the answer to the user.

3.4 Non-Functional Requirements

In systems engineering and requirements engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. They are contrasted with functional requirements that define specific behavior or functions. [7]

Following are the non-functional requirements of our system.

3.4.1 Availability

Our system is collaborative management for the disease so that users can use it easily anywhere without the hurdles of finding specialized clinics.

3.4.2 Easy to use

Our web application is easy to use. So that users can interact with our system easily to give samples of their defective eyes. It has a user-friendly interface that allows the user to get the appropriate results.

3.4.3 Authentication

Authentication is important for user login, if the user is new then sign up is required then the user can log in by giving credentials.

3.4.4 Efficiency

Ai-based Congenital Cataract identifier is an efficient system it will provide the results with accuracy. Takes less time to respond and reduces human error.

3.4.5 Robustness

Our project can cope with errors during execution and cope with erroneous input. The application is developed to handle all the exceptions and errors.

Chapter 4

Design and Architecture

4 Design and Architecture

Following are the software diagrams of our project.

4.1 System Architecture

A system architecture is abstract and explained the model of the system to help understand the behaviour of the system. The architecture supports the detailed structures of the system. The basic architecture of the system is given below. The structural flow of the system starts from the user giving eye samples in image form to the server, goes to the pre-processing phase which includes cropping, and extraction of features using CNN, classification of an image then computing the results shown to the user using backend rest API.

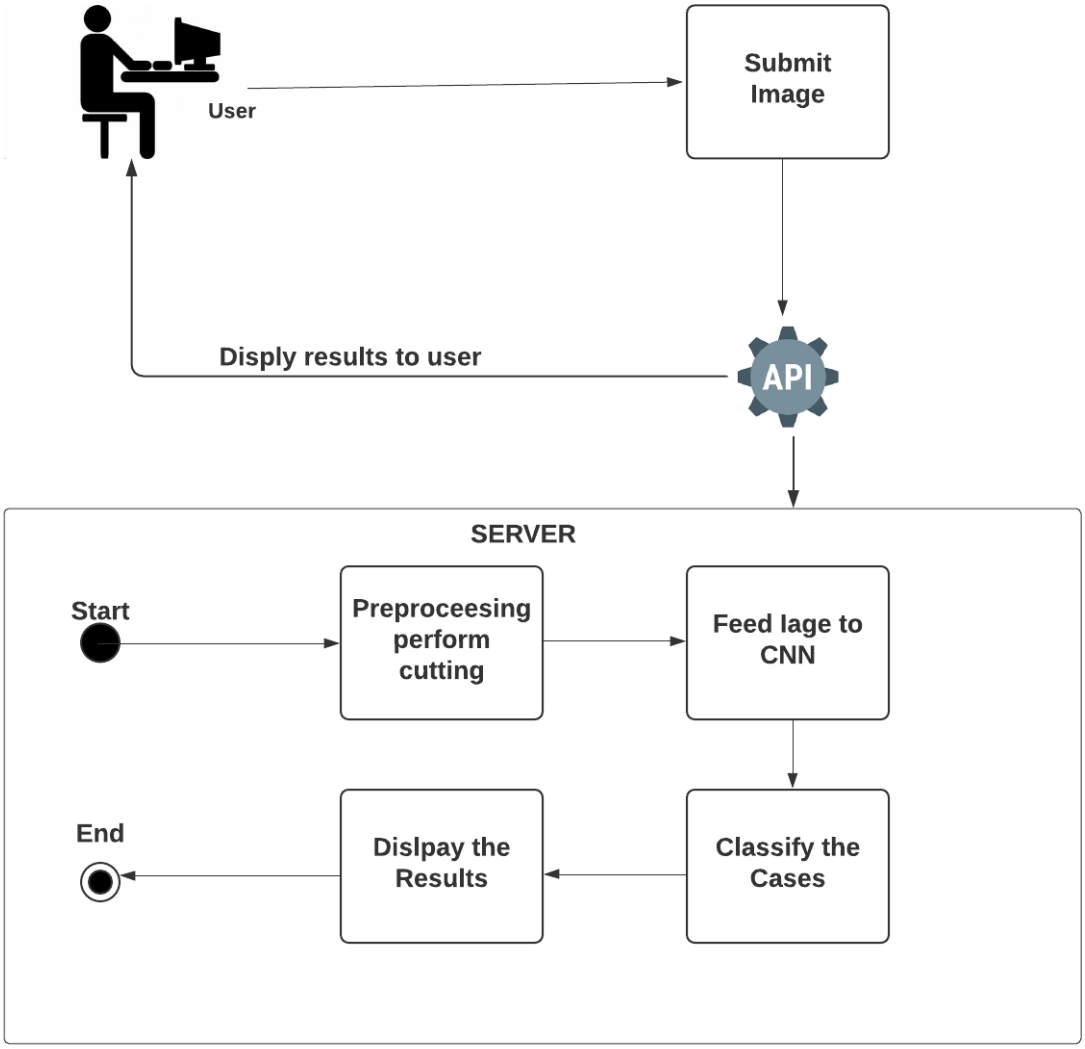

Figure 4. 1.1: Architecture Overview of the System

4.1.1 Block Diagram of the system

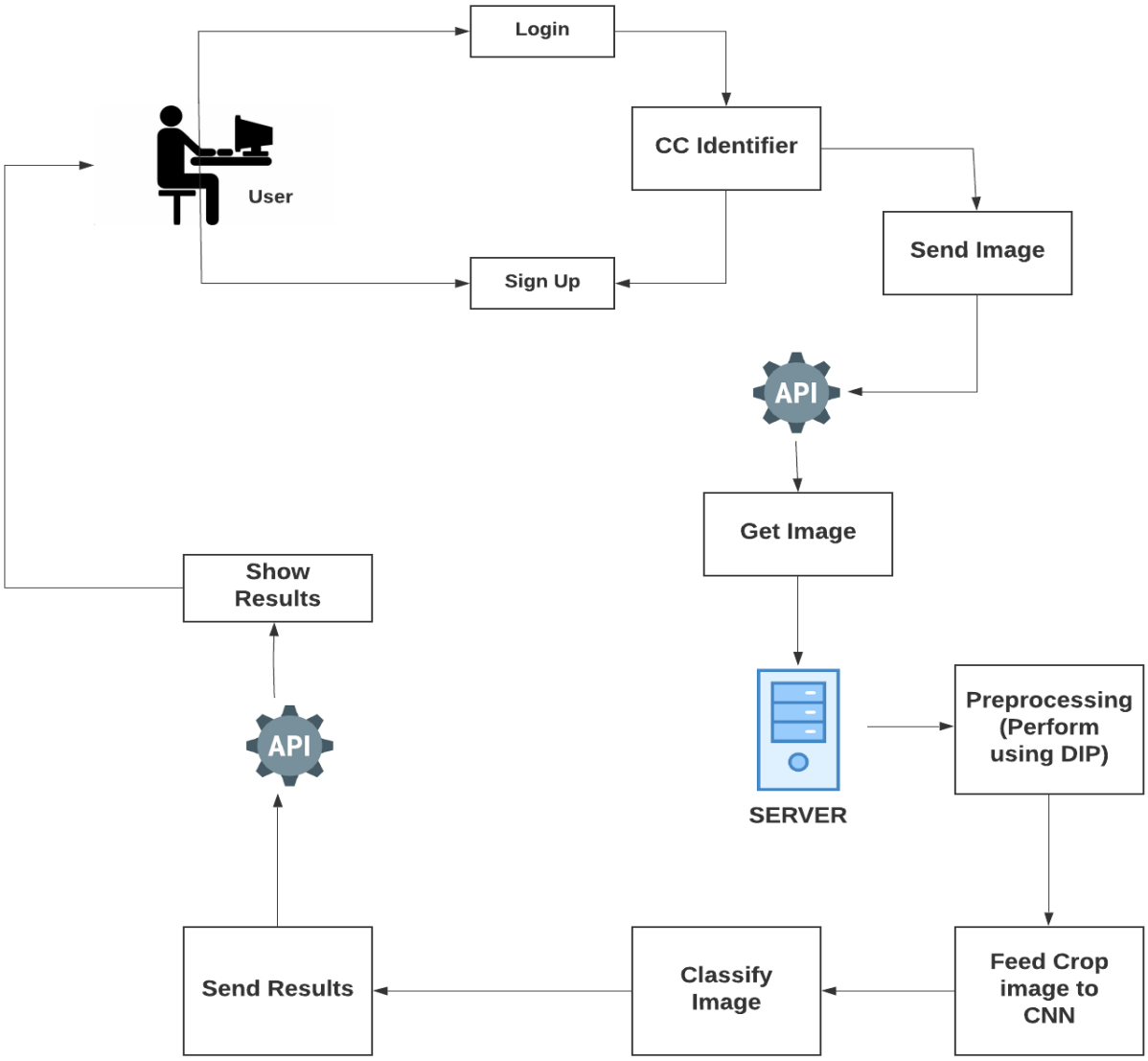

Figure 4.1.2: Block Diagram of the system

4.2 Design Models

Following are the design models of our system.

4.2.1 Sequence Diagram

A sequence diagram shows interactions arranged in time sequence. It shows the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality. A sequence diagram is a type of interaction diagram because it describes how and in what order a group of objects works together. [8]

4.2.1.1 Main Activity Sequence Diagram

CC identifier will respond to the user for his/her problem. The image will be sent to the application through rest API and deliver through the post method to the server. After preprocessing, images will be classify using CNN. After the computation response will be sent to the server and then to the user.

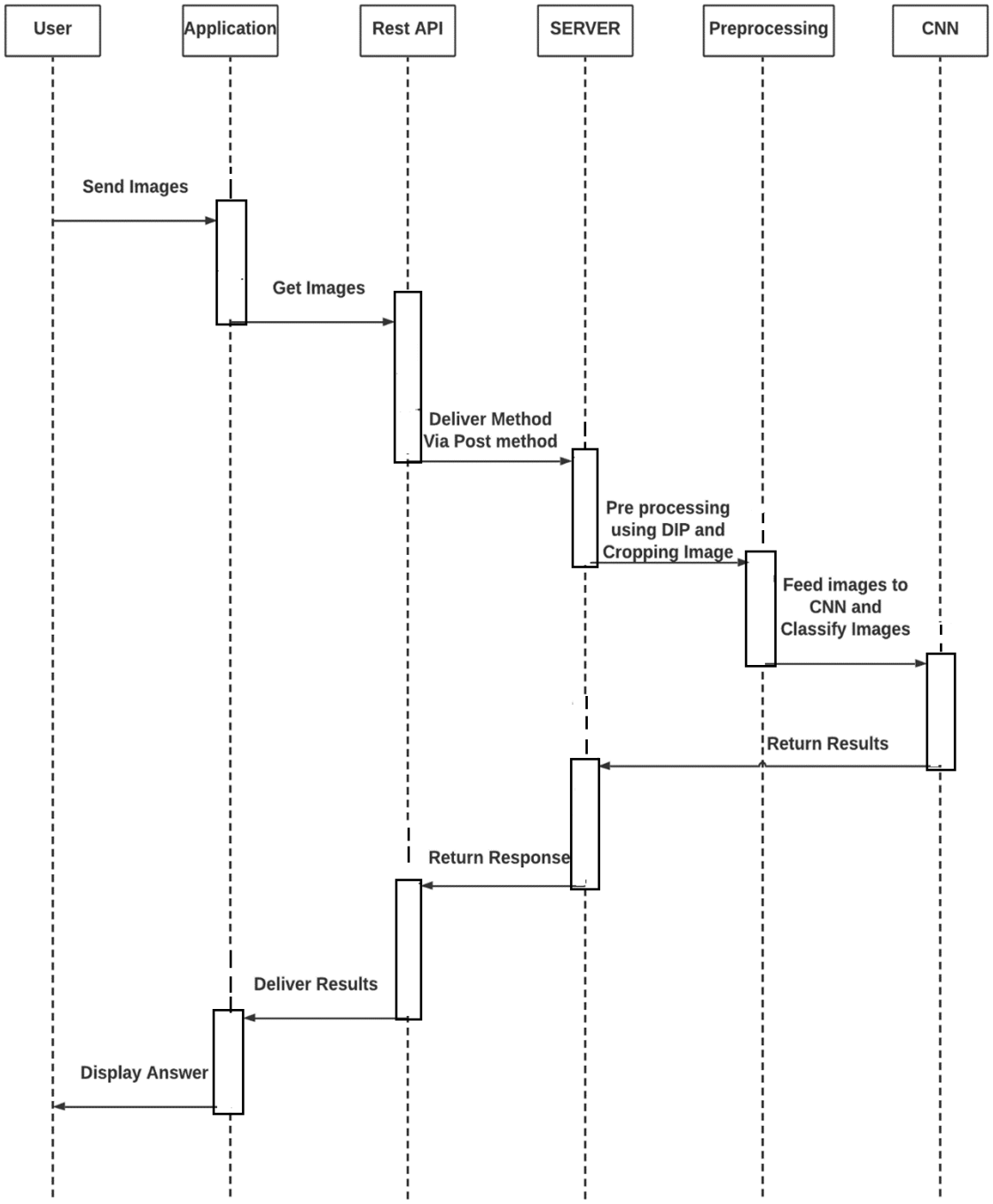

Figure 4.2.1: Main Activity Sequence Diagram

4.2.2 Activity diagram

Activity diagram is an important UML diagram to show the dynamic aspect of the system. It is basically a flowchart to represent the flow. The activity diagram can be described as the operation of the system. The flow of control from one operation to another.

4.1.2.1 Activity Diagram (User Sign in/ Sign up)

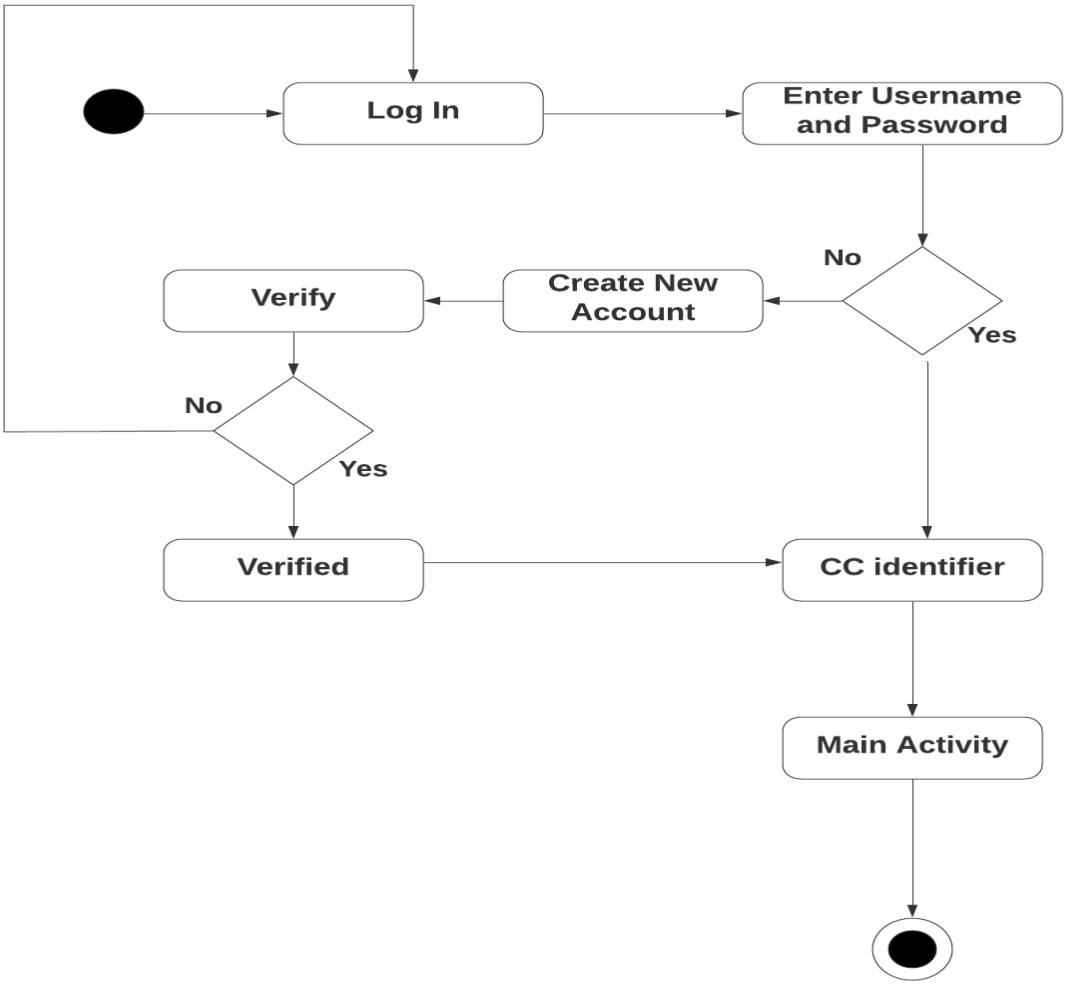

Figure 4.2.1: Activity Diagram (User Sign in/ Sign up)

4.2.2.2 Activity Diagram Main Activity

The figure shows the main functionality of our system.

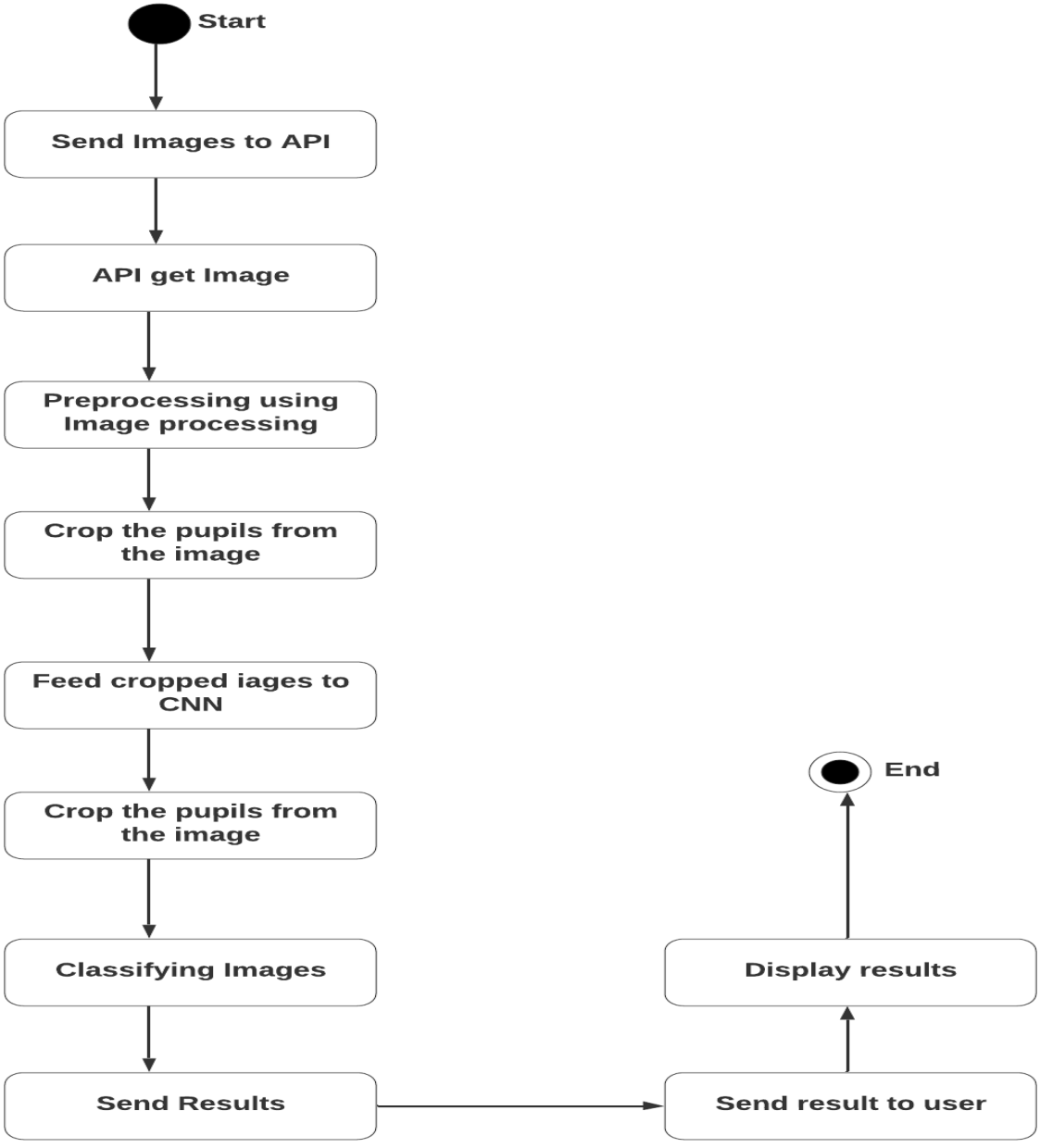

Figure 4. 2.2: Activity Diagram Main Activity

Chapter 5

Implementation

5 Implementation

5.1 Algorithm

In this chapter we will discuss about the algorithms we use used for the implementation of our project. This phase has helped us a lot in developing skills and applications.

We are using the algorithm called CNN (convolutional neural network), which is used for image processing, classification, and segmentation.

5.1.1 CNN (Convolutional Neural Network)

CNN is a deep learning algorithm which is used for image processing, segmentation, and classification. We are using CNN for binary classification and image processing.

5.1.1.1 Dataset

The dataset we used in this project has binary class. The classes with and without congenital cataract. The datasets contain different RGB images. Images are placed into the separate folder corresponding to their types. "ok" which contains negative cases and "others" contains positive cases.

5.1.1.2 Preprocessing

Pressing is the essential step in neural networks. Preprocessing is the first and essential part of the CNN. It our model it is required for the data augmentation and image resizing. As the image's dimensions can be different. So, dimensions of all the images can different. So, all the images need to be in the same size before feeding it to the neural network. Changing the dimensions of the images with different sizes makes all the images to be at the same level.

Data augmentation is used to flip, rotate the images. As the dataset can be smaller. So, increasing the dataset can increase the accuracy of the algorithm.

5.1.1.3 Image Resizing

Image resizing refers to distorting the image from one-pixel to another pixel grid. And it is necessary to give standard size to all the test images so that they can contain same features. The changing of dimensions that is from original image size to standard size make all images to process at same level. So, we resized each image into dimension of 64 X 64.

5.1.1.4 Color Space Transformation

Images in the dataset are in RGB format and we convert them into greyscales to provide less information to each pixel. This step removes the color information and provides us cataracts region in context of greyscale range. Every image is grey scaled to retrieve the important information.

5.1.1.5 Feature Extraction

After taking the picture the picture detail plays an important role in feature selection because they can be of different size and properties. These are divided into color and textual properties. Feature extraction is an important step in object recognition algorithm. It refers to extract the useful information which is referred as feature of image. The features should be delegate in nature and convey the critical and unique attributes of image.

We used Convolutional Neural Network that automatically performs feature extraction and pass those features for classification.

5.1.1.6 CNN Architecture

In this architecture, there are convolution layers, pooling layer, rectified linear unit (ReLu activation function) and fully connected layers. There are four convolution layers used, in first convolution layer there are 32 filters with 3x3 size and in second convolution layer there are 64 filters with 3 x3 size. Pooling layer used for down sampling the image and preserve its features in feature vector. There are 2 classes at output layer. The number of iterations is 80.

The input sizes of the images in this architecture ranges 64x64 pixel.

We used 90% images from all three classes for training the classifier. Using a learning algorithm, we update the filters at the convolution layers. Weights are updated and learning algorithm learns the input to update the filters at

the convolution layers. The learning algorithm takes a classification error or loss. The loss act as an input and back propagates the error into the network. Then weights and filters are updated. This process continued. After training the model we save it and use it with our backend application.

5.2 Implementation steps

5.2.1 Training

We preprocessed the dataset and split into folders Train and Test. It contains 80% images in train folder and CNN model. It learns the features and save the model and pass those extracted feature to the agent. Then for testing 20% images used and images are browsed from input directory and the image is matched with trained model and identify the cataract. Then the result will be shown to the user. Accuracies are 98% and validation accuracy is 90%.

5.3 External APIs

CC Identifier is capable of handling multiple users, so we need to link our pretrained model with CNN. For this linking purpose we use API Application Programming Interface. REST API is used, and it is responsible for acquiring the patient data and sent to the patient to process. Storing the result after from CNN and then its response will be sent to the user.

Table 5.1: API

Name of API	**Description of API**	**Benefits of REST API**
REST API	REST API is designed to take the advantage of existing protocols. For configuring this API, we used the library of JavaScript that is “Axios”. This library is used for fetching the data through http request from third party. Here we pass the json object to the server with post, get, put methods of axios. i.e., Classifier. In the response of this get the details of the patient. Then the CNN calculates if the case if positive or negative. The results are displayed to the user through the API, which will display it to user and an email is sent to the patient. Our rest api have further apis.	The required data is provided instead of entire web page. REST Api creates the object of the required information of the user on server side. Benefit of REST Api is that it is fast and can be integrated on both web and mobile applications.

5.4 User Interface

5.4.1 Screen Images:

Sign Up Page

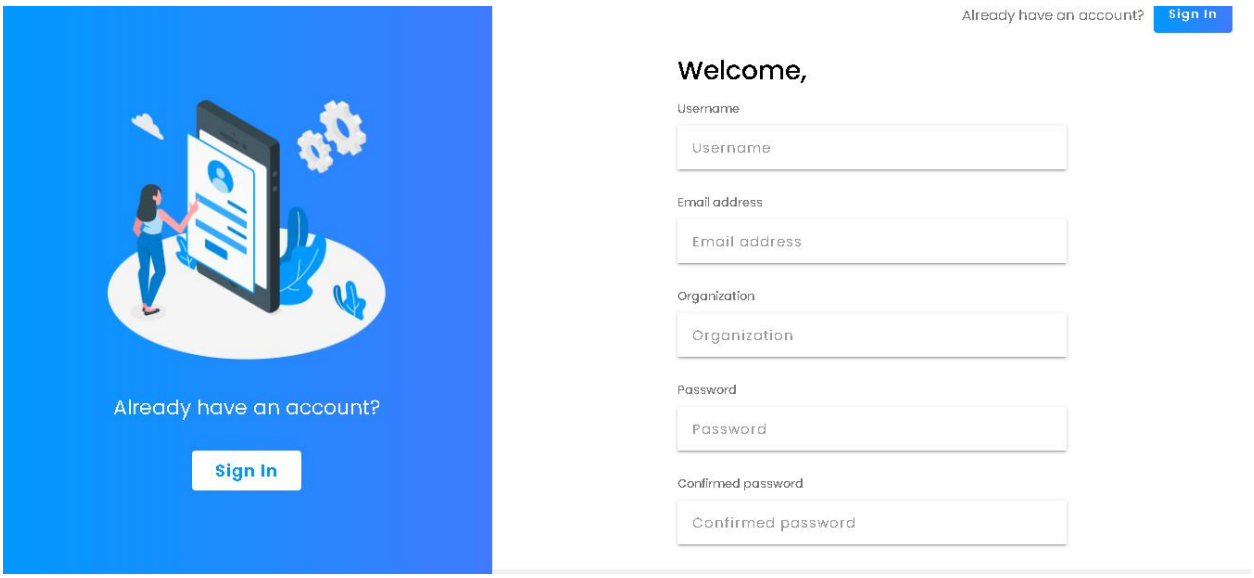

Figure 5.3.1 Sign Up Page

Log In Page

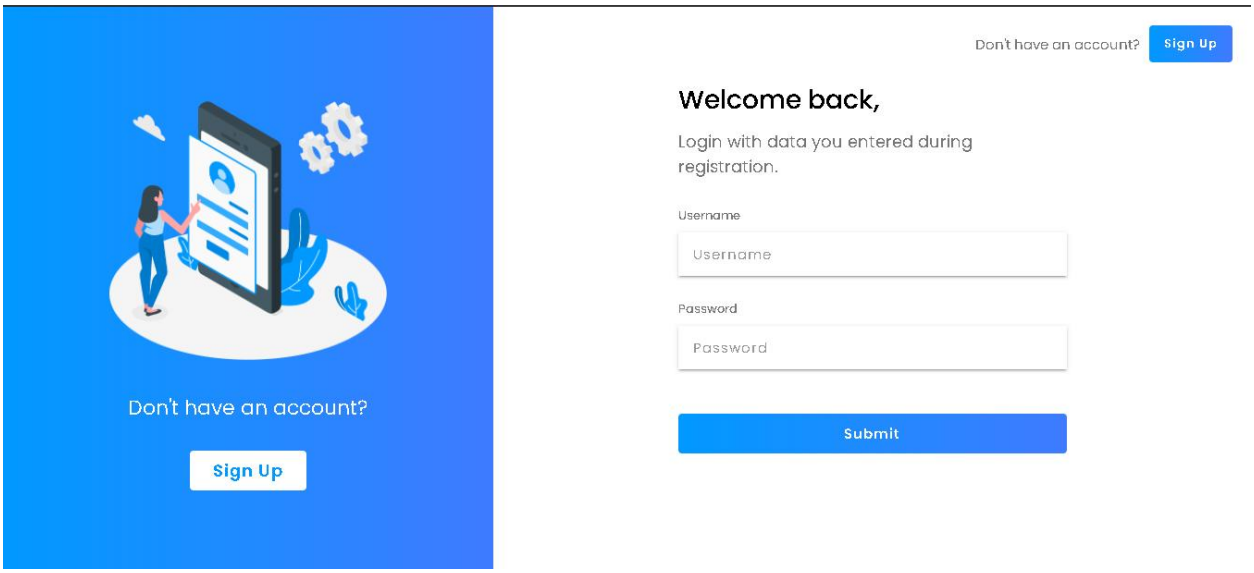

Figure 5.3.2 Login in Page

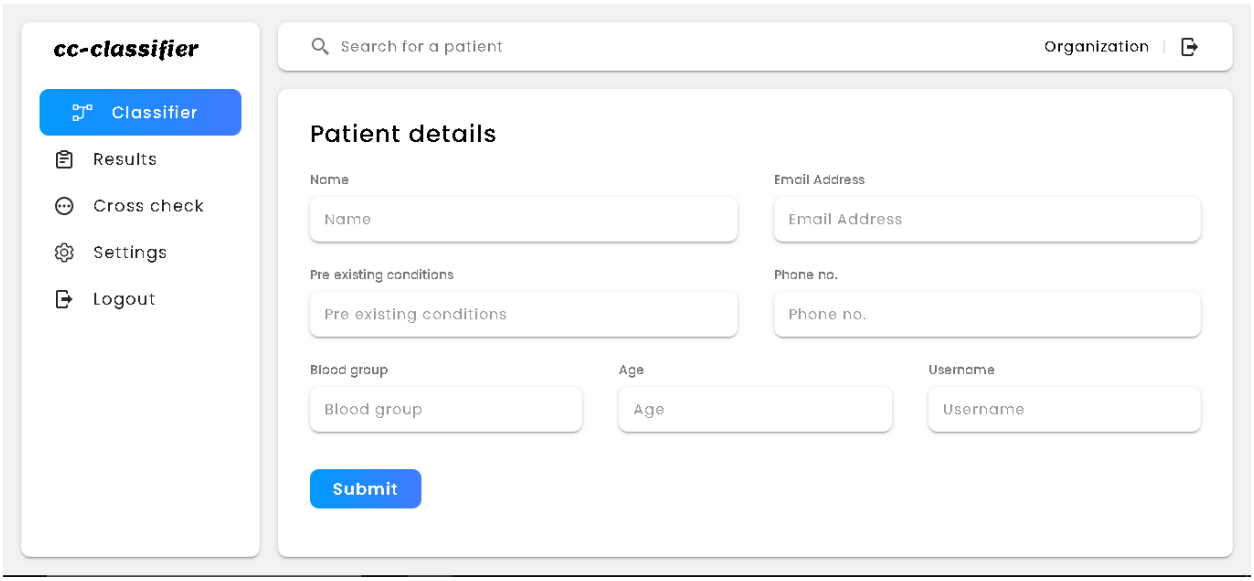

Figure 5.3.2.1 Patient details

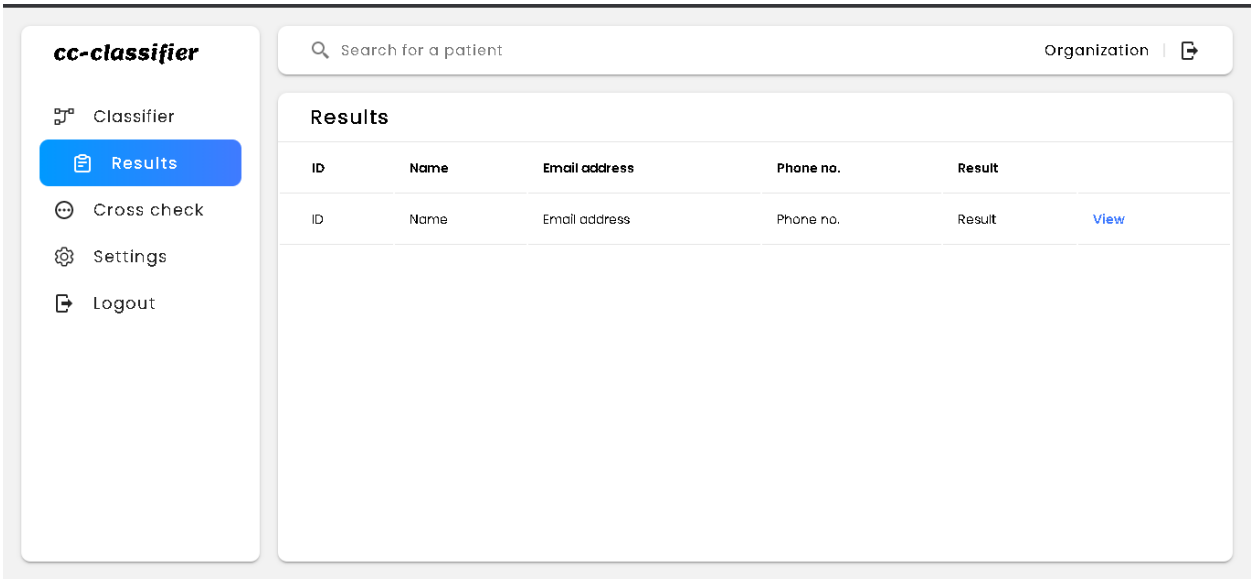

Figure 5.3.3 Results

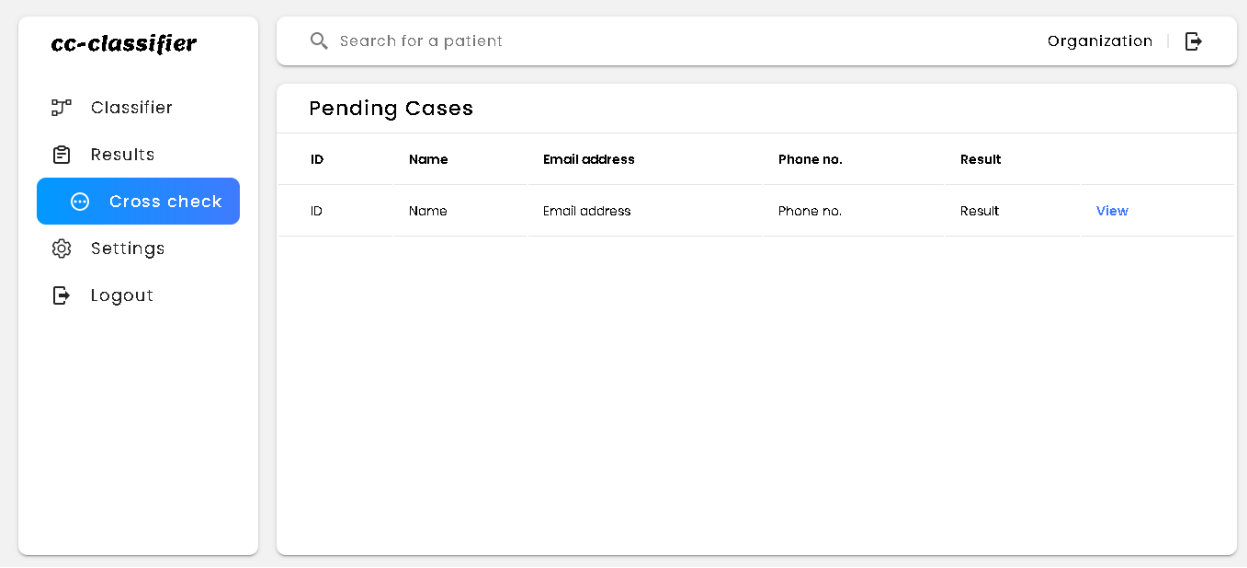

Figure 5.3.4 Pending cases reports

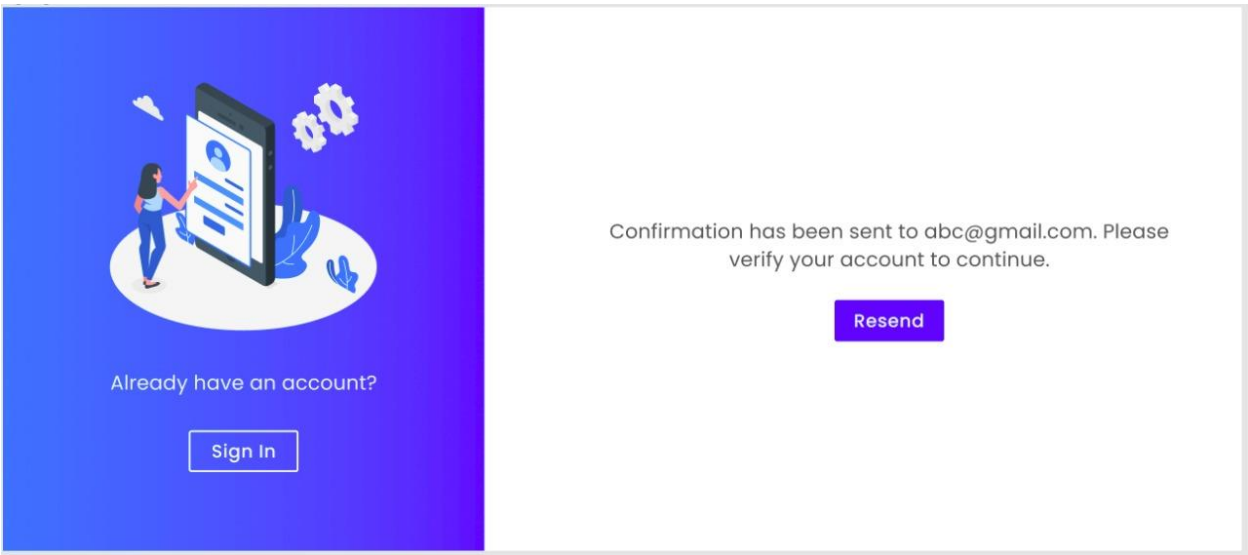

Figure 5.3.5 Confirmation email

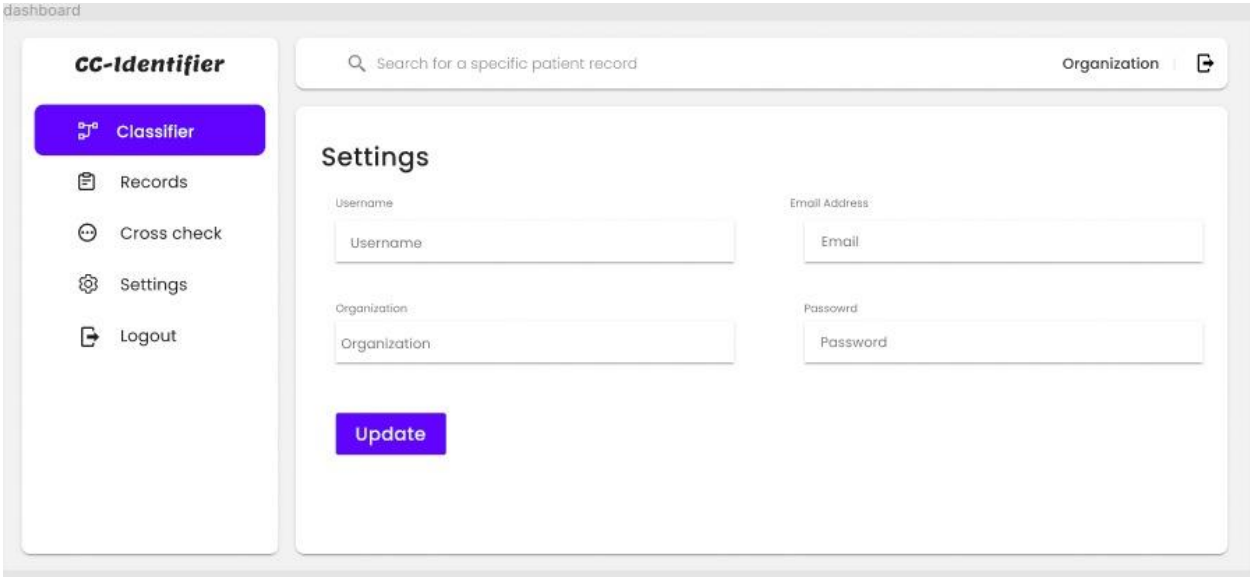

Figure 5.3.6 Patient record Update (Settings)

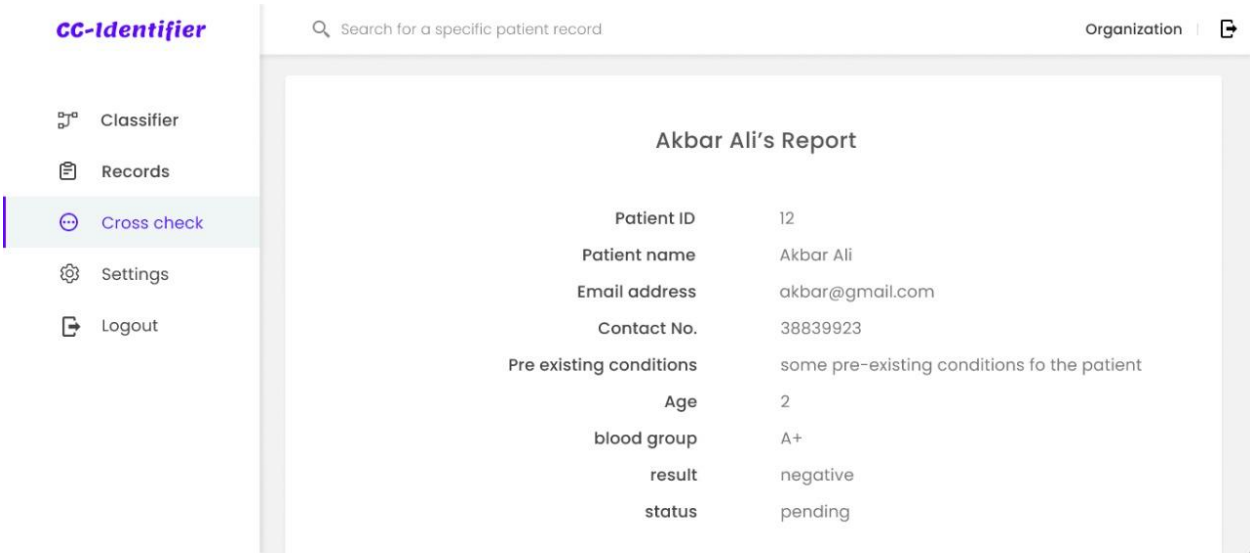

Figure 5.3.7 Report

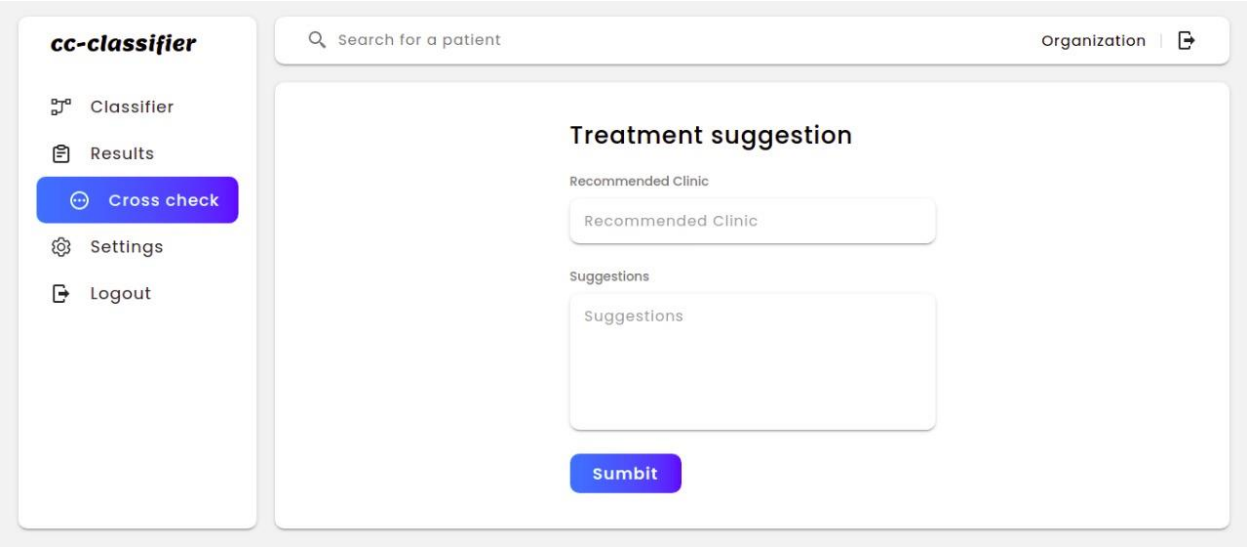

Figure 5.3.8 Treatment Suggestion

Figure 5.3.9 Tracking result

Chapter 6

Testing and Evaluation

6 Testing and Evaluation

In this chapter we test and evaluate functionality of our project because testing is crucial phase of development. Making sure that our project is fulfilling the requirements that are defined at the initial stage. After integration testing is necessary to check functionalities at each stage and finding bugs in the system. The testing is done testing at each development stage. Manual testing includes further types of types which includes integration testing and unit testing.

6.1 Manual Testing

Manual testing is the processing in which the developer tests software manually. Its purpose is to find bugs and errors. This testing is useful in identifying critical errors in the code. Although it requires more time and effort, but it can increase systems efficiency.

6.1.1 System Testing

To evaluate complete system functionalities system testing is performed and to ensure that system functionalities are working as required. System functionalities are tested though end to end system in which development team is not involved. Without going into the technical aspects system requirements are tested to observe overall performance with simple basic inputs. Validation and verification are also important feature of testing. You can check the application by checking the functionality of all the elements whether they are clickable or not. You cannot directly login and the login button will not be clickable, for that purpose you have to sign up into system in order to use the application. After login you can check your status, result, cross check, and you can also navigate to settings and other features to check all the functionalities.

6.1.2 Unit Testing

Unit testing is performed to validate that our modules or unit of the system performs as expected. Its main purpose is to check whether each unit of the system is performing or not according to the desired output.

Unit Testing 1: User Signup

Testing Objectives: To ensure User Sign Up is working.

Table 6.1.2.1 User Signup

Test case/Test script	**Attribute and Value**	**Expected Results**	**Output**	**Actual Results**
Signup with Patient ID, Name, Patient Email, Password & confirm Password	Username: Akbar Ali Email: Akbar@gmail.com Organization: ABC Password: Akbar123 Confirm Password:Akbar12	Confirm password is not matched	Kindly enter same password.	Pass
	Name: Akbar Ali Email: Akbar@gmail.com Organization: ABC Password: Akbar123 Confirm Password:Akbar123	Password matched. Account is created.	Signup Successful Account created.	Pass
	Name: Akbar Ali Email: Akbar@gmail.com Organiztion:ABC Password: Akbar123 Confirm Password:	The confirm password field is empty.	Kindly enter confirm password	Pass
	Name: Akbar Ali Email: Akbargmail.com Organiztion:ABC Password: Akbar123 Confirm Password:Akbar123	Incorrect email format	Please add email in the correct format. Must contain special character	Pass

	Name: Akbar Ali Email: Akbar@gmail.com Organiztion:ABC Password: Akbar123 Confirm Password:Akbar123	Already registered. Please Login	Your account already exists please login	Pass

Unit Testing 2: User Login

Testing Objectives: To ensure User Login is working.

Table 6.1.2.2 User Login

Test case/Test script	**Attribute and Value**	**Expected Results**	**Output**	**Actual Results**
Login with Patient username, Password	Username: Akbar Ali Password: Akbar12	Password is incorrect	Incorrect password.	Pass
	Username: Akbar Ali Password: Akbar123	Password matched	Login Successful. Homepage Shown	Pass
	Username: Akbar Ali Password:	Password field is empty	Kindly enter your password	Pass

Unit Testing 3: Add patient details.

Testing Objectives: To ensure patient details are successfully submitted.

Table 6.1.2.3 Add Patient Details

Test case/Test script	Attribute and Value	Expected Results	Output	Actual Results
Show Classifier page	Add Patient details	Details submitted	.Patient Details successfully submitted	Pass
	Username: Akbar Ali Password: Akbar123	Password matched	Login Successful. Homepage Shown	Pass
	Username: Akbar Ali Password:	Password field is empty	Kindly enter your password	Pass

Unit Testing 4: Sending email to user after results.

Testing Objectives: To ensure that sending email to user after the patient's report.

Table 6.1.2.4 User Login

Test case/Test script	Attribute and Value	Expected Results	Output	Actual Results
Sending Email	To: Subject: Patient report Body: Results	Enter Recipient	Recipient not satisfied	Pass
	To: User Subject: Patient report Body: Results	Email sent successfully	Email sent.	Pass

	Username: Akbar Ali Password:	Password field is empty	Kindly enter your password	Pass

Unit Testing 5: Add Image

Testing Objectives: To ensure that patient eye samples added.

Table 6.1.2.5 User Login

Test case/Test script	**Attribute and Value**	**Expected Results**	**Output**	**Actual Results**
Show add image in classifier	Add Image sample.	Your image is added	Image added	Pass
	Without Image	Please add sample image.	Add Image	Pass

Unit Testing 6: View results from classifier.

Testing Objectives: To ensure user can view results.

Table 6.1.2.6 View Results

Test case/Test script	**Attribute and Value**	**Expected Results**	**Output**	**Actual Results**
Show results	ID: 3 Name: Amjad Khan Email: amjad@gmail.com Phone No: 3585538495 Result: +ve	Results shown	Report has been added successfully.	Pass

6.1.3 Functional Testing

We perform functional testing to test the validation of all the functional requirements. All functions of the system are tested by providing different inputs and verifying the outputs with functional requirements. We also check APIs, Database, Interface, and designed different test cases to ensure all the functional requirements are satisfied.

Table 6.1.3.1 Functional Testing

Phase to test	**Test Description**	**Expected Results**	**Actual Results**
Database insertion In signup.	User record Inserted in database. after successful Signup with accurate details.	Record successfully inserted in database with username and email.	Pass
Forget password	Click on Forget password, and then get a link on his email to reset password.	After user get the link, he/she can add new password and confirms the password, new record successfully inserted in database	Pass
If email already exists	If email is already in the database send verification email	Verification email is sent	Pass
Cross check and setting	User can view results and can extract information from setting	User can view information and he/she will be able to view results from classifier.	Pass

6.1.4 Integration Testing

This testing is performed to ensure that the system modules are integrated and working properly after integration. We tested the major modules side by side to see the actual output. This testing allows us to check the integration of frontend with backend .

Table 6.1.4.1 Integration Testing

Phase to test	**Test Description**	**Expected Results**	**Actual Results**

The integration of frontend with backend.	When user enter its details, the complete integration will insert the data from frontend to backend in the database.	The process will be done if the user enters correct details otherwise it will show error.	Pass
Settings and Change Password.	User can change his/her password and get access to that end point with email link which change the password and then insert that record in the database	For changing the password user has to enter new password and then it will be added in the database that shows successful integration.	Pass
Email for Verification	User will get email verification in login and signup.	This integration works successfully by providing the link in the email to user.	Pass
Email of result	Users will also get email of patient report	User can view result through email	Pass
Patient data in classifier	Patient data can be inserted in classifier to see results of its eye sample.	Patient's data can be added for further process.	Pass

Chapter 7

Conclusion and Future Work

7 Conclusion and Future Work

7.1 Conclusion

Our project identifies the congenital cataract disease by using convolutional neural network. If you have followed every chapter, you will have a better understanding of our CC Classifier and also its development and designing process. Our system is capable of identifying the disease with better efficiency and can suggest the treatment.

7.2 Future Work

As the use of technology is arising in medical field, our project can pursue further integrations in the future.

- Extension of the system to further enhance the agent to identify the results more accurately.
- Providing counseling to the patients.
- Development of android application to provide facility to patients.
- Incorporation of a feature in application so the doctor/user can share the patient report with other experts and discus it, for better examination of the case.

Chapter 8

References

8 References

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