National University of Computer and Emerging Sciences

Emergency Expert

FYP Team

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Abstract

Several people are distressed because of patients crowding a single medical institute and this overburdens the medical staff of the institute. Patient face issues such as unavailability of services/doctor/medicine or large travel time to reaching the hospital, which put the patient's life in jeopardy by delaying their treatment. We plan to develop a mobile-based AI expert system application capable of diagnosing the patient's illness, and then send them to the closest hospitals with all the treatment, equipment, medicine, a bed and doctor readily available so that the patient can receive the treatment instantly. The application will also help in the even distribution of patients and workload in all available medical institutes in a city. This will lead to the prevention of unnecessary loss of life.

Executive Summary

When a patient faces an emergency, in all the panic, they travel to a hospital that takes more time to reach than a nearby hospital because either the fear of incomplete services or not knowing about the existence/location of that hospital. This also minimizes the amount of time a doctor might have to save the patient's life, as it is wasted in traveling to the farther hospital. Because of patients clustering at a single hospital, medical supplies often become scarce too, as, in such scenarios of catering to this many people, some medicine is bound to run out of stock.

All of these uncertainties, inconveniences and delays can decrease the chances of recovery/survival, and in some cases, even lead to loss of life. The root causes are:

1) unequal scaling of the medical workload in the medical institutes of the city

2) patients visiting medical institutes that do not have the required treatment/doctors/medicine

3) large travel time required to reach the hospital

After careful analysis of the root causes, we propose to build a mobile-based AI expert system application that first asks users to enter their symptoms (or with an illiterate user, ask them simple yes/no questions), and diagnose their illness with a certain threshold of certainty and guide them to a medical institute with all the requirements.

In this report, we will have a detailed view of all the health care problems that our FYP is resolving, all the field related to the problems or being affected by the problems that we have identified. We will then have a comparison of our project with the products that are available in the market and see how our project differ. We have analyzed the research papers and articles that have been published related to our work. We have discussed the functionalities and requirements that are project must fulfil in order to be considered deployable and what services our project must provide

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Chapter 1: Introduction

In moments of mass crisis (such as COVID-19, earthquakes etc.), patients usually go to a single well-known large government hospital, which causes an overload of patients at a single hospital. The hospital staff give their best efforts to cater all the patients, but even to the best of their abilities, a considerable number of patients cannot receive beds or doctors or treatment timely.

When a patient faces an emergency, in all the panic, they travel to a hospital that takes more time to reach than a nearby hospital because either the fear of incomplete services or not knowing about the existence/location of that hospital. This also minimizes the amount of time a doctor might have to save the patient's life, as it is wasted in traveling to the farther hospital.

Even if the patient is aware of the location of the nearby private hospitals/semi-private hospitals/clinics (all available to cater for the patient's needs), because of the doubts such as:

1) Unavailability of desired medical treatments
2) Unavailability of qualified doctors
3) Fear of huge check-up fees
4) Unavailability of good medical equipment

Patients avoid taking the chance.

Because of patients clustering at a single hospital, medical supplies often become scarce too, as, in such scenarios of catering to this many people, some medicine is bound to run out of stock, and restocking can take a consider amount of time which can prove to be curtail for the treatment of the patient. So, the short of medical supplies will eventually put the safety of the patient's life at risk.

1.1 Purpose of this Document

The Purpose of this project is to develop a mobile-based AI expert system application, which can aid in the following:

1.1.1 Guidance of the Patients in Emergency

The application will be capable of diagnosing the patient's illness using simple questions with only yes or no answers so that can be easily understood by the users, and then send them to the closest hospitals with all the treatment, equipment, medicine, a bed and doctor readily available so that the patient can receive the treatment instantly.

1.1.2 Optimal Utilization of All Medical Institutes

The application will also help in the even distribution of patients and workload in all available medical institutes in a city. This will lead to the full and optimal utilization of all the medical power of a city in moments of mass crisis. This will lead to the prevention of unnecessary loss of life due to the improper management of the medical resources by the head authorities in case of an alarming situation.

1.2 Intended Audience

The audience and professionals that can be affected by this project and utilize its use to either find comfort or ease in receiving treatment or better manage the services that they provide are as listed below:

1.2.1 Patients

Patients will receive great assistance in finding the medical institutes that best cater their needs and will be free from the worries of the unavailability of treatment, medicine or equipment while go for a check-up at the hospital. The patient will also be able to see whether the budget of treatment at the medical institute is friendly with their pockets or not and then can a more suitable choice.

1.2.2 Hospital Staff

Hospital Staff will be able to manage the patients in a more effective and arranged manner and also being at ease from the worries of loss of life due to improper management of resources in timely manner. They will also be able to redirect the patient's more swiftly and timely and prevent them any sort of inconvenience.

1.2.3 Pharmacy

Pharmacy will be able to manage orders of medicine requested by the Patients in case they are unable to find the medicine at the hospital pharmacy due to shortage of medical supplies. Pharmacies will also be able to maintain record of their sales and stock of medical supplies. This will also lower their efforts for management of their orders with pharmaceutical companies to restock on medicine and avoid the risk of shortage of medicine.

1.2.4 Pharmaceutical Companies

Companies will be able to more efficiently send supplies to the pharmacies and will be able to fulfill the demand of their products and medicines, timely and effectively.

So, in this project, we will further understand the vision of our project and the problems that the project is offering solution for. We will see some work and products that are already in market and identity the difference in services that our project is offering that are missing in the already existing market products and services. We will also look all the requirements that must be fulfilled for the development and deployment of this project in the market.

Chapter 2: Project Vision

The Vision of this project is to improve the health care system. Health Care is an important part of the human life but while dealing with the larger concerns, we sometimes tend to ignore the little problems, which if left unattended for a long period of time, can become the cause of major incidents. The problems that are project is trying to counter may seem small but they have proven to become the cause of death of a considerable number of Patients in Pakistan. In the field of Health Care, even a single loss of live is unacceptable and can cause serious difficulties for the hospital or the personal related to that case.

2.1 Problem Domain Overview

The Problems we identified are mainly concerned with efficient traveling time, informed decisioning of patient for choosing a treatment center and proper resource management of the medical institute. Our project will assist in helping the patient make an informed decision by giving them easy access to information which is critical for that decision as well as useful recommendations based on expert knowledge, provide them optimal paths to reach their destination so that the traveling time can be as low as possible and provide means for the medical institutes such as hospitals, pharmacies and pharmaceutical companies to provide their services more effectively.

2.2 Problem Statement

Loss of a Patient's life due to either unavailability of beds and medical services in the hospital where the patient has chosen to go in an emergency situation or the deterioration of patient's health and lowering chances of survival due to long travelling time for reaching a medical institute of Patient's choice, is a crucial concern for the country.

2.3 Problem Elaboration

When in a state of panic, it is natural for a human to make decision there and then, instead of waiting to gather information and then make an informed decision. In case of Health Care, in emergency case, the patient does not have the time to verify and check the location of the closest hospital and whether or not if the desired services are there. The patient impulsively and instinctively rushes to a familiar or trustworthy institute to save their health. In this hastiness, they go to the institutes that are well-known, but sometimes they are far and due to the deny in instant treatment, the health is compromised.

Even if we arrive to the medical institute on time, time taken to verify the availability of the bed and medical services forces the patient to wait and, in that wait, the health is being put at risk and if it is found that the bed is unavailable then relocating to another medical institute again raises the issue of delay in treatment due to traveling.

Even if the above two case do not hinder the health of patient, the lack of medical supplies, or overburdening of the doctor on duty, will definitely affect in the performance of the medical institute again endangering the patient.

There might not seem as major issues individually, but it put together, they pose a serious threat to the patient's life. We have seemed many cases in Pakistan where people have faced difficulties cause of the above identified concerns.

2.4 Goals and Objectives

Objectives of the project are listed below:

- Creating an Expert System for effectively diagnose the disease (via simple Questions)
- Find the nearest hospitals that provides the treatment for the diagnosed disease
- Check the availability of beds in the hospitals
- Check the availability of Doctors in the hospitals
- Check the availability of tests and equipment related to the diagnosed disease in hospital Labs or Labs in a nearby fixed vicinity of the hospitals
- Check the availability of medicines related to the diagnosed disease in the hospital Pharmacy or Pharmacies in a nearby fixed vicinity of the hospital
- Check the rush in the wards and estimate waiting time for availability of bed/treatment to assist the patient in deciding if he should wait or move to a different institute
- Rank the hospitals according to their services and patient feedback
- Assist the patient in getting a token/reservation/appointment in a hospital (only in cases of the hospitals which work on token system)
- Provide the optimal route to the hospital selected by the patient
- Assist the Hospital Staff in management of the beds
- Assist the Hospital Staff in redirecting the patients to any nearby hospital with the desired services (if necessary).

2.5 Project Scope

This project is an industrial level project which requires a large amount of computational power and resources along with real-time data of the medical institutes, to reach its full potential. With the vast variations of unlimited number of diseases/illnesses (all related to a distinctive field of medical science i.e. Optometry, Dentistry, Radiology, Neurology, Cardiology etc.), there is also the challenge of developing an expert system capable of identifying these vast variety of diseases, which, with the limited time of 1 year, is highly difficult to achieve.

With the limited time, we aim to make a prototype of our model in our tenure of FYP and be sure to achieve as many functionalities as possible.

Therefore, the scope of the project will cover the following functionalities:

- Diagnosis of common illness and diseases (via simple Questions)
- Find the nearest hospitals that provides the treatment for the diagnosed illness
- Check the availability of beds in the hospitals
- Check the availability of doctors in the hospitals (via simple Availability Status)

- Check the availability of medicine needed for the diagnosed illness
- Estimate minimum waiting time for availability of beds in the hospital
- Assist the Hospital Staff in management of the beds
- Provide the optimal route to the hospital selected by the patient
- Ranking of hospitals on patient feedback
- Assist the Hospital Staff in redirecting the patients to any nearby hospital with the desired services (if necessary)

More Advance Functionalities such as: Advancement of the Diagnosis system for identification of more diseases, Verification of the documentation and registrations of hospitals, Check the availability of tests and equipment related to the diagnosed disease in hospital Labs or Labs in a nearby fixed vicinity of the hospitals, Verification of the documentation and registrations of pharmacies etc. will be employed in the further future extension of the project after the tenure of the FYP.

2.6 Sustainable Development Goal (SDG)

Good Health and Well Being is our main concern in Pakistan. We want to be able to improve the provision of Health Care services in Pakistan as the well-being of our public will eventually ensure a brighter future for our country and upcoming generation.

2.7 Constraints

The constraints that can be faced are:

1) Efficiency of the system that we are recommending
2) Trust of the general public on our services
3) Correctness of information provided by the medical institutes
4) Completeness of the data provided by the pharmacies
5) Real time assessment of the optimal route

2.8 Business Opportunity

This project has a fairly well business opportunity in the Health Care field. There is nothing more important to a person than their own health or the health of their loved ones. One can charge a reasonable amount as fee to the hospitals, clinics and the pharmacies that will be registered on the platform of this project as the use of our services will eventually lead to the boost in their sales and overall performance. And with the help on in-built medicine promotion services, we can target pharmaceutical companies for a fee to advertise their medicine

2.9 Stakeholders Description/ User Characteristics

Health care is a vast field and concerns many other fields parallel to it in the well-being of Human Beings. Major of them will belong to the medical institutes and medicine provider and production companies. They often overlook the stakeholders affiliated with their work. A few of the stakeholders we have identified are as follows:

2.9.1 Stakeholders Summary

1) Hospitals

They can use these services to manage their patients in real time and quickly redirect them to their other branches, to not only avoid incidents caused by mis-management but also to effectively cater more patients.

2) Pharmacy
They will be able to boost their sales by effectively handling the demand of medicine of the Patients and they will be able to counter the issue of restocking on medicine that are facing shortage more effectively.
3) Pharmaceutical company
They will be able to better cater the production demands of their medicines and products as they will be able to analyze the real time demand of the medicine in the pharmacies and start production of that product in the desired amount.

2.9.2 Key High-Level Goals and Problems of Stakeholders

1) Hospitals

Goal: We plan to have all the medical institutes available in each city to be registered on our platform.

Problem: This will require that the hospitals will agree to the terms of providing us real time data of the operations and cases that are being dealt at their institute. This will also require us to have access to the information related to the doctors that are appointed at the hospitals. Also, the registration fee paid be the hospital to be able to be registered on our platform will have to be justified by their improvement in conduction of their tasks to provide effective and timely treatment to the patients. We will require a certification of their medical status to authenticate that their status is officially recognized as a medical institute by credible and well-renowned institutes with the confidence of the public

2) Pharmacy

Goal: We plan to have all the well-renowned pharmacies to registered on our platform.

Problem: This requires that they provide us real-time data of their inventory and their sales and purchase. Pharmacy registration charges must be balanced out by their gain in sales. We will require a certification of their pharmacy status to authenticate that their status is officially recognized as a pharmacy by credible and well-renowned institutes with the confidence of the public

3) Pharmaceutical company

Goal: We plan to have all the top pharmaceutical firms to registered on our platform

Problem: We will require real-time data of their production and sales. We will require a certification of their medical status to authenticate that their status is officially recognized as a medical institute by credible and well-renowned institutes with the confidence of the public.

Chapter 3: Related Work

In this chapter, we will review research papers and articles that fall under the same field of work as our Project. We will also analyze information (from multiple highly credible sources) that have deepened our understanding of different components of our Project and guide us in their implementation.

3.1 Comparison with Existing Services

In order to understand what is already available in the market and to distinguish how our product is different from those services that are already existing in the market, we have made a simple comparison table to illustrate the difference in the products.

Table 1: Comparison with Market Products

Note: The Information is drawn from Ref. [1] and Ref. [2].

Services / Features	Diagnose Illness	Bed Availability	Doctor Availability	Medicine Availability	Medical Equipment Availability	Required Test Availability at Hospital Lab	Optimal Route to Hospital
Mayo Clinic [1]	✓	×	✓	×	×	×	×
WebMD [1]	✓	×	✓	✓	×	×	×
Your.MD [1]	✓	×	✓	✓	×	×	×
IMS Maxims [2]	×	✓	✓	×	✓	×	×
Symptomate [1]	✓	×	×	×	×	×	×
Ada- The personal Doctor [1]	✓	×	✓	✓	×	×	×
Acgil [2]	×	✓	✓	×	✓	×	×
Emergency Expert	✓	✓	✓	✓	✓	✓	✓

Through the above table, it can be clearly seen that currently there are no product that provides all the functionalities given by our project.

3.2 Hospital Bed Management Methodologies

For the Bed Management System Development, using the TOC to create an interface for the targeted hospitals help form the basis for improving bed management processes and increasing the understanding among the hospital staff with regard to operational functions and the existing constraints that cause problems in the bed management of the Hospitals. (Source: Ref. [4]). This will require the effective training of the hospital staff for the effective and proper use of the project.

3.3 Pharmacy Inventory Management Methodologies

As for the Effective Management of the pharmacy Inventory, there are three methods used in pharmacy to manage inventory (Source: Ref. [5]), are given below:

3.3.1 Visual Method

This Method is to train the Pharmacist in such a manner so that he can verify the need to restock by only the use of vision. Furthermore, labels and tags are used to navigate through the supplies

of the pharmacy. The issue with this is human can be trained but to a limit and there is always room for error, therefore, this method has failed to provide surety and consistency.

3.3.2 Periodic Method

This Method is to verify the need to restock by checking the stock of each medicine after a fixed period of time. (i.e. weekly, monthly). The issue is if the medicine is out of stock before the verification date, this cause failure to provide surety and consistency.

3.3.3 Perpetual Method

This Method is to verify the need to restock on medicine by sending the check inspectors of the pharmaceutical companies to the pharmacies to get the demand of supplies (if any). This also has room for error as sometimes that inspectors can overlook a pharmacy that they were supposed to visit, which can be troublesome.

In our system, we will be creating an interface that can best cater and deal with all the issues faced by the above-mentioned methods for optimal performance.

3.4 Optimal Route Algorithm

In today's era, Google Maps API is the most widely used API for route planning as it searches the best route using the Genetic Algorithms in real time. The main advantage of Genetic Algorithm is that it produces a number of different optimal solutions since the result can differ every time the Genetic Algorithm is executed to be best suited to the real time environment. (Source: Ref. [6]). The disadvantage is that Google API follows some regulations that are recognized by the international community but are not applied in every country. For the route to be optimal in Pakistan, taking in account the various environmental conditions, we will be applying additional constraints and Algorithms in order to obtain a more optimal route.

So, we can conclude that all the related work that we have looked support our agendas but as to a similar product in the market, currently there is no similar product that provide the same services as our project.

Chapter 4: Software Requirement Specifications

4.1 List of Features

- Diagnosis of common illness and diseases (via simple Questions)
- Find the nearest hospitals that provides the treatment for the diagnosed illness
- Check the availability of beds in the hospitals
- Check the availability of Doctors in the hospitals (via simple Availability Status)
- Check the availability of medicine needed for the diagnosed illness
- Estimate minimum waiting time for availability of beds in the hospital
- Assist the Hospital Staff in management of the beds
- Provide the optimal route to the hospital selected by the patient
- Ranking of hospitals on patient feedback
- Assist the Hospital Staff in redirecting the patients to any nearby hospital with the desired services (if necessary)

4.2 Functional Requirements

- System shall let users create a new account.
- System shall authorize the unique phone number, password from the user and allow users to login.
- System shall allow users to find nearest hospital location on the map
- System shall allow users to order medicine from the nearby pharmacies.
- System shall allow users to book a bed in a ward of a hospital.
- System shall allow users to make an appointment with a doctor.
- System shall allow users to diagnose his illness via simple question answers.

4.3 Non-Functional Requirements

1) Performance

   The application should have good performance in terms of response time.

2) Scalability

   The application should be easily scalable with the addition of new servers on the network.

3) Capacity

   The application should be able to handle large number of traffic and users.

4) Availability

   The application should be up and running all the time.

5) Reliability

   The application should give accurate results in the diagnose of illness and optimal route plan.

6) Recoverability

   The application should easily recover from any incident that hinder its services.

7) Maintainability

   The application should have low maintenance cost.

8) Security

   The application should have good security for the safeguard of the information of the hospitals, pharmacies and the patients.

4.4 Assumptions

The Assumptions that we are make are as follows:

1) The user will be literate enough to understand and answer the questions for diagnose
2) The Hospitals will provide correct information
3) The Pharmacies will provide correct information
4) The user will know how to navigate through the application cause of user-friendly GUI.

4.5 Software Requirements

4.5.1 Programming Language

1) Python
   This system shall make use of the programming language, python, for its functionality on the server side. Within this language, we shall also use various libraries with python such as NumPy and selenium etc. as well for testing.
2) Java
   The major application that we are developing for use by our clients is a mobile application, which shall be coded on Android Studio and in the programming language, Java. 3.5.2

4.5.2 Google API's

1) Maps
   The google maps API is the backbone of our project as far as mapping is concerned, since it is to be used on the homepage to display all information on map. We chose Google API as it is one of the most reliable API to-date.
2) Places
   Another API from google is the Places API which tells us about locations and landmarks that exist on the map displayed, it will also be helpful in getting real-time information about the locations.

3) AutoComplete
The final API is the autocomplete API which is used primarily in searching and can suggest us various locations based on our currently typed search in the search box.

4.5.3 Database

The Database that we are using is the Firebase cloud database. This decision was made keeping in mind the compatibilities with Android Studio and Google Collab's

4.6 Use Cases

They are as follows:

4.6.1 Login:

Name	Login
Actors	User
Summary	The user shall provide their phone number and password on the login form and after successful verification, redirect the user to the home page.
Pre-Conditions	The user must be in the database records either added by any of the authorized users or added manually by a developer. The user must not already be logged in.
Post-Conditions	The user's session is successfully established and shall be redirected to the home page.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the login page.	1	The login page is displayed asking for phone number and password.
2	The user enters valid phone number and password.	2	The system verifies the phone number and password, establishes a session for the user and redirects the user to the home page.
Alternative Flow			
3	The user enters invalid phone number or password.	3	The system responds with an error message: *Incorrect phone number or password entered.*

4.6.2 Sign Up:

Name	Sign Up
Actors	User
Summary	The user shall provide their phone number and password on the Sign-Up form and after successful verification, redirect the user to the home page.
Pre-Conditions	The user must a valid phone number. The user must not already be logged in.
Post-Conditions	The user's session is successfully established and shall be redirected to the home page.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the Sign-Up page.	1	The Sign-Up page is displayed asking for phone number and password.
2	The user enters valid phone number and password.	2	The system verifies the phone number and password, establishes a session for the user and redirects the user to the home page.
Alternative Flow			
3	The user enters invalid phone number.	3	The system responds with an error message: *Incorrect phone number entered.*

4.6.3 Go to Near-By Hospital Location:

Name	Go to Near-By Hospital Location
Actors	User
Summary	The user shall provide their current location and the system shall locate the hospital with the least distance and the most optimal route for minimum travel time and show it to the user on the map.
Pre-Conditions	The user must already be logged in.
Post-Conditions	The user's request is processed and the appropriate position is shown on the map.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the login page.	1	The login page is displayed asking for phone number and password.
2	The user enters valid phone number and password.	2	The system verifies the phone number and password, establishes a session for the user and redirects the user to the home page.
Alternative Flow			
3	The user enters invalid phone number or password.	3	The system responds with an error message: *Incorrect phone number or password entered.*

4.6.4 Diagnose Illness

Name	Diagnose Illness
Actors	User
Summary	The user shall answer binary questions for the system to diagnose a number of possible illness that the user may be suffering from.
Pre-Conditions	The user must at least be literate enough to understand the questions and must be aware enough of his body to correctly answer whether or not he is experiencing the symptoms being asked in the question.
Post-Conditions	The user's illness will be identified and he will be redirect to the most recommendable medical institute.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user must answer the question in a manner of yes or no.	1	The system will analysis the answer and then ask a limited number of further questions to give diagnose of illness.
2	The user asked for the most recommend hospital based on the given information and diagnosed illness.	2	The system analysis the registered medical institutes on real time data, to check availability of the beds and the doctor in the ward and then redirect the user to the institute.
Alternative Flow			
3	The user is not literate enough to answer the questions and just wants to find the nearest hospital.	3	The system redirects the user to the map page when optimal path to nearest hospital is shown.

4.6.5 Order Medicine

Name	Order Medicine
Actors	User
Summary	The user shall type the name of the medicine he wants to order and will be able to make online payment for the order.
Pre-Conditions	The user must already be logged in.
Post-Conditions	The user's request is processed and the desired medicine is delivered to the user.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the order medicine page.	1	The pharmacies listed on the system are shown.
2	The user enters the name of the medicine.	2	The system shows all the pharmacies where the medicine is available and with the least delivery time.
Alternative Flow			
3	The user enters invalid phone number or password.	3	The system responds with an error message: *Incorrect phone number or password entered.*

4.6.6 Book Bed

Name	Book Bed
Actors	User
Summary	The user shall be able to book a bed in the ward of a hospital.
Pre-Conditions	The user must already be logged in.
Post-Conditions	The user's request is processed and the bed is booked in the desired hospital.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the Book Bed page.	1	The hospitals listed on the system are shown.
2	The user chooses the hospital, the ward and the bed to be booked.	2	The system books the bed choose by the user if and only if the bed is available otherwise alternative bed is given.
Alternative Flow			
3	The user chooses a bed or a hospital that is unavailable.	3	The system redirects the user to the book bed page again.

4.6.7 Make Appointment

Name	Make Appointment
Actors	User
Summary	The user shall make an appointment in a hospital with the doctor by which the user desires to be diagnosed.
Pre-Conditions	The user must already be logged in.
Post-Conditions	The user's request is processed and an appointment with the desired doctor is made.
Special Requirements	None

Basic Flow			
Actor Action		**System Response**	
1	The user opens the make appointment page.	1	The hospital listed on the system are shown.
2	The user enters the hospital and the doctor to make appointment with.	2	The system shows a time slot for the user to get an appointment in.
Alternative Flow			
3	The user chooses a slot that is already booked.	3	The system responds with an error message and redirect the user to the hospital list so that we can make an appointment with another doctor.

4.7 Graphical User Interface

The Graphical User Interface that we wish to follow for this project is as given below:

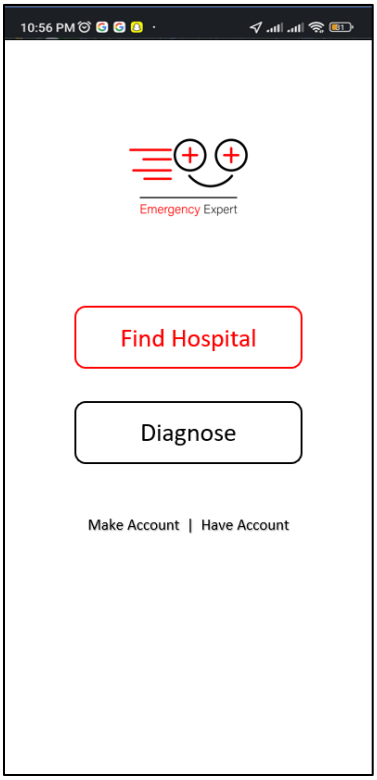

Figure 1: Front Page

This Figure represents the Front Page of our user-interface

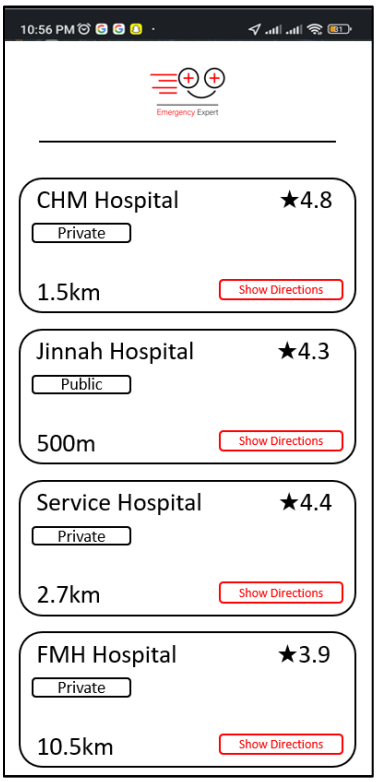

Figure 2: Hospital List Page

This Figure represents the Hospital List Page of our user-interface

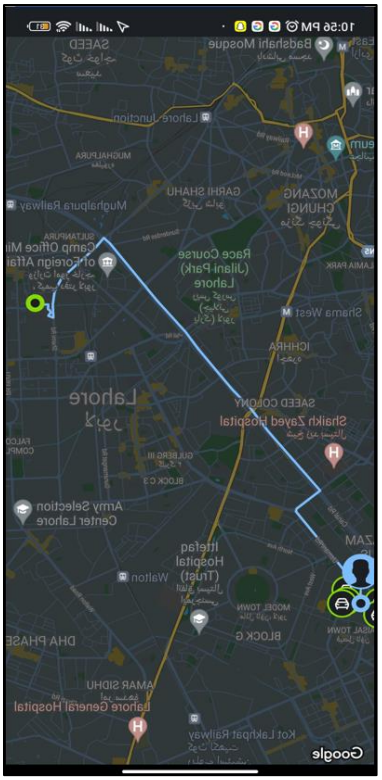

Figure 3: Map Page

This Figure represents the Map Page of our user-interface

Figure 4: Diagnose Page

This Figure represents the Diagnose Page of our user-interface

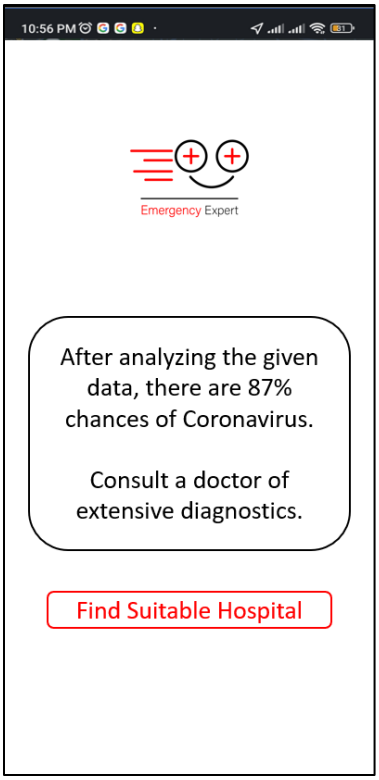

Figure 5: Result Page

This Figure represents the Result Page of our user-interface

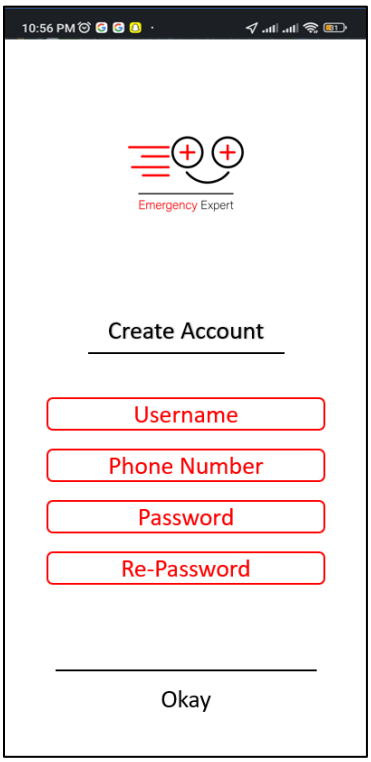

Figure 6: Sign up Page

This Figure represents the Sign up Page of our user-interface

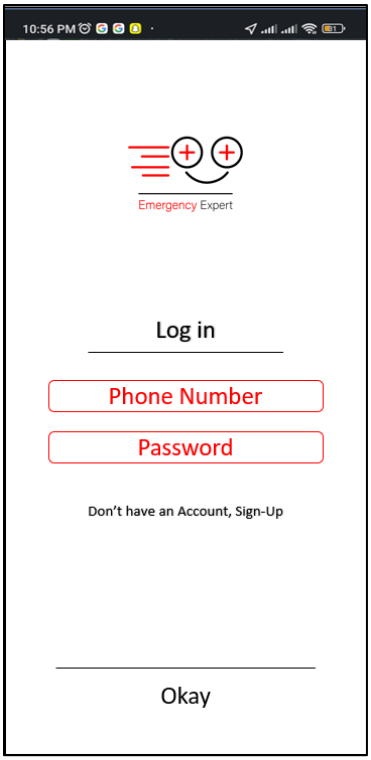

Figure 7: Log in Page

This Figure represents the Login in Page of our user-interface

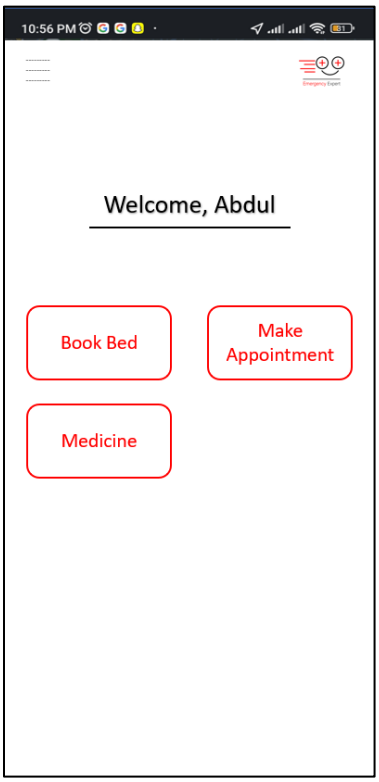

Figure 8: Home Page

This Figure represents the Home Page of our user-interface

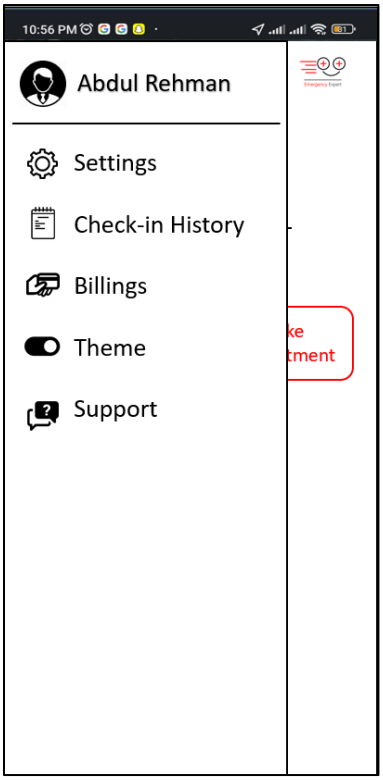

Figure 9: User Panel Page

This Figure represents the User Panel Page of our user-interface

In the Front Page in figure 1, the "Find Hospital" option shows the user all the hospital that are the closest to the user with a predefined distance, the "Diagnose" option will redirect the user to the Diagnose Question Page, the "Make Account" Option will automatically redirect the user to the Sign-Up Page and the "Have Account" Option will automatically redirect the user to the Log in Page.

In the Hospital List Page as seen in figure 2, it will show the user a list of all the hospitals that are currently registered at the platform, which are closest to the user's currently location. It will also show whether the hospital is private or government, the overall rating of the hospital which will be calculated by the feedbacks that will be received by the users who have been treated at that hospital and the distance between the user's current location and the location of the hospital. When the user clicks on the "show Directions" button, the user will be redirected to the map page, where the optimal path to reach the hospital will be shown to the user.

In the Map Page as seen in figure 3, it will show the user the optimal path to reach the hospital will the user has selected.

In the Diagnose page as seen in figure 4, it will ask the user easy-to-understand questions with only yes/no answers so that the system can diagnose the illness experienced by the user. After the system has diagnosed the illness or after the system has reached the threshold of the maximum question to ask, in the Result Page as seen in figure 5, it will show the illness it has diagnosed that the user might be experiencing. When the user clicks on the "Find Suitable Hospital" button, the user will be redirected to the Hospital List page, where only the hospitals that are best suited to deal with the diagnosed illness will be listed.

In the Sign-up page as seen in figure 6, it will help the user to make an account on the platform.

The user will be required to provide the following information:

1) Username
2) Phone number
3) Password

After the requested information is provided by the user and (after verification) saved in the system, the user will be signed up and then redirected to the home page.

In the Log-up page as seen in figure 7, it will require the user to provide the following information:

1) Phone number
2) Password

After the requested information is verified by the system, the user will be signed up and then redirected to the home page.

In the Home page as seen in figure 8, it will help the user to either book bed, or make appointment or order Medicine. It will also help the user to access the control/user panel.

In the User Panel page as seen in figure 9, it will help the user to access:

1) Profile
2) Settings
3) Check-in History
4) Billings
5) Theme
6) Support.

The user can easily access any of the above services or features and either make changes or get answers to their queries or get reports/ records accordingly.

4.8 Database Design (*if required*)

4.8.1 ER Diagram

The ER Diagram of our project shows the major classes as well as the major functionalities that we wish to target. The Basic classes contained in it are: Hospital Class, Ward Class, Bed Class, Doctor Class, Patient Class, Pharmacy Class, Medicine Class, Illness Class, Symptoms Class and Dosage Class. There are other derived classes that can be seen in the diagram as well to further enhance the understanding of all the functionalities that our project will be targeting and how these derived classes are linked to the basic/main classes in the project. It also shows the dependencies between the classes as well. It is as shown below:

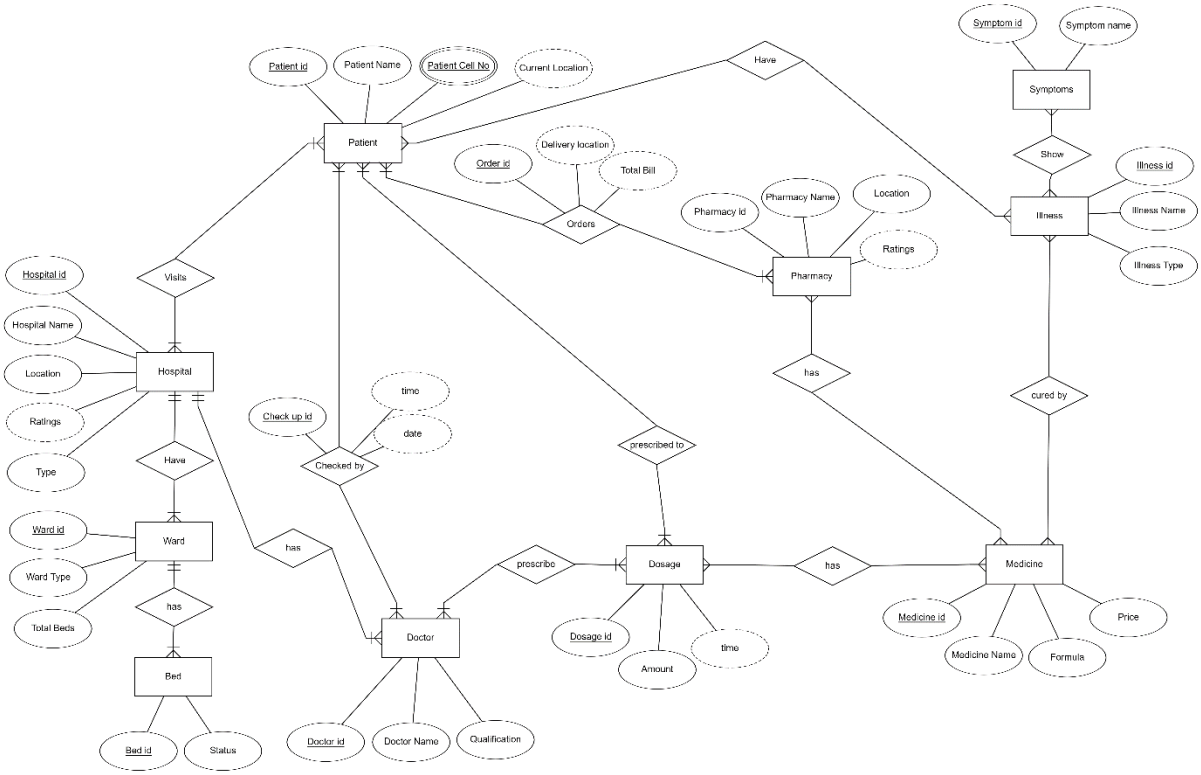

Figure 10: Database ER Diagram

This is the Graphical ER Diagram of our database for this project.

4.8.2 Data Dictionary

Table 2: Data Dictionary

This is the Data Dictionary of our database for this project.

Field Name	Data Type	Field Length	Constraint	Description
Patient id	int	9	Primary Key	id of the user and will be auto generated
Patient Name	varchar	20	Not Null	name of the user to show on profile
Patient Cell No	int	11	Primary Key	contact number of the user
Illness Id	int	9	Primary Key	id of illness and will be auto generated
Illness Name	varchar	20	Not Null	name of illness
Illness Type	varchar	10	Not Null	whether the illness is severe or normal
Symptom id	int	9	Primary Key	id of symptom and will be auto generated
Symptom Name	varchar	20	Not Null	name of the symptom
Hospital id	int	9	Primary Key	id of hospital and will be auto generated
Hospital Name	varchar	20	Not Null	name of hospital
Hospital Location	varchar	50	Not Null	location of the hospital

Hospital Type	varchar	12	Not Null	whether it is private or government
Hospital Ratings	float	1	Null	ratings of the hospital
Doctor id	int	9	Primary Key	id of the doctor and will be auto generated
Doctor Name	varchar	20	Not Null	name of the doctor
Qualification	varchar	30	Not Null	qualification of the doctor
Pharmacy id	int	9	Primary Key	id of pharmacy and will be auto generated
Pharmacy Name	varchar	20	Not Null	Name of pharmacy
Pharmacy Location	varchar	50	Not Null	Location of pharmacy
Pharmacy Ratings	float	1	Null	Ratings of pharmacy
Medicine id	int	9	Primary Key	id of medicine and will be auto generated
Medicine Name	varchar	20	Not Null	Name of medicine
Formula	varchar	80	Not Null	Formula of medicine
Price	int	5	Not Null	Price of medicine
Ward id	int	2	Primary Key	id of ward and will be auto generated
Ward Type	varchar	15	Not Null	whether it is ICU, General ward etc.
Total Beds	int	20	Not Null	total no of beds in the ward
Bed id	int	2	Primary Key	id of bed and will be auto generated
Status	varchar	10	Not Null	whether available or occupied

In this table, we are showing the data members of each table in our database, their data type, constraints and description. All the data members, their needs and their uses can be seen in the ER Diagram that is shown above, in order to better understand their functionalities and relationship in accordance with the project.

4.9 Risk Analysis

Risk Analysis that comes with the deployment of this project are as follows

1. Financial: This project is an industrial level project which requires a large amount of computational power and resources along with real-time data of the medical institutes, to reach its full potential, therefore a considerable sum of credits will be invested in the project in order to avail the API and the Database and other deployment requirement.

2. Legal: As the project also deals with online transactions and payments, so the services provide by the project must abide by the law of the state, otherwise, it can be charged with heavy fines by the government.

3. Ethical: Since the project deals with Health Care, so all the Ethical rules and practices must be abiding by, as it must handle the life of people. Any loss in life caused by the use of this project or due to misfunction of its services may lead to violation of Ethical Laws and shut down of the whole project entirely.

Chapter 5: High-Level and Low-Level Design

5.1 System Overview

The software will be able to diagnosis of common illness, find the nearest hospitals that provides the treatment for the diagnosed illness and provide the optimal route to the hospital selected by the patient also providing some additional functionalities. After careful assessment, we have considered to go with the structural design pattern.

5.2 Design Considerations

In order to provide an accurate design, we must first identify all the actors and end users as well as other important working components of our model.

5.2.1 Assumptions and Dependencies

The assumptions we are taking regarding the software and its use are:

- The user will be literate enough to understand and answer the questions for diagnose
- The Hospitals will provide correct information
- The Pharmacies will provide correct information
- The user will know how to navigate through the application cause of user-friendly GUI

The dependencies we have identified are:

- Ethical Response from the Medical Institutes will be needed for the successful working of the application.
- The usability of the application will very much depend on its user-friendly GUI
- Considerably accurate results are required in the diagnose system
- System is highly dependent on the user’s ability to provide correct information

5.2.2 General Constraints

Some global limitations or constraints that have a significant impact on the design of the system's software are:

- Programming languages used for fast computation of results
- Quality of services used in the system such as database services etc
- Literacy of the end user
- Availability of services at the medical centres at all times
- User friendly interface
- Fast network access for system to analyse data in real time
- Scalability of the system
- Confidentiality and integrity of data provided by user and the medical centres
- Good verification of data
- Intelligent system for learning from the data in real time to provide more accurate results (diagnose and recommendations) to the user

5.2.3 Goals and Guidelines

The goals might be:

- Keep it as simple as possible considering that majority of our target market is laymen
- We will try to provide optimality in both speed and memory, but in the end, we will prioritize speed over memory to provide accurate results efficiently in real time
- Our final product should look reliability for use and easy to navigate through to provide the end user comfort and assurance while they use our services.

5.3 System Architecture

The Architecture of our system consist of the Patient, Doctor, Medical Services, Database, Central Server, Security Layer etc. The Whole System Architecture is shown by figure 11.a and figure 11.b. The high-level design of the system is given in the Figure 11.a as shown:

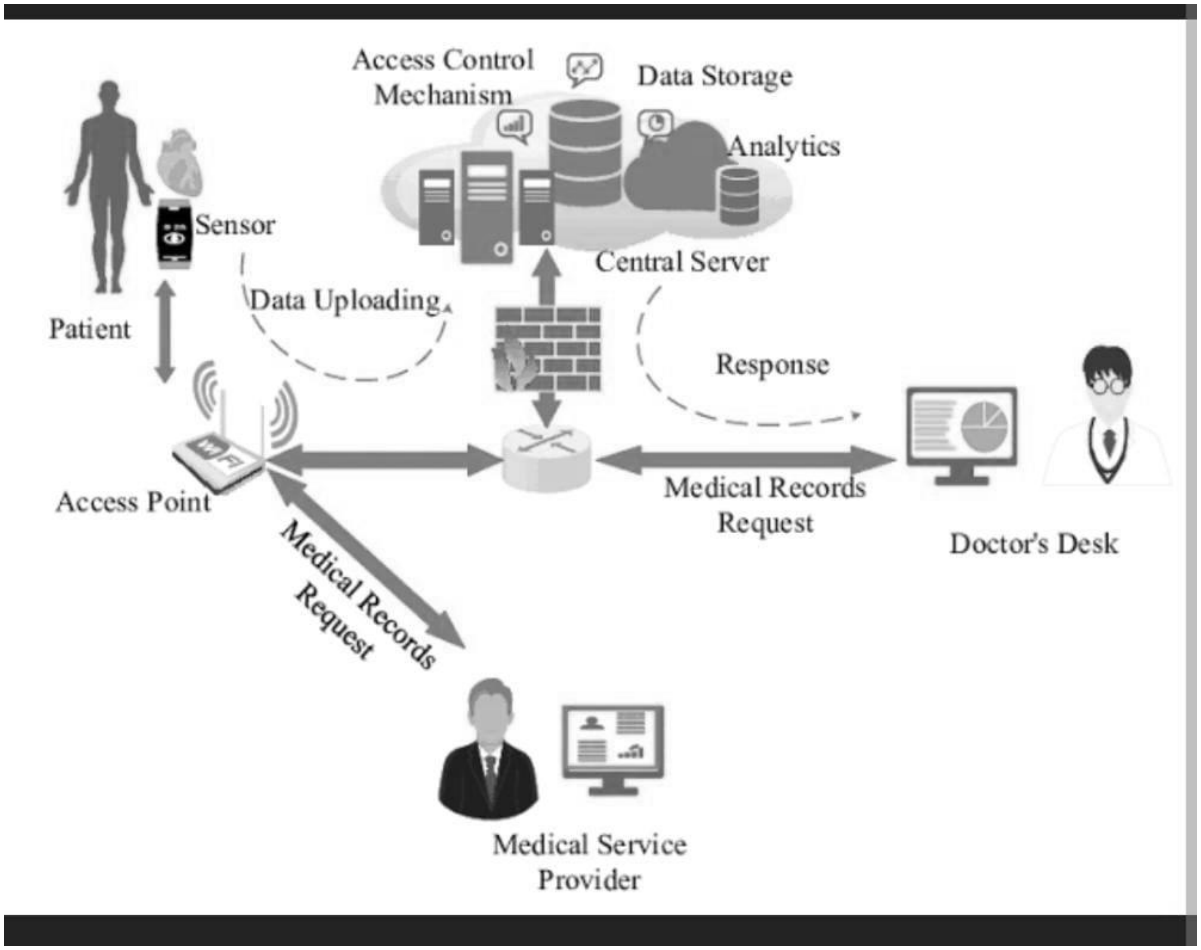

Figure 11.a: Architecture Diagram

This is the Architecture Diagram of this project

In Figure 11.b, the diagram shows the client layer, database layer and logic layer of the system. Both of them combined show the Architecture structure of the system that we are planning to implement.

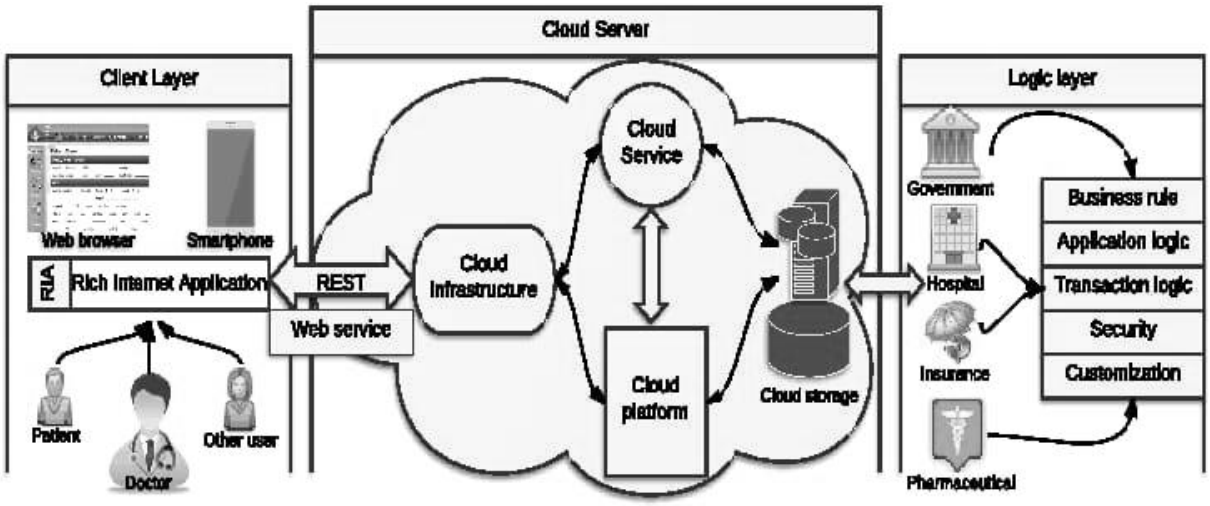

Figure 11.b: Architecture Diagram

This is the Architecture Diagram of this project

5.4 Domain Model/Class Diagram

The class diagram consists of classes such as: Hospital Class, Ward Class, Bed Class, Doctor Class, Patient Class, Pharmacy Class, Medicine Class, Illness Class, Symptoms Class and Dosage Class. It is as follows:

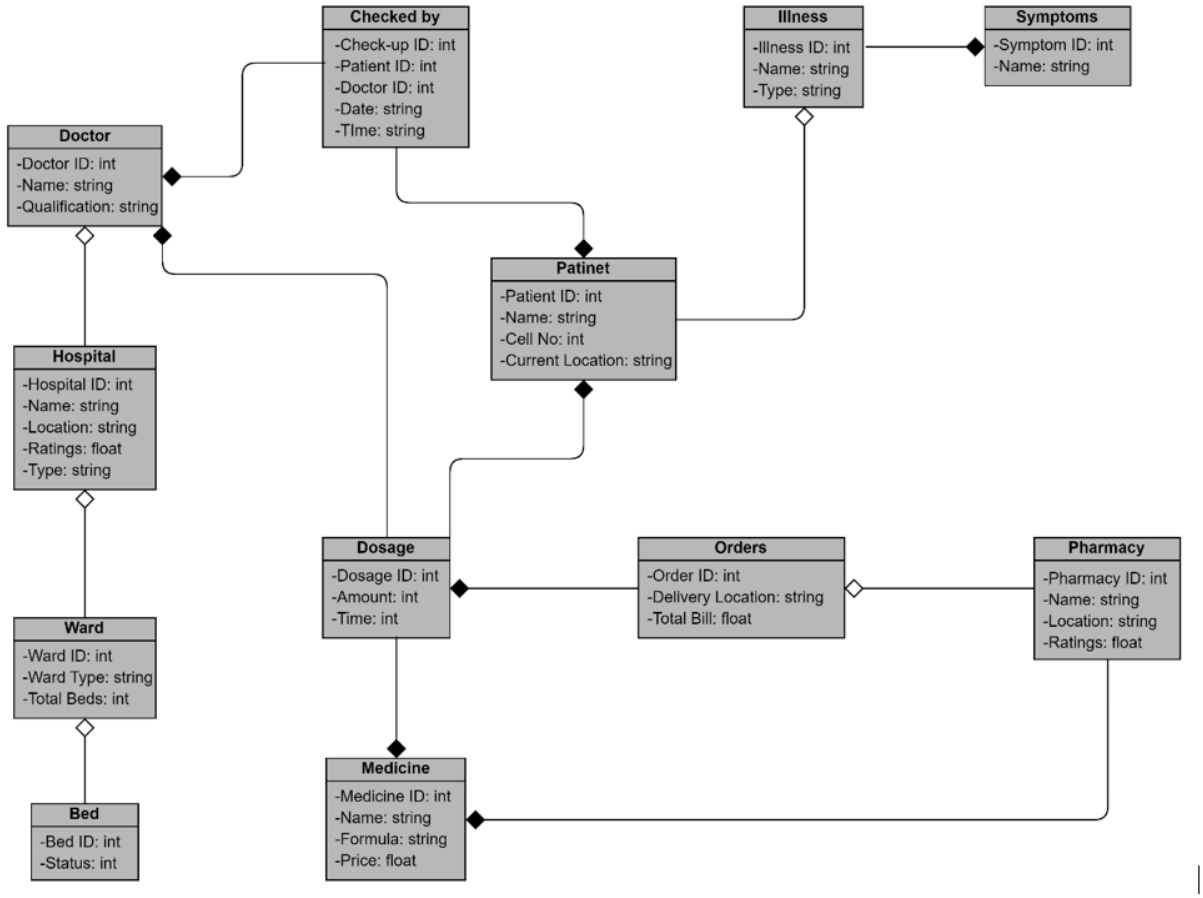

Figure 12: Class Diagram

This is the Class Diagram of this project

5.5 Sequence Diagrams

The Sequence Diagrams showing in detail how the operations are carried out for each functionality and how the user interacts with the system is given as follows:

5.5.1 Login

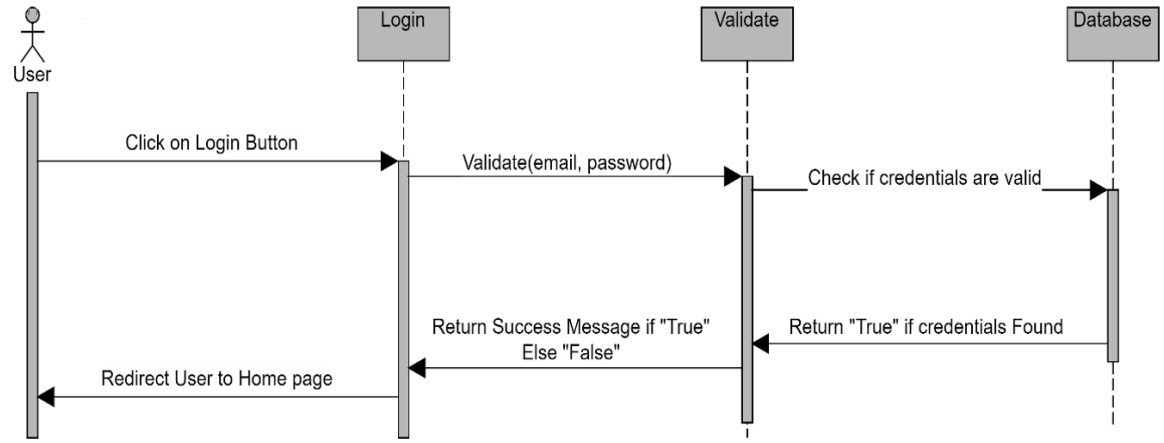

Figure 13: Login Sequence Diagram

This is the Sequence Diagram for Login Functionality

In this, the User clicks on the “Login in” button and then is asked to give his email and password, then the systems check if the provided credentials are valid or not. The systems return “True” if and only if the credentials are valid, then redirect the user to the home page.

5.5.2 Sign Up

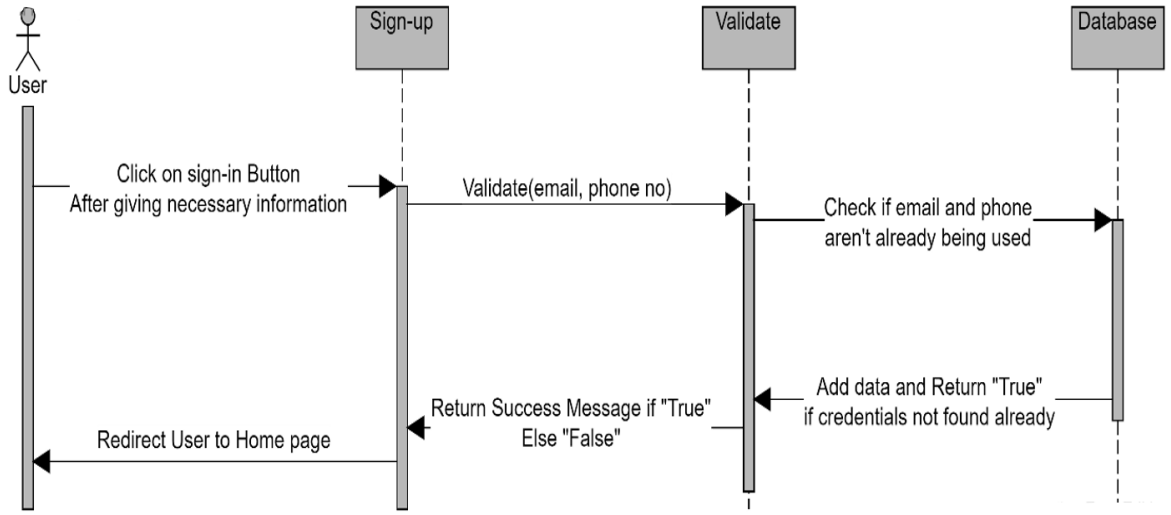

Figure 14: Sign Up Sequence Diagram

This is the Sequence Diagram for Sign up Functionality

In this, the User clicks on the “Sign up” button and then is asked to give his email, phone no and password, then the systems check if the provided credentials already exist in the database or not. The systems return “True” if and only if the credentials did not exist in the database and adds them in the database, then redirect the user to the home page.

5.5.3 Go to Near-By Hospital Location

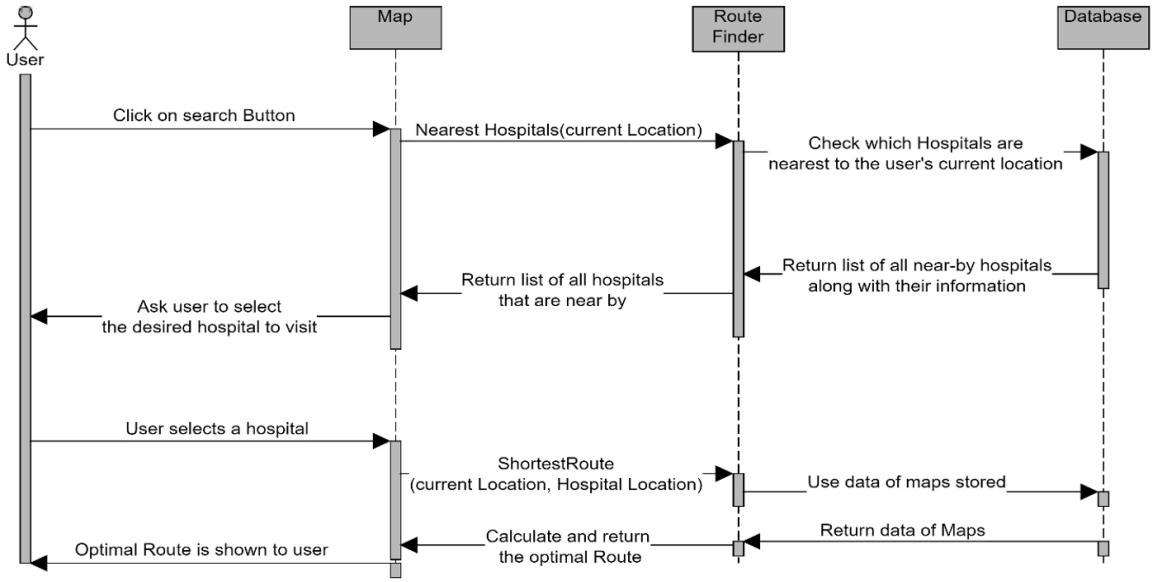

Figure 15: Find Hospital Sequence Diagram

This is the Sequence Diagram for Find Hospital Functionality

In this, the User clicks on the "Search" button and then the system takes the user's current location and sends it to the Route Finder to make a list of all the hospitals that are in a fixed radius of the user's current location, then displays that list and ask the user to choose a hospital the user would prefer going to. After the user chooses the hospital that they want to visit, the shortest route to the chosen hospital is calculated and then displayed to the user.

5.5.4 Diagnose Illness

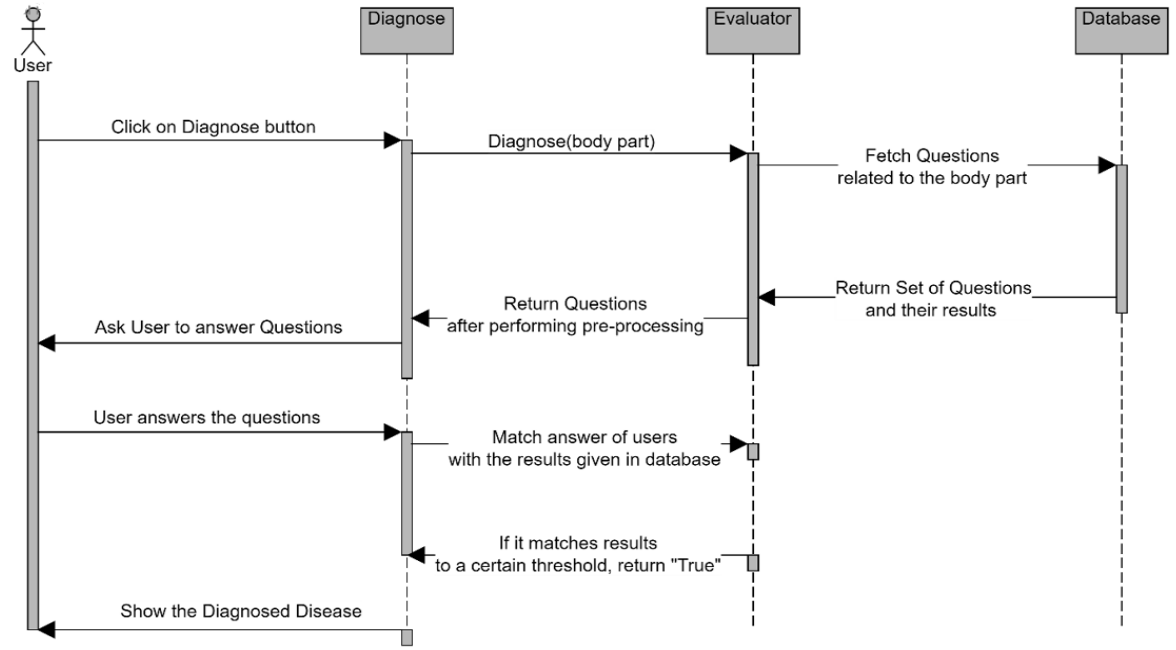

Figure 16: Diagnose Sequence Diagram

This is the Sequence Diagram for Diagnose Functionality

In this, the User clicks on the “Diagnose” button and then is asked to select a body part in which the user is most likely experiencing the pain. After the user choses a body part, the diagnosis questions related to that body part are fetched from the database and displayed to the user. The user is required to answer those questions. After the user answers the questions, the answers are cross matched to evaluate the percentage of the illness being present in the user. If the answers of the user cross match to a certain threshold, then the results are shown to the user.

5.5.5 Order Medicine

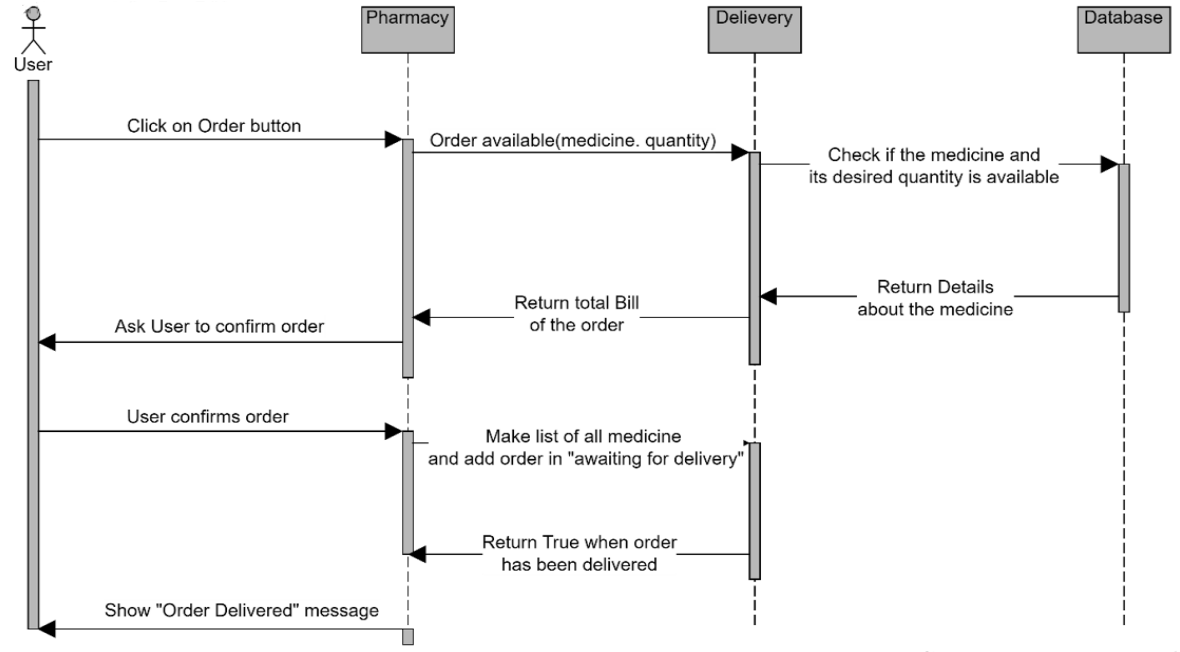

Figure 17: Order Sequence Diagram

This is the Sequence Diagram for Order Functionality

In this, the User clicks on the “Order” button and then is asked to give the medicine name and the quantity required, then the systems check if the required medicine and its quantity is present in the database. It checks all the record of all the pharmacies that are registered in the system and make a list of pharmacies that have the desired medicine and its quantity. After making the list, it deduces the list by evaluating the pharmacies that are in a fixed radius to the user’s current location. After finding the pharmacy that has the required supplies and is the closest tot the user’s current location, the system checks the medicine charges and the delivery charges and then computes the billing , then the total billing is presented to the user and the user is asked to confirm the order. When the user confirms the order, the order of the user is placed in the “awaiting for delivery” and when the order has been delivered to the user, the “Order Delivered” Message is shown to the user.

5.5.6 Book Bed

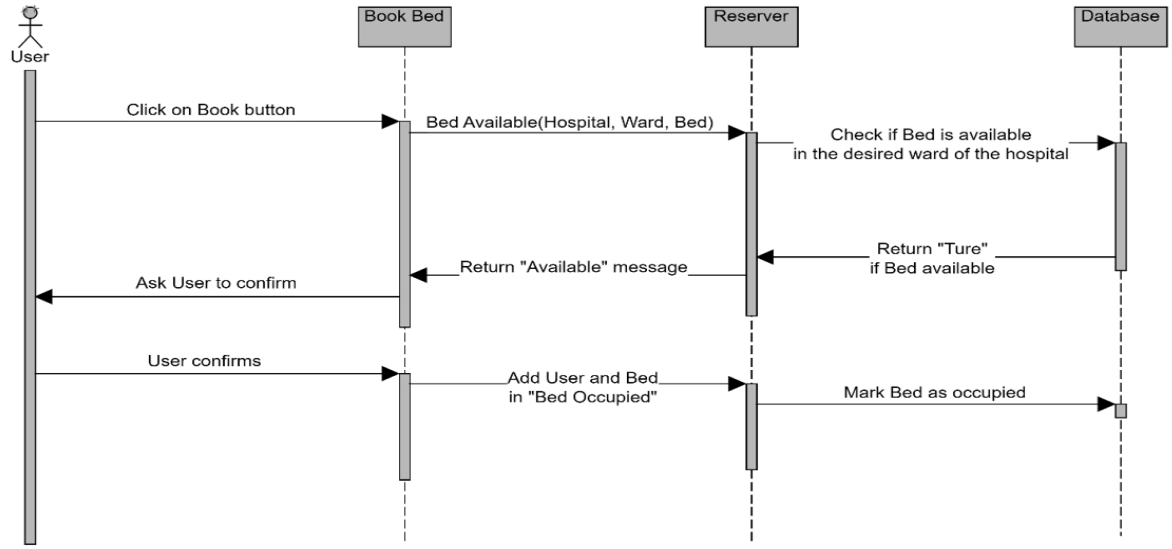

Figure 18: Book Bed Sequence Diagram

This is the Sequence Diagram for Book Bed Functionality

In this, the User clicks on the "Book" button and then is asked to give the hospital, Ward and bed no that they want to book, then the systems check if the provided place is available for booking. If it is available, the user is asked to confirm booking and after user confirms, the user and the bed he has booked is added to the "Bed Occupied" table.

5.5.7 Make Appointment

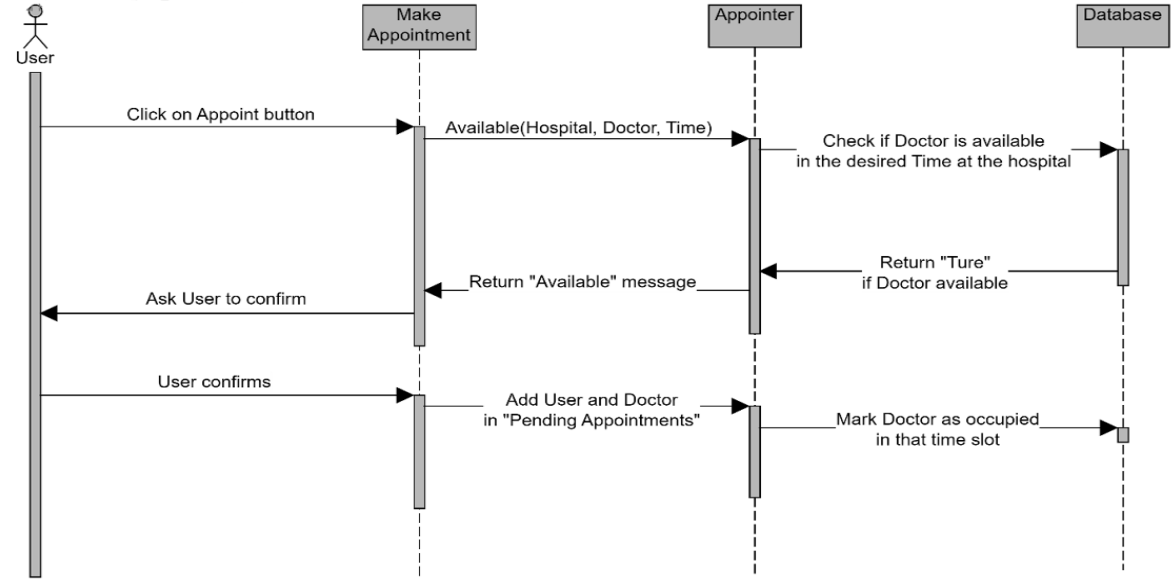

Figure 19: Make Appointment Sequence Diagram

This is the Sequence Diagram for Make Appointment Functionality

In this, the User clicks on the "Appoint" button and then is asked to give the hospital, doctor and time for appointment, then the systems check if the provided time slot is available. If the time slot is available then the user is asked to confirm and once the user confirms, the time slot is added to the "Pending Appointments" table.

Chapter 6: Implementation and Test Cases

In this, we will discuss the implementation of the first major functionality that we have implemented in our project which is to find the most optimal route to reach the desired hospital according to the user's choice.

6.1 Implementation

We have used the Google Map API and integrated it in our application. It works in a way that when the user is using the application on the mobile device and select the hospital where the user wishes to visit, the application takes the users current location for the mobile and then sends that location and the location of the desired hospital (that was in the database) to the Google Map API. The user is then redirect to the Google Maps application, where the navigation is automatically called and the user is shown the optimal path to reach his desired hospital.

6.2 Test case Design and description

We tested the Google Maps API and examined its behaviour with our application to see if it working properly with the application.

6.2.1 Passing User's Current Location

Path Finder			
-			
Test Case ID:	*0001*	**QA Test Engineer:**	*Saad Shafiq*
Test case Version:	*V1*	**Reviewed By:**	*Abdul Rehman*
Test Date:	*8-11-2022*	**Use Case Reference(s):**	*Go to Near-By Hospital Location*
Revision History:	-		
Objective	*Needed to check if the application is giving the correct user location to the Google Maps API*		
Product/Ver/Module:	*The optimal path being found in the Path Finder Module.*		
Environment:	*Google Map API and Android Studio*		
Assumptions:	1. *The User's Mobile has GPS functionality.* 2. *The User's Mobile has good pinpoint location*		
Pre-Requisite:	*Google Maps application must be installed at the user's mobile.*		

Step No.	**Execution description**	**Procedure result**
1	*Asking the user's mobile to give the current location of the user by sending get location request from the application*	*User's mobile responding to the request and providing the current location of the user.*
2	*Giving the obtained location to the Google Maps API to see if the Google Maps API accepts the user's current location without any form of errors*	*Passed the user's current location and the Google Maps API accepted the given location without any error.*
Comments:		
☒ *Passed* ☐ *Failed* ☐ *Not Executed*		

6.2.2 Passing Hospital's Location

Path Finder			
-			
Test Case ID:	*0002*	**QA Test Engineer:**	*Saad Shafiq*
Test case Version:	*V1*	**Reviewed By:**	*Abdul Rehman*
Test Date:	*8-11-2022*	**Use Case Reference(s):**	*Go to Near-By Hospital Location*
Revision History:	-		
Objective	*Needed to check if the application is giving the correct hospital location to the Google Maps API*		
Product/Ver/Module:	*The optimal path being found in the Path Finder Module.*		
Environment:	*Google Map API and Android Studio*		
Assumptions:	1. *The system will have the correct location of the desired hospital stored in its database* 2. *The system will be correctly able to pass the hospital location to the Google Maps API*		
Pre-Requisite:	*Google Maps application must be installed at the user's mobile.*		

Step No.	**Execution description**	**Procedure result**
1	*Fetching the hospital's location from the database of the application*	*Hospital's location is fetched from the application's database.*
2	*Giving the obtained location to the Google Maps API to see if the Google Maps API accepts the hospital's location without any form of errors*	*Passed the hospital's location and the Google Maps API accepted the given location without any error.*
Comments:		
☒*Passed* ☐*Failed* ☐*Not Executed*		

6.2.3 Redirecting the User to Google Maps

Path Finder			
-			
Test Case ID:	*0003*	**QA Test Engineer:**	*Saad Shafiq*
Test case Version:	*V1*	**Reviewed By:**	*Abdul Rehman*
Test Date:	*8-11-2022*	**Use Case Reference(s):**	*Go to Near-By Hospital Location*
Revision History:	-		
Objective	*Needed to see if the application can redirect the user to the google maps application*		
Product/Ver/Module:	*The optimal path being found in the Path Finder Module.*		
Environment:	*Google Map API and Android Studio*		
Assumptions:	1. *The user's mobile system will give access to our application for opening the google maps application* 2. *After getting launched, Google Maps will work properly*		
Pre-Requisite:	*Google Maps application must be installed at the user's mobile.*		

Step No.	**Execution description**	**Procedure result**
1	*Sending request to the mobile system to launch google maps application*	*User's mobile responding to the request and launches Google Maps.*
2	*Giving the user location and hospital location in google maps application to get an optimal path with the start point as the user's current location and the ending point as location of hospital*	*Passed the user's current location and the hospital location in the google maps application*
Comments:		
☒*Passed* ☐*Failed* ☐*Not Executed*		

6.2.4 Navigating the Optimal Path

Path Finder			
-			
Test Case ID:	*0004*	**QA Test Engineer:**	*Saad Shafiq*
Test case Version:	*V1*	**Reviewed By:**	*Abdul Rehman*
Test Date:	*8-11-2022*	**Use Case Reference(s):**	*Go to Near-By Hospital Location*
Revision History:	-		
Objective	*Needed to see if we can navigate the optimal path shown by the google maps application*		
Product/Ver/Module:	*The optimal path being found in the Path Finder Module.*		
Environment:	*Google Map API and Android Studio*		
Assumptions:	1. *The Google maps navigation will automatically launch and show the optimal path* 2. *The user will be able to navigate the path provided by the Google Maps application*		
Pre-Requisite:	*Google Maps application must be installed at the user's mobile.*		

Step No.	**Execution description**	**Procedure result**
1	*When the user is redirected from our application to the google maps application installed in the user's mobile, it automatically shows navigation.*	*The google maps application automatically starts its navigation feature.*
2	*The user is able to navigate through the path given by the google maps application and is able to reach the desired location without any difficulty*	*The user is easily able to navigate through the path and reach the desired destination*
Comments:		
☒*Passed* ☐*Failed* ☐*Not Executed*		

Chapter 7: Conclusion and Future Work

7.1 Conclusion

In this report, we have understood the basic demand of our project and all the field that are related to our project, we have seen how the fields impact our project's value. We have compared our project with some of the products that are already existing in the market to see how they differ from our product and what addition features are being offered by our product. We have gone through the Functional and Non-Functional requirement of our project and the minimum criteria that our project must meet in order to be implementable.

We have also shown the basic structure of our project, its GUI, its architecture and some implementation. We have written user cases that must be handled by our product and then we have tested our project against some test cases related to the predefined use cases to see if the project is working properly and if it is feasible or not in terms of implementation.

7.2 Future Work

In our future work, we plan to achieve the following objectives:

- Improve the GUI of the project according to the feedback we receive from the targeted audience, in order to make the product more user friendly.
- Improve the optimal route finder in accordance to the feedback we receive from the targeted audience (if needed)
- Implement the Diagnose Functionality
- Further Test the product to handle as many scenarios as possible
- Harden Security of the Project (if needed)
- Optimize the Code to get more efficient performance (if possible)

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