

ONLINE POLYCLINIC APPOINTMENT AND DATABASE MANAGEMENT SYSTEM

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ABSTRACT

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Online Polyclinic Appointment and Database Management System

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The objective of this thesis was to develop an Online Doctor's Appointment and Medical Database Management System in Pakistan. The purpose of implementing this application was to create a system through which a patient can easily compare, choose and make an online appointment for a doctor just by sitting at home. The second objective was to replace manual medical file keeping system with online database management system.

The reason behind creating this system was the “trend of private medical clinics” and manual medical file keeping system in Pakistan. Online appointment and database management system aims to improve quality medical care by bringing all medical clinics of the city at one platform, eliminating long waiting lines and replacing manual medical file keeping with an online database.

The application was successfully implemented by using famous technologies and programming languages. This application does not aim to target any specific group but every individual who wants to seek medical help and that is why it was kept in mind to keep the user interface simple and friendly while building this application. Like all other applications, this application also has a client side and a server side. This application was developed by using HTML, CSS, and JavaScript at the client side while PHP and MySQL on the server side.

For now, basic functionalities have been implemented but for the future, work will be done to link pharmacies and laboratories to the system. Online follow-up for the distant patients is another feature that is aimed to add at later stages.

Keywords: online appointment, database management, online database.

FOREWORD

I would like to thank my supervisor 'Erkki Hietalahti' for his guidance and help during my thesis work.

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ABBREVIATIONS AND TERMS

CSS	Cascading Style Sheet
ER diagram	Entity Relationship diagram
HTML	Hypertext Mark-up Language
JavaScript	Scripting programming language
MySQL	Open source database
PHP	Server-side scripting language
TAMK	Tampere University of Applied Sciences
UI	User Interface
XAMPP	X-OS, Apache, MySQL, PHP, and Perl

1 INTRODUCTION

Health care is one of the fastest growing industry all over the world. Before the last few years, medical appointments were usually taken on the phone calls or by visiting the hospitals in person. This process needed the involvement of individuals so, the ability to take appointment was restricted to the availability of schedulers, phone lines or the physical presence of a person.

With the growth of time, everybody demanded timeless and efficient medical care delivery because manual appointments (that requires the physical presence of both individuals) and long waiting lines have formed an irritating situation for the healthcare institutions. So, it created a need for such an integrated health care system that could deliver seamless care to both outpatients as well as inpatients. The emergence of online appointment system offered timeless and efficient access to health care services. Therefore, for hospitals and other medical societies, online appointment booking has a great importance and a subject of interest (Koole, 2007).

Booking appointment online has become a new trend in the past few years and is considered as one of the key processes in the healthcare industry. Bailey (1952) considered scheduling system as a trade-off or a compromise between a doctor and patient's waiting times. Patients who get late for the appointments or who fails to come becomes the reason for the underutilization of a doctor's time. Idle time and underutilization of doctor's time are also resulted by gaps in the appointment times (Bailey, 1954).

Different researchers agreed that main patient dissatisfaction is caused by long waiting times. Cayirli (2003) defined access time as the time between patients' request for the appointment and the time he is checked up. According to Veral, waiting time is the time between consultation and the scheduled time while neglecting the early arrival of a patient (Veral, 2003). Different researchers defined waiting /access time in different ways. A well-designed appointment system supposed to improve patients' satisfaction by reducing cost and time of clinics and hospitals especially in the busy lives we are leading today.

With the growing population need for more efficient ways to access a medical treatment is also growing. Through an online appointment scheduling system, a user gets access to the doctor's online webpage and can make an appointment with online software. Patient/user can also provide additional medical history in advance, giving adequate time to the doctor to prepare the necessary information for consultation. In this way, online appointment scheduling systems are helping doctors and the patients and making the healthcare delivery efficient.

Nowadays there are many kinds of online appointment tools available in the market which are easy to set up and not too much expensive. Online scheduling system offers value-added services and lots of benefits to the doctors and patients. It makes the patient appreciated by eliminating the hassle of long waiting times. Online appointment systems are also getting popular because of its low-cost availability.

1.1 Main Purpose

The main purpose of this project is to link and bring all major private medical clinics of the city (of my country) to a single platform. So that patients can easily get access to the doctor's profile and make online appointments. The second purpose is to create an online medical history database so that doctors and patients can freely exchange patients' medical history information much easier, faster, and safer.

1.2 Objective of the Project

The main objective of the thesis is to provide quality medical care to the patients by bringing all medical practitioners of the city to a single platform so that everybody can easily access them and make appointments. The second objective is to replace the current manual file keeping system with an online medical patient database system.

1.3 Aim of the Project

The aim of this project is to create a platform where patients and doctors can access /interact efficiently with each other and provide ease and comfort to the patients. It also aims to resolve the problems that patients have to face while taking appointments and keeping medical files. Patients can choose a medical practitioner based on their professional profile and other patient's reviews. While doctors can access and update a patient's medical record after every checkup.

Following features will be added in the future:

- Online follow up with doctors (specially for distant patients)
- Linking laboratory and pharmacy so that medical store administrator can view suggested prescription and laboratory can view clinical tests recommended by the doctor. This feature aims to eliminate paper-based prescriptions.

1.4 Project Scope

This system is implemented for all the individuals who want to get treated by the city practitioners. The users can participate only if they have created an account through the registration form and have provided their medical history. Once they get registered themselves further they would not need to update their record as it would be done automatically after each doctor's visit.

1.5 Study Limitation

The lack of time was the main the limitation. Secondly, because there is no such system in my country so there may be some difficulties to implement and convince people to use this system.

2 LITERATURE REVIEW

2.1 Waiting time

Fernandes et al. (1994) defined waiting time as the period of time an individual wait until a specific action occurs. Waiting time was also defined as the time a patient entered a clinic or service point and gets consulted by a doctor with a prescription in his hand. There are two different ways in which the waiting time has been defined in the past. At first, waiting time is the time that starts when an individual comes for the appointment and it continues until the individual gets consulted by the doctor. In the second definition, it starts when an individual comes for taking appointment and ends when he got prescribed medicine after being consulted by the doctor.

With the passage of time, long waiting lines at doctor's clinics became a major problem in developing countries. In a South African health clinic, block appointment system was introduced as an experiment, in which waiting time for patients was measured for the period of one week before and after the implementation of the appointment system. During the experiment, interviews were taken from focus-group, staff, and patients and from results it was realized that acute medically ill patients with prior appointments had short waiting times as compared to the patients without appointments.

It has also been stated that the appointment system has no benefit for the patients not seeing the doctor or who are taking routine repeated medication. Later it was realized that the block appointment system offers shorter waiting time only for acutely ill patients and not for others.

2.2 Appointment Delay

It has been proved in the past research that there is a direct relationship between appointment delay and cancellation of the appointment. Appointment delay is defined as the time which starts when an individual request for an appointment and ends until he/she gets consulted by the doctor. Longer appointment delays cause more appointment

cancellations. So, the best way to reduce appointment cancellations or no-shows is to minimize the time gap between the appointment request and doctor's check-up/consultation time. Minimizing this gap is called open access (abbreviated as OA) or advance access policy which later became a popular practice and part of an active research also. Both positive and negative results were experienced by the researchers in their experiments. Some practitioners were in the favor of OA and highly recommended it, and on the other hand, there were some practitioners who disagreed and were against of OA implementation.

2.3 Managing Patient's Appointment

In a health care centre, an application which is used to manage and minimize patient waiting time is called managing patient's appointment system. Some health care clinics use this kind of applications while some do not. Medical clinics who use such applications usually have shorter waiting times as compared to those medical clinics who do not use any appointment application. Patients who supposed to wait more than an hour for their medical check-up feel disgraced and unfair. Patients can evaluate the quality of any medical centre based on the waiting time they have to experience. Therefore, it has become important to consider factors like "saving time" and "minimizing idle time" while developing any patient's appointment system. Whereas according to Klassen (2002), scheduling doctor's time and patient's appointment supposed to depend on the seriousness of the case and patient's need.

2.4 Online Booking

An online appointment system is a web-based system which is made up of independent components or web pages, working together for a common purpose. Such systems are available on the internet for the users to accomplish some purpose.

James (1999) defined internet as a system which provides an opportunity to millions of people to get access to a large amount of stored data and get connected to each other despite distances. Increased rate of missed appointments and patient dissatisfaction

pushed to recognize the need for better-quality care services. With the advancement of information technology and the sensitive situation of medical care, online appointment system emerged as an important output for efficient and timely delivery of health care services. Earlier, appointment requests were used to make through the phone call, email or fax but with the advancement of technology and internet, the trend changed towards the proper online appointment systems.

According to Gruca (2004), a patient can make an appointment for a doctor either by going directly to the doctor's clinic or making a manual appointment through the phone call or sending the email. With the emergence of the internet, health care centres can connect and communicate with their patients efficiently. Therefore, many healthcare centres have started using online appointment systems. Such systems ensure efficiency and effectiveness.

2.5 Existing System

In Pakistan, there is a huge trend of private medical clinics and hospitals. Doctors run their own private clinics and consult patients during the evening or any time of the day depending on their availability. Some are popular and known to all while some are known by few people. This situation proves to be a challenge for new practitioners as they are known to very few people even if they have a good academic background. On the other side, patients also face difficulty in finding and choosing a nearby doctor. Unscheduled appointments, long waiting lines and keeping medical files in physical form are also the common problems faced by the people/ patients of Pakistan.

2.5.1 Determination of Problem

Challenge for new practitioners

Starting a private clinic can be a challenge for new practitioners. For example, if a new doctor wants to open his clinic there is no platform exist, by which or from where people can get to know about his clinic.

The problem for a new individual in a city

In the same way, the same problem goes for any person new to the city as he is unknown, who is the best or closest doctor/clinic to go for a medical checkup.

Long waiting lines

To get doctor's consultation, patients come twice to the clinic once for taking the appointment and second time for the checkup. Some patients visit the doctor without any prior appointment resulting in a long waiting time. There is also a possibility that they don't consultation by the doctor even after a long waiting line.

Managing paper-based medical files

Patients must carry their medical related report or files every time they visit a doctor. And sometimes they lost their files too.

2.5.2 Proposed System

In “Online Polyclinic Appointment and Database Management System” I have tried to consider all of the above problems with the existing system in Pakistan. My objective was to provide a platform where all practitioners and patients can be brought together. In this application, all practitioners either new or working for a long time can sign up themselves. This way people can get to know and choose to visit any doctor of their choice. By using this application user will be able to know and access the professional profile of each registered doctor from all specialties. Doctor’s profile includes information regarding their professional experience, practicing license, educational background, clinic timings, working days, clinic accessibility and other patient reviews also. Users would be able to book appointment sitting at their homes. The user can choose a doctor close to them or have more professional experience or have more good reviews from the other patients. New practitioners can easily join the platform and start taking appointments without the need of any expensive advertisement.

When registering as a patient, the user can give all necessary medical history so that he doesn't need to keep or bring his medical file when going for a check-up. Every time

when a user books his appointment, the doctor can easily get access to the patient's profile and also update medical record.

2.6 Patient's Appointment Time

Scheduling appointments for the patients started long years ago. Primarily appointment system was developed to minimize doctor's idle time because it was thought that doctors time is more valuable as compared to the patient's waiting time. But later it was realized that the importance of minimizing the patient's waiting time is as important as the doctor's time. So now while developing an appointment system doctor's idle time and the patient's waiting time both factors are given equal importance. Patient's scheduling also includes improving quality health services, reducing doctors and nurses idle time and reducing patient's waiting time.

2.7 APPLICATION TECHNOLOGIES

The purpose of this project is to build an Online Appointment and Database Management System. It is important for the user to understand how this application works and knowing the technologies that are used to implement this project. For a better understanding, all steps are described in detail to give a full overview of the system.

2.7.1 Web Server

Role of a web server is to communicate between the client side and server side by storing, processing and delivering web pages to the client side. Usually, web browser initiates the communication using HTTP by sending the request of a specific resource and server gives the response with the content of that requested resource. For this project work, Apache HTTP server was chosen, and it exists on the WAMP service. Apache HTTP server is one of the popularly used web server software used in a lot of project works.

Apache web server

Apache web server is a free, open source and most popularly used software. Apache web server is used by many famous websites such as Apple, Wikipedia, and PayPal. Another reason for its popularity is that it can run on multiple operating systems such as Linux, UNIX, windows, and macOS. Another feature of Apache web server is that it can host websites which use server-side language code (Perl, PHP). Because in this project server-side implementation is done by using PHP so Apache was a good choice.

2.7.2 Programming Languages

In this project, PHP was chosen as a server-side programming language and MySQL was selected as a backend database. HTML, CSS, and JavaScript were used for the client-side work.

PHP

PHP is a server-side programming language commonly used to develop dynamic web pages. It is free and accessible in numerous different versions. It can be used on multiple OS such as macOS, windows, UNIX and different platforms. Because it is a scripting language so in this program code is taken after the program execution. PHP can also be used in desktop applications.

One of the reasons for choosing PHP in this project is that it supports MySQL which is chosen as a database in our project. PHP programming language makes easy to present images and PDF files on HTML pages.

Client-side programming

For the development and designing of web pages HTML, CSS and JavaScript languages were used. HTML for creating the web pages, CSS for styling and for adding further functionalities JavaScript was used.

JavaScript

JavaScript is dynamic, high-level scripting language and considered to be one of the core three technologies of the world wide web. It is considered an important part of a web application. It is used for adding functionalities and making web pages interactive. In simple words, it informs the browser about a certain activity or event that occurred and changes the web page as a response to that event, for example, a click on a button.

HTML

Hypertext markup language (HTML) is used for creating web pages and web applications. It describes the structure of the web pages. Information from the HTML documents is sent to the web browser to render or display on the multimedia pages. Html used to describe the structure of a document by presenting a document in a heading, paragraph, image, list, links and other objects like that. Web browser presents the HTML document by using its tags.

CSS

It is important to make HTML pages attractive to the users and for this purpose, developers choose colors, nice fonts, and different layouts. All this work is done by the CSS. In short, CSS is used for styling of a HTML document. It is designed in such a way that enables separation of content and presentation so that it makes easier any change of

content without interfering with a design. It also enables multi web pages to share the single CSS file for styling to reduce repetition and complexity.

Backend technology

For this project work, MySQL was chosen as a database.

MySQL

It is an open source relational database management system which aims to offer multiple user access to several databases. In simple words, a database is a collection of data which can be a list of shopping items, number of items in a shopping centre or even a vast amount of numerous data in a corporate network. To manage such kind of data, a database management system is required such as MySQL which aims to access data and perform functions like add, remove or edit data. Since MySQL is a relational database so it stores data in different tables instead of putting into a large storeroom. Storing /organizing data into tables increases the accessibility speed and flexibility.

Applications which demand availability and scalability use MySQL. Because it has the capability to recover and cope with failures on the host, MySQL, operating system or the hardware that may cause downtime. Scalability refers to the ability to spread the database as well as application queries. MySQL is reliable for data security. MySQL has a good memory management system and provides multiple development interfaces (ODBC, JDBC).

Since MySQL is a free open source software so anyone can download it without paying anything and make changes into the source code. For this project, MySQL was chosen because it is very easy to use and PHP's ability to work with MySQL.

2.7.3 Software Tools

For this project work following source tools were chosen to perform various tasks:

Notepad++

Notepad++ is an unrestricted, plain text editor used widely by developers for Microsoft Windows. Notepad++ supports several languages and is used to write and edit code. In this project Notepad++ is used to write HTML, CSS, PHP and JavaScript codes. Its main features include syntax highlighting, correcting and auto-completion.

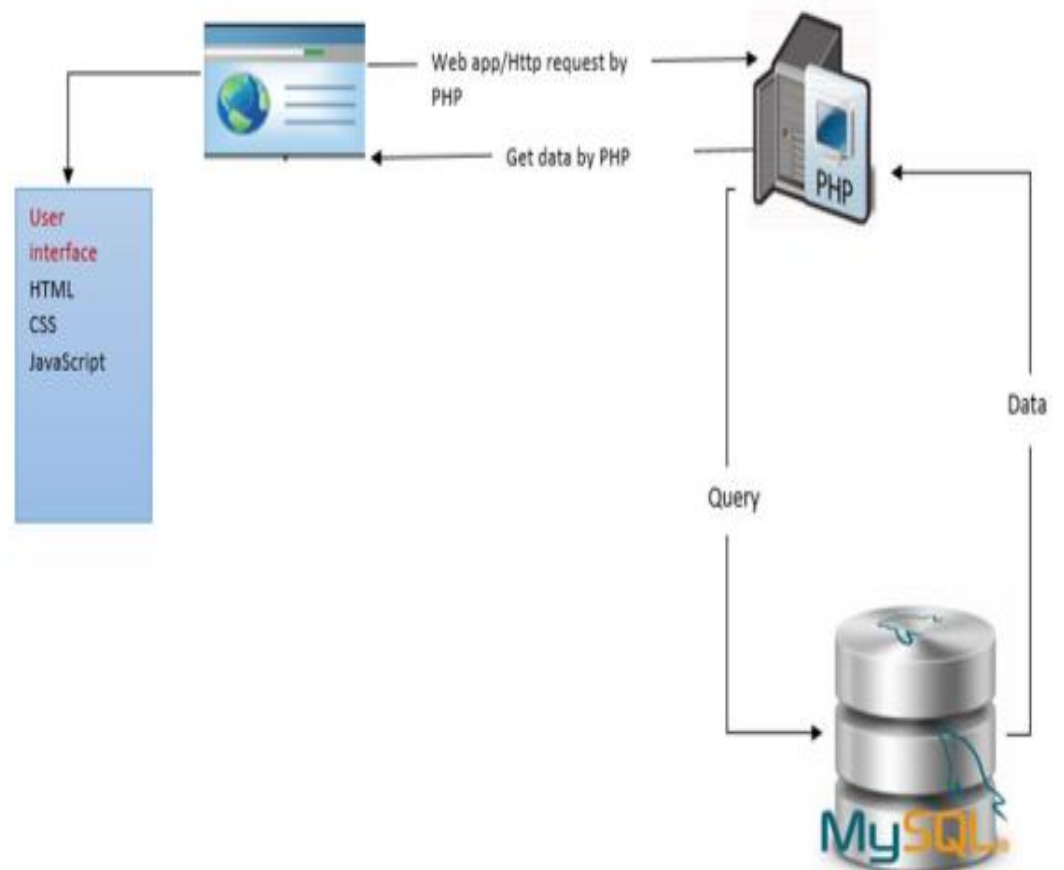
XAMPP Server

XAMPP is a free and open source software which empowers technologies, processes, and machines to link and work together. It is established by Apache. It stands for x-OS, Apache, MySQL, PHP, and Perl and used as a stage for coding and designing web pages.

Xampp is very easy to install and has the capability to run on several platforms. Xampp has very strict security settings and with a single command it can start and stop the server.

3 SYSTEM ARCHITECTURE

The system architecture of this system is divided/split into two parts. One is the client side and the other is the server side. Client-side is the user interface whereas the server side is the combination of web pages written by PHP and the MySQL database. PHP pages contain the written SQL queries which make the accessibility to database possible. The following figure shows the architecture of the system while the detail of the technologies used in this application is discussed in chapter 2.



4 REQUIREMENT AND SYSTEM DESIGN

4.1 System Overview

We are implementing a web-based appointment system in Pakistan for booking an online appointment and keeping an online medical history. Users can sign up online, search for the nearby doctor and book appointment while sitting at their homes by using a web browser. Two different types of actors are using this system: user actor (patient), which can be registered to the system, search for the doctor and book an appointment. Administrative actor (doctor/ physician), which can log in to the system with a username and password, accept patient's appointment request and update medical record after each visit. The functionality and more features are explained in more detail in this chapter.

The main characteristics of the system are:

- Every individual either a doctor or a patient will have an independent id, name and a profile. Doctors are further categorized by the specialty of practice (i.e. Obs/Gyne, Urology, Internal Medicine etc.)
- The user (patient) can get, change or cancel appointment time and view medical record while the doctor can make changes in his calendar and accept or reject appointment request by log in to the site and accessing his/her personal page.

4.2 Use Cases

To explain the better view and functionalities of the system, use case diagrams are chosen. The use case diagram is important to document the requirement of the system as well as to specify functionalities of the system. Use case diagrams better explain the way the user interacts with the system.



Figure 1: Use Case Diagram

4.2.1 Patient Use Case



Figure 2: Use Case for Patient (user)

Use-Case 1: Registration

Primary-actor: generic user/patient.

Description: To make an appointment, user registration is required.

Precondition: National ID card and valid email address.

Basic use-case flow: For the registration process, the user/patient needs to give some information by filling the form. Some of the required information includes the following:

First name

Last name

Gender

Email address

National ID no.

Main scenario: The user/patient will go onto the patient sign-up button either from the main page or from the drop-down menu. After clicking the sign-up button, a registration form will appear, where the user must give his personal information i.e. name, gender, email address, CNIC, any medical history etc. After giving the required information user will submit the form. If all the fields are filled including the valid email address and CNIC, the user will be registered onto the system. In case of any missing entry or invalid format of an email or CNIC, the error occurs onto the page.

Exception: Expired/invalid National ID card no or email address.

Use-case 2: Login

Primary-actor: Patient/user.

Description: Before taking any appointment or get access to his medical record, the user must have to provide his username and password.

Precondition: the user must have a valid username and password.

Basic use-case flow: a valid username with a password must be entered by the user.

Main scenario: To be able to get into the system, the user needs to enter his username and password either from the main page or from the drop-down menu from the top of the page. After clicking onto the login button, authentication request will be forwarded to the system.

Exception: wrong/invalid entered username or password.

Use-case 3: search for a doctor

Primary-actor: User patient/generic user

Description: In this use-case, any registered or unregistered user, can look and search for a doctor of any desired specialty.

Precondition: this use-case has no exception.

Basic use-case flow: By going into the category of any specific specialty, the user can view the list of all registered doctors.

Main scenario: The user will go to the down menu at the top of the page. A list of all specialties will appear in a drop-down list. The user will hit on the desired specialty. After that, a page will open with all doctors of that specific specialty. Now the user has the choice to choose any doctor based on qualification, experience, location etc.

Exception: no exception for this use-case.

Use-case 4: Take Appointment

Primary-actor: User/patient

Description: After choosing a doctor user will go further to send an appointment request from the available timings.

Precondition: the user must be login

Basic use-case flow: The patient/user hits the button for taking an appointment for the doctor. A list of available timings will appear for the chosen date. The user will select the suitable time for him and send the request for approval.

Main scenario: The user will hit the button for "take appointment". List of available timings will appear for a chosen date. The user selects the suitable time. The user will hit the submit button to send the request for approval.

Exception: this use-case has no exception.

Use-case 5: View history

Primary-actor: User/patient

Description: the user can view his medical history.

Precondition: the user must be signed in.

Basic use-case flow: The user/patient will click on the name of the patient and it opens the patient's profile. By going into it the user can view the history by clicking on the button for the patient's old reports/history.

Main scenario: The user clicks on the name of the patient and then press the button "view history" to view old reports.

Exception: no exception for this use-case.

Use-case 6: Log out

Primary-actor: User/patient

Description: the user will log out from the system.

Precondition: the user must be logged in

Basic use-case flow: the user can sign out himself from the system.

Main scenario: the user clicks on the log out button. The system will bring the user to the main page for the generic user.

Exception: no exception for this use-case.

4.2.2 Doctor's Use Case

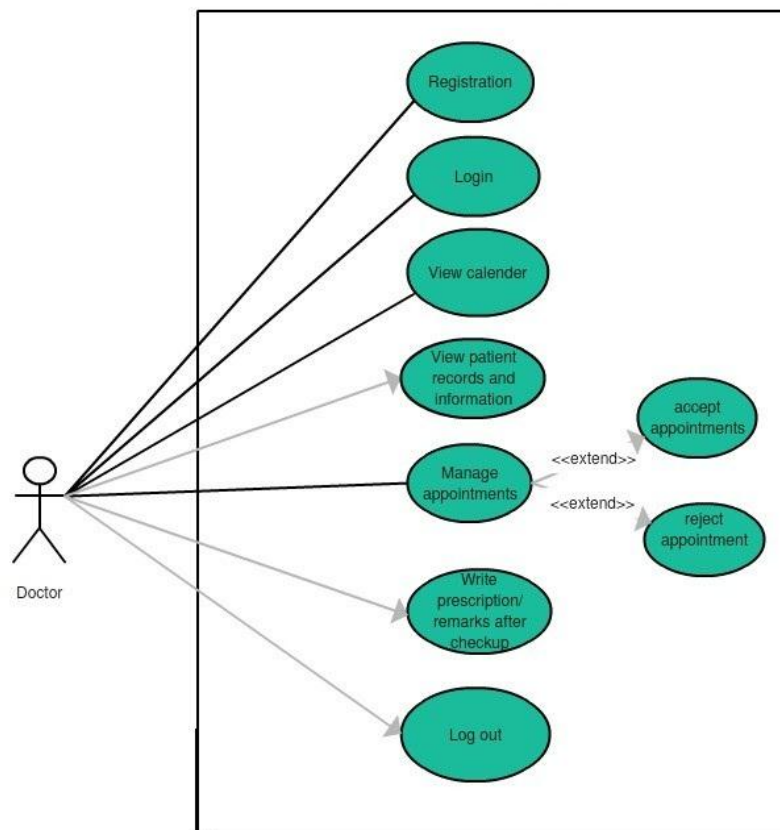


Figure 3: Use Case for Doctor (user)

Use-case 1: Registration

Primary-actor: Generic user/doctor

Description: To get online appointment requests, the doctor must register himself as a user on the application/system.

Precondition: National ID card and active email address.

Basic use-case flow: To register as a doctor, the user must fill the form. Required fields include the following information:

Full name

Email address

National identity number

Qualification

Experience

Valid PMDC certificate (Practicing license issued by the PMDC authority)

Clinic address

Clinic timings

Main scenario: The user/ doctor has to go onto the doctor's sign-up button either from the drop-down menu at the top or from the main page. After clicking the sign-up button, a registration form will appear, where doctor/user has to give his personal as well as professional information i.e. name, clinic address, qualification, working experience etc. The user must give valid PMDC certificate for the registration process. After giving the required information user/ doctor will submit the form. If all the fields are filled, request for registration will be sent to the admin. As soon as admin receives a request for a doctor's registration he will verify his documents and only then the user will be accepted /registered. In case of any missing entry or invalid format of email or CNIC, an error occurs onto the page. PMDC certificate is a license or a proof that an individual is allowed by the authority to practice medicine. Any user fails to give valid PMDC certificate issued by PMDC authority will not be allowed to register as a doctor. PMDC certificate is important to avoid any scam.

Exception: False documents, expired or invalid PMDC certificate, missing fields, expired national ID card or inactive email.

Use-case 2: log in

Primary-actor: User/doctor

Description: For further functions, the user must have to provide his email address and password.

Precondition: the user must enter the username and password.

Basic use-case flow: user/doctor should provide his username and password to log in.

Main scenario: To be able to get into the system, the user needs to enter his username and password either from the main page or from the drop-down menu from the top of the page. After clicking onto the login button, an authentication request is forwarded to the system.

Exception: occurs if fails to provide username and password.

Use-case 3: View calendar

Primary-actor: User/doctor

Description: User would be able to view his calendar.

Precondition: The user must be signed in.

Basic use-case flow: After logging in, the user/patient selects the date from the calendar to filter out the appointment.

Main scenario: After signing in, the user/doctor can view the page of his calendar. The user will select the month and date to see the appointments of that period or date. The user can view all the patient's appointments of any date.

Exception: no exception for this use case.

Use-case 4: Accept or reject a request

Primary-actor: User/doctor

Description: User/doctor can accept or reject any patient's request.

Precondition: User/doctor must be signed in.

Basic use-case flow: User/doctor selects any date and decides to accept or reject any appointment request.

Main scenario: After logging in, all the patient's appointment requests will be appearing on the calendar according to the dates. User /Doctor will select the date from the calendar. User /Doctor can view all the appointment requests. User /Doctor can select the option to accept or reject the appointment request from the drop-down menu.

Exception: no exception for this use case.

Use-case 5: View patient

Primary-actor: User/doctor

Description: User/doctor would be able to view the patient's detailed information including his/ her medical history.

Precondition: User/doctor must be signed in

Basic use-case flow: After selecting the date, user/doctor selects the patient. User/doctor can view the patient's detail and medical history.

Main scenario: After selecting the date, list of patients of that particular date will appear. User /Doctor will select the patient. User (doctor) can view his all information including the medical history by clicking on the "view patient" button

Exception: no exception for this use case.

Use-case 6: Add comments

Primary-actor: User/doctor

Description: User/doctor would be able to write his own comments into the patient's medical profile.

Precondition: User/doctor must be signed in

Basic use-case flow: After clicking on the "write comments" button, user/doctor can add his own reviews after checking the patient.

Main scenario: User/doctor will hit the "write comments" button. User (doctor) will write his or her comments. User/doctor will hit the submit button.

Exception: no exception for this use case.

Use-case 7: log out

Primary-actor: User/doctor

Description: the user/doctor will log out from the system.

Precondition: the user/doctor must be signed in

Basic use-case flow: the user/doctor can sign out himself from the system.

Main scenario: the user/doctor clicks on the log out button. The system will bring the user to the main page for the generic user.

Exception: no exception for this use case.

4.2.3 Admin Use Case

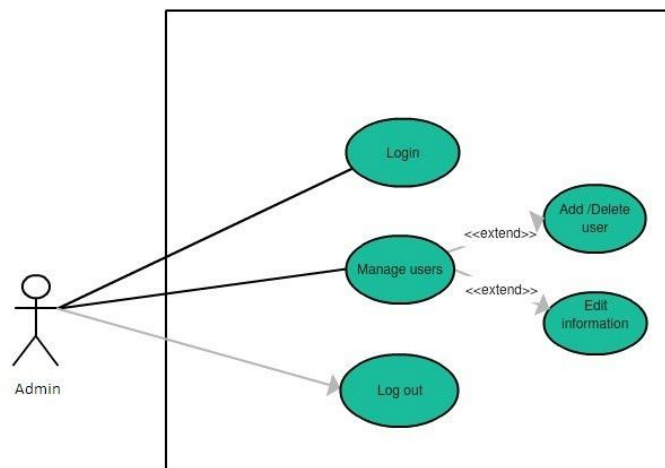


Figure 4: Use Case for admin

Use-case 1: Login

Primary-actor: Admin/administrator

Description: A user, who possesses admin username and password, owns administrative rights.

Precondition: username and password.

Basic use-case flow: Admin/user needs to provide the username and a password.

Main scenario: Admin/user enters valid username and password. After verification, the user will be logged in as an admin and can use all the administrative rights.

Exception: occurs if user provides wrong username/password.

Use-case 2: Manage users

Primary-actor: Admin/user

Description: User/admin can use his administrative rights.

Precondition: the user must be logged in as an admin.

Basic use-case flow: Admin/user can view, edit or delete any user information.

Main scenario: Admin can view, edit or delete any user or any information related to user doctor or user-patient.

Exception: no exception for this use case.

Use-case 3: log out

Primary-actor: Admin/user

Description: Admin will log out from the system.

Precondition: Admin must be signed in

Basic use-case flow: User signs out himself "as an admin".

Main scenario: User clicks onto the logout button. The system will remove information from the local storage and brings the user to the homepage.

Exception: no exception for this use case.

4.3. System Design

4.3.1 Class Diagram

The class diagram is chosen to explain the design phase of the system. A class diagram describes classes of the system, attributes, and operations and relationships of the classes in a better way. We can also say that class diagrams are used to justify the structure or behavior of use cases of the system. Class diagrams best explain the conceptual model of the system in terms of entities and their relationships. The class diagram looks like a shape of a rectangle, comprising three compartments stacked vertically. The first top box comprises the class name, the second middle box contains the attributes of the class and third the last box contains the methods or functions performed by that class. The first compartment /box of the name is compulsory while rest of the two can be omitted to simplify the diagram. So, in any class diagram first compartment must be drawn while the second two compartments are optional.

The class "patient" contains multiple parameters (such as id, name, age, address), which depict the information of all the registered patients. The user class also contains the methods performed by these users such as get appointment, view/ create own medical record etc. In the same way, the class "doctor" has the parameters id, name, department, address possessing all the required information of the users registered as a doctor on to the system. Methods include accept/reject the appointment, check the patient, view a medical record of any patient etc. These methods are the functions performed by the users registered as a doctor on the system. The class "appointment" has the parameters of date and time, explaining what time or day patient user has requested for the

appointment to the doctor. The class “department” has the parameters id and name and methods include add/ delete doctor and add or delete department. Every doctor user must belong to any department class. The “report” is another class containing methods like write report or prescribes medicine. In the end, class “admin” contains the parameters like id and name and methods of this class include manage users.

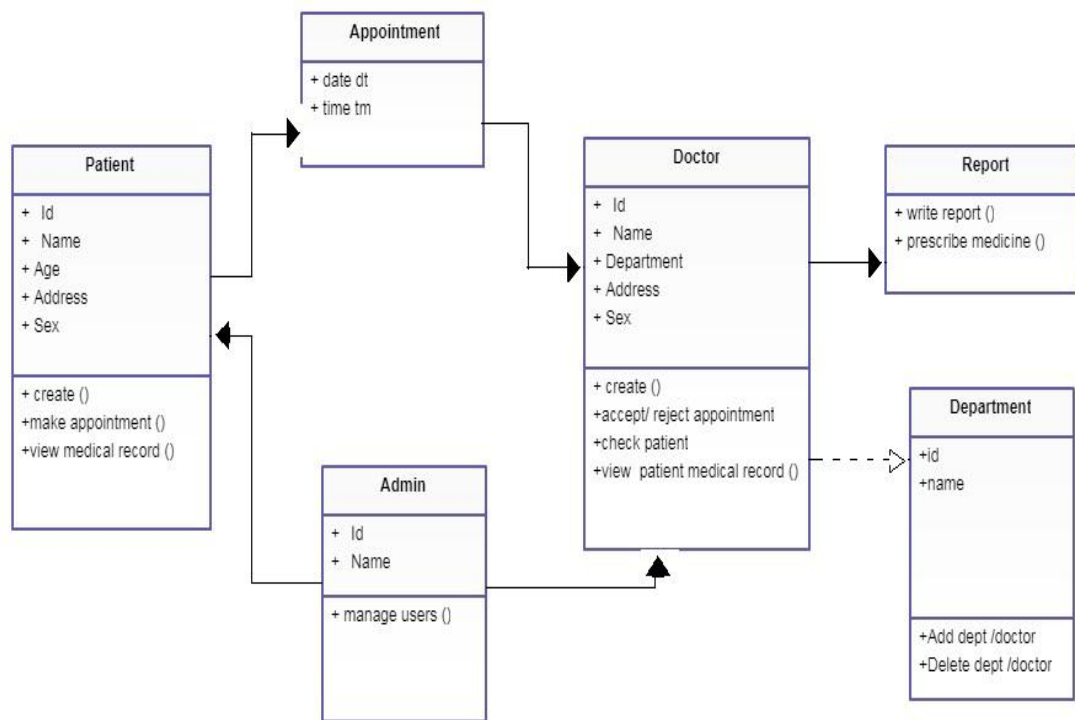


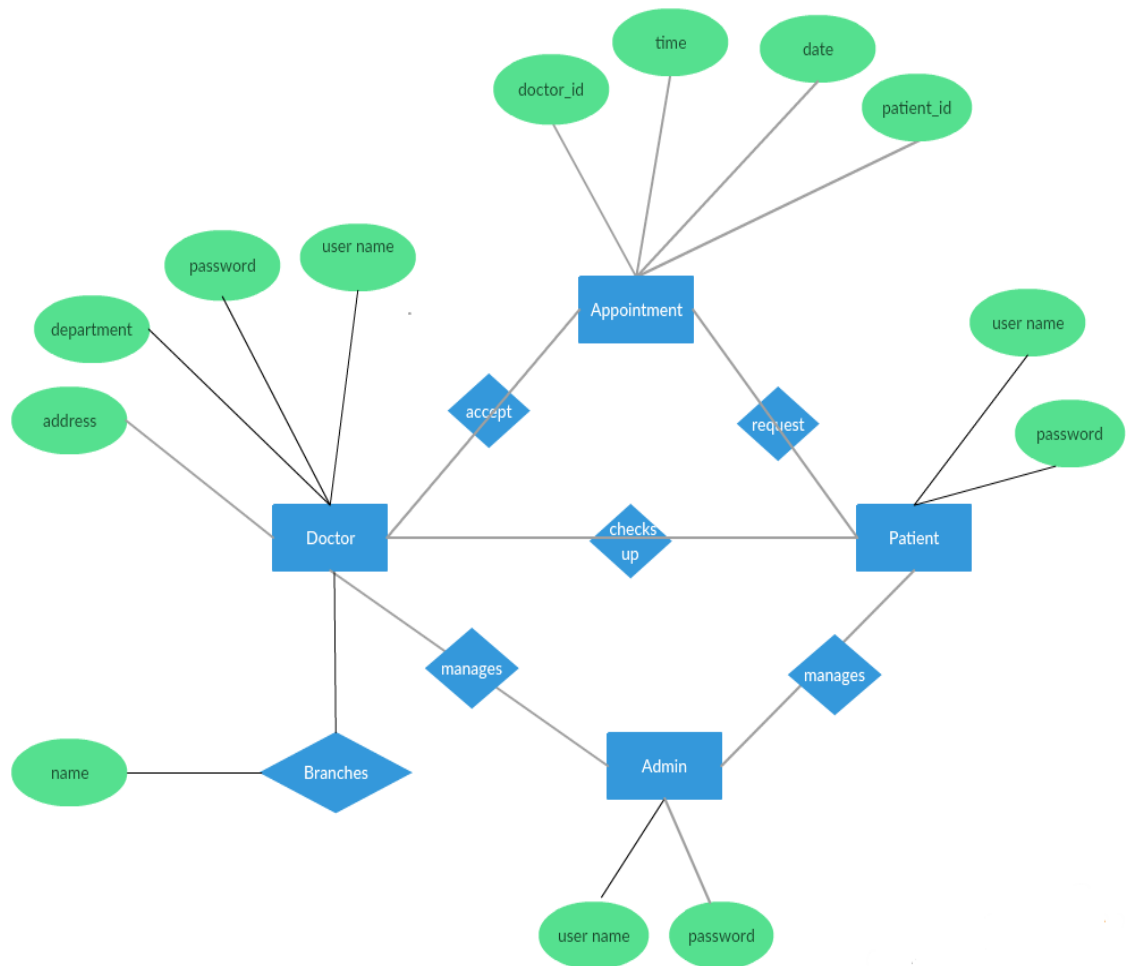
Figure 5: Class Diagram

4.3.2 ER Diagram

A basic ER model consists of objects called entities and specifies relationship among those entities. Purpose of this diagram is not to define any functionality rather show association and dependency among entities. ER diagram is drawn with "rectangular boxes" as entities and the "straight lines" showing the relationship between these boxes. An entity is an object or a thing that has an independent existence and can be easily differentiated from others. Each entity has some attributes like name, age, address, department etc. In the following diagram the doctor, patient, appointment, admin etc, all are different entities. So, an entity can be a person, animal, plant, event or a company.

Entities consisting of similar attributes make the entity sets. These entities have some association among each other which make a relationship. These relationships can be "one to one" or "one to many" or "many to many". For example, a doctor and department can have "one to many" relationships, means one department can have many doctors but one doctor is related to only one department.

Figure 6: ER Diagram



5 SYSTEM IMPLEMENTATION AND SOFTWARE TESTING

5.1 System Testing

For the sake of software quality assurance, system testing is a very essential thing to do. It is a process by which we try to make the system error proof by performing the program to find an error. The goal is to run the program, find errors or bugs and then fix them. Testing is considered a very essential step in software development and any system is not considered to be complete without this process. Different developers follow different approaches for system testing. System testing is followed to make sure that system is working fine and meets the requirements.

Test case ID	Test case name	Precondition	Priority	Input test data	Steps to be executed	Expected Result	Successful or not
1	User_reg	no	high	Valid email address or correct national ID card no	Need to fill the registration form and submit	Registration successful	OK
				invalid email address or incorrect national		Error message	Error

				ID card no			
2	User_login	Must be registered earlier	high	Valid username and password	Enter username and password and submit	A successful login to the system	OK
				Invalid username or password		Login failed, and the system displays an error message	Error

5.2 User Interface Layout

This online clinical appointment system is the first system to be implemented in Pakistan, so it is very important to keep the interface simple and easy to be easily understood by a user. For this purpose, simple and common UI elements are used. It makes the common user to easily understand the system and get used to it. The below-given figure shows the prototype of the system. There is a horizontal menu list on top of the home page. This menu list contains drop down buttons such as specialization, patient, doctor, and contact. All these buttons open a new webpage. When a user brings cursor onto the specialization button, a drop-down menu list appears showing/ containing all the existing departments. All doctors are classified based on the departments or specialty. The user can choose to view the doctors of any specific specialty by clicking on this button. Next comes the button for the doctor. The user can register himself or sign in if he already has an account. Next button on the menu is for the patient, the user can again sign up or sign in if he/she has already an account. The last button on the menu bar is of “contact us”. Any user can call or send an email to the admin by using this option. This page contains all the information or possible ways to contact in case of any need. When we go down of the homepage there is a big picture to make the page look good and then again there are two blocks for the doctor registration/ sign in and patient registration/sign in.

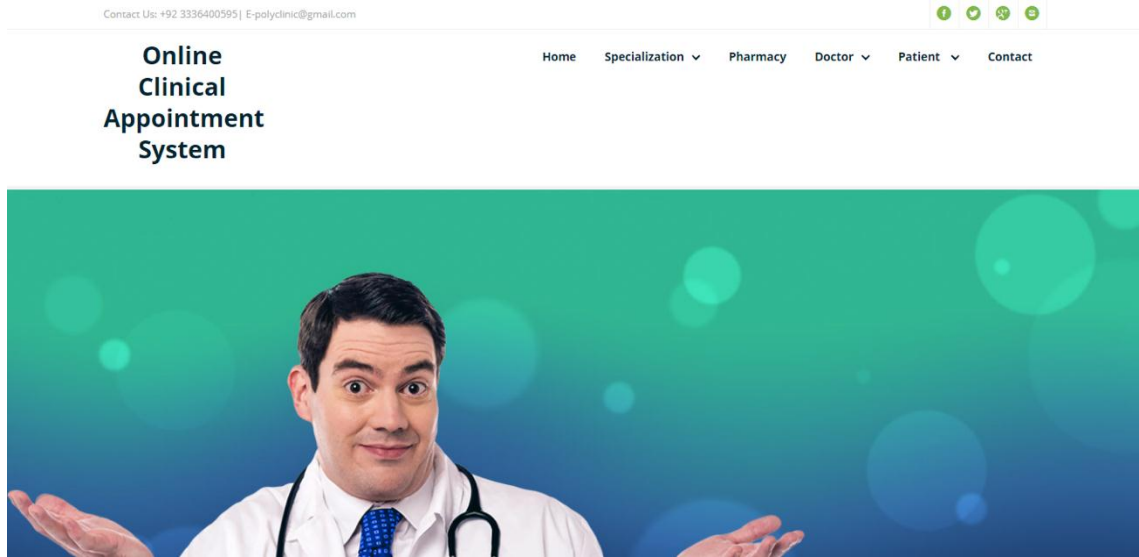


Figure 7: Layout part 1

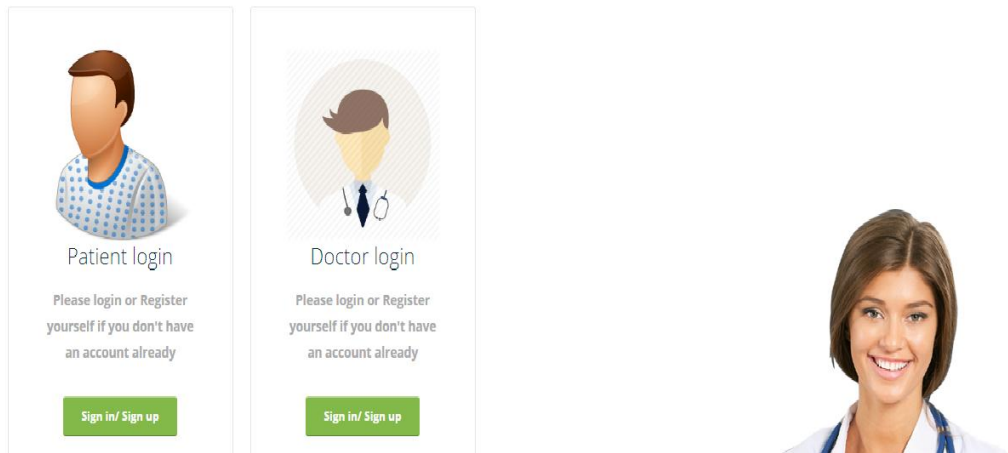



Figure 8: Layout Part 2

PROVIDING ADVANCED MEDICAL SERVICES






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LEAVE A MESSAGE

Your message

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Figure 9: Layout part 3

5. DISCUSSION

After coming to Finland and experiencing such an organized and centralized health care system for the public, I also decided to make a similar application for my country. Of course, the scope of the application I am developing is not too big, but I hope at least it would be a good solution to the prevailing problems of my country. As I have mentioned earlier there are a lot of small clinics in every next street, creating a very confusing problem for the public as well as new practitioners. So, this kind of system will help the users to choose which doctor to consult, maintain an online medical record, get an appointment online and equal opportunity to all practitioners to be reached by the public.

Because it is going to be the first-ever system of this kind in Pakistan, so it is very important to keep the user interface very easy to understand and simple to use. So, I tried not to bombard web pages with too much stuff.

Usually developing any system comprises of three basic steps planning, design, and the testing phase. After finalizing the basic requirements that should be met by the system, it was also important to decide which technologies to use for the development of this system. For this purpose, I took help from the web and carefully studied already existed similar web applications. Use case diagram, class diagram, and ER diagram are used to better explain the system and its working. The purpose for drawing use case diagram was to explain not only functionalities but also to write down the requirements of each user very clearly. The class diagram was drawn to explain the relationship and behavior of entities.

For now, I have chosen and working on some basic functionalities like an online appointment, online database, and online doctor review. But for the future, I would like to extend my system to the pharmacies and laboratories. For example, different pharmacies and laboratories can also be registered with the system. And when the doctor prescribes some medicine or writes some tests, the patient can just go to any registered pharmacy and get the medicine after showing his ID. In the same way, if a doctor writes some tests, the patient can go to any registered laboratory. Registered pharmacies and laboratories would have some limited access to the patient data like what is prescribed by the doctor and they can add the report result into the patient's

database. Online follow up is another feature that I would like to add in my system at some later stages. The idea of this feature came into my mind because the patients living in faraway places have to come multiple times for the “laboratory test results” and “doctors' advice/ follow-up appointment” based on those tests. So, after the laboratory tests, patients just have to book an online time and they can have an online conversation with some fewer fees. Online payment is again another feature I would like to add at later stages.

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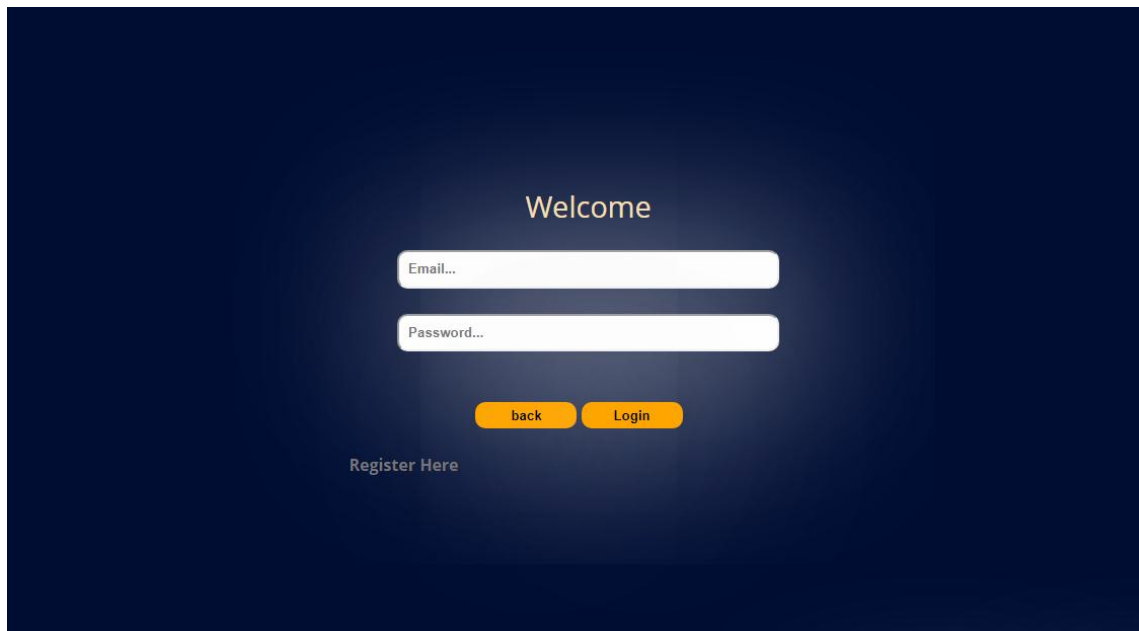
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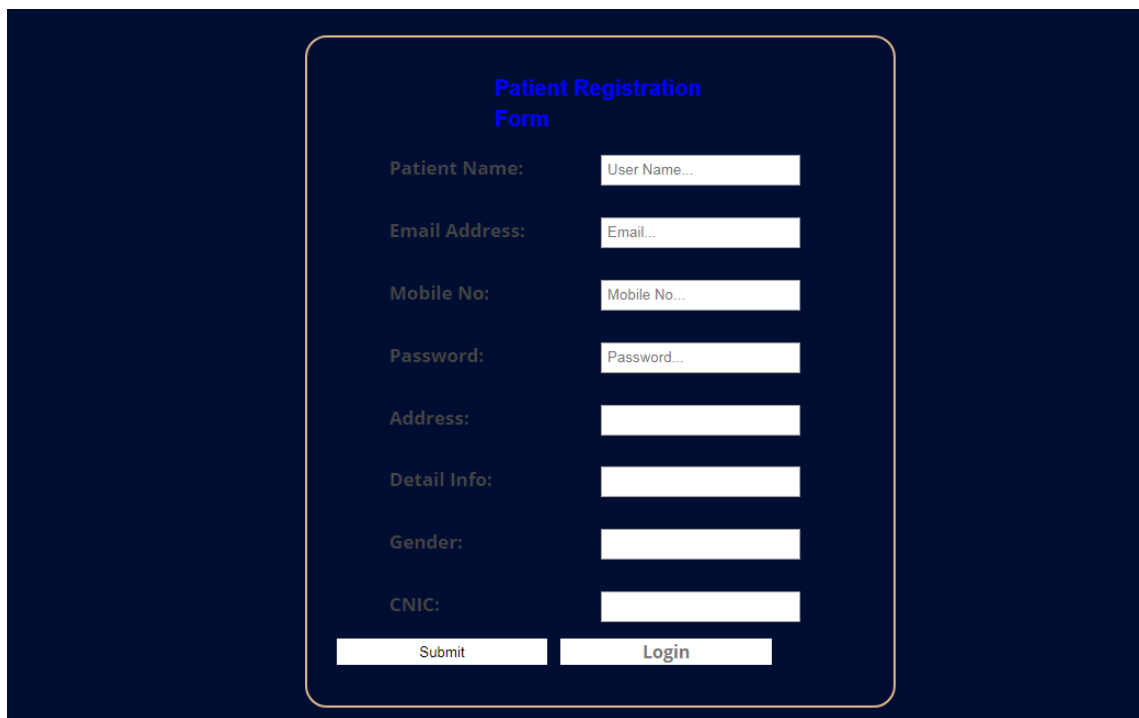
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APPENDICES

A dark blue background with a white 'Welcome' text at the top center. Below it are two white input fields: 'Email...' and 'Password...'. Underneath the password field are two orange buttons: 'back' and 'Login'. At the bottom left, there is a white text link 'Register Here'.

h 1:User Sign in/ up page

A dark blue background with a white rounded rectangle containing the 'Patient Registration Form'. The title 'Patient Registration Form' is in blue. The form fields are: 'Patient Name:' with 'User Name...', 'Email Address:' with 'Email...', 'Mobile No:' with 'Mobile No...', 'Password:' with 'Password...', 'Address:', 'Detail Info:', 'Gender:', and 'CNIC:'. At the bottom are two white buttons: 'Submit' and 'Login'.

h 2:Patient's registration form