

# Design and Implementation of a Patient Appointment and Scheduling System

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**Abstract:** The current health care landscape desired efficiency and patient satisfaction for optimal performance. The outpatient of most clinics in developing countries are faced with plethora of issues. These include: overtime for doctors and nurses during clinic sessions, long waiting time for patients, and peak workloads for counter personnel. The quality of health care delivery has been threaten by overtime and peak work load. This paper focuses on developing a system to improve upon the efficiency and quality of delivering a web based appointment system to reduce waiting time. In this paper, a patient appointment and scheduling system is designed using Angular JS for the frontend, Ajax framework for handling client-server request and Sqlite3 and MYSQL for the backend.

**Keywords:** Patient, Appointment, Scheduling, Angular JS.

## I. INTRODUCTION

Globally, health care sector is the pivot and integral part of human lives. Thus, any error committed in the clinical services might leads to defect or termination of life. Recently, information and Communication has been used extensively to improve the various operations and services in the field of the health care service. Patient appointment with the Doctor is one of the clinical services that have been automated. Healthcare providers are motivated to reduce operation cost while improving the quality of service. This has given rise to preventive medicine in order to avoid disease, lessening the demand for emergency department and hospital stays for sick people. The importance of Patient Scheduling cannot be underestimated in the health care delivery landscape. Patient scheduling is a complex process that perform a crucial role in health care. Patient scheduling performs several functions, from allocating resources to patients in need of exams and allocation of surgery rooms to on-demand appointment scheduling with Family Doctors working at Primary Care clinics. A good appointment scheduling system encourages patient and physician satisfaction, and as such, is an important component of healthcare[1]. The efficiency of health care delivery hinged solely on the effectiveness of the Patient scheduling system. it reduces medical error among practitioner and also reduce the number of unsatisfied patient. Appointment systems have been extensively used to reduce patient waiting times and waiting-room congestion[2]. Such systems have the potential to increase access to medical resources while reducing cost, as well as staff and patient dissatisfaction derived from unmet schedule constraints. The main aim of optimal patient scheduling is to determine an appointment technique for which a particular measure of performance is optimized under uncertain conditions [2]. Appointment scheduling system is a system for planning of appointments between resources such as patients, facilities and providers. It is used in order to minimize waiting times, prioritize appointments and optimize the utilization of resources. Angular JS is an extensible and exciting new JavaScript MVC framework developed by Google for building well-designed, structured and interactive single-page applications (SPA). It lays strong emphasis on Testing and Development best practices such as templating and declarative bi-directional data binding. The framework is used to create rich and interactive SPA's (Single page Architecture). The framework consists of several core and optional libraries[29]. In this paper, an appointment and scheduling system is designed to reduce time waiting and ensure optimal use of clinical resources. The proposed system uses Angular JS framework for the front end design and PHP for the server side logic.

## II. LITERATURE REVIEW

### Scheduling

Scheduling can be described as the process of assigning jobs to resources for some duration. Scheduling problems are ubiquitous, ranging from computer systems and networks, to production factories and patient appointments. Many of such problems are either solved by manual operation or using heuristics specifically designed to the context[1]. According to [3], Patient appointment scheduling can be classified into three:

**Single Batch Process :** In this Appointment scheduling process, decisions are delayed until after receiving all appointment requests for a given period. This model is commonly used in surgery starting times, and allows scheduling with complete information, so that a perfect or near perfect solution can be found through discrete optimization or heuristic methods.

**Unit Process Appointments:** In this appointment scheduling model, the process are assumed to come one at a time and are scheduled at the time of the request arrival. Through this process, a perfect solution will unlikely be found, but may be approximated if the distribution of appointment request types is learned.

**Periodic Process Appointment** requests are kept in a buffer of fixed size and are scheduled once the buffer is full. This allows a better approximation to the optimal solution by considering optimal or near optimal solutions at each period.

### **Online Appointment Scheduling system**

Online appointment scheduling system is a system through which a user or guest or simply, patients can access the website of the doctor, and through the online software, patients can easily make their appointments. In addition to that, patients can also provide additional information to the doctor, making the doctor aware of their situation and giving the doctor time to prepare the necessary information for when the patient's arrives. An online scheduling system allows individuals to conveniently and securely book their appointments online. Compared to the usual queuing method, the web-based appointment system could significantly increase patient's satisfaction with registration and reduce total waiting time effectively[10].

### **Waiting Time**

Waiting time refers to a period of time which a patient must wait in order for a specific action to take place, after that action is triggered or requested. It is defined as "the length of time from when the patient entered the outpatient clinic to the time the patient actually received his or her prescription. It is also described as the total time expended by a patient from registration until consultation with a doctor.

### **Angular JS**

AngularJS is a JavaScript-based open-source front-end web application framework mainly controlled by Google and by a community of individuals and corporations to address many of the challenges encountered in developing single-page applications. AngularJS framework works by first reading the HTML page, which has embedded into it additional custom tag attributes. Angular interprets those attributes as directives to bind input or output parts of the page to a model that is represented by standard JavaScript variables. The values of those JavaScript variables can be manually set within the code, or retrieved from static or dynamic JSON resources.

The importance of AngularJS includes the following:

- AngularJS is a powerful JavaScript based development framework to create Rich Internet Application (RIA).
- AngularJS provides developers options to write client side application (using JavaScript) in a clean MVC way.
- Application written in AngularJS is cross-browser compliant. AngularJS automatically handles JavaScript code for each browser.
- AngularJS provides data binding capability to HTML thus giving user a rich and responsive experience.

AngularJS applications can run on all major browsers and smart phones including Android and iOS based phone

### **III. RELATED WORKS**

[21] developed a decision support system Tool for Appointment Scheduling to Reduce Patient No-Show Rate in an Outpatient .

[5] proposed a smart appointment reservation system. The proposed system helps in managing appointments and also provides platform for patient to cancel or reschedule appointment by integrating distributed clinical systems into a set of consistent and convenient services accessible via a web browser.

[20] proposed a mobile application for booking appointment using Android .The authors developed a system that will ease the process of booking appointment of the doctor. The patient will book the appointment through his/her mobile phone. The doctor , at the other end could determine the number of patients he has to attend whole day.

[6] proposes an online patient appointment scheduling system based on the Web Services architecture. The analysis and implementation results show that the Web Services architecture provides an ideal design paradigm for the development of integrated health care information system in the primary care setting.

[23], proposes dentist online Reservation System. The aim of the proposed system is to save the time and effort of the users in safe and convenient ways. It enables patients to book and check their appointment schedule. administrator to maintain the database online easily. It enables the administrator to check the patient's requests, manage the appointment schedule, and manage the patient's information.

[24], in their paper titled "Dynamic Scheduling of Outpatient Appointments under Patient No-shows and Cancellations", proposed a framework for heuristic dynamic policies for scheduling patient appointments, taking into account the fact that patients may cancel or not show up for their appointments.

[12] developed a web-based appointment system by integrating with Intelligent System techniques. The system was designed to manage appointment and time reserved between students and Lecturer for any academic-related activities such as discussion and weekly meeting with lecturers. The main focus of the prototype is to manage appointment and calendar updating.

[26] proposed a framework for Appointment Systems with Patient Preferences. The authors developed a framework for the appointment systems that automatically update patients preferences to improve booking decisions.

[25] , reiterate that a local search procedure is derived that converges to the optimal schedule with a weighted average of expected waiting times of patients, idle time of the doctor and lateness as objective.

**IV. PATIENT APPOINTMENT AND SCHEDULING SYSTEM**

Current business practices that leverage on event scheduling systems are inefficient. Traditional business practices, such as employing an office assistance to manually record event times often requires the customer to languish needlessly on the telephone while waiting to receive assistance and to repeat that process several times to establish just one appointment or a meeting. This manual process is subject to human errors that may introduce significant inefficiencies in typical business processes. Use of recent software scheduling tools reduce errors, yet they are still modelled after traditional processes. The manual registration process could lead to data redundancy and put additional workload medical personnel in charge .Furthermore, there is tendency to always register a user that already been registered in the past, finding their details become a huge task[11].

Appointment and Scheduling system is one of the benefits of Automation of Clinical services and operations in various medical facilities. Automated scheduling system allows the outpatient to register their detail online, book and reject appointment. The system will reduce the waiting time of the patient and also increase the efficiency of the Doctors. The diagram in Figure 1 depicts the system flow chart for the proposed patient appointment and scheduling system

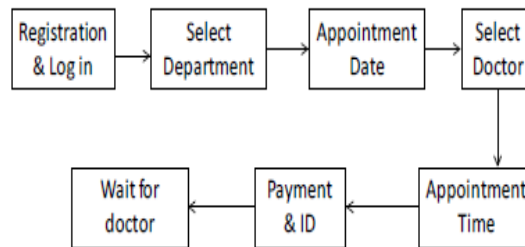


Figure 1. System flow chart for online appointment registration.

Source: [18]

**V. SYSTEM DESIGN**

The main focus of system design is to supplement the system architecture, providing information and data useful and necessary for implementation of system elements. it defines the components, modules, interfaces, and data for a system to satisfy specified requirements. This section consists of the various modules ,interfaces and data required for the design of a Patient appointment and Scheduling system.

**Use Case Diagram**

A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. The purpose of a use case diagram in UML is to demonstrate the different ways that a user might interact with a system. it describe the functional roles of the different actors(users) of a system. Thus, diagram in figure2 depicts the use case diagrams for the various users in the proposed system

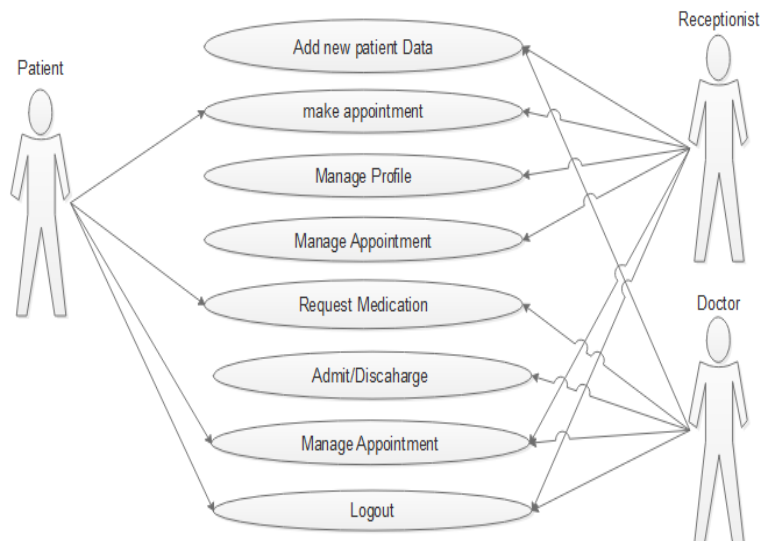


Figure 2. Use case diagram for the proposed Patient Appointment and Scheduling System

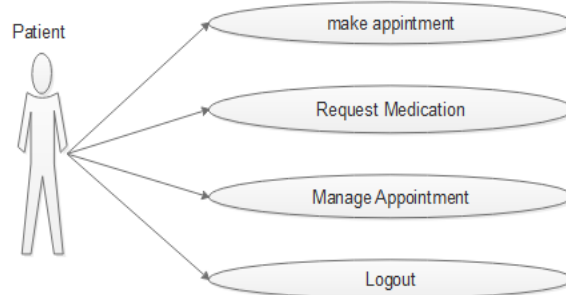


Figure 3. Use case diagram for Patient

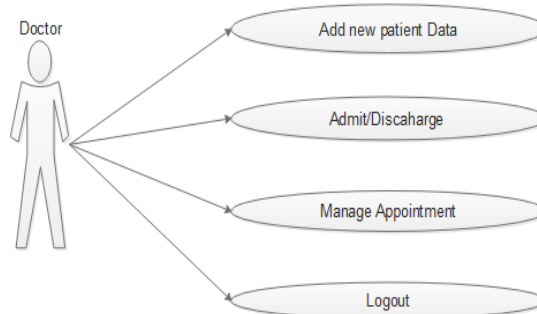


Figure 4. Use case diagram for Doctor

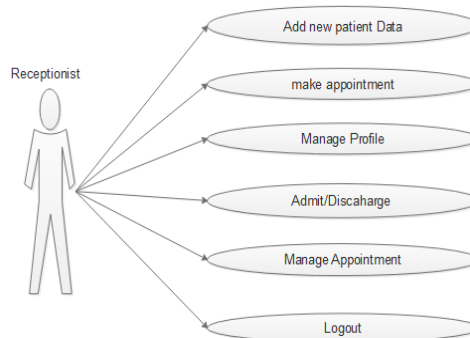


Figure 5 . Use case diagram for Receptionist

**Database design**

Database is the platform used to store data in most information systems which stores the data. It is regarded as the “heart” of most systems. Database design follows a sequential order. These include the inflow schema, Entity Relationship diagram and Relational data model.

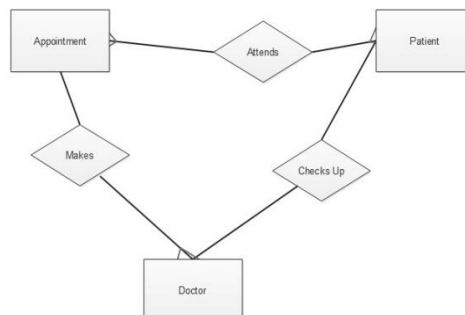


Figure 6. Entity Relationship Diagram for the proposed system

The database was designed using SQLITE and MYSQL due to the level of functionalities both database can offer. SQLITE offers a higher level of control over the operations of stored data and structural communication between the backend languages. It also offers expansive control using JSON and PYHON.

**Relational Data Model**

Table 1. Doctor table

NAME	DATATYPE	OTHER ATTRIBUTES
doctor_id	INTEGER	Pry key Not Null
doctor_name	VARCHAR(100)	Not Null

Table 2. Appointment table

NAME	DATATYPE	OTHER ATTRIBUTES
appointment_id	INTEGER	Pry Key Not Null
appointment_start	DATETIME	Not Null
appointment_end	DATETIME	Not Null
appointment_patient_name	VARCHAR(100)	Null
appointment_status	VARCHAR(100)	Not Null
appointment_patient_session	VARCHAR(100)	Null
doctor_id	INTEGER	Not Null

**VI. SYSTEM IMPLEMENTATION**

**Software Implementation**

The proposed software system consists of two major components-Front end and Backend.

**Front end (Client Side)**

AngularJS is used to design the front end or interface of the system. AngularJS is an open source JavaScript framework maintained by Google and community which can help developers to create single page applications. AngularJS which are built on top of the JavaScript are making the life of developers very easy. application is to make your web application modular and easy to maintain. Its purpose is to help developing the web applications with model-view controller (MVC) capability in an effort to make development, maintaining and testing easier.

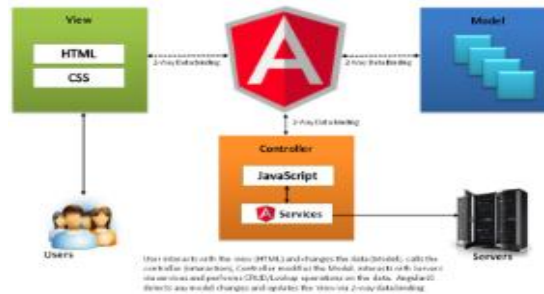


Figure 7. [30]

**Back end (Server Side)**

The backend describe the data access layer ,server and other computational logic of the system.The backend of the proposed system was designed with AJAX and PHP for scripiting.MYSQL AND SQLITE are used for developing system's Database .Apache server software was used for the server side. The Sign up form in Figure 8 was designed using Bootstrap Modal function with proper form controlling using JavaScript to ensure user details are captured correctly. It also provides notification if the user details had been registered before so as to prevent conflicting credentials on the database.

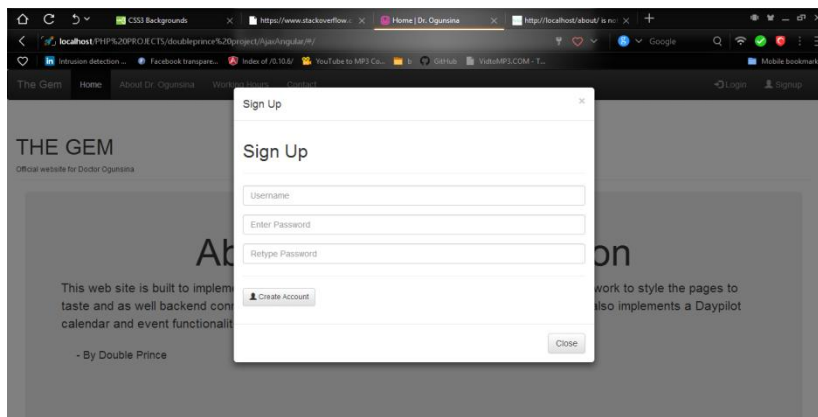


Figure 8. Registration Form

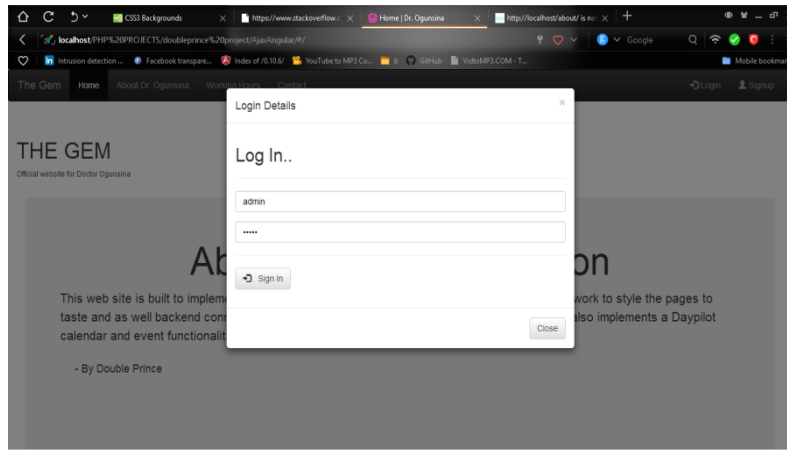


Figure 9. Login Form

The module above is the login form. The form is designed using Bootstrap Modal function which provides a seemly smooth and easy to use pop up display. It provides both the doctors and patients with a single interface for logging in to the system.

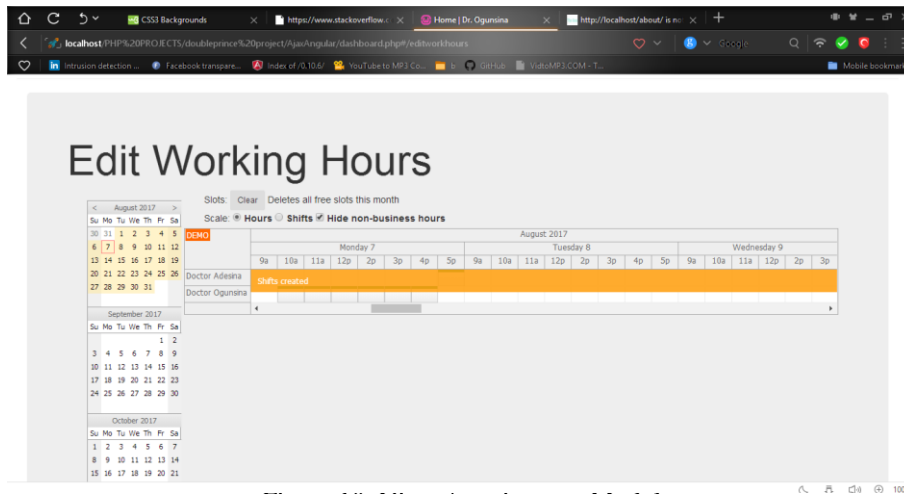


Figure 10. View Appointment Module

The Module in figure 10 above, enables the general public to view medical appointment dates that are free and those that are booked. This page enables the public to view the calendar as scheduled by the system administrator based on the weekly activities of the doctor.

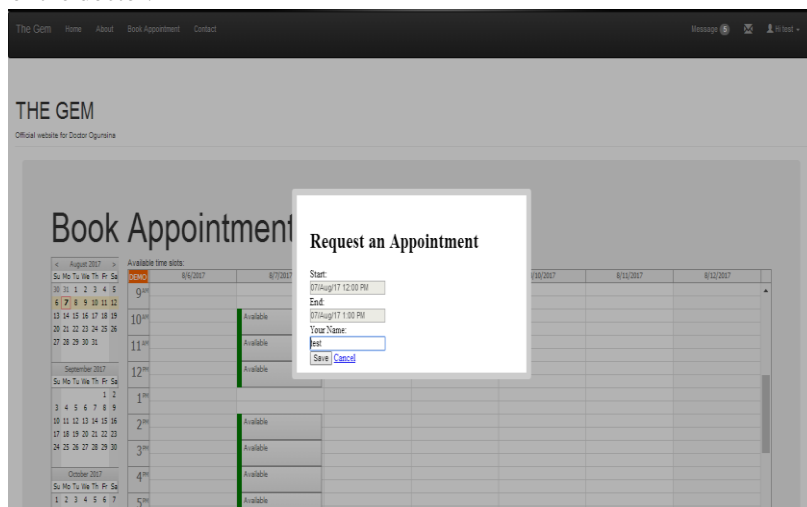
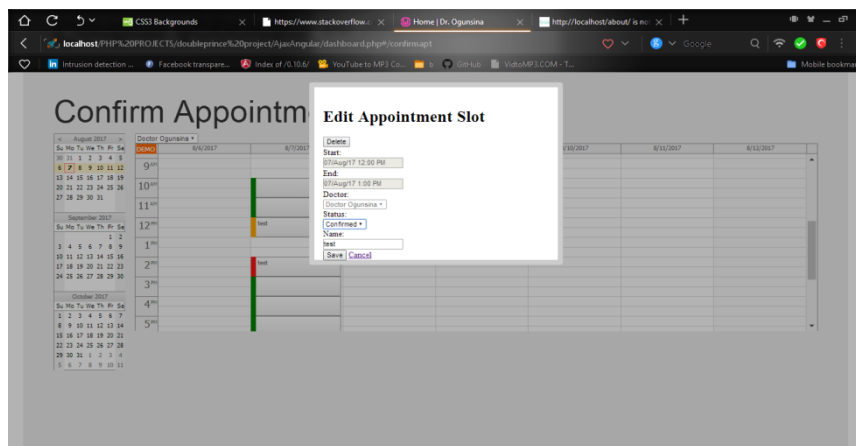


Figure 11. Book appointment page

The patient Book appointment Menu page depicted in figure 11 is to allow the patient to book medical appointments based on the calendar(available) slots made available by the doctor or scheduler.



The Module above allows the doctor in charge or scheduler to edit appointment slot on the system in case of emergency or critical situation .

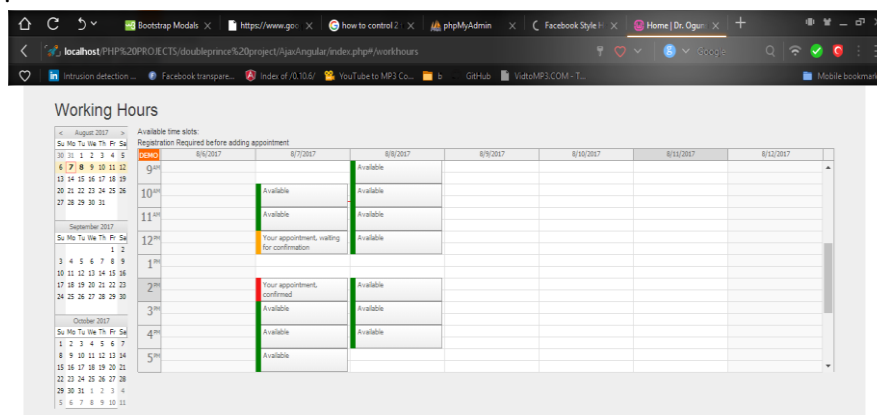


Figure 12. Display booked, free and pending appointment dates page

The module above gives patient the opportunity to view the status of the scheduling system .The patient will know the ideal time to request for an appointment,when the system is free and when there are pending medical cases

## VII. CONCLUSION

AngularJS is the present-day tool of choice for building Single Page Applications. Single-page web applications (SPA) provide many advantages compared to traditional web applications. AngularJS provides a means of carrying out complex logic on data without the need of the web browser making round-trip to the web server for every request. The appointment-scheduling process, has become a necessary burden in medical offices, healthcare facilities and wellness centers. An automated Appointment and scheduling software have been developed to address some of the challenges faced medial workers. The benefits of implementing this technology would touch everyone involved in the scheduling process, as administrators and staff can conduct their tasks more efficiently and accurately, while customers and clients have the ability to book their appointments and reservations quickly and more conveniently. The proposed system is aimed at simplifying the task of the patient and the doctor. It will reduce long waiting time for patients and eradicate long queue .Patient also have freedom to fix their appointment and also book an appointment according to their preference. The system will deliver timely and convenient access to health services for all patients.

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