



A MOBILE BASED MEDICAL APPOINTMENT AND CONSULTATION (MMAC) SYSTEM

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Abstract— Medical appointment and consultation is of necessity in the field of medicine which gives the doctor the opportunity to access, examine, test and diagnose a patient of an ailment or diseases. Several researches have been done in this domain whereby some researches allow a patient to book an appointment with a particular doctor and majority of these researches only handle the appointment section of the work. This prompted the researcher to delve into a real-time appointment scheduling whereby a patient only fixes a time and date and the system allocate a doctor available at that particular time and date and also handles the rescheduling of patients with doctors. Also, the system integrates a live consultation with a doctor available online. The study adopted object-oriented analysis and design approach and implemented the mobile application using android studio which is an integrated development environment (IDE) developed by Google, and JAVA was used as the choice of programming language for the logic and the frontend while PHP and MySQL were used for the backend. The research work played a major contribution in the field of medicine which allows and enable the patient to have a real time scheduling of appointments with a doctor and also allows patient and doctors to come online and have conversation and interact together.

Keywords— MHealth, Mobile Health, Medical Appointment, Medical Consultation, Medical Appointment and Consultation, Online Consultation, Appointment

I. BACKGROUND

Global Observatory for eHealth (GOe) defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices (Medicine, 1990). mHealth is a major factor in providing personal toolkits that will help manage online medical appointment and also for medical consultation, enabled by technology, connectivity and data.

Mobile health (mHealth) describes the use of portable electronic devices with software applications to provide health services and manage patient information. With approximately 5 billion mobile phone users globally, opportunities for mobile technologies to play a formal role in health services, particularly in low- and middle-income countries, are increasingly being recognized (Källander et al., 2013).

Consultation can be defined as the communication process between a patient and a physician on a medical issue (Internet consultation in medicine, 2006). Pawlikowska et al (2016) Explained that the medical consultation is a two-way encounter between a doctor and a patient. This may be initiated by a patient when they are ill or by a doctor when instituting preventive medicine or screening. The medical consultation is being done by the patient booking an appointment with the physician by physical appearance of the patient at the health center which at time lead to queue as many might also be waiting to be responded to by the physician

Medical appointment can be seen as a means of patient booking and securing a particular time with the doctor either for medical checkup or for medical consultation. Online medical appointment scheduling helps to manage and effectively utilize the time spent at the health center in a way that the patient is assigned a time which is visible for both the patient and the doctor. Large waiting times at hospital outpatient clinics are a cause of dissatisfaction to patients, cause additional stress to hospital staff, increase the risk of contagion and add complications for patients with medical conditions. Reducing waiting times and surgeon idle time improves the quality of service and efficiency of a hospital (Strahl, 2015).

The penetration of mobile phone networks in many low and middle-income countries surpasses other infrastructure such as paved roads and electricity, and dwarfs fixed Internet deployment. The growing sophistication of these networks offering higher and higher speeds of data transmission alongside cheaper and more powerful handsets are transforming the way health services and information are accessed, delivered, and managed. With increased accessibility comes the possibility of greater personalization and citizen-focused public health and medical care.

Peter et al (2014) explained that; with the advance of IT technology today and seen healthcare system as a critical system, appointment booking system lies at the intersection of delivering efficient, dependable and timely access to health services. The conventional way of appointment booking is via fax, phone or email. But with the growing internet penetration, healthcare industry is moving towards the use of an online appointment booking system.

The establishment and improvement of doctor-patient interaction system is a very important requirement, especially now when the mobile communication technology is developing rapidly. The advantages of mobile web can be made full use of to make up the time and distance gap between doctors and patients and to provide fast and adequate medical services. Through the connection between mobile terminals and specific service, both doctors and patients are able to obtain required data to achieve a better interaction (Choudhari et al, 2014). The mHealth technology has allowed patients to improve & manage their health by gathering information about health symptoms and notifying doctors for appropriate consultation & treatment. There are times when the patient misses to schedule an appointment with the doctor. This leads to delays in providing healthcare service by the practitioner. Now with a healthcare mobile app, the patient can schedule appointments directly from their smartphones.

II. RELATED WORKS

Rinder et al., (2012) proposes a Healthcare Scheduling by Data Mining: Literature review and future directions. The article presents a systematic literature review of the application of industrial engineering methods in healthcare scheduling, the research work defines two categories of healthcare scheduling which are; work/patient scheduling and provider resource scheduling, Patient appointments are scheduled based on the number of appointments slots available. The number of appointments available is established based on the type of work, such as regular visits, follow-up visits, tests and procedures, education sessions, and the number of providers available by hour and day of the week. The paper described application of data modelling technique to improve scheduling in healthcare, and the modelling technique had to be a data mining technique. However, none of the methods modelled no-show and walk-ins patient behaviour, also the research work should include more variables related to patient and/or environment.

Mardiah & Basri (2013) researched Analysis of Appointment System to Reduce Outpatient Waiting Time at Indonesia's Public Hospital. The research aimed to provide a study of the major causes of patients length of time for medical treatment in an outpatient clinic at one of Indonesian public hospital and also provide recommendation on the best strategy to improve the appointment system so that can maximize the effectiveness and efficiency of resource and capacity, The research made use of interview method (Data Collection) to see the appointment system and the factor that effect patient waiting time, Observations was also employed for field visit to public hospital and to see directly outpatient service and arrival pattern of patient hospital, the collected data was analysed using descriptive analysis. However, the research is a preliminary study that analysed each variable separately. The analysis was performed to confirm that the waiting time target not met the minimum service of standard of hospital. For future, further analysis is still required to design this system such as make a simulation of all variable that affects bottleneck and it supposed to make clinical performance more effective and efficient.

Zhan & Liu (2013) “Design and implementation of a clinic appointment registration system”, designed and implemented a desktop-based .NET application for clinic appointment registration with the use of MS Access as the database for keeping medical records. The operational function of the system includes appointment registration, data management (Data addition, deletion and searching) and data backup and recovery. The research is based on the following sections: the introduction into the system, the second section is based on the system requirements analysis where the functional requirement analysis and the technical requirement analysis are specified, the third section was the system design where the system function modular design, and database design, the last section of the research work is the System implementation. Because of the inadequate teaching equipment, the functionality of online credit card payment was not implemented.

Peter et al. (2014) the research work proposed a dependable online appointment booking system for NHIS outpatient in Nigerian teaching hospitals. The research proposes a web based medical appointment booking. The scope of the research work is to design a web-based appointment booking system where patients can register, login to the system, book an appointment with a doctor and view appointments. The system also includes the doctor logging into the system, cancel an appointment, generate appointment and view appointments. However, the research was limited in that the display of bio-data an X-rays and laboratory results were not included in the system due to technical constrains. And more so, the system was not able to diagnose of prescribe drug for usage.

Choudhari et al (2014) proposes an Android Application for Doctor’s Appointment. The proposed system consists of two main panel which include the patient, the patient can register with the system, login into the system. After logging into the system, the patient can see list of available doctors and click on any available doctor to view profile of the doctor and access the doctor schedule, and can send a request for an appointment. The doctor on the other hand will be able to view request from patients and can respond to patient request by either accepting the request or rejecting the request. The system will then notify the patient as to the response from the doctor and get notification 2 hours before the actual appointment which will be very useful in case the patient tends to forget the appointment. However, the research does not integrate medical consultation.

Kyambille and Khamisi (2015) researched Enhancing Patient Appointments Scheduling that Uses Mobile Technology. The research presents a mobile based application scheduling system for managing patient appointments in hospital by allowing patients to register for appointments through mobile phones at their own time wherever they are, and make an appointment on their desired slot of time. The design and development of the mobile appointment scheduling system was done using MYSQL with WAMP server and PHP. The database system is developed with MySQL and the scripting language was done utilizing PHP. However, the limitation of this research work is for the system to be able to direct appointment requests to another hospital where doctors with similar expertise are working.

Jain et al (2016) proposed Android Application of patient Appointment System, the system is a mobile based for medical appointment. The focus and scope of this research work is to provide communication between the patient and the doctor, whereby a patient can schedule appointment with the doctor as per the doctors’ availability, patient can also interact with doctor through a message system. Modules in this research work include the patient registering, login, search for available doctor, request for appointment. The server generates a QR code for the patient and accept the appointment, the doctor also login, and scan the QR code generated for the patient and also view patient details. The research work does not take into consideration the online medical consultation.

Mahalakshmi, et al (2016) proposed an Online Appointment Reservation and Scheduling for Healthcare, this research work show the Different types of Appointment Scheduling, also Show the study between the traditional appointment reservation and scheduling system, also the software architecture for online appointment reservation and scheduling system were enlisted which include; Features of online appointment reservation and scheduling (Schedule appointment, Reschedule appointment, Check doctors availability, send reminder message, view patient information cancel appointment), practical flow of an online appointment structure, functionality of the appointment system. However, the research work was not implemented on any platform.

Doctor patient interaction system for Android by Bhuvanewari (2017) present a mobile based application that allows patient to register to use the system, login to the system, book an appointment with a doctor, and can also make complaints on the system, also the system brings the doctor into the platform whereby they can also login into the system, view complaints and as well pot solutions to complaints, also view the clinic register. The research work is categorized into sections which include: the introduction into the research work, the second section is the system analysis which include the existing system, the proposed system and also the system requirements of the proposed system where the hardware and the software specification are mentioned. In the

third section, the UML model is being shown showing the use case of each entity concerned in the system, also showing the Data Flow Diagram, Sequence diagram. While the last section includes the System development and implementation.

Android Application for Healthcare Appointment booking System by Chaudhari et al (2017). The system is a mobile based application which was implemented on android operating system, the system proposes two main panels which include the Doctor and the patient, the scope of the research is for the patient to request an appointment with a doctor after seeing various doctor specialization, the doctors' profile and view the doctors schedule so as to know when to fix appointment with the particular doctor. The doctor can either accept or reject the appointment. The proposed system is Doctor's Appointment Booking System for Nagpur City only, the research can enhance the system by expanding the application and including more cities in the application.

III.STATEMENT OF PROBLEM

Several researches have been carried out in the area of health among which include (Peter Idowu et al., 2014)- Dependable Online Appointment Booking System for NHIS Outpatient in Nigeria Teaching Hospitals; (Choudhari et al., 2014)-Android Application for Doctor's Appointment. Searches have however shown that none have been able to integrate a real time online medical appointment and online consultation. This study therefore intends to design and implement a mobile based medical appointment and consultation system.

IV.METHODOLOGY

The study adopts the use of Object Oriented Analysis and Design (OOAD) method. The underlying principle is that one model software systems as collections of cooperating objects, treating individual objects as instances of a class within a hierarchy of classes (Booch, 1998).

Object-oriented analysis describes an information system by identifying things called objects. An object represents a real person, place, event, or transaction. For example, when a patient makes an appointment to see a doctor, the patient is an object, the doctor is an object, and the appointment itself is an object. Object-oriented analysis is a popular approach that sees a system from the viewpoint of the objects themselves as they function and interact. The end product of object-oriented analysis is an object model, which represents the information system in terms of objects and object-oriented concepts.

The following procedures shall be followed in the execution of the work:

- i. **Data Collection/Information Gathering:** Information was gathered on flow of the manual method of medical appointment and consultation.
- ii. **Modelling:** Well-defined UML diagrams (Data Flow Diagram, Use Case Diagram, Sequence Diagram) were used for the modelling the proposed system.
- iii. **Design and Implementation:** Object-oriented design approach is adopted for the design of the proposed system, which is to be implemented as android-based.

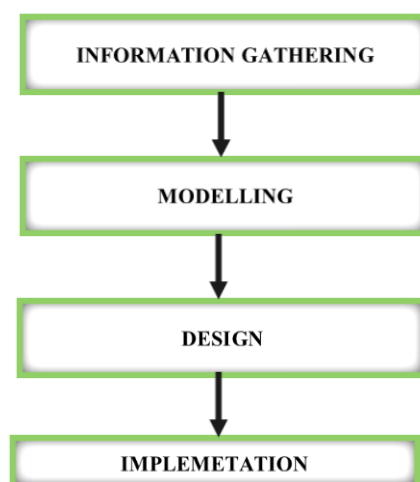


Figure 1: Diagram showing the research methodology

V. DESIGN

System design is systematic wherein it takes into account all related variables of the system that needs to be created, from the architecture, to the required hardware and software, right down to the data and how it travels and transform throughout its travel through the system.

A. System Architecture

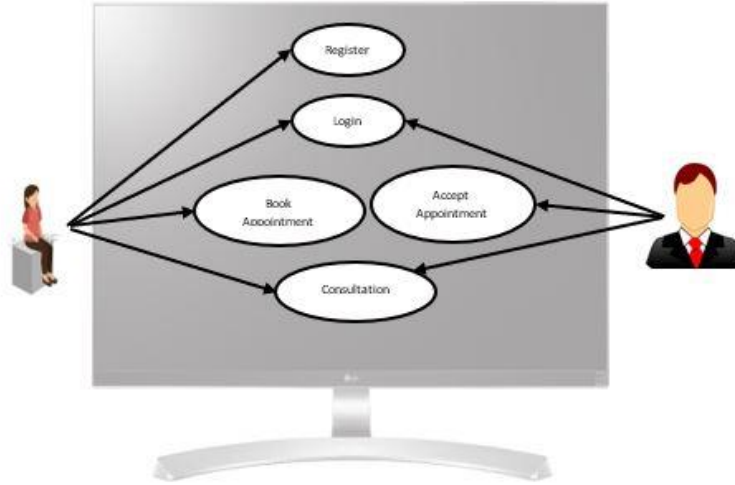


Figure 2: Diagram showing proposed used case model

B. Flow Diagram

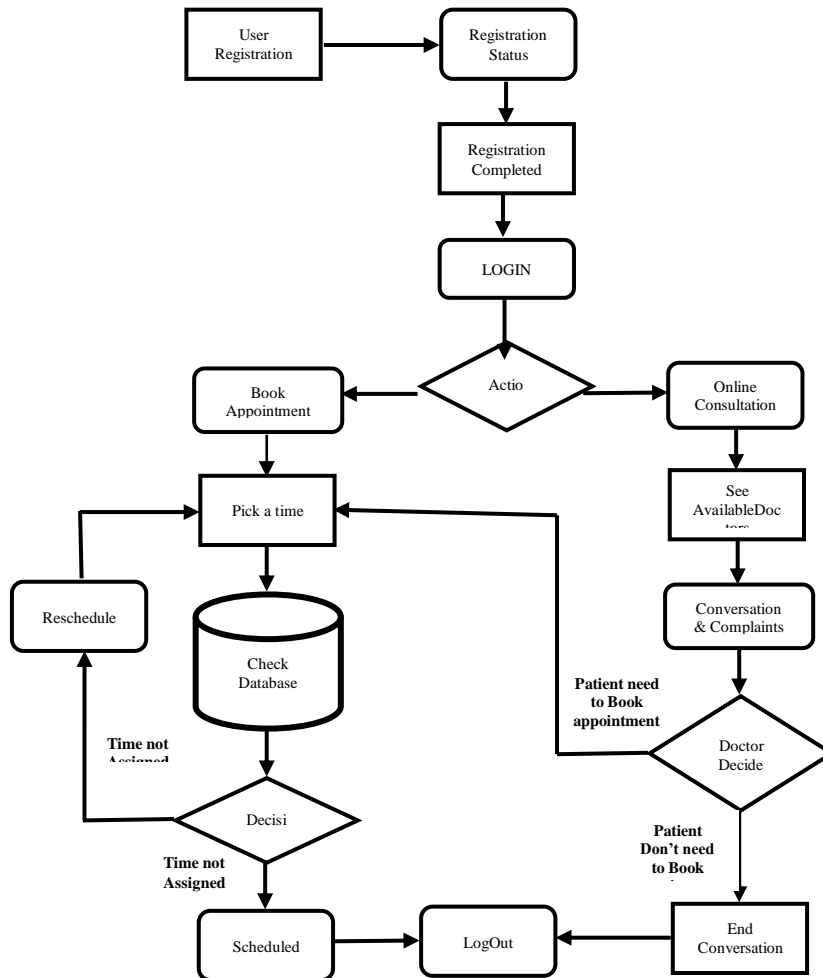


Figure 3: Proposed System Flow

C. Algorithm

Algorithm for some of the logical program module

```

-newlogin
  Find (search) card_no and stud_lect_id in newregistration table
  If exist => load form
  else
    prompt access denied, you are new, please register
-new_register
  If cardno != cardno_indb => save patient details
  else
    prompt already registered
-appointment_book
  Find(search) time_pick and date_pick in appointment table
  If exist => reschedule appointment
  Else
    Save time selected and date selected into appointment table
-rescheduling_appointment
  Suggest time and date available to patient
  If accept => save date and time approved in the appointment table and set reminder
  Else
    Prompt to re-apply for appointment
-live_consultation
  Find (display) available doctors
  If (found) => initiate conversation
  Else
    Prompt no doctor available at the moment for live chat
-appoint_conflict_resolve
  d – date selected
  t – time selected
  et = 2:00 – end consultation time
  appt – approved time
  if(!checkperiod(d,t)){
    checkperiod(d,t)
  }else{
    Prompt “the time available is” appt
  }
  Boolean checkperiod(d, t){
    if ( !(d == date in appointmentdb) && !(t == time in appointmentdb){
      if (t > et){
        prompt “No time slot available for the date selected, please check the online
live consultation or book appointment for the next day”
      }else{
        appt = t
      }
      return true
    }else{
      t = t + 15min
      return false
    }
  }
}

```

This part of the algorithm differentiates the work from existing work because it checks to ensure a patient is assigned to a particular doctor at a particular time interval depending on the available doctors on duty in the hospital. It also helps to resolve time conflict and suggest available time to the patient which can in turn accept the time suggested or reject the time and reschedule time convenient.

VI. SPECIFICATION

This section describes the various database, input, output, as well as program module specifications used.

A. Database Specification

The goals of this database design are:

- Create a database that provides for efficient storage, update, and retrieval of data.
- Create a reliable database that stored data with high integrity.
- Create an adaptable and scalable database that meets a new and unforeseen requirements and applications.

For the purpose of achieving the goals of the database design MySQL Database was used for the implementation of this work.

B. Interface Specification

This section demonstrates the various input and output designs of the proposed system. Below is the designed interface.

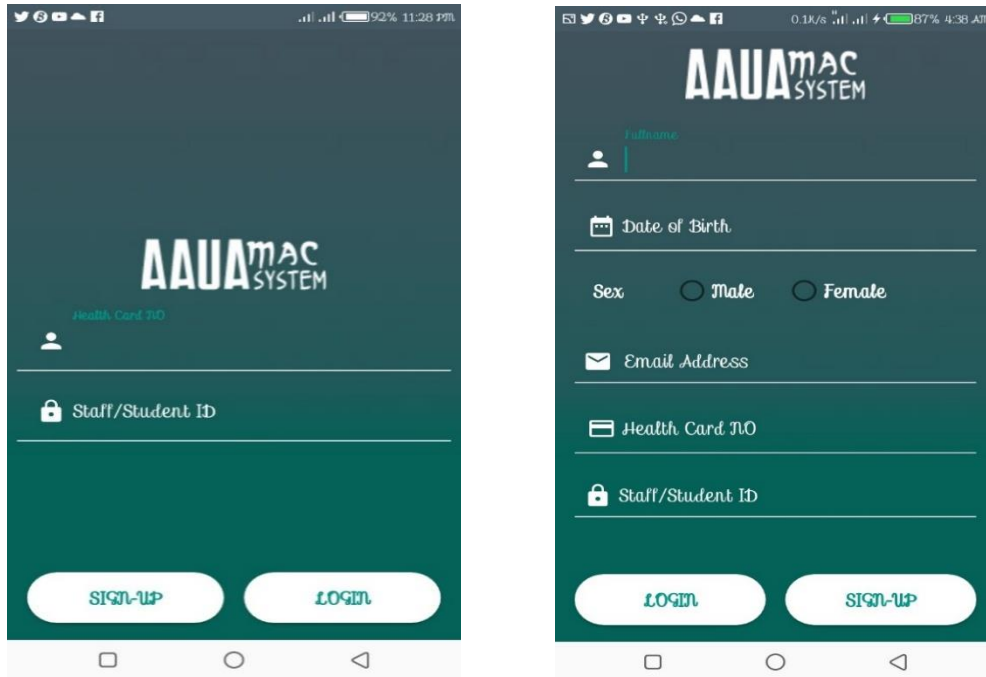


Figure 4: Login and Signup Interface

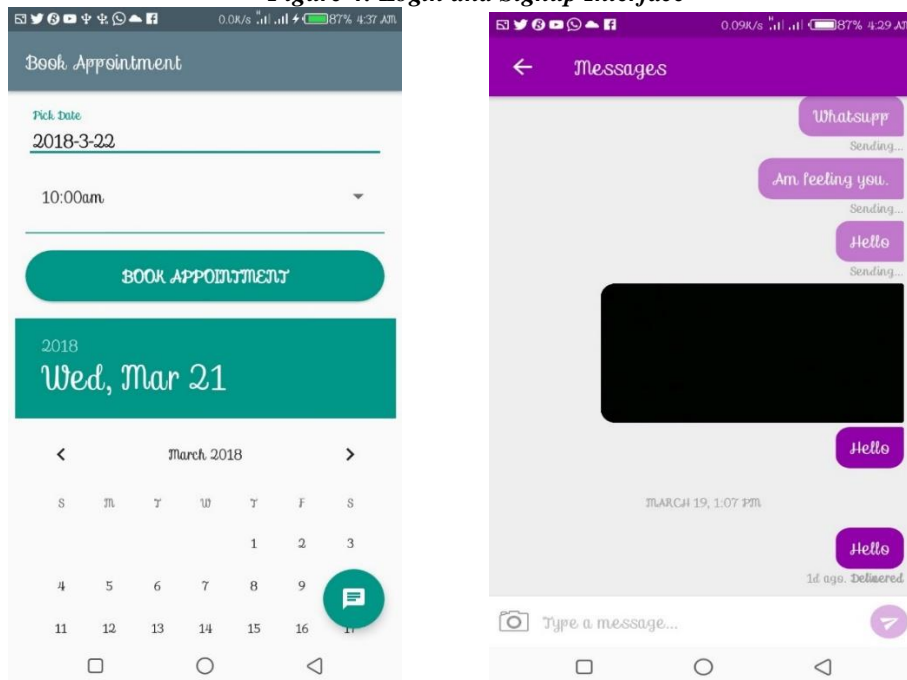


Figure 5: Appointment Booking and Consultation with Doctor Interface

VII. IMPLEMENTATION

A. Implementation Approach

The implementation approach adopted for this study is V-Shaped Development Model. The V-Shaped is considered as an extension of the waterfall model. Instead of moving down in a linear way, the process steps are bent upwards after the implementation phase, to form the typical V-shape (Yadav, 2012). This development model was adopted because it allows for effective planning and requirement analysis phase which then lead to both architectural and detailed design of the system to implement which enable and aid in the implementation and execution of the system, another important feature of this model is the testing phase which integrate the unit testing, integration testing and the system testing, all of these enable and avoid flaws in the system.

B. Language of Choice

Java programming language which is an object-oriented language with features for objects and methods that allows for code structuring in modules, and also being the google official language for developing and creating android mobile application, was made the choice of programming language. The language is used for the logically development of the system. Specific logic and the process that allows for communication with server, data validation and display of that data are integrated into construct called methods.

Also, PHP will be used for the server-side scripting language, will be used as the host language for performing the backend logic like interacting with the database and also communicating with the system by feeding it with data, MySQL which is a high-end relational database management system is used for effective data storage and retrieval.

C. Development Environment

Android Studio (Android Studio 3.0.1 – Google Developed Integrated Development Environment) is well-enriched. It has lot of facilities that aids mobile application programming, for debugging and also for compiling the program into an Application.

D. Unit Testing

A unit is the smallest piece of software that can be tested. A typical example in a procedural programming language would be a function/procedure or a group of these contained in a source file. In an object-oriented programming language, this typically refers to simple classes and interfaces.

An example unit testing session would involve a number of calls to the unit (function, procedure or method) under test where each call might be preceded by a setup code that generates appropriate method parameters wherever required and another call performed after the test to check whether the test was successful or unsuccessful.

Unit testing is the lowest testing level. It helps to refine the testing process so that reasonable system reliability can be expected when testing is performed on the next hierarchical levels. Testing at the unit level helps to expose bugs that might appear to be hidden if a big-bang testing approach was used and unit testing omitted (Oladimeji, 2007).

At this level of testing various module (classes and methods) of the system were tested individually, for instance the appointment scheduling method was tested with valid and non-valid data to know how the system will behave and respond back to user, and at this stage, various exceptions were handled appropriately.

E. Integration Testing

This is to test the communication between various modules to make sure data is flowing across various components correctly (Hooda, Scholar, & Singh Chhillar, 2015). At this stage we begin to combine the different tested units or components to form a working subsystem. Despite the fact that a unit has been through a successful unit test, it might still behave unpredictably when interacting with other components in the system. Hence the objective of integration testing is to ensure correct interaction and interfacing between the units in a software system as defined in the detailed design specifications.

At this stage the login, registration and the main home page modules were integrated together and communication was tested between them and how data are being passed through these modules.

F. System Testing

At this stage of testing, the overall system is tested to ensure that it is behaving or functioning as intended and as specified in requirement document.

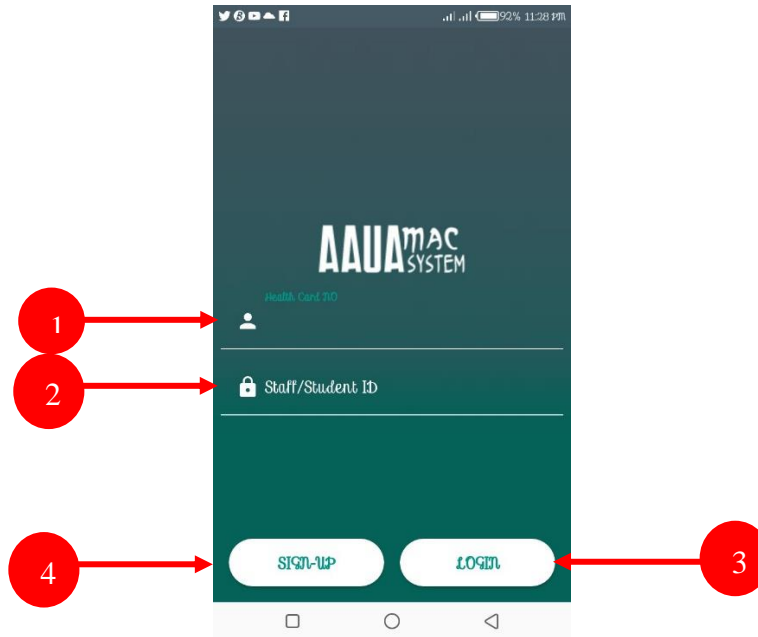
System test planning phase is very dependent on the high-level design specification in the development process. As a result, any errors made in translating the requirements specification and the design specification would be very drastic as it would propagate downwards to the lower levels of test and development.

At this level of testing, the whole system of the medical appointment and consultation system was tested so as to certify it conformity with the design specification and requirement.

G. System Documentation

**MEDICAL APPOINTMENT AND CONSULTATION SYSTEM
(MAC System)**

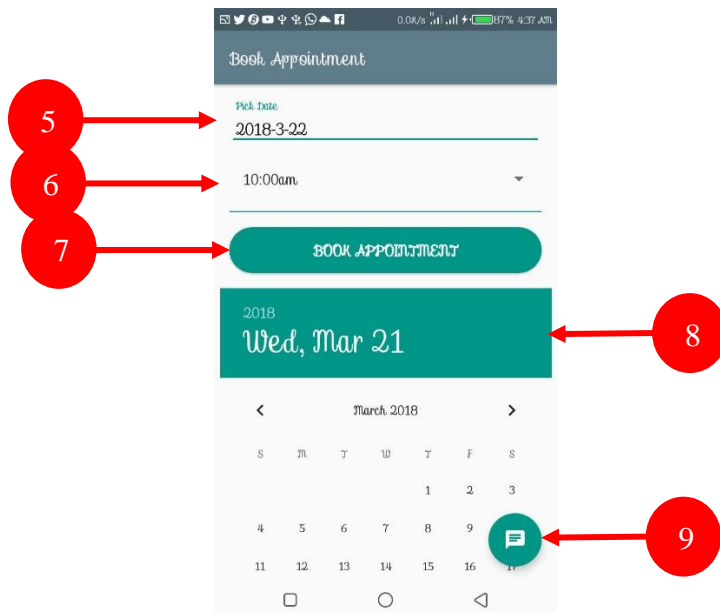
On launch of the application the following interface pop up which enable users to login as shown below



1. Is an Edit Text Field that allows to type health center card of user who have successfully registered on the system
2. Is also an Edit Text field that allows user to type id which can be a student matric no or staff id number
3. Is a button that allow user to Login into the System else deny the user access into the system and prompt the user to register
4. Which is a button that allows user to register on the system with their health center card details and personal information as shown below



The main screen of the system is shown below



5. Is an Edit Text Field that when clicked will launch a date picker to pick a date to fix an appointment with a doctor
6. Is a Dropdown where you can pick available time to meet with a doctor.
7. Is a button to click to fix an appointment with a doctor
8. This shows users schedule and appointment with a doctor
9. This is a floating button that when click will launch the live consultation with a doctor and show the interface below.



VIII. CONCLUSIONS

After successful completion of the research work, the work has been able to achieve the main aim of the work which is the implementation of a mobile based medical appointment and consultation system. The research has been able to achieve a real time scheduling and rescheduling of patients with number of available doctors.

Also, the system will help reduce the stress or fatigue patients go through waiting on the queue to meet a doctor. More so, the research helps in bringing the doctors and patients closer anytime and anywhere with the successful integration of the live consultation module.

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