Mobile Healthcare System

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***Abstract*—This paper presents a mobile healthcare system based on Android and Web applications. The system provides assistance to patients, identifies and selects doctors based on the location and the specialties of the doctors. The system allows patients to make appointments with doctors and assigns reminders to take the prescribed medications and vaccinations. The results of testing the applications show a big saving of time and mobility of doctors and patients.**

I. Introduction

Many medical applications for smart phones have been developed and widely used by health professionals and patients [1]. The use of these applications is very helpful because it leads to better communication between doctors and patients and help to enhance the overall treatment quality. The literature review of healthcare applications shows that applications focus on different area of healthcare such as patient care and monitoring apps [2], weight loss and fitness apps, communication among doctors and nurses on inpatient wards, the uses of the smart phone in medical education and research [3]. Our proposed healthcare system is based on Android and Web apps to provide medical assistance for patients who live in regions where mobility is difficult and limited and can save the doctor and the patient lots of time. The proposed application identifies and selects doctors registered in the system based on their location, specialty and availability. The application allows patients to make appointments with doctors and assigns reminders for the prescribed medications and vaccinations. The paper is organized as follows; first we present the design of our mobile healthcare system and its different applications and service, followed by testing results and finally a conclusion.

II. Mobile Healthcare System Design

Our healthcare system is composed of three parts; the mobile application, the web application and the web service as it shows in Figure 1. The mobile application synchronizes with the Web application using the Web service where data can be transferred via GPRS, 3G or WIFI. This system enables data communication between patients and doctors and saves lots of time and efforts in mobility.

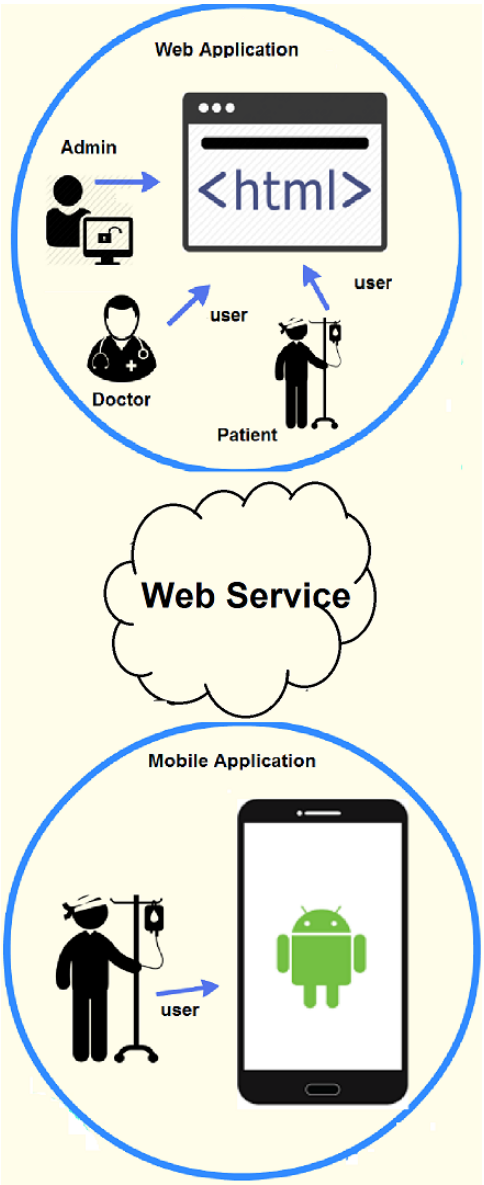

Fig. 1. Mobile Healthcare System

The use case diagram for our healthcare system is shown in Figure 2. The use case diagram of the patient includes patient account, check vaccinations, schedule an appointment with reminder, reminder for medications and application update. The use case diagram of the doctor includes vaccination

details, schedule a patient appointment, write a prescription, check patient's medical history and manage patient's visit. Admin is responsible of updating all resources including doctors, patients, vaccinations and medications.

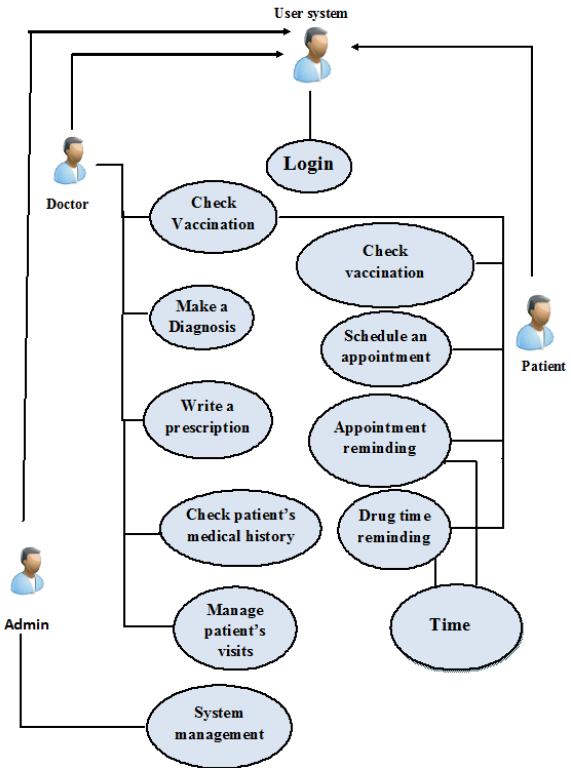

Fig. 2. Use Case Diagram

The system works as follows: The patient describes his symptoms using the mobile application or the Web application. The system identifies and selects doctors registered in the system, based on their location, specialties and availability. The patient takes his appointment with a doctor found in the system from a list of available time slots. The doctor consults the medical history of the patient and adds his diagnosis and prescribed medications. Medications are scheduled in the calendar of the patient's mobile phone with reminders to take the medications and this allows monitoring the patient's medical status. The system reminds the parents of children of the compulsory and optional vaccinations, depending on their childrens ages. The system proposes a list of doctors who have the vaccinations and helps to schedule an appointment with the doctor. The vaccinations are then added to the patients medical history.

III. The Web application

The Web application is implemented using CodeIgniter framework 3.0, an open source framework, built on the Model View Controller (MVC design) [4] to develop Web application. Figure 3 shows that the MVC separates the design into three layers; the database layer, the view layer and the control layer, which reduces the complexity of the Web application and increases its extensibility.

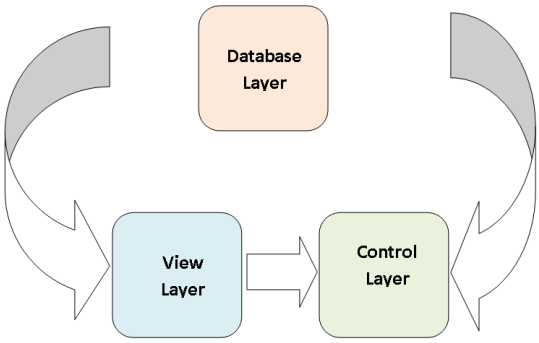

Fig. 3. Model View Controller for Web Application

MySQL is used for creating the database of the Web application. As shown in the database schema in Figure 4 there are three types of users: Admin, Doctor and Patient. The database contains several tables such as drug table, vaccination table, and appointment table. The database tables are encapsulated with models, the views are developed using HTML, CSS3 and JavaScript. The Bootstrap library, an open source, is used to create responsive interfaces. The Grocery CRUD [5], an open source framework used to create the admin panel used to do actions such as create, read, write and update on database tables.

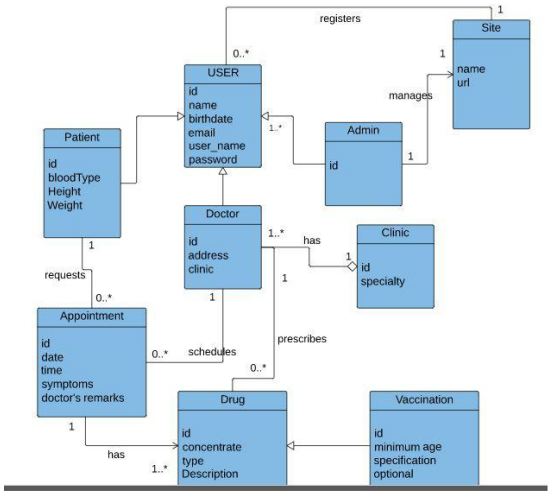

Fig. 4. Web Application Database Schema

IV. The Mobile Application

The mobile application is developed using Android Studio, for Ice Cream Sandwich version and later [6]. The design in Figure 5 is composed of six packages; the main, the connections, the adapters, the fragments, the parsers and the models. The main package contains the activities, the login and signup activities and the interfaces of the application. The Connection package manages sending and receiving data via the Web. The adapter package displays menus in List View.

The fragment package contains the sub views. The parser package decodes and parses the received JSON [7] formatted data using Gson open source library [8]. The model package contains the classes that encapsulate the tables of the database.

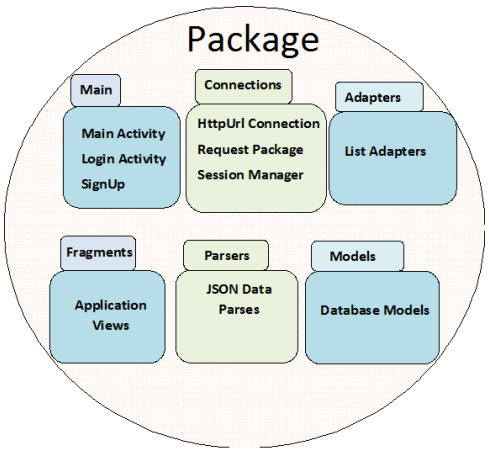

Fig. 5. Main Packages

SQLITE [9] is used for the database of the mobile application. It is encapsulated with Sugar ORM [10] as it shows in Figure 6.

Fig. 6. Data Base of the Mobile Application

The mobile database is synchronized with the Web application database as it shows in Figure 7.

Fig. 7. Synchronization

The times and dates of the prescribed medications are saved in the calendar of the patients mobile phone with notifications to take the medications on time. These notifications allow the patient to keep up with his treatment and helps him monitoring his medical status as it shows in Figure 8.

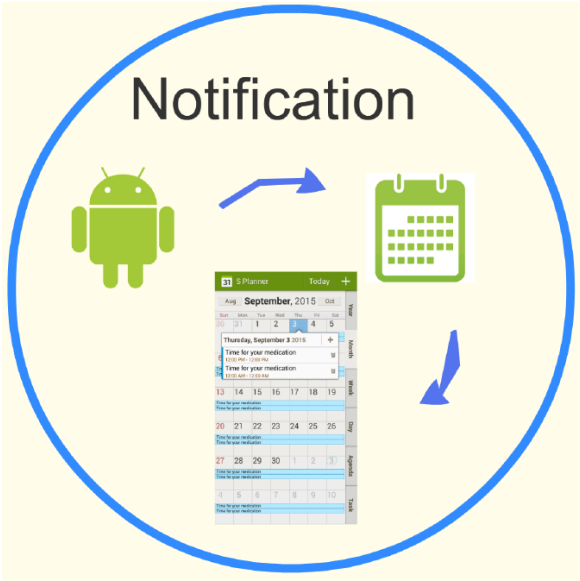

Fig. 8. Notifications

V. Web Service

Figure 9 shows the RESTFUL Web service [11] which is designed to answer data request call from either the web application throws AJAX [12] or from the mobile application through HttpURL connection. The Service Consumers (Web application and the mobile application) use functions from the Web service to exchange data such as sign in, sign up, appointments with doctors, vaccinations and medications using the HTTP verbs (GET, POST, PUT, DELETE) and all the responses are in JSON format.

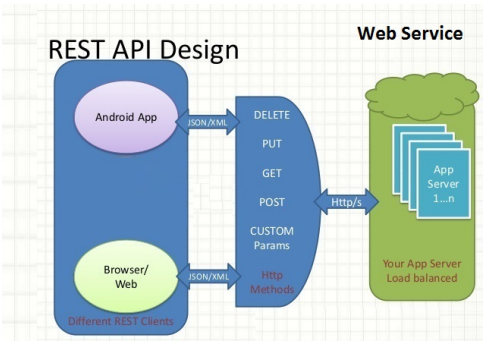

Fig. 9. Web Service Design

VI. The tests of the Web Application

The Web application is tested on a local network and local server using Xampp [13]. Figure 10 shows the home page of the Web application.

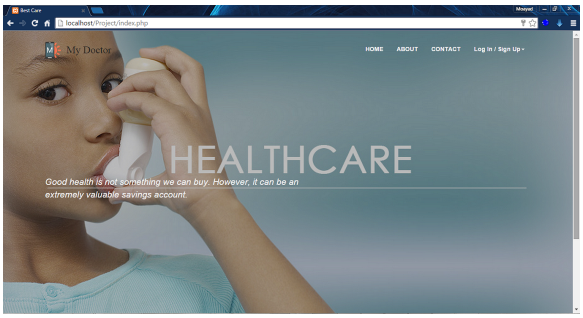

Fig. 10. Web Application Home Page

When a user logs as a patient to the Web application he will be directed to the patient page as shown in Figure 11.

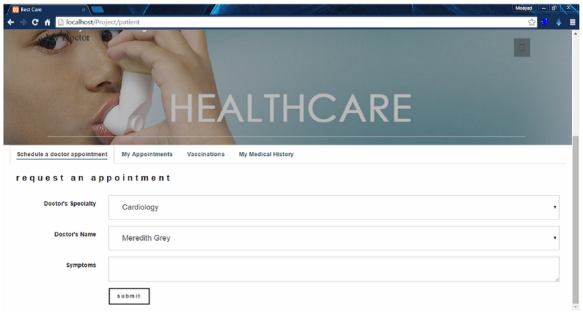

Fig. 11. Patient Page

The patient can schedule an appointment with a doctor, view his appointments and his medical history. The patient can also view the compulsory and the optional vaccinations as it shows in in Figure 12.

Fig. 12. Vaccination Page

When a user logs as a doctor to the Web application he will be directed to the doctor page as shown in Figure 13.

Fig. 13. Doctor Page

The doctor can view the information of his patients and their medical history. He can also view the available vaccinations in the system and all requested appointments sent by his patients as shown in Figure 14.

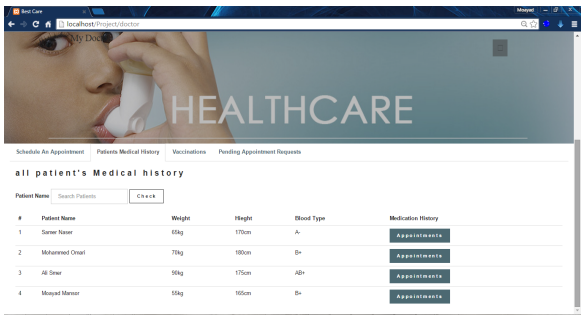

Fig. 14. Doctor Appointments

VII. The tests of the Mobile Application

The mobile application is tested using a variety of emulators of Android Development Tools from Google, and on several smartphones such as Galaxy Grand 2, Galaxy Core Prime, and Sony Xperia C. The applications are tested by the students and the employees of the Higher Institute for Applied Sciences and Technology and we noticed a big satisfactions of the users in time saving and mobility. Figure 15 and Figure 16 show the mobile application signed by a patient and its interfaces.

Fig. 15. Web Application SignIn and SignUp

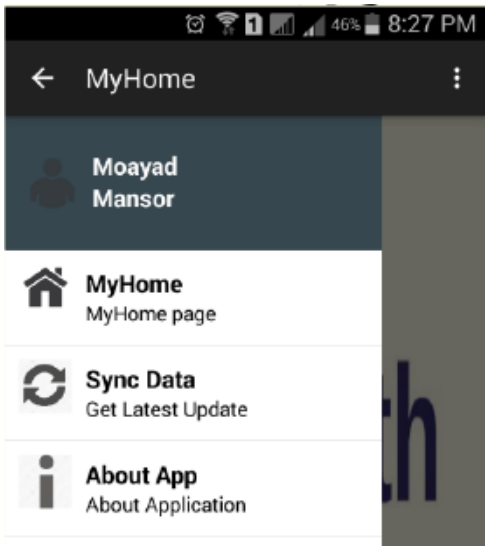

Fig. 16. Web Application Interfaces

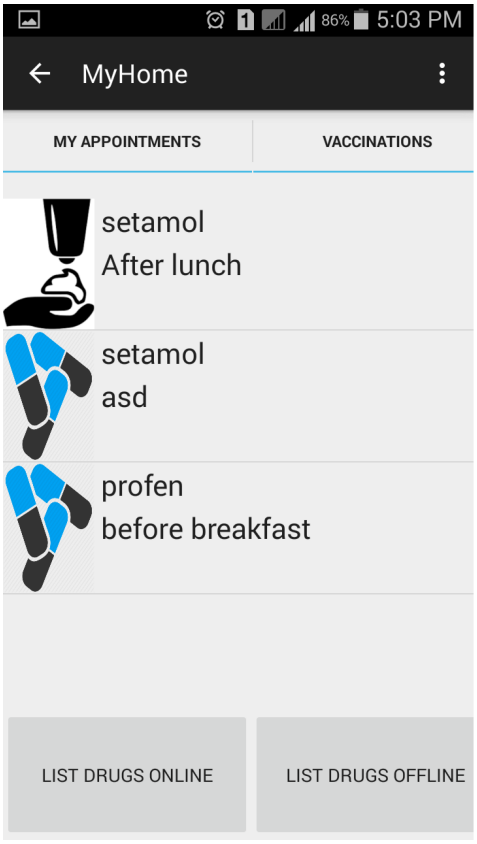

Fig. 17. Patient Medications

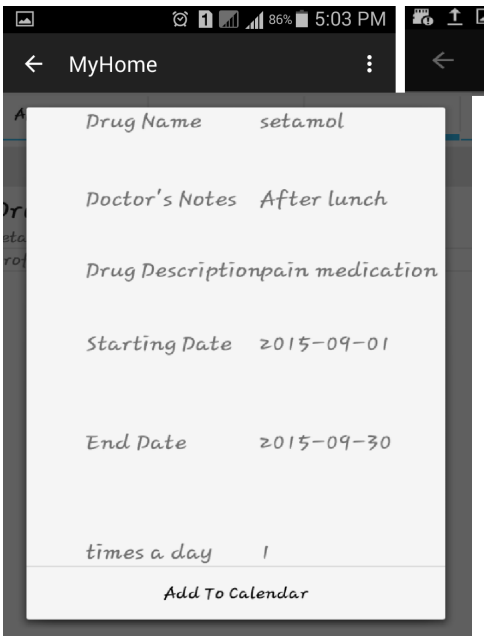

Fig. 18. Details of the Patient Medications

Figure 17 and 18 show the prescribed medications to a patient and the details of each medication.

Figure 19 and Figure Figure 20 show the appointments of a patient and his request for a new appointment.

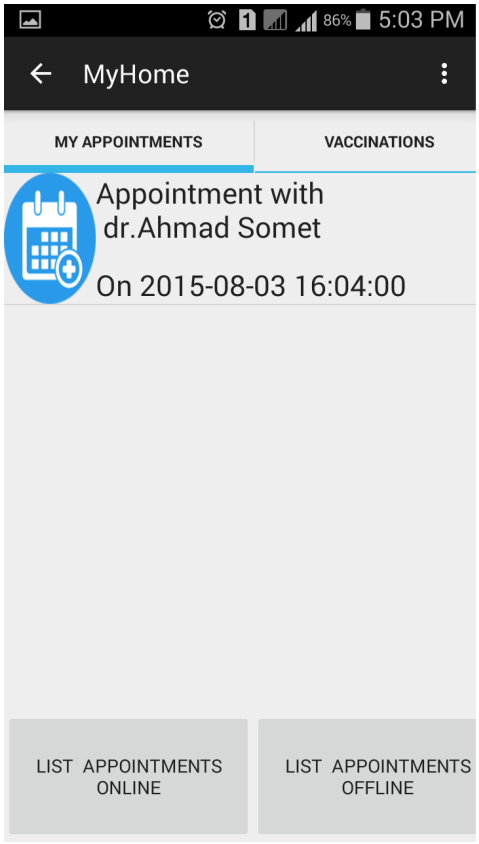

Fig. 19. DPatient Appointments

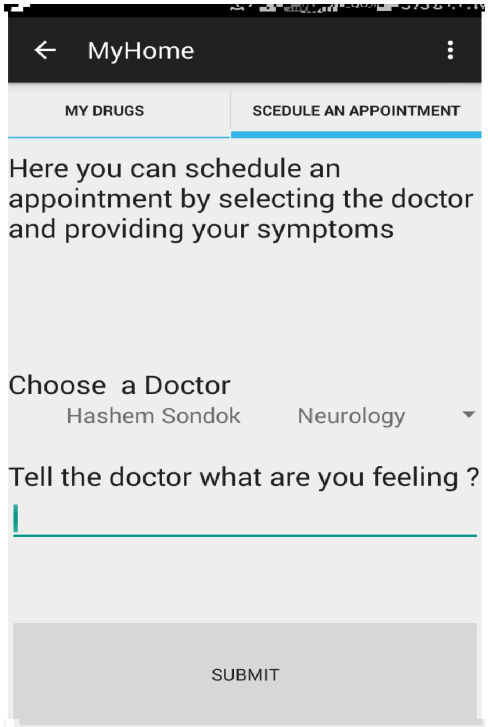

Fig. 20. Patient New Appointment

VIII. Conclusion

A mobile healthcare system based on Android and Web applications is presented. The system provides medical assistance to patients and save time and mobility. The applications allow patients to make appointments with doctors and assigns reminders for the prescribed medications and vaccinations.

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