Development of Mobile Phone Medical Application Software for Clinical Diagnosis

K. Prahlad Rao, Mohammed Ahmed Hanash, Gaafar Ahmed AL-Aidaros

Abstract - Rapid advancements in communication technology have spread to medicine also. Particularly, smartphone technology has made medical provisioning through mobile systems a reality. Innovations in mobile software application are potential benefits to the public health since the mobile platforms became more user-friendly, computationally powerful and are affordable. The innovative mobile apps can contribute in clinical consultation complementing face-to-face interaction in the health care at lower risk to the public. We have developed and evaluated mobile app for smartphone on Android platform to facilitate interaction between the patient and doctor where the patient seeks advice, diagnosis and treatment from the doctor from remote places. The Graphic User Interface (GUI) display screens of the smartphones are incorpotated the medical data needed by the clinician to interpret and respond to information.

Keywords - Smartphone; Android; Clinical diagnosis; Doctor app; Patient app

I. INTRODUCTION

Smartphones and mobile devices have rapidly become part of everyday life around the world. The availability of cheaper, faster and more capable mobile devices has led to a lot of innovations in every field where it can be applied. According to a recent Epocrates 2013 survey [1], more than 80% use smartphones today and 90% are expected to use tablets by 2014. Mobile phone use in particular is exploding across the developing world, offering the opportunity to leapfrog other applications and services on both the health and technology fronts [2]. Recent breakthroughs in communication technologies have stimulated the development and demonstration projects in telemedicine, which is therefore considered as an essential technology for reformed healthcare [3]. The success of various *tele* health care methods is due to the following factors.

- Traffic and transport difficulties in big cities
- Unequal geometric distribution of physicians [4]
- Very low doctor to population ratio [5]
- Poor socio-economic conditions of rural people, and
- Severe shortage of trained doctors and nurses in rural areas.

All these factors can be eased to some extent by using smartphones with dedicated software. A mobile application which is known in short as 'mobile app', is a software application designed to run on smartphones, tablet computers and other mobile devices. They are usually available through application distribution platforms, which are typically operated by the owner of the mobile operating system, such as the Apple App Store, Google Play (Android) Windows Phone Store and BlackBerry App World [6]. Some of the general mobile apps are email, calendar, stock market, banking, GPS and location based services, order tracking, ticket purchases, mobile games, and the list is increasing as the public demand is in rise. Medical field is no exception. They are changing the traditional way of doctors and patients approach of health care. Many 'apps' are designed for the doctors themselves and others are for the patients. Most of the commercially developed 'apps' designated for doctors are ranging from handy databases about drugs and diseases to sophisticated monitors that read a person's blood pressure, glucose levels, heart rhythms or other exclusive disease symptoms which are received from the patients. Apps designated for the patients enable them to gather diagnostic data through portable devices by do-it-yourself procedure and they are transmitted to the doctor's app for further recommendations of treatments. The mobile phone apps for health care applications that are available to 'consumers' today are produced by a variety of developers, ranging from small to large organizations with a commercial strategic goals. As such there is a wide range of scale, investment, and return in their business models. Therefore, the app users need to pay either directly or indirectly to the developers. For example, one particular globally reputed mobile phone application developer charges the consumer in the range of $0.99 to $5 [7]. Despite initial appearances of free app just as sample, but in many cases the user needs to buy an upgrade or a subscription. Those that combine an app and a wireless monitor cost from $80 to $200. This paper describes the development of simple medical application software which is user-friendly and can be easily installed in any smartphones with no cost. The app may be used by the patients and the doctors to save the time of travel and expenditure to visit the clinic for the follow-up of diagnosis. The doctors can attend more patients of urban and rural residents in his saved time from one-to-one consultation with the patients. The organization of this paper is as follows: The following Section 2 describes the system components and architecture. Section 3 included the final results and evaluation and in Section 4, the conclusions and future scope of work are discussed.

II. MATERIALS AND METHODS

2.1 System Components

In this section, the main components involved in the proposed work are explained.

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Figure 1 shows the schematic of the proposed system. The system component is divided into two parts: mobile communication network and the system software. The mobile communication network transmits the medical data between doctor and the patients. Existing data transmission system between the telecommunication towers from the service provider will be utilized just similar to the common SMS facility provided by them. There will be good offers for such facility by the service providers which in turn, might not be expensive to the users.

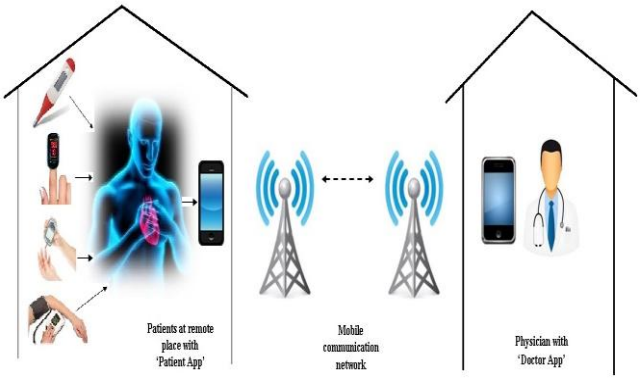


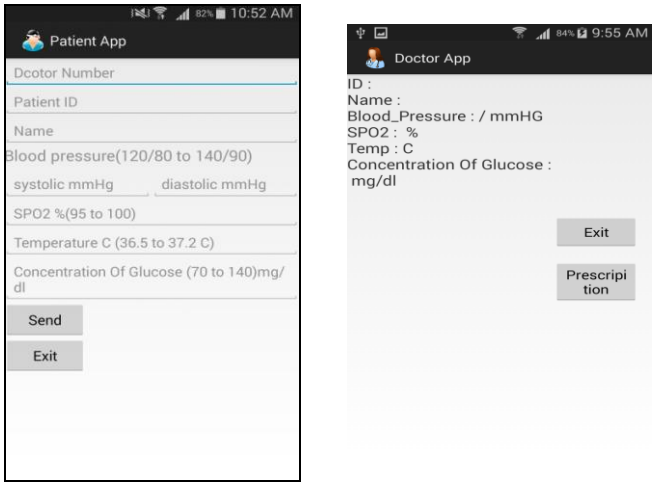
Figure 1. Schematic of the Patient and Doctor's Premises with their Smart Mobile Phones

2.2 System Software

The software for the proposed system is developed on Android platform which is emerging as most popular operating system intended for smartphones and tablet computers. Android platform, which is based on Linux kernel with a user interface, is chosen in this work because of its greater flexibility to third parties to use as an open source for programming [8]. Hence, it does not require any license or any kind of fees to develop on this platform. The code for Android application is written in java programming language which is then converted to java class files by java compiler. The Android SDK converts these files into executable files with file extension as ".dex". The "dex" files and application project resources are packaged into a new file with extension as ".apk". These are the files which contain all the contents of the Android application. The resulting APK files are downloaded to the smartphones either by Bluetooth or High Speed micro USB data transmission cable to publish in its device manager. The respective application with unique user ID is then installed into the corresponding user's mobile phone. The installed app will appear on the display screen of the phone with assigned user ID.

2.3 Application Design

To begin with the design of any system, the governing factors need to be thoroughly investigated. Primarily, the requirements for a new medical app are listed and then the design steps are outlined. The app developed should be more efficient in health care and medical diagnosis by speeding the process, improving patient monitoring, saving the doctor's time as well as reducing frequent visits by the patients to hospitals and feasibility to diagnose remotely irrespective of the location and time aiding the 'rurban' (rural and closer to urban) patients. Thus, we have produced two different applications which could be used separately by the doctor and patient. The app on doctor's side used by the doctor is named as "Doctor App" and the one on patient's side used by the patient is called as "Patient App". Selecting the icon of Patient App appeared on the splash screen of the smartphone, the application will load and open with a display screen in which the patient data need to be entered. The screen of this application is designed to enter the patient's biomedical data which are required by the doctor for the diagnosis of chronic diseases. These values may be obtained by direct measured from the patient with the help of digital portable biomedical instruments. To enter the data, a variety of text-entry techniques are available with the smartphones. Some of the phones included with a stylus activated S-Pen may be used in touch sensitive screens which other model phones are provided with an option to open with a small QWERTY keyboard when the text cursor is initiated on the screen [9]. The screenshots of Patient App and Doctor App from our test phones are shown in the Figure 2. The graphical display on the mobile screen is designed to include the contents of the critical medical data required for diagnosis of the patient and the treatment plan suggestion from the doctor in the return reply.



(a) **(b)**

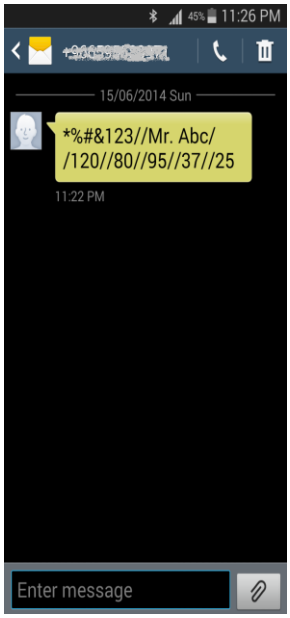
Figure 2. Screenshots from Mobile Phones Showing the (a) Patient App and, (b) Doctor App Display Screen Designs

The design of the app display screen is implemented on Android platform which is explained in the above paragraphs. Many people are unaware about the normal values of the physiological parameters such as blood pressure, body temperature or glucose level in the blood. When they feel about any change in their health conditions or symptoms of un-healthiness, they may undergo preliminary diagnostic tests by themselves either at their premises or nearby primary health care centers and observe the measured values. If they are found to be abnormal values, then they may immediately seek the advice from the doctor without any kind of hassle from getting the appointment or traffic congestion to visit the hospitals. The patient should enter the mobile phone number of the doctor before sending the medical data for seeking the advice.

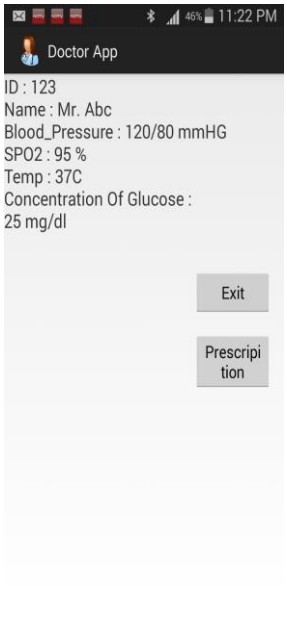
The GUI display of the Doctor App on doctor side is designed to receive the data sent from the patient for his consultation at his/her premises. After investigation of the values, the doctor can write the suitable prescription before sending to the patient's contact number. Also, this will help the doctor for compression of the patient frequently, without travelling by either party. The screenshot of the display showing the prescription pad is shown in the Figure. The pad for text-entry will open when the button "Prescription" on the Doctor App is activated either by touch screen option or stylus activation mode. Once the prescription is typed in the pad then it is sent to the same patient. This will help to communication between the patient and doctor remotely for the follow-up diagnosis and treatment at any time unless there is an emergency to contact the doctor individually.

III. RESULTS AND EVALUATION

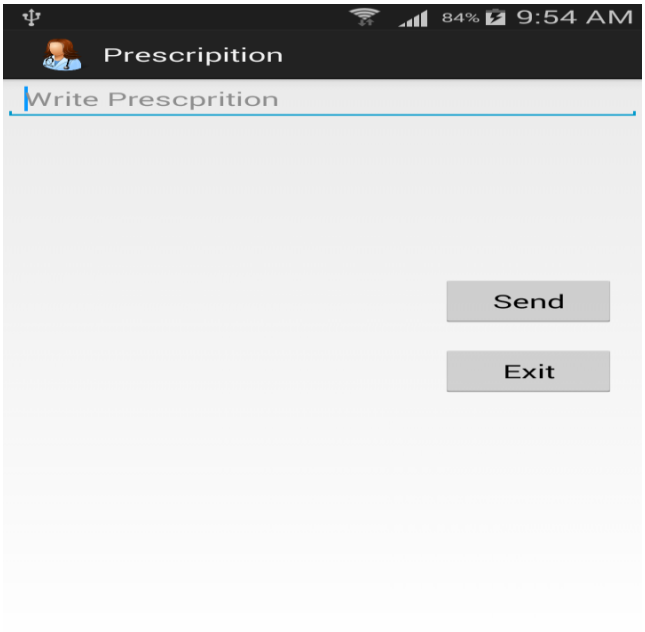
The programmed medical app was tested in our smartphones. To evaluate the diagnostic data communication from the medical app, we have taken two smartphones; one was considered as Patient App and another as Doctor App. The patient name was assigned as Mr.Abc with an ID 123. From the patient's app, the systolic pressure of the blood was entered in to the app through the keypad as 120 mm of Hg and the diastolic pressure as 80 mm of Hg. The normal blood oxygen level was then entered as 95 percent. The body temperature was typed as 37^{o}C and the concentration of glucose was typed in to the smartphone as 25 mg/dl. These values are selected to test the program and they are not really concerned with the patient's state since this is only an evaluation of the program designed in this particular medical app. Once these values are typed by the patient then the 'SEND' button was pressed. The data was sent to a doctor whose mobile contact number was known to the patient. The data sent from the patient Mr.Abc was received by the doctor through his smartphone as text message similar to the popular SMS format in the cellular phones. The screenshot of the message received by the doctor is shown in Figure 3 (a). After receiving the message from the patient, the doctor will open the 'Doctor App' application file by selecting and launching the icon from his smartphone. The file will open with the details of the patient which is shown in Figure 3 (b).



(a)



(b)



(c)

Figure 3. Results of Medical App Displays. (a) Shows the Message Received by the Doctor's App in the Text Form (b) The Display Screen Opens After Launching the Doctor App Icon (c) the Screen to Write Prescription to the Patient and to Sent to the Same Patient

The doctor will take the note of medical parameters of the patient and will press the button "Prescription" button to write the prescription to the patient. The 'prescription' screen will open in the same phone immediately where he can write his remarks about the diagnosis and treatment plan to the patient to be followed. The screenshot of the prescription pad from the phone is shown in the Figure 3 (c). Finally, the prescription was sent to the same patient by pressing the button "Send" from the screen.

The patient shall follow the treatment plan from his premises itself. The software program designed for medical application was thus evaluated to demonstrate the workability of the application.

IV. CONCLUSION AND FUTURE WORK

The medical application software for quick diagnosis helps the patients to get treatment plans remotely by saving the time of travel to visit the clinic. The doctors can diagnose and treat the patients by this app at their convenient time from their places. Thus the time and cost of both patients and doctors will be saved. The software is user-friendly without involving many operations and no computers or dedicated software are required. It is an open source, freely accessible software to benefit the user whoever need this app. Installation of the app in the smartphone is quite simple and more useful to socio-economically poor people as well as rural dwelling patients. The software need to incorporate more security and privacy, scope for payment of fees to the doctor directly to the specified bank account and more physiological data for chronic diseases. Also, the software will be updated to attach graphical data files such as ECG or even X-ray images also. These are the scope of further work which is in progress.

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