

Remote Rural Health Care Management for Preliminary Detection of Diseases using Android based Cell Phone

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Abstract: *The usage of mobile technologies is increasingly growing in developing countries like India. This work embodies the development of simple and robust technique for preliminary detection of diseases in the rural population of resource poor countries like India without presence of medical practitioner. We have developed a Java based mobile phone application, that can be used to assist and connect health workers and trained medical professionals through a backend Database using android phones. Rural areas often have fewer doctors and certain specialists might not be available at all. This work aims to improve the health care facilities in the rural areas. It also aims at providing interactive information and communication exchange between the health care officials and the rural population via android applications.*

Keywords: Cell phone, Disease Detection, Sqlite, Android OS.

1. Introduction

There is severe shortage of medical practitioners in India. In rural areas of the India, there is only one doctor for every 17,230 people, while the United States of America (U.S.A.) has one doctor for every 500 Americans. Most of the doctors prefer to practice in urban areas and so rural population have to face lot of hardships for getting medical treatment. The basic idea of this work is to alleviate some of health related problems of villagers by developing a system which can be helpful in detection of various disorders and enable correct and proper guidance for treatment. The system is based on a pulmonary auscultation instrument at remote rural area and auscultation will be recorded community health worker (not a doctor). This worker is trained to record pulmonary sounds at appropriate chest locations and also various parameters such as age, weight, gender, blood pressure, body temperature, symptoms, etc. The recorded sounds and various parameters are obtained and maintained the database in the android based application. This information is then transmitted to healthcare server and various parameters to draw the conclusion and carry out the diagnosis of the patients using expert doctor in initial stage. Further the need of expert doctor will be minimized at later stage for only conflicting cases if the system developed is able to classify the diseases correctly based on the previous knowledge. Each Health care server can handle several villages.

2. Motivation

Many resource-poor regions of the world, especially in developing nations like India, are struggling to provide basic healthcare for people due to a number of reasons. There is often shortage of trained medical specialists, poor access to diagnostic devices, and a supply-chain infrastructure that is unable to provide sufficient consumables, calibration, and maintenance for medical equipment.

About 75% of health infrastructure, medical man power and other health resources are concentrated in urban areas where 27% of the population lives as shown in Figure 1 and 2 respectively [2] People who reside in such resource-poor communities are forced to travel long distances from their home to seek medical expertise in more urban areas. Apart from the significant medical bills, the travel is financially burdensome due to the transportation cost and lost earning potential. Travel also includes the risk of road traffic, accident and can exacerbate a medical condition. The health status of Indians is still a cause for grave concern, especially that of the rural population.

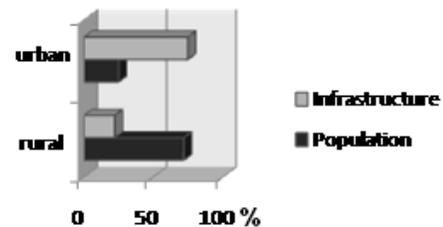


Figure 1: Health infrastructure versus population



Figure 2: Access to physicians

Most of the medical treatment is based on physical examination of patients by qualified doctor. However in many rural regions of India there are no qualified doctors and even if there are some government primary health center, there are scarcity of medicines and doctors do not

report for work regularly as they have their own flourishing private practice going on in cities. Cellular coverage has been extended to the rural regions also. So to improve the prevailing situation, the rural health problem needs to be addressed by developing system that can provide low cost approach for basic detection of diseases and local volunteers can be appointed to use this system through training.

3. Literature Review

Sufficient literature is available for describing mobile based remote health care system. These studies are aimed to combine pulmonary auscultation with that of communication device for database management from remote location to Health care server through Android OS. Some prior approaches are described

Sherin Sebastian. [3] provides an image based techniques to acquire and analyze a constant streaming of ECG signal through digital camera for image capturing, information extraction and analysis performed using MATLAB tools as well as data sending system based on internet network .The method captures the vital signs and parameters from the ICU monitoring machine using a webcam and transmits the image through the internet. The original image is then availed to the consulting doctor via an ANDROID cell phone. In case of anomaly a notification is send to the doctor's phone.

M V Ramana Murthy [4] describe status of mobile devices based Health care management systems in the world particularly in India and present the describe some feature of Mobile based Primary Health Care Management System under development by CDAC, Electronics City for deployment in the PHCs in rural India.

Rushil Khurana[5] developed Jiah, a Java based mobile phone application, that can be used to assist and connect health workers and trained medical professionals through a backend Medical Record System (use OpenMRS at the backend). Jiah(on symbian OS) is an extension of Sana, a similar application currently available for android phones, and is developed to cater to the majority of Java based phones currently available in developing countries.

Fuchao Zhou [6] developed a personal diabetes monitoring system which integrates wearable sensors, 3G mobile phone, smart home technologies and Google sheet to facilitate the management of chronic disease - diabetes. It automatically collect physical signs, such as blood glucose level, blood pressure and exercise data like heart rate, breathing rate and skin temperature. It allows users, especially seniors with diabetes, to conveniently record daily test results and track long term health condition changes regardless of their locations. It does so without having to ask users to manually input them into the system. The system also utilizes Google sheet to manage Personal Health Records (PHRs), which not only bridges the gaps between patients and different health care providers but enabling accesses to patients' PHRs anywhere and anytime by taking advantage of the universal accessibility of Google sheet. The system further integrates with GPS, Google Search and Google Map functionalities to facilitate the user to find all hospitals near to his/her current location including address, phone number, directions to the selected hospital and street view of the selected hospital.

Dr. Priyesh Tiwari MD [7] describes a healthcare delivery model based on mobile technology as an information transmission tool between rural patients and centrally located providers, using trained intermediaries as local facilitators, entrepreneurs and health activists. A customized handheld device that carries added features like biometric identification of all users, thermal printer, smartcard reader and writer and USB ports for connecting external diagnostic devices, was configured to collect healthcare information.

S. Lozano-Fuentes [8] describes Low-cost approaches to improving prevention and control of vector-borne diseases, such as mosquito-borne dengue and malaria. The application supports the use of cell phones for field capture and rapid transfer of mosquito vector surveillance data to a central database. The cell phones exploit existing communication infrastructure, introduce near real-time monitoring, and provide rapid feedback to field data collectors.

All these systems are basically oriented towards personal individual critical care mobile based systems with substantial cost component while our focus is to develop system which caters to group of rural villagers with the help of local healthcare volunteer

4. Proposed Work

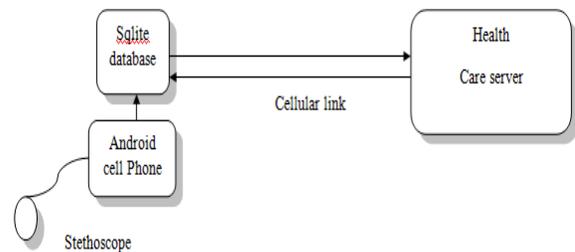


Figure 3: Block Diagram of the system

The frame work of the proposed system is shown in figure 3. Mainly there are three parts of this system:

- 1) Auscultation sound recording mechanism.
- 2) SQLite database to store the information of patient.
- 3) The Health care server located at nearby city.

The sound auscultation system contain stethoscope attached to mobile phone with android application. The application in the mobile phone records the lung sound and the other necessary information about the patient is obtained manually through form with fields for name, age, gender, body temperature, blood pressure, etc, along with the symptoms of various diseases such as fever, vomiting, sweating, etc. The information is stored in to SQLite database, and also transmitted to Health care server (PhpMyadmin) from remote location. After processing, the relevant information and summary report is sent to doctor for case study using SMS. The medical volunteer may request for sound file from the server through internet. [1], [11]

The system involves the integration and interfacing of following domains:

1. The medical aspects like diseases related data accusation and modification of stethoscope for appropriate interfacing with mobile phone.

2. Developing a Java application for mobile phone to record and to transmit lung sound to Health care server along with the patient's information.
3. Developing an application on mobile phone with modified stethoscope for data entry and transfer of patient disease information to health care server and receiving report/subscription from server for treatment

4.1 Android Platform

Android is described as a mobile operating system, initially developed by Android Inc. Android is based on a modified Linux 2.6 kernel. Google, as well as other members of the Open Handset Alliance (OHA) collaborated on Android (design, development, distribution). Currently, the Android Open Source Project (AOSP) is governing the Android maintenance and development cycle.

Operating Environment

It includes operating system, middleware and key applications. The platform will continue to evolve as the developer community works together to build innovative mobile applications. The various characteristics of android are:

- Data transmission using Wi-Fi, GSM, EDGE, CDMA, EV-DO and UMTS.
- It has a rich set of libraries for audio, video and image files.
- Dalvik Virtual Machine
- SQ-Lite for data storage.
- IPC message passing facilities.
- Integrated browser
- Comprehensive libraries for 2D and 3D graphics.
- Have features for video camera, touch screens, GPS etc.

To develop android applications the following software needs to be installed on our system:

- Java Development Kit [JDK]
- A compatible Java IDE [Eclipse]
- Android SDK tools and documentation
- Android Development Tools[ADT] plug-in for Eclipse

The application is coded using the popular programming language java. Java is a general-purpose, concurrent, class-based, object-oriented language that is specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere"(WORA), meaning that code that runs on one platform does not need to be recompiled to run on another. Java is currently one of the most popular programming languages in use, particularly for client-server web applications [2]

4.2 Database Management System

A Database Management System (DBMS) is a set of programs to store, modify, and extract information from a database. It also provides users with tools to add, delete, access, modify, and analyze data stored in one location. The present trend is to use SQL database. This approach does not require fixed table schemes, avoids joint operations by

storing de-normalized data, and are designed to scale horizontally.

For android cell phone SQLite database is used. SQLite provides a simplified subset of SQL statements for managing your data. Databases are stored on the device's public data area, either on the SD card or in the device's internal memory [9], [12]

4.3 Health Care Management System

The health care management system involves diseases related data consisting database of various diseases and their detection rules at the server end in collaboration with opinion of expert doctor. On receipt of SMS from rural healthcare worker, the symptoms are compared with the disease database and pulmonary sound and the system generates report of possible illnesses according to received symptoms and case history. It may also suggest further investigation whenever data is not enough to ensure precise diagnoses. After receipt of final information, the report is supervised by doctor and subscription is sent to the rural healthcare worker mobile for concerned patient [12] Each case is reviewed periodically depending on the type of disease. Some diseases in the database are

4.3.1 Malaria

Malaria is a disease that is transmitted by the bite of a particular kind of mosquito. Parasites travel to the liver and can lay dormant in this region or can start to rapidly multiply. The symptoms of malaria can be varied. Usually the symptoms are

- high fever
- Chills
- Headache
- feeling unwell
- muscle aches
- Cramps
- Sweating
- Vomiting

The treatment of malaria is dependent on the species of parasite responsible and it might be necessary to carry blood test to identify the parasite.

4.3.2 Dengue

Dengue has become one of the major widespread arthropod-borne viral diseases of human beings. WHO estimates that 50–100 million dengue infections occur each year in more than 100 countries. The symptoms of dengue are

- Headache
- Prolonged fever
- Skin rash
- Aching bones, joints, and muscles.

4.3.3 Tuberculosis

TB is an airborne disease caused by the bacterium Mycobacterium tuberculosis. In the United States, the majority of TB cases are caused by M. tuberculosis are also called tubercle bacilli. There are two types of TB infection,

latent or active. Latent infection is when you may have no signs of TB. The bacteria are in your body, but they are not active. Active TB is when people have signs of the bacteria, such as:

- Cough that lasts more than 3 weeks.
- Fever
- Weight loss or loss of appetite
- Feeling weak and tired
- Chest pain
- Night sweats
- Trouble breathing

These are the some of the frequently observed diseases in the rural area. The data of such diseases are stored into the database at the server end.

4.4 Application Development

The application use to store database and information sending message facility. It contains four layouts and each layouts having separate class. The layouts are:

1. **MainActivity:** The main activity layout is the first page of the application. It contains two button used to create and check the record. The *Intent i= new Intent (this,classname.class);* command is used to pass messages between components of the same or different applications or layouts.
2. **SaveInformation:** This activity is used to fill the information in the form available on the layout. The data entered into the form is stored in SQLite database. *DataManipulator* class is called to store data into SQLite database which use *DataManipulator(Context context){}* method. It also uses *intent* command to switch next activity.
3. **CheckInfromation:** The activity is used to show the SQLite database. It shows the data which is stored in the SaveInformation activity. *ArrayAdapter<String> adapter = new arrayadapter<string> ()* command is used to show data.
4. **ServerData:** This activity contains same form as that of SaveInformation activity, three additional buttons are available in the form i.e. start recording, stop recording and save&send to doctor. *AudioRecorder* class is used for recording of pulmonary sound. The class *SMSReceiver* is used for receiving the SMS from the server. *sendSMS, uploadfile* methods are used to send sms and to upload the data on to the server [10].

For satisfactory operation of the application certain permissions are needed which are mentioned below:

```
<uses-permission
android:name="android.permission.RECORD_AUDIO"/>
android:name="android.permission.WRITE_EXTERNAL_ST
ORAGE"/>
android:name="android.permission.INTERNET"/>
android:name="android.permission.SEND_SMS"/>
android:name="android.permission.RECEIVE_SMS"/>
```

The major activity information used in the application is described below:

```
<activity android:name=".SaveInformation"
android:label="@string/title_activity_main"/></activity>
<activity android:name=".CheckInformation"
android:label="@string/title_activity_main"/></activity><a
ctivity android:name=".ServerData"
android:label="@string/title_activity_main"/></activity><r
eceiver android:name=".SMSReceiver">
<intent-filter>
<action android:name=
"android.provider.Telephony.SMS_RECEIVED" />
```

5. Result

The system is provided with suitable user-friendly interface to enable unskilled healthcare worker to accept patient health information for rural population on daily basis and transmitting it to healthcare server. He also checks incoming information from server and informs concerned patient relating treatment/ drugs dosage.

The screenshots of various stages of data entry of application are as shown in figure 4

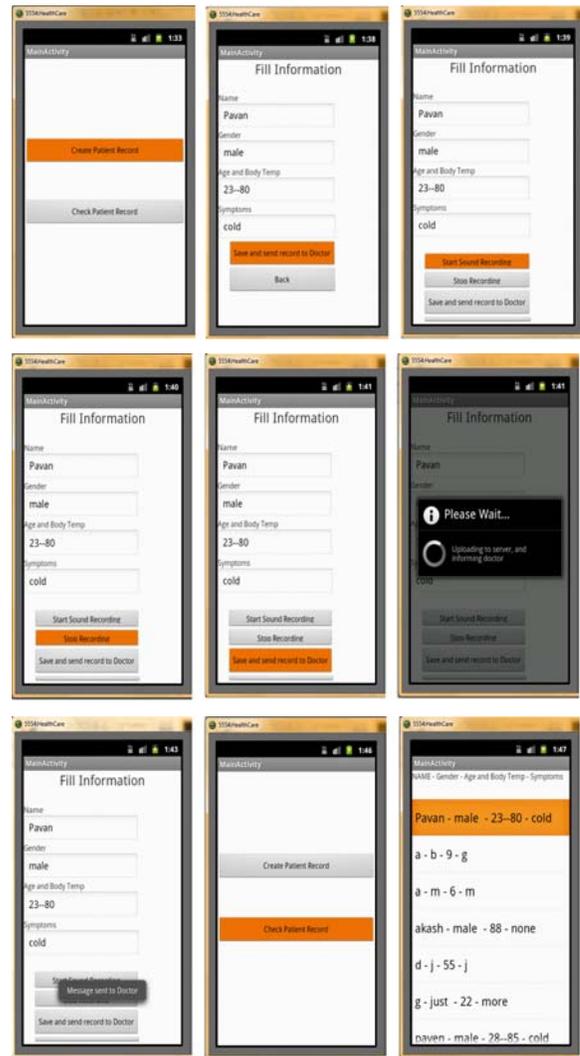


Figure 4: Snapshots of the application

6. Conclusion

The proposed system is able to interface low cost modified stethoscope with that of mobile phone. The detailed symptoms and case history of patient is transmitted to Health care server through SMS. The auscultation sound file is transmitted through e-mail due to its large size. The system is low cost because expert doctor is not required at the remote village end. The poor people living in the remote rural area will get benefited as they don't have to rush to the cities for preliminary treatment of their general diseases. These people would also get diagnosis and prescription within one or two days depending on the work load of the Health care server. So this is a very beneficial idea for the health of rural people living in the remote villages of developing countries like India. The Preliminary detection and treatment of diseases is very important as it can prevent the deterioration in health of patients due to improper and untimely treatment. It is expected that with integration of these services into health care project, substantial portion of affected rural population can be effectively treated resulting in great improvement in quality of life.

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