

Survey of Android based Healthcare Application

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Abstract- Nowadays, the usage of mobile technology and application is escalating as it providing different services in various fields. This paper defines how the mobile phone with Android OS is very useful in medical field because Android OS phone can retrieve the medical images which are in .dcm format where .dcm is known as DICOM format image and DICOM is abbreviated as Digital Imaging and Communication in Medicine. @HealthCloud, Ubiquitous Healthcare system and “D’s Viewer” application are the some applications which are developed on Android OS to access the medical image and to see the patient’s information. Ubiquitous Healthcare System and “D’s Viewer” application provides even security while accessing medical image and @HealthCloud and “D’s Viewer” access the medical image with the help of cloud computing.

Keywords: Medical Image, DICOM, Android OS, Cloud Computing.

I. INTRODUCTION

Presently everyone wants everything instantly which is easily possible by mobile technology. Here mobile technology is used to see the medical images on Android OS phone. So some systems are developed for the mobile which concentrates on two things such as the availability of e-health applications and medical information anywhere and anytime. But accessing medical information on phone is critical task because while accessing medical image it introduces several interrupts such as data storage, efficiency, security etc.

The medical images which are generally .dcm format which are known as DICOM (Digital Imaging and Communication in Medicine) and it is developed by NEMA (National Electrical Manufacturer’s Association) and ACR (American College Of Radiology)[1]. These images are in large size because it contains both the information of patient such as patient image and patient details. So for storing these large images needs huge database and high bandwidth while transferring these images from one server to another server. The main important issue while transmission of medical information is security because the data get changes by unauthorized person [8][9][10].

@HealthCloud, Ubiquitous Healthcare System and “D’ Viewers” application are the systems which are presented in this paper. These applications are developed on mobile phone having Android Operating system. Android Operating system which Linux based operating system is developed by Google and Open Handset Alliance for mobile which includes an operating system, middleware, and applications. These systems are developed to overcome data storage, efficiency and security issues. @HealthCloud and “D’s Viewers” application uses cloud computing services but @HealthCloud application doesn’t provide security. Ubiquitous healthcare system provides security but it uses

server application to access images not cloud computing services.

In section 2, there is description of DICOM format image. Section 3 gives complete description about Android operating system, Section 4 defines the various applications and in Section 5 experimental results are given and Section 6 concludes the paper..

II. DICOM

Here android is accessing DICOM format image. DICOM is abbreviated as Digital Imaging and Communication in Medicine and its standard is developed by ACR (American College of Radiology) and NEMA (National Electrical Manufacturer Association). It uses the ISO reference model of network for communication purpose and object oriented design concept is applied. Own syntax and commands are define for this standards and by using these protocols the information can be exchanged. Media through which information can be shared is the storage of media storage devices, file format and the way of accessing medical image and some related information.

Proper connectivity should be there while transferring of images. The DICOM file contains both information such as name of the patient, date of birth, age, diagnosis and the multiple images. A DICOM file has the following structure:

- A preamble of 128 bytes
- Prefix (4 bytes) where are stored the letters ‘D’, ‘I’, ‘C’, ‘M’ which represent the signature of the DICOM file
- Data Set, which stores a set of information such as: patient name, type of image, size of the image, etc.
- Pixels that compose the image (s) included into the DICOM file.

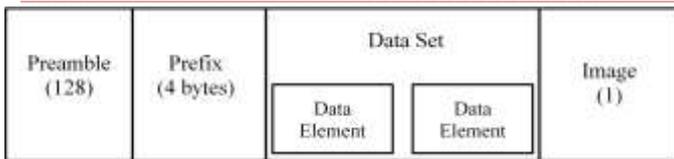


Figure 1. DICOM File Format

Numbers of elements are composed into Data set and each Data Set represents a single SOP Instance related to a single SOP Class (and corresponding IOD). An IOD (Information Object Definition) is a model of abstract and object-oriented data and it allows to specify information about objects from the real world. As patient image and patient data contain in same file it is considered to be very useful format. So the size of DICOM image will be large [2].

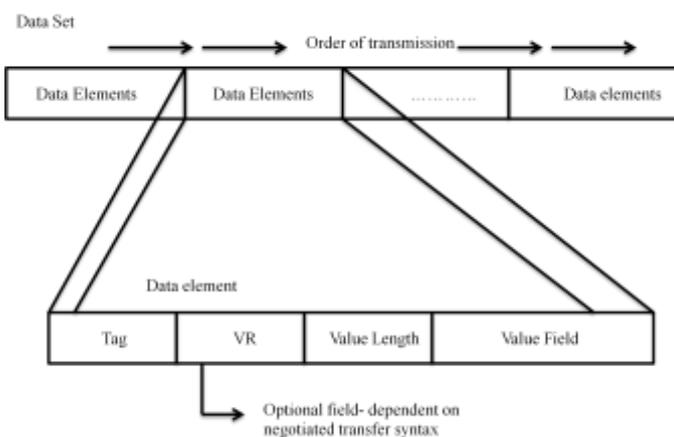


Figure 2. Data Element of DICOM Structure

"PS 3.A- YYYY", this is the form of DICOM standard where A is a part number and YYYY is publication year. For example, DICOM Part 2 is "Conformance" and document number "PS 3.2 - 2003". The above diagram is the Data element of DICOM file structure. One attribute represents one data element and several data element represents whole IOD instance. In Data element first field Tag contains two integers and it specifies patients ID. VR means Value Representation describes characteristics information and In the value length consist of length of the data. Value field actually it represents the data and in if value field contains name (data), so it is represented as PN (DA) where PN means Patient Name and DA means Date. From the above description of DICOM it is understood that DICOM image file format contains important information which should not be modified by anyone. So DICOM image should be secured [7].

III. ANDROID OPERATING SYSTEM

Very Popular Android Operating system which Linux based operating system is developed by Google and Open Handset Alliance for mobile which includes an operating system, middleware, and applications. Android is often referred to as the first complete mobile platform, open, and free. This operating system software contains various java applications which are based on object oriented application framework

on top of java core libraries. This java application runs on Dalvik virtual machine featuring JIT application.

A. Android Architecture

Mainly Android operating system is a collection of software stack with different layers. The each layer which is present in operating system represents collection of several components of the program and provides different services to the other layers [6]. Descriptions of each layer of the android operating system architecture are given below:

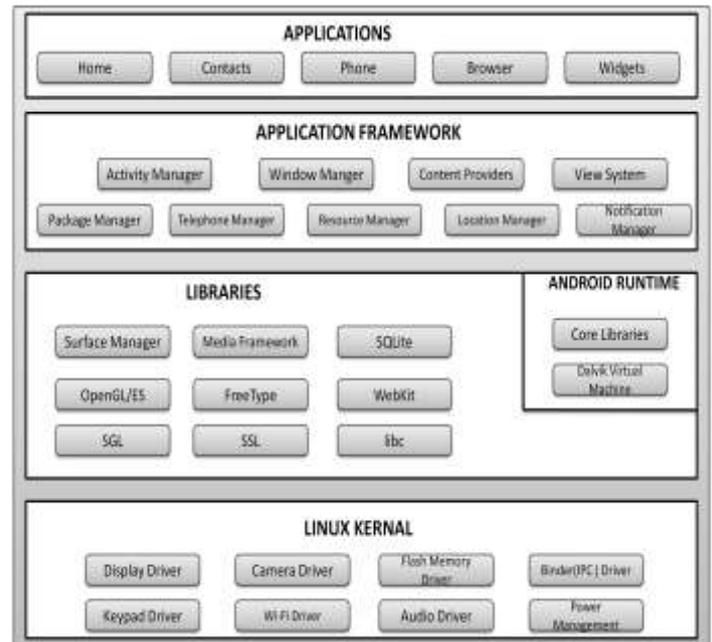


Figure 3. Android Architecture

- Linux Kernel: It is the first and most basic layer of the android architecture and it is an intermediate layer between the hardware and software of the operating system android.
- Libraries: Several different types are handled by this layer in android operating system.
- Android Runtime: By using Linux Implementation this layer allows to run the android operating system.
- Applications Frameworks: on this layer applications are designed and made.
- Applications: is the uppermost layer and in this layer the user associated with application only.

B. Activity Cycle in Android Operating System

In the android operating system there is an activity stack in which system governs the application activity. When an activity is started, the activity will be on top of the pile of the activities that been run before. An activity of the android operating system has four states which are mention below:

- Active/running state: activity is being in the topmost of the pile of activity stack and its running.

- Pause state: activity is not used but its running and visible to user..
- Stopped state: activity is no longer visible on the screen. Activity is still running but the system can easily destroy the activity.
- Destroyed state: activity no longer exist in memory means it get destroyed.

C. XML

The markup language which is designed to exchange data is known as XML or *eXtensible Markup Language*. XML is a standard data storage format and it contains the metadata that has a description of the data itself. The word "extensible" in XML means that XML allows users to add and define "markup language" itself. In general, XML explains the structure of the information stored and it is saved in a text file (ASCII). The XML information in it is written in the tags that can be defined by the user.

D. API level 9

The downloadable component Android 2.3 (GINGERBREAD) platform is available for the Android SDK and this platform compose of not only an Android library and system image but also a set of emulator skins and more. Download Android SDK manager on platform to get started developing or testing against Android 2.3. An amended set of standard applications lets the user take new approaches to supervise information and relationships using Internet Calling, Near- Field Communications, Downloads Management, and Rich Multimedia etc.

E. Eclipse

Eclipse is a multi-language software development environment and it involves an integrated development environment (IDE) and an extensible plug-in system. Frequently it is written in java and mostly it is used to evolve the applications in java, Ada, C, C++, COBOL, Perl and PHP. Android provides a custom plug-in for the Eclipse IDE known as Android Development Tools (ADT) .This ADT is invented to provide a powerful, integrated environment which can be used to build Android applications. It enhance the capabilities of Eclipse to let you instantly set up new Android projects, build an application UI, correct your applications using the Android SDK tools, and even export signed (or unsigned) APKs in order to distribute your application.

IV. APPLICATIONS

In this Sections , various healthcare applications are present such as @HealthCloud , Ubiquitous Healthcare system and "D's Viewer" Application which all are developed on android operating system.

A .@HealthCloud

By using Cloud Computing Charamlampous, Thomas and Ilias developed the @HealthCloud application as mobile user interface so that medical experts and patients will be able to access, storing, querying and retrieving medical

images, patient health records and patient-related medical data on mobile for managing healthcare information [3]. The data resides at a distributed Cloud Storage facility and it is already transferred or stored by medical personnel through a Hospital Information System (HIS).

The main application manages healthcare information by using Web Service and the REST API. The content resides remotely into the distributed storage elements but the user feels that he is accessing that the data from the resource which are located in locally in the device. Information regarding patient's status, related biosignals and image details can be displayed and managed through the application's interface.

The DICOM medical image protocol is supported, while the to support various compression such as lossy and lossless compression, progressing coding and Region of Interest (ROI) coding, JPEG2000 standard has been used to implement. The progressive coding grants the user to decode large image files at different resolution levels optimizing this way network resource and allowing image acquisition even in cases network availability is limited. By using SHA1 hash technique for message and SSL is used to encrypt data user is authenticated.

1) Implementation Process

Cloud Computing is used to developing and deploying the mobile healthcare application and its service usually are the platform frontend interface that communicate directly with users and allows the management of the storage content. The Cloud Storage Facilities manages the physical infrastructure and is also responsible for performing maintaining operations (e.g., backing up data, etc.) The Cloud Platform interface is also connected to the Cloud Service module, which handles the user request as well as keeps in order. At last, the Cloud Infrastructure module manages user account, accessibility and billing issues. HealthCloud has been developed based on Google's Android mobile Operating System (OS) using the appropriate software development kit (sdk). The Cloud Service client running on Android OS consists of several modules.

It decodes images in DICOM format displaying both image and heard information. When JEPG2000 compression is used, the relevant sub-module decodes the image. The communication with the Cloud is operated through an implementation of Web Services REST API that is supported genetically by Android. The innate interoperability that comes with using vendor, platform, and language individualistic XML technologies and the ubiquitous HTTP as a transport mean that any application can communicate with any other application using Web services.

The Cloud repository is presented as a virtual folder and does not provide the features of a database scheme. In order to serve the user with data querying functionality, medical

records and related data (images and biosignals) are stored into a SQLite file. Internally Android is already connected with SQLite is the database platform. The file occupies the specific location at the Cloud and is retrieved on the device every time user needs to query data. The query is executed locally and the actual location of the data in the cloud is revealed to the applications. The database file is restored and uploaded into the Cloud every time user modifies data, respectively. This application retrieves the images very quickly.

B. Ubiquitous Healthcare System

For developing android mobile application, Android 2.3(GINGERBREAD) platform is downloaded for the Android SDK. To run the android SDK Eclipse Plug-in is used. Datagram Server program is written using the java program. The Client and Server connection is managed. The Client and Interface is designed using XML coding and Android Java Coding respectively. Eclipse is used to build and resemble the mobile. The Server is created using Datagram Server in java. Now the Server system is connected to the database and database is connected to the ODBC connectivity, where the database is created by using MySQL. ECC (Elliptical Curve Cryptography) is used to encrypt the data which is present on the Server system and this encrypted data is transferred by using Wi-Fi.

The mobile application is able to connect with only low level database such as SQLite where as the other database like MS Access, Oracle, SQL Server which are high database, the mobile application can't get connect with it. Datagram server program helps the mobile application to get connect with high level database. In server system, the medical data which is requested by the user is in encrypted form. In this process the data which is transmitted is encrypted in the server system and the data which is received is decrypted in the mobile application. The implementation of this application is given in flow chart which is present in figure 4[4]

C. "D's Viewer" Application

Yi-Ying Chang, Huai Bing Zhong, and Min-Liang Wang created an application based on Android Operating System in which doctor can access medical images of patient after identity is authenticated by him[5]. The identity proceedings have two ways to authenticate such as typing identity information and scanning the QR-Code of identity. The QR-Code is used to authenticate as well as it is used for used searching patient number as every patient has their own QR-Code which is considered to be as patient number. This QR Code is encrypted by AES (Advanced Encryption Standard) for information security purpose. At the server, there is an application program interface (API) and it is connected with server to communicate. It handles up all responding information, requesting and encoding it to JSON (Java Script Object Notation) format between mobile application and server. The API is coding in PHP, Popular general-

purpose scripting language PHP is used for API coding. With

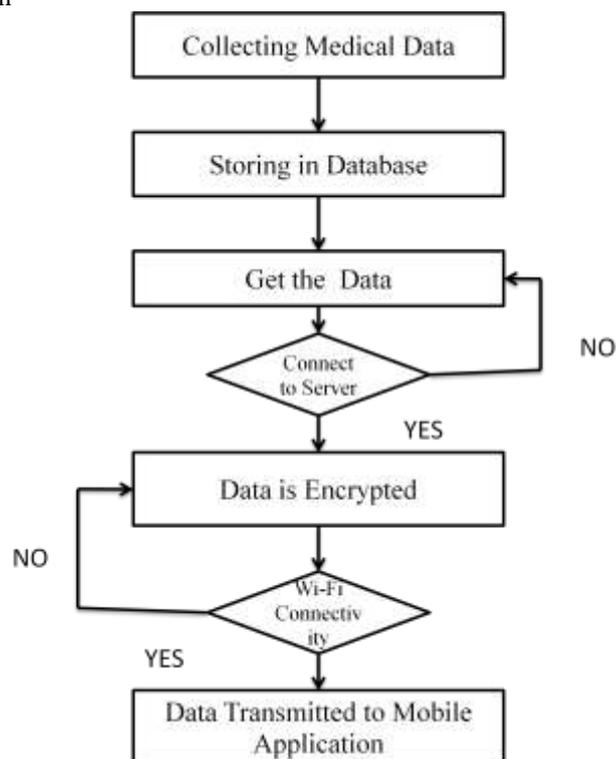


Figure 4.Flow Chart for Ubiquitous Healthcare System

Processing medical image (DICOM), this technique uses the DCMTK tools for retrieving tags and image. DCMTK consist of libraries and applications which are implementing on large parts of the DICOM standard. Even it is composed of software for examining, constructing and converting DICOM image files, handling offline media, sending and receiving images over a network connection, as well as demonstrative image storage and work list servers. DCMTK is open source software which is coded in both languages such as ANSI C and C++. . The application which is created is name as "D's Viewer". QR-Code replaces the patient personal information which is only readable by application because it has encrypted by AES. The cipher is encoded in Base64 before encoding QR-Code. It makes sure to protect privacy of patient in the ward, and the key of AES is set on the server. This system is made according to the Health Insurance Portability and Accountability Act (HIPPA) as Privacy and information security are very significant issues.

V. RESULT

In the first application which is @HealthCloud, it concentrates on the transmission of an image to mobile but it is not focusing on security of an image whereas the other two techniques QR-Code and SQLite gives importance to the both security and transmission. So the Experiments which is performed on @HealthCloud application concern about time needed to transmit data to the Amazon S3 Cloud storage service.. The @HealthCloud application is installed

on a HTC G1 mobile phone running Android OS version 1.6. A number of medical images of different modalities (MR, CT, PET, OT and Ultrasound) and different file sizes have been used. These images are transferred through two different wireless network infrastructure types such as a WLAN and a commercial 3G Network because the performance of both WLAN and 3G networks can be easily tendentious by traffic and other network conditions, Also, the acknowledgement time of the Amazon S3 Cloud service can play an crucial role on the total transmission time. As the application is installed on HTC G1 mobile phone, the time required by @HealthCloud to display uncompressed CT images which is resolution of 512x512 pixels was 0.52 sec and compressed CT images with JPEG2000 coding which is resolution of 512x512 pixels was 4.53 sec. The time needed to decode OT images compressed with JPEG2000 at resolution of 3072x2048 was 21 sec. and 7.5 sec. for a sequence of 10 ultrasound images of 600x430 pixels

In the ubiquitous healthcare system, connection is fixed between the server system and the mobile application. The data is transferred from database of server system to the mobile application using Wi-Fi.



Figure 5.Snapshots of Login Doctor



Figure 6.Snapshots of Patient Details.

The third application which is named as “D’s Viewer” in this the personal information of patient has replaced QR Code. This QR-Code only can be read by application because it has encrypted by AES. Before encoding QR-Code, the cipher is encoded in Base64. It makes sure to protect privacy of patient in the ward, and the key of AES is set on the server.

VI. CONCLUSIONS

The above three application which are presented in this paper makes to see .dcm image which is medical image on android operating system phone. The first, @HealthCloud a prototype application of a mobile healthcare information management system build on Cloud Computing and Android OS. This application permits us to manage patient health records and medical images and it takes advantage of Amazon’s S3 Cloud Storage Service. As it access the medical image on phone so quickly but it doesn’t provide security to the image.

The Ubiquitous Healthcare system helps to access medical image on android SDK 2.3 from large database by creating connectivity with the help of server program as mobile have small memory to store data and it assures security and authenticity in accessing database. The “D’s Viewer” Application is standard medical image retrieve implementation with QR-Code authentication based on Android OS and Private Cloud Integration of mobile and cloud systems will lead to better clinical decision

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