Mobile Application for Monitoring and Management of Out-Patients

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***Abstract*- The most important dependencies for life sustainability with the growth of same is Health Care. Mobile technologies offers a tremendous opportunity for health care system for developing countries through provision of remote medical consultations. The challenges in our health system serve as the motivation for this research. This research focused on the development of Mobile Application for Monitoring and Management of Out-Patients that can be used by health providers and patients to provide medical consultations remotely with instant feedback using android mobile phone. The features includes chatting between patients and the health providers. Agile Software development life Cycle is employed. The implementation was carried out using Extensible Mark-Up Language (XML), Java Programming language and Android Studio with Android 7.0 Naugaut for the client-side while MySQL database with Django as the web framework and Anaconda as the interpreter at the server-side. Questionnaire method of data collection was employed, and Descriptive Statistics was used to analyze the data collected. The result of the evaluation shows that the application was rated positively and the average score from the users reached 95% Confidence Value.**

Keywords- Mobile Application, Monitoring, Management, Remote Consultation,Out-patients,M-health. Android-Phone, Doctor-Patient Interaction.

I. INTRODUCTION

A. The invasion of mobile phones in the developing countries has been both great and remarkable due to fact that global mobile phone consumption is high, with nearly 7 billion cell phone subscriptions and an estimated 96% mobile penetration in the world in 2014 [1]. This is evident according to World Bank Group report [2], that mobile device have reached more people in many developing countries than power grids, road system, water works or fibre optic networks. Therefore, a technology which would allow doctors to patient's consultations remotely will therefore be of good use to the doctors and the patients. Remote consultation for outpatient defines the distant consultation for patient that is in a remote site. The remote site may be at the comfort of their house or any available place in which the services are needed without being to the hospital [3].

A. Mobile Health

Mobile-Health (m-Health) is a subset of e-Health that focuses on the delivery of health care services via mobile communication devices [6]. M-Health broadly encompasses the use of mobile telecommunication technology within health care delivery systems. In WHO' report [7], m-Health was defined as medical and public health practice supported by mobile devices, including mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. It focuses on the use of mobile phones (both simpler phones capable only of voice and text message communication and smartphones with many other capabilities, including access to websites and application software known as "apps" [8].

B. E-Health

E-Health (or electronic health) is broadly defined by the World Health Organization as the "use of information and communication technology for health" [9]. The main objective of e-Health programs is to use Information and Communication Technology (ICT) to improve healthcare service delivery and health outcomes through the strategic use of technologies such as:

a. Computers
b. Internet satellite receivers
c. Mobile phones
d. Personal Digital Assistants (PDA).

In addition the expansion and enhancement of wireless networks throughout low and middle income countries will increase access and capabilities of these technologies to healthcare providers and the general public in more remote geographical locations. The objective of this work is to develop a real-time mobile health system for monitoring and management of out-patient for remote consultations.

II. LITERATURE REVIEW

In 2009, the use of mobile telephone in reducing pre-natal maternal mortality for Abiye safe motherhood in Ondo State is presented. The motivation comes from the need to use mobile telephone to manage maternal mortalities resulting from childbirths. The objective was to reduce the maternal mortality rate by 75% by 2015. Short Messages Service (SMS) for push notification were used. The results shows that about 47% reduction of maternal mortality, an increase of 58% of registered patient and an increase of 96% of the number of live births in Ifedore and Idanre LGA were generated [9,10]. The limitation is that the timely delivery of notification messages was not considered.

In 2011 Dakoza mobile phone monitoring system for disease management was developed. The research was motivated by the need to improve communications between the different players in the health network and to improve the health status of patient. The objective of the research was the need to fast-track and improves critical services for HIV and TB patients. SMS/MMS based system was developed which includes auto-reminders of next appointments. The result shows an increase in patient compliance [11]. The limitation is that the system does not allow instant feedback.

A mobile phone intervention for the management of depression and Autism is proposed by Chen *et.,al*. The research was motivated by the need to reduce adolescence psychiatry. The objective is to explore the utility of text message interventions. Text-messages were deployed. The result shows that daily messages constituted the perfect amount of contact and improved patient communication with providers [12]. The limitation of the system is that text messages should not be the only benchmark for intervention in adolescent psychiatry.

Ran Wei and Zhimin Yang (2012) developed a system on Doctor-Patient Interaction based on Android mobile technology was developed. The motivation arises from the need to have a convenient and urgent means of communication between doctors and patients. The objective was to develop a doctor to patient interaction system using Android mobile phones. The design implements an e-mail system on Android platform. Embedded database system (SQLite) was used [13]. The result shows that the need for protocol conversion was reduced but communication exists in non-real-time mode.

A research work on Android Mobile Application Platform for Remote Medical Monitoring System is developed by Ziyu *et., al* (2015). The research was motivated by the need to get more health care and doctor's professional advice when patients feel unwell. The objective is to build a remote medical monitoring system using Android mobile terminal for remote data acquisition, medical data analysis with push notifications. The research work employed development tools and application such as Google cloud messaging for push notification and Android platform on Bluetooth BLE technology, Java programming for the API, C++ for the library, and MySQL for the database. The result show that the system compared with traditional medical monitoring system, significantly reduced medical resource inputs, making health care more efficient and practical [14]. The push notification messages are delivered at will and not as instant messages with no feedback. This research is therefore motivated by the need to overcome the stated limitations by developing a real-time mobile health system that can be used by health providers and patients to provide medical consultations remotely with instant feedback.

III. RESEARCH METHODOLOGY

The development of Mobile Application for Monitoring and management of Outs-Patients is divided into two: the Android Application Design and the Database Design. The application is developed using Android Studio 2.3.3.

IV. SYSTEM FEATURES

The development of real-time mobile health application for the monitoring and management of patients incorporates the following:

- Electronic Medical Records
- Chatting
- Video Recording
- Medical Images
- Drug- Prescription
- Data transmissions include files, images and videos.

C. Software Development Method

The Agile software development is a combination of iterative and incremental process model with focus on product adaptability and satisfaction. Agile software development life cycle for mobile applications was adopted. It comprises the planning, requirement analysis, design and Testing phase. Agile methods break the product into small incremental builds (Remote Clinical Consultations Users) which are provided in iterations for functional activities and it was developed with the view of some users. The build is divided into six stages of application package kit (.apk) as follows:

- Administration *.apk*
- Doctor *.apk*
- Nurse *.apk*
- Medical Scientist *.apk*
- Pharmacist *.apk*
- Patient .apk

At the end, the *apk* was merged as one, except the admin *apk.*

D. Database Design

The database model of the clinical consultation system is presented. The MySQL data model is adopted which is of the family RDBM. Data for the Remote Clinical Consultation Application is organized into table structures. It is composed of 12 relations. *Android Application with the Database in Real-Time*

The application is written in Java programming Language with XML for the interface, embedded in an android mobile phone. The real-time app resides as a tool in the Presentation Layer. When requested, it is downloaded on the client phone. Once loaded, it communicates with consultation server using the HTTP protocol. It establishes an HTTP connection and then posts HTTP requests to it. The HTTP requests are received and forwarded by the mobile phone layer to the

presentation layer. At the presentation layer, the request is processed and then an HTTP request is made to the application layer which fetches the required information from the database layers.

E. Consultations In the Remote Clinical System Application

The aim is to effectively utilize the available doctors. The consultation is based on set theory, and the modeling is to increase the patient satisfaction and effectively utilize the available doctors. The parameters for the remote consultations and the modeling are denoted as follows:

$P = \{P1, P2, P3, P4, P5, \ldots Pn\}$ (1)

where P is the set of Patients in the system, where $Pi \in P$ denote specific Patient Pi

$D = \{D1, D2, D3, D4, D5, \ldots Dn\}$ (2)

where D is the set of registered Doctors in the system to attend to Patient, where $Dj \in D$ denote specific Doctor Di

$A = \{AD, AD2, AD3, AD4, AD5, \ldots ADn\}$ (3)

where A is the set of available Doctors, where $ADj \in \{1,0\}$ is the availability of specific Doctor.

$Q = \{QD1, QD2, QD3, QD4, QD5, \ldots QDm\}$ (4)

where Q is the set of patient waiting for a Doctor, where $QDj \in Q$ denote the specific Doctor's queue that contains an assigned patient.

$H = \{HD1, HD2, HD3, HD4, HD5, \ldots HDm\}$ (5)

where H is the set of average patient handling time of each Doctor, where $HDj \in H$ denote specific Doctor's handling time.

V. SYSTEM ARCHITECTURE

The system operates based on the application being downloaded on the phone register and login then he/she can communicate with rest of the module such as Doctor, Nurse, SMS channel, Pharmacy, Lab Scientist, Chatting Channel and Database Server. All annals are shared with the HTTP (Hypertext Transfer Protocol).The system features chatting, medical images, health Tips, drug- prescription and registrations of patients all in real-time environment. The behaviour of the system when the patient wants to share information with the specific module (Doctor or Nurse) is that of an on-line chatting box. The web server interacts with the centralized database named as Relational Database Management System (RDBMS) via JAVA script, it also receive query, update, and execute the query. The client side is Android Device and server side is combination of MYSQL, PyCharm and Django web framework.

Patient is to access and input data to the system through the web browser from the Android Phone. Data transmissions include file, image and video transfers, and vital health statistics of patients. The characteristics of each of these data streams can differ greatly. The database tier is responsible for storage, retrieval, update, and integrity of the data. The connectivity of the application to the database is through the Java Script.

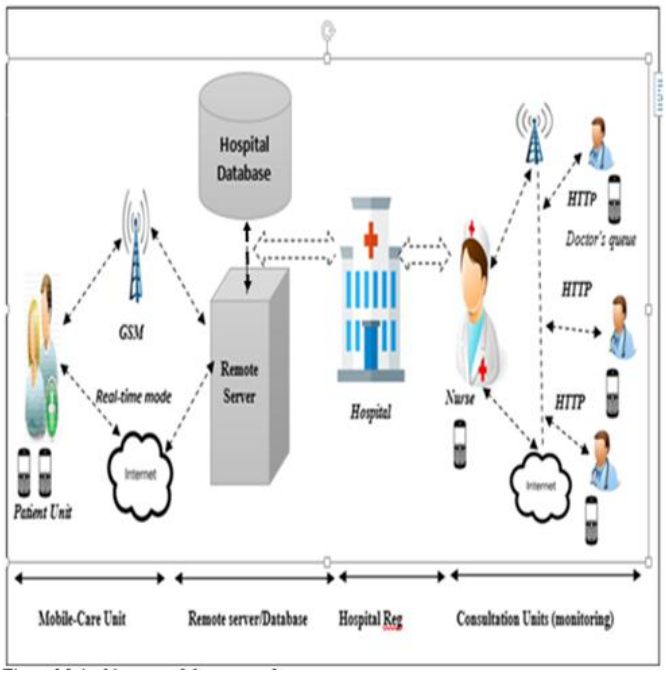

Figure 1: Architecture of the System

VI. COMPONENTS OF THE ARCHITECTURE

The components of the proposed system architecture are presented as follows:

- **Patient Mobile Unit:** An interface where online patients submit requests in a real time mode.
- **Remote Server:** A two-way communication link servicing the patient requests with the hospital database.
- **Hospital Database:** A repository containing the records of patients and various health providers.
- **Virtual Nurse:** An intermediary between the patients and the specific doctor in attendance for a first time user.
- **Doctors' List:** A list of doctors in attendance with different specialties.

VII. SYSTEM DESIGN REQUIREMENT

The system was implemented using the following minimum requirements:

Client Side:

a. Xml (1.0)- Interface Design
b. Android Studio 2.3.3 - Integrated Development environment for Android
c. Android o/s version 7.0 – Naugat
d. Java Runtime Environment
e. SQLites- Login Details

Server Side:

a. Pycharm (2017.2 Professional) - Integrated Development Environment (Django)
b. Django 2.0.3 - Web Framework
c. Anaconda(5.1.0) - Interpreter

d. MySQL database 2008 (5.7.21)

TABLE I THE SYSTEM FLOW ALGORITHM

VIII. RESULT AND DISCUSSIONS

The Clinical Consultation application was tested by some experts comprises Doctors, Nurses, Pharmacist and Laboratory Scientist. The total of Sixty-Five (65) questionnaires and sixteen (16) questions in each was administered. Evaluation was based on ease of use, acceptability and functionality. The users had the clinical consultation system installed on their mobile phones.

Questionnaire method of data collection was applied, the questionnaires are closed-ended which allow respondents with choices of options (Strongly Agreed, Agreed, Strongly Disagreed and Disagreed). The objective of the questionnaire approach is basically to evaluate the clinical consultation system.

Descriptive statistics is used to summarize the features of the information collected from the questionnaires. It measures the central tendency and variability. The average score from the users who consented from the hospital and from those outside of the hospital gave the overall user success for the clinical consultation system, which reached 95% Confidence Value. This is quite impressive taking into account that most users were acquainted with mobile phone usage. The usefulness of the application and the functionality were rated positively. Users were comfortable with using the system. Overall, users stated that they were enthusiastic about the potential of using such applications.

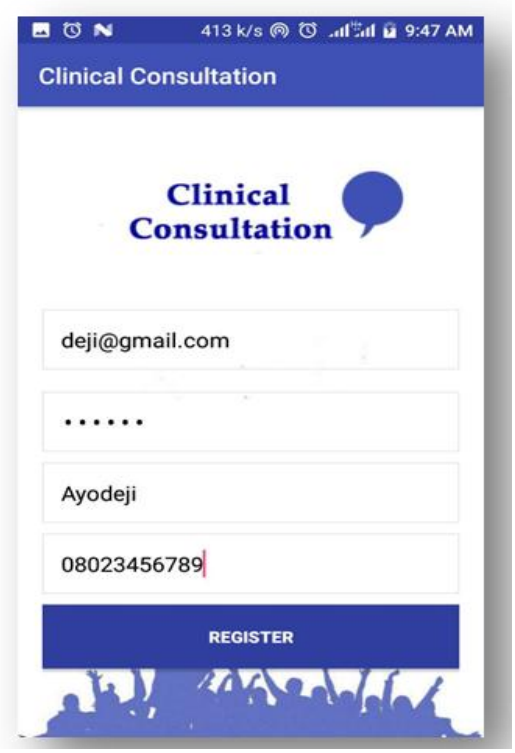

FIGURE 3: AYODEJI REGISTRATION

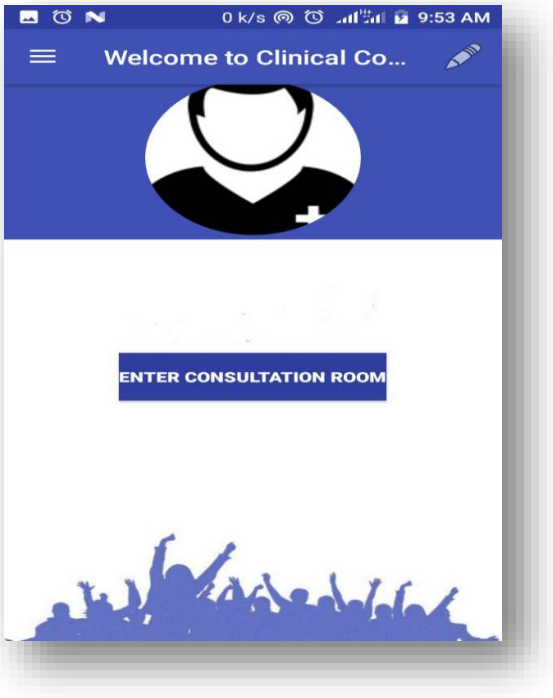

FIGURE 2: WELCOME PAGE OF THE APP

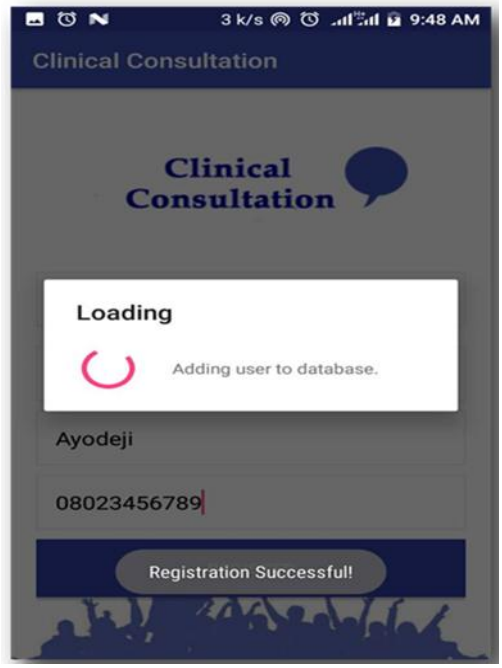

FIGURE 4: ADDING AYODEJI TO DATABASE

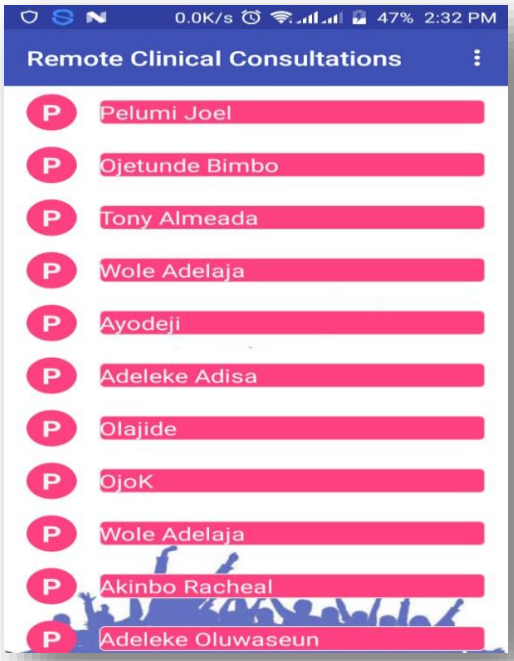

FIGURE 5: LIST OF PATIENTS (P) REGISTERED

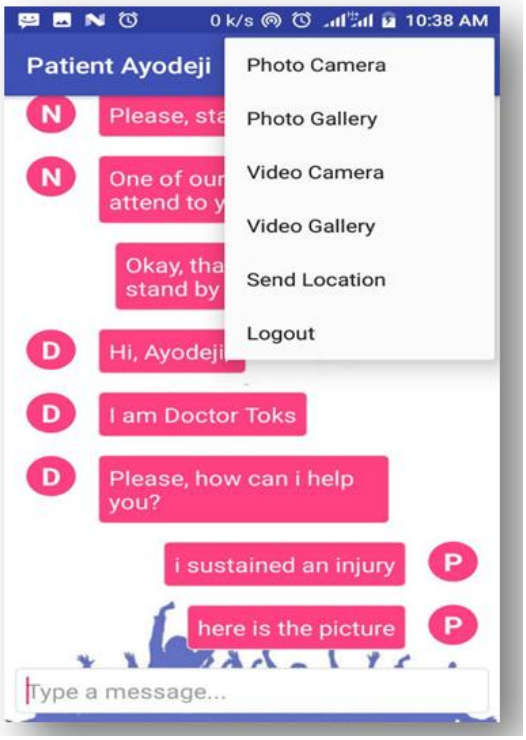

FIGURE 6: USERS CHATTING: DOCTOR (D), NURSE (N) AND PATIENT (P)

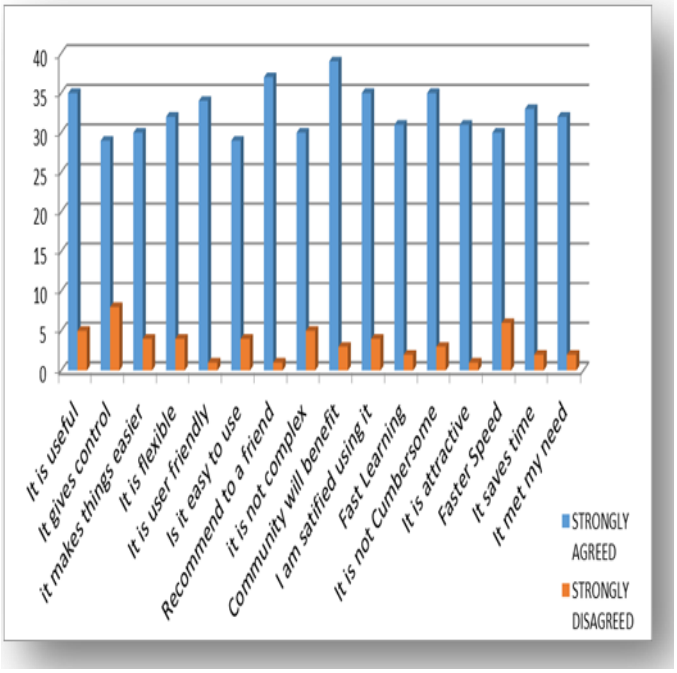

FIGURE 7: CHART OF STRONGLY AGREED AND STRONGLY DISAGREED

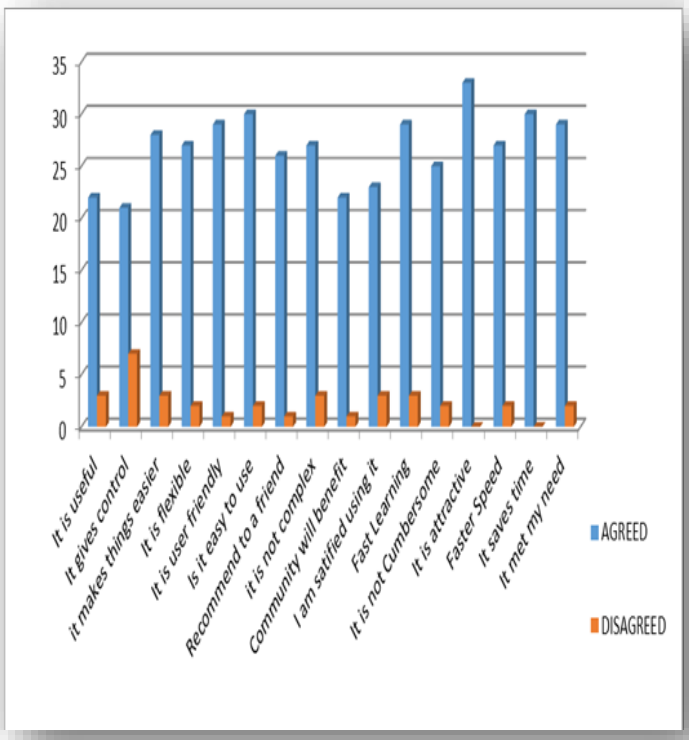

FIGURE 8: CHART OF AGREED AND DISAGREED

IX. CONCLUSION

In this research work, the need to develop Mobile APPLICATION FOR Monitoring and Management of Outs-Patients been identified. A remote patient monitoring and management system for clinical consultation that increase the doctor to patient interaction using a Java-enabled mobile android phone was developed and the file size for Remote Clinical Consultation Application version (1.0) is 16.44MB. It is a multi-way communication care and management application, with real-time feedback. This research work is recommended to medical practitioners including doctors, nurses, medical laboratory scientist, pharmacist and medical patients to enhance real time medical interaction via mobile platform. Moreover, healthcare policy makers are encouraged to peruse the contributions of this research work in the use of mobile healthcare system.

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