A Mobile Based Expert System for Disease Diagnosis and Medical Advice Provisioning

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A Mobile Based Expert System for Disease Diagnosis and Medical Advice Provisioning

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Abstract— **Most developing countries like Nigeria are facing health care challenges caused by inadequate medical personnel, shortage of modern medical equipment and the dearth of modern hospitals in the rural, leading to high mortality rate especially in these rural areas. Statistics have revealed the high number of smartphones in different parts of Nigeria. Hence, a mobile based system could serve as a solution to these problems. Some researchers in this area of study tried to develop different stand-alone and web-based medical diagnostics systems using different approaches, in order to provide easy and fast access to diagnose and provide medical advices. In this paper, a rule based mobile expert system was designed and implemented to proffer diagnosis and medical advices to ten (10) common diseases that are prevalent in Nigeria. The mobile system was implemented on Android operating system technology which is the one the most common mobile operating system in Nigeria presently. The system was evaluated with some users and the results of the evaluation carried out on the system emphasizes its usefulness as an efficient decision support tool in the diagnosis and medical provisioning of the common health problems in Nigeria with a very high success rate from prospective users.**

Keywords- Android operating system; Expert system; Health care; Mobile medical system; Smart phones.

I. INTRODUCTION

EXPERT system is a branch of computer science that transfers the intelligence of human experts into machines [1][2] and it is now a very prominent cross disciplinary area [3]. The knowledge base of any medical system is often composed of medical information, rules extracted from patient inputs and advice for diagnosis of possible diseases of patients [4]. With the advent of expert systems, a lot of intelligent systems have been developed to assist in handling health care challenges such as detecting, diagnosing symptoms and advice provisioning for diseases. The medical field is a very delicate area that requires appropriate medical facilities and adequate expertise for reliable and efficient delivery.

Technology is a very useful tool that aids every kind of process resulting in increase of efficiency and in turn productivity, automating some of the processes involved in attending to patients will help to reach a wide number of them at the same time from different locations which will be of immense benefit [5]. Diagnoses and advice provisioning will be ineffective without the aid of automatic experts. The advancement in mobile technology and the innovations in wireless communication technology have also inspired researchers to focus on developing mobile systems which can improve on the stand-alone and web-based medical systems and make them accessible with greater functionality, especially in developing countries. The proliferation of mobile phones also in developing countries and the progress in their technological development (large memory capacities, spacious screens and open access operating systems) makes them powerful health care service delivery tool in that they reduce overall cost of accessing medical care and eliminate a lot of medical errors [6]. Aside this, mobile technology makes it possible for the accomplishment of big tasks within a relatively short period of time. The intelligent user interface is friendly and effective for easy user adaptation [7][8].

This study designed a rule based mobile system to diagnose ten common diseases in Nigeria, provides medical advices and prescriptions where applicable. The proposed system is designed to act as a medical assistant which should be able to provide medical diagnosis to common health conditions through user-inputs combined with their personal health record and hence generate medical advises to patients based on the results of their diagnosis. The system is expected to be useful in remote regions of Nigeria where there is little or no access to medical facilities to reduce mortality rates.

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II. PREVIOUS STUDIES

Several studies have demonstrated the significant use of mobile phones to support decision making process in health care service delivery. Yinyeh and Alhassan presented an offline medical expert system for the diagnosis and treatment of common ailments of patients [9]. The system was developed using Visual Basic at the front end and Microsoft SQL Server at the back end. The system is expected to be installed on personal computers by medical experts, medical students or people who are interested in using personal medical assistant. Akande and coleagues designed and implemented a web based expert system for diagnosis and management of kidney diseases [10]. For the development of the expert system, free e2gLite expert system building tool (shell) implemented as a Java applet was used which is equipped with an inference mechanism and a knowledge base, and the web interface was developed with the use of HTML. The system asks questions from the user to elicit the information needed in order to recommend result based on the user input and uses IF-THEN rules to represent knowledge. Muslim and friends, developed an expert system for the diagnosis of Chronic Kidney Disease using Mamdani Fuzzy Inference System [11]. Four processes were employed in the method which include, fuzzification, implications, composition of the rules and defuzzification. Agile Method was used for software development in a systematic way while the simulation of the expert system was built using Matlab R2009a. The accuracy expert system of diagnosis Chronic Kidney Disease is calculated using the Confusion Matrix. Arellano et.al., proposed a mobile health expert system as a tool to assist and support athletes and students who are enrolled in human kinetics that usually experience physical injuries at one time or the other [12]. It utilizes the Rete pattern matching algorithm used specifically on expert systems to improve speed in the generation of solution.

Borgohain and Sanyal designed and implemented a rule based expert system for cerebral palsy [3]. The expert system diagnoses cerebral palsy by classifying it as mild, moderate or severe. It could also support the decision making processes of medical experts and bail out parents of cerebral palsy children in assessing them and hence, take appropriate measures to manage the disease. The study discussed the implementation of a rule based backward chaining mechanism, Java Expert System Shell (JESS) for diagnosing neuromuscular diseases such as Cerebral Palsy, Multiple Sclerosis, Muscular Dystrophy and Parkinson's disease. The system presents to user a list of questionnaires on the specific symptoms of each patient on which the disease of the patient is diagnosed and possible treatment suggested. The system is expected to create awareness and support for patients suffering from neuromuscular diseases.

This study in this paper is directed towards designing a rule based mobile medical system to diagnose and provide medical advices of ten common diseases in developing countries such as Nigeria.

III. DESIGN OF THE SYSTEM

The proposed mobile medical diagnosis and advice provisioning for common diseases in Nigeria is illustrated in the figure 3.1 below. The proposed system describes the design concept, components and how they interact with one another within the system.

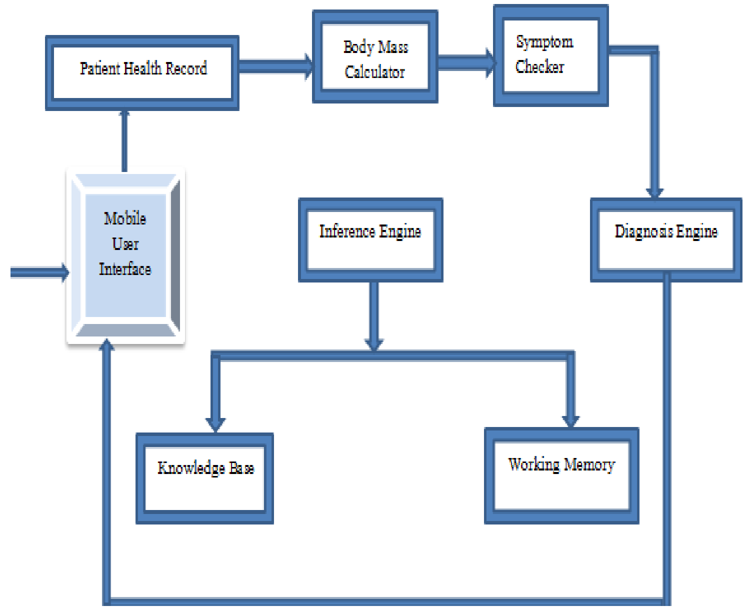

Fig.3. 1: Mobile Medical Expert System Architecture

The mobile user interface allows the user to interact with the Patient of Health Record (PHR) section of the system by supplying some basic information such as Username, Sex, Weight and Height that will help in calculating the Body Mass Index. BMI calculator is responsible for collecting the patient information from the knowledge base through the inference engine. It uses the information to determine the possibility of a patient being obese or hypertensive. BMI is calculated using the formula:

$$BMI = \frac{Weight\ in\ kilograms}{(Height\ in\ Metres)^2} \qquad (3.1)$$

Whenever the user sends the first symptom through the symptoms user interface, the symptoms checker interfaces with the Inference engine in order to perform its function by sending the user initial suggestion to the inference engine, which then generates possible groups of symptoms based on some set of rules. The Diagnostic engine interfaces with the inference engine to match the patient symptoms to diseases based on the facts in the knowledge base. It then displays the diagnosis produced by the inference engine to user alongside other details such as advice provisioning. The inference engine finds information and relationship from the knowledge base and thus provides answers, predictions and suggestions in a way similar to a human expert. In the proposed system, the function of the inference engine is to interacts with different part of the systems, it provides rules for storing patient record, it queries data sent to the BMI engine and symptoms checker, and it also provides the diagnostic engine access to relevant

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data tables for generating diagnosis. Another role performed by the inference engine is to fetch details of the diagnosed disease from the knowledge base and send them to the diagnosis section. The knowledge base provides a relational database consisting of five tables of symptoms, diseases, PHR data, diseases'causes, prevention and referrals. Working memory stores the rules and facts for the system. The rules stored are always in the form IF-THEN statements of how the mobile medical diagnosis should be done while the facts stored gives uniqueness for problem solving.

IV. SYSTEM IMPLEMENTATION

A. *The proposed System Implementation*

The system is designed with an Android (mobile) operating system which is the most prevalent and commonly used mobile operating system in Nigeria and Africa as of now. The implementation was designed to be suited for offline diagnosis recommendations in very interactive ways. The implementation was done using the Android Studio (an Integrated Development Environment) by Google which supports the use of XML (eXtensible Markup Language) for the development of an attractive and friendly user interface. Java programming language was used for the development of the inference engine that runs in background to match patient's input with rules for diagnosis. SQLite database (an SQL database similar to MySQL but specifically built to work on the Android operating system) was used to develop the five tables used in the system. The first table is a patient Health Record table which stores personal user information such as username, sex, weight and height used in initial diagnosis. The second table is an android_metadata table needed for the SQL database to run on the Android operating system. It usually contains relevant data about the database useful for successful integration into the Android operating system. The third table is a diseases_Table which contains disease details, causes, referrals and recommendations. The fourth table is the sqlite_sequence table**,** a table used to monitor the sequence of the data sent and received from the database, and finally the symptoms_table which is used for symptom generator part of the system. The table serves as the symptoms storage and also the "diseases-symptoms link table.

B. *The Screenshots of the Implementation System*

The screenshot for the user interface of the implemented system is shown below which describes the various user processes. The first thing the user sees when the system is launched is the splash screen, which is a welcome screen that intimate users about the essence of the system.

Figure 4.1: Splash Screen

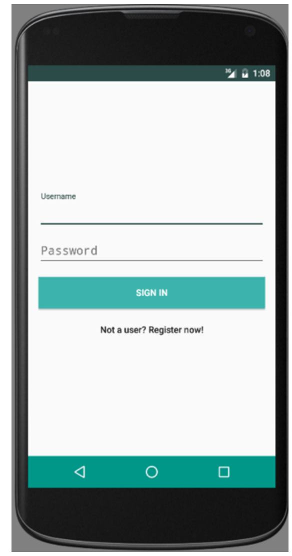
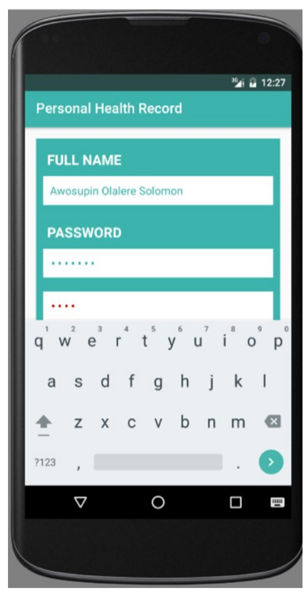


Figure 4.2: Login Activity

Next, a user is prompted to either login (existing users) or register as a new user. Existing user of the system can login with their previously created PHR username and password. Authentication would be carried out offline using the PHR data stored on the offline database.



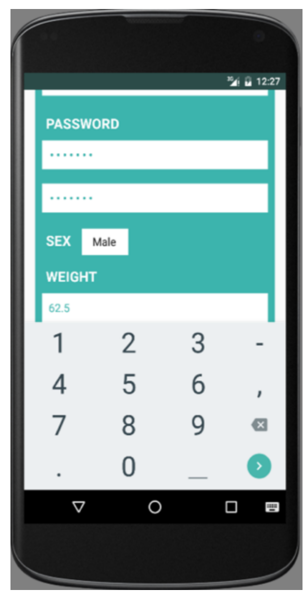


Fig. 4.3: The Registration screen

Fig. 4.4: PHR

The screen will is used to store user's personal health record (the intelligent password field changes color from red to green to provide interactivity while validating user's input) while Weight and Height are accepted by the PHR as numerical values.

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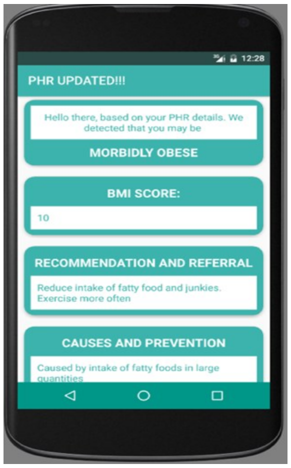


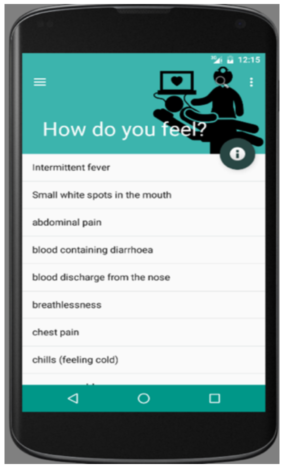
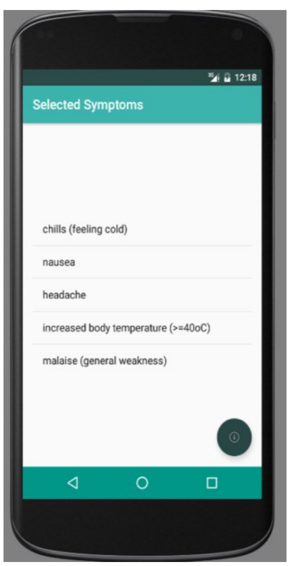


Fig. 4.5: The BMII Diagnosis Screen   Fig. 4.6: Symptoms Selection Engine

BMI diagnosis is carried out to diagnose user's tendency to obesity which is generated based on the patient's personal health record data that include: sex, weight and height. The BMI diagnosis is once when the user first register. Existing users would skip this screen to continue diagnosis. From the symptoms selection interface, user are able to continue diagnosis after selecting their symptoms from the list displayed, the interactive interface updates its contents based on user's input in order to avoid any situation of invalid diagnosis.



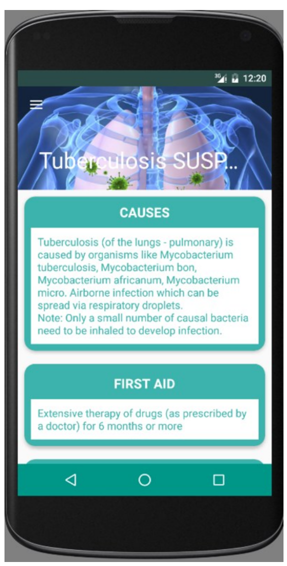


Fig. 4.7: Selected Symptoms Generator   Fig. 4.8: Diagnosis Engine

All the symptoms selected by the user are displayed after the "view symptoms" button is clicked, then when the "Diagnose" button is clicked, the diagnosis is done based on user's input displaying the result of the diagnosis, the causes, first aid and referral.

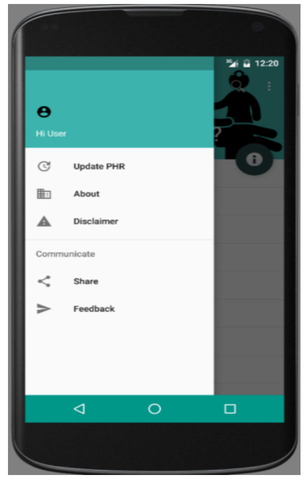
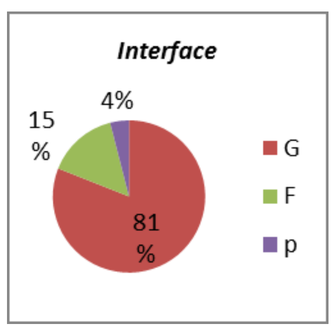


Fig. 4.9: Main Navigation

The symptoms selection and diagnosis screen include a navigation pane where users can update their Personal Health Record. The "About" section is where users can understand the description of the system; its peculiar characteristics, a "Disclaimer" section. Also, users can share the system with other users and also provide feedback that would be sent to user’s email.

C. *Evaluation of the Proposed System*

Thirteen (13) respondents were selected for the evaluation of the proposed system. Three Computer Science lecturers, three Medical students, three Computer Science students, two Industrial Chemistry students, one Biochemistry student and one Pre-degree student. The students were at different levels of their degree programmes. A rating scale of 1-4 were used to represent responses, where VG stands for (very good), G (good), F (fair), and P (poor) respectively.



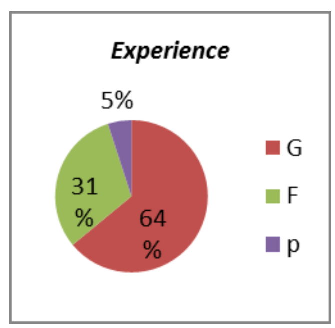


Fig. 5.1:System interface   Fig. 5.2: Users experience of the system

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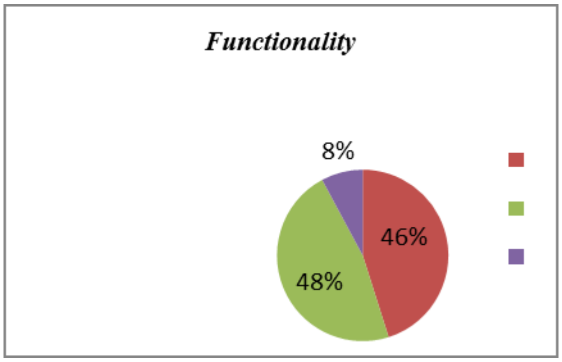

Fig. 5.3: The functionality of the system

In Fig. 5.1, 81% of the respondents rated the user interface as good, 15% rated it as fair while 4% rated it as poor. In relation to the user experience of the system, 64% respondents rated it as good, 31% rated it as fair while 5% rated it as poor. For the functionality of the system, 46% respondents rated it as good, 48% rated it as fair while 8% rated it as poor. Based on the feedback received from the respondents, the implementation meets most of the users expectations based on its current limited scope. Also, the system has been able to successfully meet its aims and objectives.

V. CONCLUSION

The advancement in the technological development of mobile phones and the recent successes of wireless communication systems have improved the capability of mobile phones to provide and host web services and internet applications. This paper proposed and implemented a rule based mobile medical system that stores knowledge-base of diseases such as malaria, typhoid fever, tuberculosis, common cold, lassa fever, measles, dysentery, conjunctivitis, and hypertension for the purpose of providing diagnosis and advice. The system was evaluated with some users. The results of the evaluation carried out on the system emphasized its usefulness as an efficient decision support tool that could provide easy and fast access to diagnosis and medical advice provisioning of common health problems that are peculiar to Nigerians with a very high success rate.

REFERENCES

[1] M. Tiwari and B. Mishra. (2011). Application of Cluster Analysis In Expert System–A Brief Survey. *International Journal of Computer Science. 8(5),* 342-346
[2] M. Pandit. (2013). Expert system - A review article. *International Journal of Engineering Sciences & Research Technology*, *2*(6), 1583-1585.
[3] R. Borgohain and S. Sanyal (2012). Rule Based Expert System for Cerebral Palsy Diagnosis. *arXiv preprint arXiv:1207.0117*.
[4] A. Keleş. (2014). Expert Doctor Verdis: Integrated medical expert system. *Turkish Journal of Electrical Engineering & Computer Sciences*, *22*(4), 1032-1043.
[5] L.J. Frost and M.R. Reich. (2009). Creating access to health technologies in poor countries. *Health Affairs*, *28*(4), 962-973.
[6] T.O. Oladele and Y. Sanni. (2015). Dental Expert System *International Journal of Applied Information Systems. 8(2),* 1-15.
[7] R.B. Ramírez, R.M. Arellano, C.G. Sandoval and A.C. Flores (2015). An Expert System Oriented towards the Detection of Influenza and Dengue Developed on Mobile Platforms. *Journal of Software Engineering and Applications*, *8*(06), 295-301.
[8] K.W. Su, S.L. Hwang and C.T. Wu. (2006). Developing a usable mobile expert support system for emergency response center. *IAENG international Journal of computer science*, *32*(4), 489-498
[9] M.O. Yinyeh and S. Alhassan, (2015). Expert Health Diagnosis and Monitoring System Software for Common Medical Conditions. *International Journal of Computer Applications*, *124*(1), 17-22
[10] R. Akande B. Amosa, A. Sobowale, and M. Hameed. (2015). Web based expert system for diagnosis and management of Kidney Diseases. *International Journal of Current Research and Academic Review*, *3*(2), 9-19.
[11] M.A. Muslim, I. Kurniawati and E. Sugiharti, (2015). Expert System Diagnosis Chronic Kidney Disease Based on Mamdani Fuzzy Inference System. *Journal of Theoretical and Applied Information Technology*, *78*(1), 70-75.

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