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Design and Development of Generic Algorithm for Patients' e-Diagnosis System

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ABSTRACT

Technology has become a driving force that is fast changing the duties or routines of physicians and their co-workers in healthcare industries. Developing countries around the world are facing many healthcare challenges among which are insufficient medical personnel, shortage of modern medical equipment, shortage of modern hospitals in the rural areas and general inaccuracy and imprecision prescriptions. This has culminated in a high mortality rate and loss of precious lives. Therefore, we design and develop a generic patient e-Diagnosis system for common diseases (malaria, Tuberculosis, Diarrhea, and Cough) in sub-Saharan Africa. The system is proposed to handle the accurate and prompt diagnosis of common ailments. MySql database, CSS (Cascading Stylesheet), PHP (Hypertext Preprocessor), dart programming language, Java Scripts and HTML were used for software development. The developed system functions as a medical assistant, capable of providing fast medical e-based diagnosis for common medical disorders, based on user inputs and their personal health records, as well as generating medical advice for patients based on the outcomes of their diagnostic.

KEYWORDS: e-Diagnosis, Generic algorithm, Electronic medical records (EMR), Electronic Health Records (EHR), Prescriptions

1. Introduction

Patient diagnosis has been a process of defining or identifying the nature of a

sickness or disorder and distinguishing it from other possible conditions or ailments. A diagnosis, in the sense of a diagnostic method, is an attempt to categorize an individual's health state into discrete and distinct categories that allow doctors to make treatment and prognosis decisions. The health care field is a very sensitive and delicate area that requires appropriate medical facilities, timely responses and adequate expertise for reliable and efficient deliveries [1]. Day to day advancements in mobile technology and innovations in wireless communication technology have also inspired researchers to focus on developing electronic systems which improve on stand-alone medical systems to make them accessible round the clock with greater functionalities. Electronic Diagnosis exists to provide diagnostic support to health care workers worldwide. Receiving medical treatments in most of the hospitals does not come easy, patients have to queue up several hours from one unit of the hospital to another to get diagnosed and treated. So many times, they end up wasting the whole day without due attention [2].

The situation is so discouraging to most patients and so many times they are forced to turn to non-professionals or even resort to self-medication for quick recovery. Also, the volume of work for the hospital personnel is overwhelming, the ratio of patients to doctors, nurses and other medical personnel is very minute, and so much is expected from them, thereby making them do their work without adequate attention and expertise and still, leaving them overly exhausted day in day out. Moreover, carrying out diagnosis and prescription depend on the doctor's memory and choice of drug from thousands available. Their brains are frequently overburdened with many diseases, signs and symptoms, complications, and therapy medicines, among other things. Some of the symptoms of the ailments are strikingly similar. It is difficult for doctors to recall and absorb all this information in their clinical job. As a result, a precise diagnosis and prescription may not always be possible. The common system of the medical system and drug prescription in most hospitals in sub-Saharan Africa involves traditional activities. It is observed that to receive medical treatment in most hospitals in sub-Saharan Africa the Patients queue according for several hours in the sequence of first come first serve (FCFS) though, a new patient usually register into the hospital by filling patients form which signifies that the person

is an official patient of that hospital. Also, this gives the person access to own a hospital folder. Which is used to store the basic information about the diagnosis and drug prescribed to the patient.

In addition, the diagnosis, and prescription depends on the doctors' memory so their brain are often loaded with different diseases, symptoms and various drugs for treatment, hence, to remember and process the huge information is their clinical work is very tasking. For this reason, accurate diagnosis and prescription may not always be obtained. In this article, we design and developed a generic patient e-diagnosis system for common diseases in sub-Saharan Africa. The system is proposed to handle accurate and prompt diagnosis of common ailment in sub-Saharan Africa. The system was intended to function as a medical assistant, capable of providing medical diagnosis for common health disorders based on user inputs and their personal health records, as well as generating medical advice for patients based on the outcomes of their diagnostic.

The remaining parts of the studies are as follows; Review of previous related studies in section 2, implementation approach in section 3, system development in section 4 and the conclusion in section 5.

2. Review of Previous Related Studies

The development of an electronic diagnosis system to aid in clinical decision-making is of great advantage, as potential errors can be avoided and more reliable results produced. This section discusses some previous works. An intelligent diagnosis decision support system was proposed by [3] to serve the Middle East and North Africa region as part of telemedicine. The proposed system uses a very large health-related dataset Altibbi company. The dataset contains plenty of unstructured patient questions and structured symptoms that are identified by general practitioners. The system encompasses a machine learning model, many feature representation techniques and machine learning classifiers such as including Logistic Regression (LR), Random Forest (RF), Stochastic Gradient Descent Classifier (SGDClassifier), and variants of the Multilayer Perceptron (MLP) classifier. Results show that the model can predict the diagnosis of possible patient conditions based on the given symptoms and questions, which can assist doctors in making decisions on clinical consultations. They recommend improving the accuracy of the model and enlarging the structural symptomatic features in future works.

Khubone, *et al.,* (2020) [4] elaborate on the opportunities, barriers, and challenges to the implementation of electronic health information systems for disease diagnosis and treatments. The research work proposed the roles and responsibilities of key stakeholders for the electronic health information systems implementation for ailment diagnosis, treatments, and point of care management to help respond to the community's health needs, especially during this COVID-19 pandemic.

Azzi, *et al.,* (2020) [5] research effort proposed an innovative intelligent systems to guide basic healthcare delivery. The framework combines a variety of artificial intelligence and analytics technologies to address patient demands in a variety of healthcare settings, with a focus on challenging or chronic cases. The technology, features, and applications of artificial intelligence and analytics are intimately linked to health outcomes, allowing for a more accurate depiction of patient concerns in artificial intelligence and analytics design. The system spans a patient's lifecycle both within and outside of the healthcare system, permitting continuous monitoring and diagnosis of health conditions. To validate and reuse care pathway rules, the created paradigm stresses the use of advanced patient-centric IT with prequalified, evidence-based knowledge repertoires. It also includes AI capabilities that may connect to existing clinical and administrative information systems, streamlining processes and rules while also boosting front-line inter- professional care continuity through knowledge sharing.

Ajagbe & Adesina, (2020) [6] observed that the rapid expansion of Internet-based computers allows for the creation of different technologies, but it also increases the possibility of information falling into the hands of cyber criminals for a variety of illegal crimes. As a result, this research was informed. Computer-based technology's access control and security provide a solution to this problem, particularly in the health industry. PHP was used for the backend, HTML and CSS for the frontend, Apache for the server, and MySQL for the database. The proposed design reduced patient information access rates and improved information integrity by encrypting patient information stored in the EMR, so that data can only be accessed by authorized individuals who have obtained the patients' permission.

Ajagbe, *et al.,* (2019) [7] proposed approach for protecting patients' information on EMR

was based on secondary data. The program Open Medical System was basically one of the internet databases that was given special attention (OpenMRS). Based on the performance keys, the Rivest-Shamir-Adleman (RSA) encryption algorithm was found to be the most efficient among the three asymmetric encryption algorithms tested, and it was used to develop an email notification system prototype for the security of patients' medical records. EMR was used to set up and implement a system prototype in this study, and data was securely transmitted between the local server and the web server. It involves patients in the decision-making process on the management of their medical records by offering powerful protection via email notification, which alerts patients to any effort to read or access their medical records. It also absolves health-care providers of any potential legal action arising from access to their patient's medical records.

Isinkaye, *et al.,* (2017) [8] designed and implemented an Android rule-based mobile expert system that diagnoses and offers medical advice for ten common diseases in Nigeria. The developed system was evaluated and the results affirm it is an effective and efficient decision support tool for diagnosis, medical adviser and prescriptions for the common health problems in Nigeria. The system user interface was implemented using the Android Studio, the inference engine was developed with Java programming language and the database was developed with SQLite database.

Chawak, (2016) [9] proposed a clinical decision support system for treating patients with heart diseases, diabetes, hepatitis, food, air, and water-borne diseases. The network-integrated system studies a patient's past medical history, accepts current symptoms, and then make disease diagnosis or predictions. It goes ahead to suggest immediate treatment or laboratory tests as may be required. Doctors are able to log on to the system to perform algorithm analysis and clustering to find out the actual predicted disease. The proposed system used the KNN algorithm and Model View Controller architecture. The researcher's interest is in developing a system that is able to detect diseases at an early stage, so as to enable the patient to overcome and treat them appropriately.

A Mobile Diagnosis System with Emergency Telecare functionality was introduced by [10], the system integrates the functionalities

of a tele-diagnosis system and a smartphone based emergency report system and was further enhanced with a speech-to-text function, which allow users to communicate with the system by talking directly into their phones or through text. The system comprises two main components, a diagnosis system and an emergency telecare system. The system was designed to diagnose patients with ear, nose, throat and eye conditions. Users can use the application to establish contact with Community Health Centers through their mobile phones and handle personal diagnoses and emergency situations. The system is able to retrieve the current location of emergencies via GPS, send messages to emergency services and immediately provide help. The rule based expert system works by accepting patients' symptoms, analyzing the conditions for appropriate diseases. The doctors thereafter give prescriptions online to the patients they are responsible to and stores the patients' data in a Personal Health Record file. The future work suggests extending the system to diagnose other parts of the body and improving the user interface to automatically interact with patients by voice.

Ernest, *et al.,* (2015) [11] developed a tuberculosis diagnostic and treatment support system. The developed system diagnoses patients with tuberculosis by accepting symptoms from users and/or checking body vital signs with mobile devices and goes ahead to provide infected patients with pharmacological therapies as determined by a dedicated medical expert(s) within reach. The system consists 3 main modules, the diagnosis module that interact with users and ask all imaginable questions on the risk of getting infected with tuberculosis, the treatment module that handles the step-by-step treatment of tuberculosis and the learning module which discuss the history of Tuberculosis and ways to eradicate it. It works on android platform. The diagnostic module is a little vague and the system cannot work other mobile platforms.

Oladele & Sanni, (2015) [12] developed an Electronic Dentist Expert System based on the Coactive Neuro-Fuzzy Expert System Model. The user-friendly desktop application was implemented with C# programming language. A user is able to login in through the authentication page that leads to the main menu of the application and other modules. The Expect system displays the list of available symptoms for users to select. The selected symptoms is used to make the diagnosis based on a set of rules.

Awotunde, et al., (2014) [13] developed a medical diagnostic system using fuzzy logic with Visual Prolog Programming language. The system proposed gives solution to the enormous responsibilities of the diagnostic process carried out by medical personnel. Expert doctors defined a collection of signs and symptoms M related to malaria disease, and the authors considered a set of five diseases D. S = d1, d2, d3, d4, d5, where d1- d5 represents the five malaria diseases being considered. M = m1, m2, m3, m4... mn, where m1, m2, m3, m4... mn denotes the signs and symptoms of malaria infection. Expert physicians used weighing factors to the set M, assigning fuzzy values to the signs/symptoms, in order to indicate the strength of the signs/symptoms for a specific patient. The fuzzy values are chosen from the fuzzy set as follows: Mild (1), Moderate (2), Severe (3), and Very Severe (4) are the four levels of severity. The research work recommends future work in the area of drugs prescription, medical records and patient registration.

A web-based expert system for the diagnosis and treatment of malaria was developed by [14]. The user-friendly system diagnoses and suggests treatments based on symptoms and blood test results supplied by the user. The system retains medical doctor's expert skills, and possesses a database that stores information about drug prescription and malaria-related information. The developed system has 2 main components, a knowledge-base, and an inference engine. The knowledge base contains particular data and guidelines about a particular subject. It has a knowledge acquisition facility that is used to get expert information about diagnosing and treating patients with Malaria therapy. The inference engine developed with a scripting language accepts the user's query, processes it, and returns the relevant information to the user via a user interface by manipulating the stored knowledge in the knowledge base. The developed system is very beneficial for self-diagnosis, reduce doctors' and hospitals consultation workloads, and assist malaria-oriented research.

Kolandaisamy & Noor, (2013) [15] proposed a three-tier architecture Web-Based Online Medical Diagnosis System that concentrates on the management of Patients Registration and Administration, Diagnosing and Treatment, and Health Monitor and Tips. This web-based system use portal hypertension disease as the case study and has a special feature that alerts the patients about portal hypertension disease and

upcoming appointments. The proposed system makes inference disease diagnoses based on the symptoms provided by users and their past records. The system requires users to answer the first question before moving on to the second. If the system detects severe portal hypertension, it displays a notice stating that the system is unable to cure the ailment and that the patient should seek medical advice and treatment. If the patient's portal hypertension disease is still in its early stages, however, they can answer all of the questions and receive results and a necessary prescription in a matter of minutes.

Based on the review works, it is observed that no sufficient generic approach for e-Diagnosis, that handle accurate and prompt diagnosis of common ailment in sub-Saharan Africa. Hence this study was informed.

3. Implementation Approach

The implementation approach in this study employed data acquisition through oral interview and extraction of information from medical manuals. System was designed feeding in the output of

3.1 Data Acquisition

An oral interview was conducted and information were extracted from medical manuals to know the state of the existing study in the subject area.

i. Oral Interview

An oral interview was conducted between the researcher and the doctors in the selected hospital used for the studies, and the lab attendants were also interviewed. Reliable facts were gathered based on the questions posed to the staff by the researcher.

ii. Medical Manuals

Medical manuals and report based used by lab attendants were studied and information concerning the manual diagnosis systems in question were obtained. Some forms that are necessary and available were accessed. These include admission card, lab form, test result, and bill card. These forms help in the design of the patient mobile diagnosis system. For a computer to process data, suitable approach is needed to input the data into the machine. The format used was depend on the information acquired / gathered (text and sound). The control used to prevent the records from an unauthorized user was to by keeping the manual record in a locker where only an authorized user was have access to it. After the computer has processed the data, the output were produce as a result of the input data.

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3.2 System Design

This output could be a display on the device screen, hardcopy, or even the audio playback. The terms "input" and "output" are used both as verbs to describe the process of entering or displaying the data, and as nouns referring to the data itself entered into or displayed by the computer. Figure 1 is the flowchart of the designed system for patient e-Diagnosis system.

(a) Output from the System

The output is derived from the processing carried out on the input data. The output is presented in form of reports on a patient's diagnosis and possible treatment to the ailment. The diagnosis is being recorded on a diagnosis report paper.

(b) Inputs to the System

The input to the old system was derived from the patient's card, containing; patients name, sex, address, age, disease symptoms, date visited. The input medium for this new system is an in-line terminal system i.e. all data are entered into the system through the use of keyboard of the visual display unit.

(c) Processing Tasks Carried Out by Old the System

Based on the information collected from the patient, an analysis is carried out. The symptoms are processed to obtain the accurate diagnosis of the sickness. Also, the diagnosis will help in the processing of the system to obtain the best emergency health care system to be administered to the patient.

(d) System Administrators

The user of the system were; Hospital owner (MD), designated staff and doctors. Before now, data were stored in to the file, folder or book. The files were only accessible only within the hospital premises which was not good enough but the new system has improved from this limitation.

4. System Development

System implementation is an important phase in system development life cycle of the patient e-Diagnosis system. When a system starts functioning it is necessary to monitor its operation to ensure that the user requirements are met. The new system has to be examined from time to time to ensure that it works as expected. The user and operators of the system should constantly check the output of the system to ascertain its performance. The purpose is to deal with unforeseen problems that may occur during the operation of the system and ensure that objectives are being met. System implementation involves acquiring hardware, software, training, data conversion, switching

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over operation from the manual to the new computerized system. This paper choose to report only hardware and software requirements as it relates to this study. These two is categories are reported as follows:

a. Hardware Requirement

The hardware requires ensuring proper running of the new system are; Computer system of 5 Gigabyte of Hard drive, and 2 Gigabyte RAM.

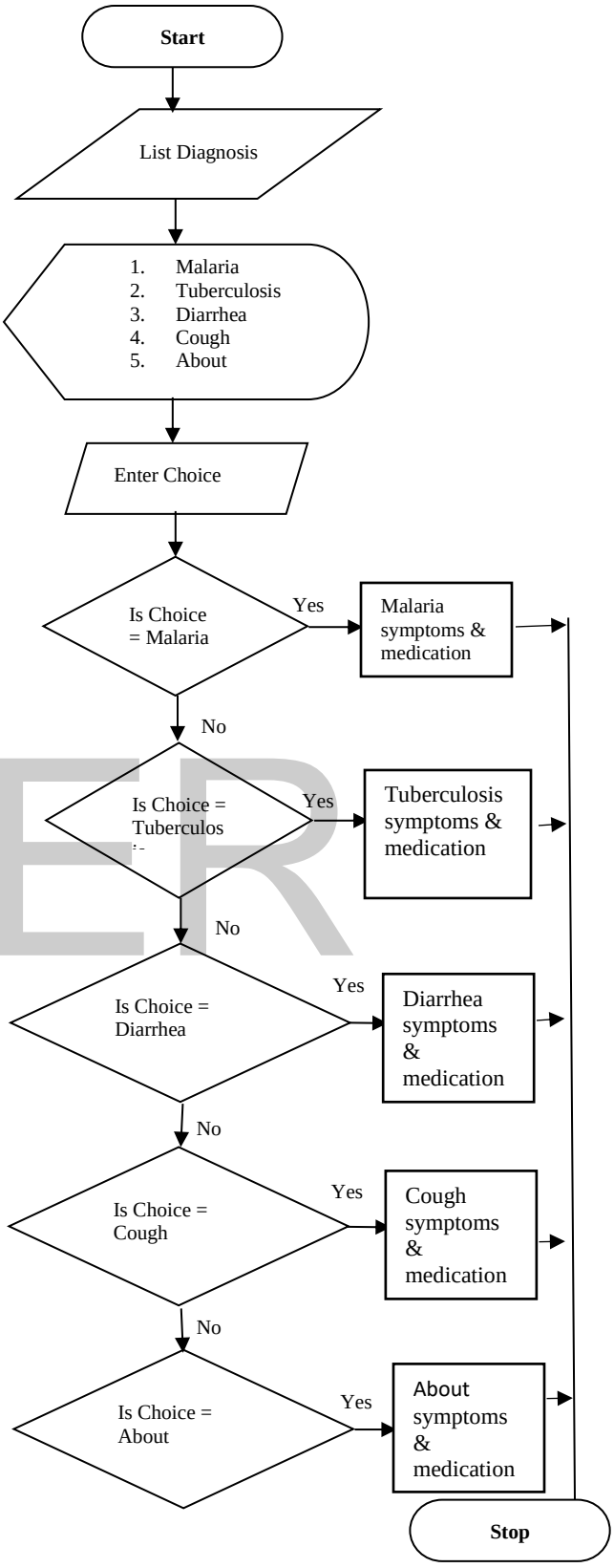

Fig. 1: System flowchart Diagram

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b. Software requirement

MySql database, CSS (Cascading Stylesheet), PHP (Hypertext Preprocessor), dart programming language, Java Scripts and HTML (Hypertext markup language) were the software requirements employed in the system.

The Patient e-Diagnosis System Developed

This stage of processing involves a lot of activities like designing the module interface, and coding activities. This generation of object-oriented programming technique where applications are developed using concept of object and class. For proper development strategy, and easy maintenance and upgrading. All the model used in development of this developed e-diagnosis system are class-based object module and their interfaces are presented in this paper. The proposed solution to the problems identified highlighted was addressed in the design and development of a patient e-Diagnosis system. The interfaces are some of the interfaces of the developed output. The developed system generates malaria, tuberculosis, diarrhea, cough and about reports. Since all the diagnosis follow the same algorithm, we report only the main dashboard, login, live diagnosis and About us interfaces are presented in figure 2, figure 3, figure 4 and figure 5. The output specification shows the details of how the information needed from the system are arranged and printed out or the interface.

(a) Main Dashboard Interface

The purpose of this interface is to display the list of diagnosis available to the newly developed patient e-diagnosis system. It consist of different ailment that available in the system, they are Malaria, Tuberculosis, Diarrhea, Cough and About us that show the system owners' details. It contains a colorful background for user-friendly purpose.

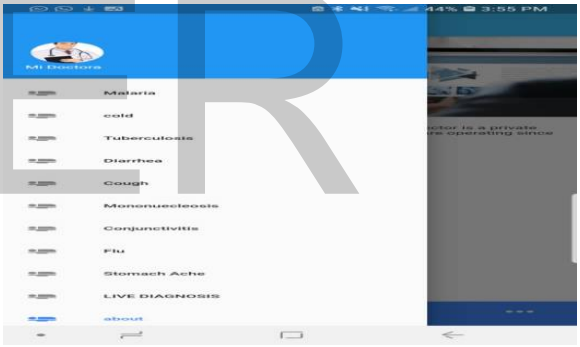

Figure 2: Main Dashboard Interface

(b) Login Interface

This is the login interface, it allows the user to gain access to the diagnosis interface.

(c) Live Diagnosis Interface

This interface is to use to interview the user/patient. It gathers facts on the perceived symptoms from the user by asking the user a series of questions that will help in making

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inference or possible diagnosis. This interface displays symptoms and possible medication that can be taken.

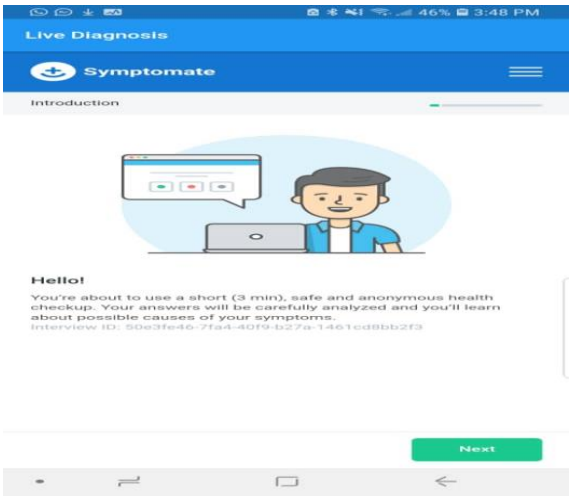

Figure 3: login Interface

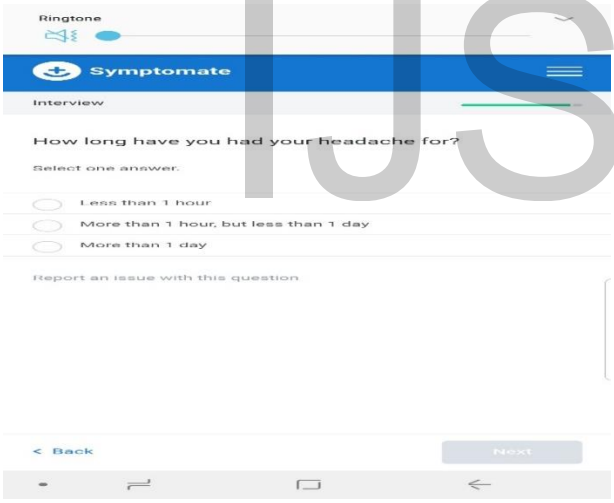

Figure 4: live diagnosis of the perceived symptoms

(a) About Us

This interface purposed to report any complaints and give feedback by the users to the healthcare provider through the email link in About Us. It also contains sub-module that gives information about the company

Figure 5: About us

System Documentation

It was a written description of any system design which tells the user how to go about using the system. It also refers to as details of all the modules involved in the design of the system. This program was developed using dart programming language which consist of the following modules, each performing specific function. During the programming stage, each modules of the program were tested to determine the reliability of the system for installation and to specify laid down rules by the designer. The testing of this particular program is easy because it was menu driven and modular in structure. Testing has been performed both by desk checking the program, design with the original specification and by running the final program using test data and selecting options from the main to carry out the desired goal.

5.0 Conclusion

The proposed system was designed in a way that the medical diagnosis was made easy by listen all possible popular symptoms and giving the medication that was likely to be taken. This study focused on the nature and purpose of the existing medical facilities, its setback, scope for improvement, its merits, and limitations. The programming work was carried out, the expected is achieved and the desired reports are produced. The study has so far reviewed the manual system, designed and implemented a mobile system that can substitute the manual system of diagnosis. The benefit derived from the computerized mobile app system was much more than that of the manual system from the information supplied by this write up especially the response time. From all these mentioned benefits on the application of computer to the activities of medical processing, it was noted that despite the fact that the introduction of mobile app quickens the response time in medical diagnosis, more still need to be done. It is therefore recommended that the newly developed system be put into its maximum use to extract all benefits attached to it and any other gain occurring from a computerized diagnosis expert system.

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