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Design and Implementation of A Wi-Fi Aided Diagnostic Software for Common and Serious Ailments for Community Medical Centres

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ABSTRACT

Diagnosis as we all know is a vital element in the medical sector of every nation. The traditional method of patients booking appointments for doctor's consultation have been very helpful over time but yet time consuming, and sometimes the absence of the doctor from the hospital has posed a challenge to the waiting patients who require urgent attention. This gave rise to more efficient methods to problem solving in some of the areas in a hospital and they being absorbed into the system. This system design, which deals with the decision support system, was developed using Case Based Reasoning technique. The case based system is a web application; designed to work on a network with the server having the database of the ailments and their corresponding symptoms. The diagnostic software acts as a Computerized Physician Order Entry (CPOE) which provides a means of requesting diagnostic tests and treatments electronically and receiving the results. It also allows for the use of electronic health records by the healthcare professionals to keep track of patients' current information and history. This software acts as a means of consumer health informatics by providing medical information to patients/users, and also allows for the diagnosis of both common and serious ailments.

Keywords: Case Based Reasoning technique, Ailments, Computerized Physician Order Entry (CPOE), Decision Support System (DSS)

Keywords: Underutilized, Bambara groundnut,Hexagonal design, Water absorption capacity.

Aims Research Journal Reference Format:
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1. INTRODUCTION

Health is generally said to be wealth. It takes healthy people to generate the wealth the nation requires for the general wellbeing of its people. There is therefore the need for adequate healthcare especially in the area of diagnosis and treatment of diseases. Since there is a good relationship between the job output and health of the workers, a good healthcare is vital. Unfortunately, in developing countries, this adequate healthcare is lacking due to poor use of technological know-how and manual handling of most medical problems. As observed by Lyiama H.C. and D.C. Chukwu, "very often, people in developing countries who are critically ill are rushed abroad for special treatment because it is felt that healthcare facilities at home are inadequate" (Menizibeya, 2011). The importance of efficient healthcare cannot be over emphasized. In most rural communities, where people can barely afford the healthcare offered by their local hospitals, most individuals usually wait till their illness become too severe before seeking proper treatment. This has led to high mortality rate and low life expectancy in the Sub-Saharan region (Stoller, 2009). According to W.H.O, there is 1:6400 doctors to patient's ratio in Nigeria.

This is a clear evidence of the presence of a non-functional healthcare system in Nigeria, as there are inadequate medical personnel to attend to the healthcare needs of patients at the community level. The quality of Nigerian healthcare institution is generally considered rather poor. While various reforms have been put forward by the Nigerian Government to address the wide ranging issues in the health care system, they are yet to be implemented in the country.

The Nigerian healthcare system can be said to have experienced five past reforms from the traditional healthcare system that existed in the individual Nigerian communities and ethnic groups before our western (British) colonization till date. Thus, while the system naturally had to develop in the wake of the British colonization, the first Nigerian Colonial Development Plan of the 1940s gave some limited framework for the health system. It was a unitary health service system. Then came the era of regionalization in the 1950's, even though no specific documentation or specific effort at such a reform exists, the national health system stopped being unitary; and the regional governments started to run independent, and sometimes, parallel health systems with the federal government (Nnamuchi,2007). Then came the Second National Development Plan of the immediate post-independence era in the 1960s. Again the plan did not articulate a system with clear levels, or the assignment of responsibilities to the three levels of government. The Third National Development Plan of the 1970s was a rather ambitious plan with the Basic Health Services Scheme as its focus. It was quite elaborate in its health reform attempt and was far too heavy in infrastructure and auxiliary health manpower development. It however failed to share responsibilities between the three levels of government for resources generation, manpower development, the services to be delivered, and especially on the health professional manpower for the services. All these happened in the absence of a clear policy framework. Following the Alma Ata Declaration, serious attempts had been made at a health systems reforms in the 1980s. (Davis et'al 2005).

Thus the National Health Policy (1988) based on the principles of primary health care and primary health care implementation were the results of that era. As the country with the largest population in Africa, Nigeria needs strong healthcare system, information and management. Despite Nigerian's strategic position in Africa, the country is greatly underserved in the healthcare sphere. Health facilities (health centers, personnel, and medical equipments) are inadequate in the country, especially in rural areas. To account for the modern day needs of Nigerians, the health care delivery system must adequately meet the function of effectively addressing the patients' dilapidating state of health. The diagnostic software would immensely improve the healthcare delivery system by referring patients to pharmacists or doctors via the online chat for appropriate treatments and supportive services. Chronic diseases management and prevention would also be fostered by the diagnostic software.

2. LITERATURE REVIEW

The first medical diagnosis made by humans were based on what ancient physicians could observe with their eyes and ears, which sometimes also included the examination of human specimens. More sophisticated diagnostic tools and techniques such as the thermometer for measuring temperature and the stethoscope for measuring heart rate were not in widespread use until the end of the 19th century. Today medical diagnosis has evolved from the traditional methods to the use of artificial intelligence in medical diagnosis. This artificial intelligence supports the use of decision support systems, Case-Based Reasoning, the Rule based reasoning and Bayesian Networks (BNs) (Hjortdahl et 'al 2009).

In ancient Egypt and Mesopotamia, the earliest physicians made diagnoses and recommended treatments based primarily on observation of clinical symptoms. Palpation and auscultation were also used. Physicians were able to describe dysfunctions of the digestive tract, heart and circulation, the liver and spleen, and menstrual disturbances; unfortunately, this empiric medicine was reserved for royalty and the wealthy. The oldest known test on body fluids was done on urine in ancient times (before 400 BC). Urine was poured on the ground and observed to see whether it attracted insects. If it did, patients were diagnosed with boils. The ancient Greeks also saw the value in examining body fluids to predict disease. At around 300 BC, Hippocrates promoted the use of the mind and senses as diagnostic tools, a principle that played a large part in his reputation as the "Father of Medicine". The 18th century is regarded as the "Golden Age" of the successful practitioner, as well as the successful quack. The use of phrenology (the study of the shape of the skull to predict mental faculties and character), magnets, and various powders and potions for treatment of illness were a few of the more popular scams.

The advancement of medicine during this time was more theoretical than practical. Internal medicine was improved by new textbooks that cataloged and described many new forms of disease, as well as by the introduction of new drugs, such as digitalis and opium. The state of hospitals in the 18th century, however, was alarming by today's standards. Recovery from surgical operations was rare because of septicemia. The concept of antisepsis had not yet been discovered, and hospitals were notorious for filth and disease well into the 19th century. In an attempt to overcome limitations inherent in conventional computer-aided diagnosis, investigators created programs that could simulate expert human reasoning. Hopes that such a strategy would lead to clinically useful programs had not been fulfilled back then, but many of the problems impeding creation of effective artificial intelligence programs had been solved. Strategies have been developed to limit the number of hypotheses that a program must consider and to incorporate pathophysiologic reasoning. (Ahmed et 'al, 2008) The latter innovation permits a program to analyze cases in which one disorder influences the presentation of another. Prototypes embodying such reasoning can explain their conclusions in medical terms that can be reviewed by the user. Despite these advances, further major research and developmental efforts will be necessary before expert performance by the computer becomes a reality (Dougherty and Conway 2008).

By the early 1970s it became clear that conventional tools such as flow charts, pattern matching and Bayes' theorem were unable to deal with most complex clinical problems. Investigators then began to study the expert physician to obtain detailed insights into the basic nature of clinical problem solving. The results derived from such studies have subsequently formed the basis for computational models of the cognitive phenomena, and these models have further been converted into so-called artificial intelligence programs (Miller et 'al, 1982). Furthermore, some systems employed Case Based Reasoning methodology to develop a case-based expert system prototype for supporting diagnosis of heart diseases. Two retrieval strategies were investigated namely; induction and nearest-neighbor approaches. 110 cases were collected for 4 heart diseases namely; mitral stenosis, left-sided heart failure, stable angina pectoris and essential hypertension. Each case contains 207 attributes concerning both demographic and clinical data. After removing the duplicated cases, the system has trained sets of 42 cases for Egyptian cardiac patients. Cardiologists have evaluated the overall system performance where the system was able to give a correct diagnosis for thirteen new cases (Murugiah and Karen,2012, Cooper,1986),

Also**,** a framework for Medical Diagnosis using Hybrid Reasoning was proposed where primary diagnosis is done based on the RBR (Rule-based reasoning) which is followed by CBR (Case-based reasoning), to make results more accurate. The hybrid system was designed by combining the Rule-based system and Case-based system; there is a knowledge base which stores the set of rules. The symptoms acquired from the user go to the RBR module. The rules are in the form of "If-Then". If the RBR module is not able to make a diagnosis of the type of the disease, then the CBR module is sought after. If the similarity of the present case is above the threshold value with respect to the stored cases, then the case is retrieved. The case is reused and revised. The new case is retained in the case-base. This framework shows how the merits of one complement the demerits of the other (Tversky and Kahneman,2009)
In addition, a prototype case-based reasoning system was developed that can give decision support for anxiety disorder diagnosticians at a different level of expertise, overcoming the limitations of a rule-based knowledge base system such as incremental learning and specific knowledge acquisition.

However, the work recommended that the system (CBRSADD) should include an explanation facility and case maintenance techniques to improve retrieval performance as the size of the case base increases (Getachew and Wassie,2012). Artificial intelligence adopts the use of questions, conditions and suggestions of symptoms (for those who don't really know what is wrong with them) to ensure the diagnosis is done with precision. The backbone of artificial intelligence through case based reasoning diagnosis has indeed greatly influenced the implementation of diagnosis in the world of software which could be used both in the presence or absence of the doctor; although we should note that it is not a replacement for the physician. It is developed to facilitate the diagnosis of very serious ailments like Ebola at its early stages; acting as a helper in the diagnosis process of ailments to the Doctor. (Suhasini et 'al 2010)

3. METHODOLOGY

This session delineates the design and methodology involved in the implementation of the proposed online medical Centre. For individuals of the community that will not be able to go physically to the medical Center, they can access the online medical center wirelessly at their homes. This wireless accessibility will be made possible by the following devices (wireless access point, Switch and Server virtualization). Virtualization technology increases efficiency in the data center by enabling x86 servers to run multiple operating systems and applications at the same time. In achieving this virtualization, the VMware virtualization was employed.

Also, interviews and visitation of experts in the field was conducted in this work for data collection, and a database of records was designed, which will serve as a data bank for the Decision Support System. The web based program for this work requires the use of PHP, MySQL, CSS and HTML for its development and the program would be accessed using a web browser.

Administrator Priviledges:

The administrator would be able to view past patient diagnosis records, as well as print such records. He would also be able to add a new ailment to the database for diagnosis purposes. Finally, he is also responsible for adding a new administrator to ensure that unauthorized guests are not given permission to view records or make changes to the database.

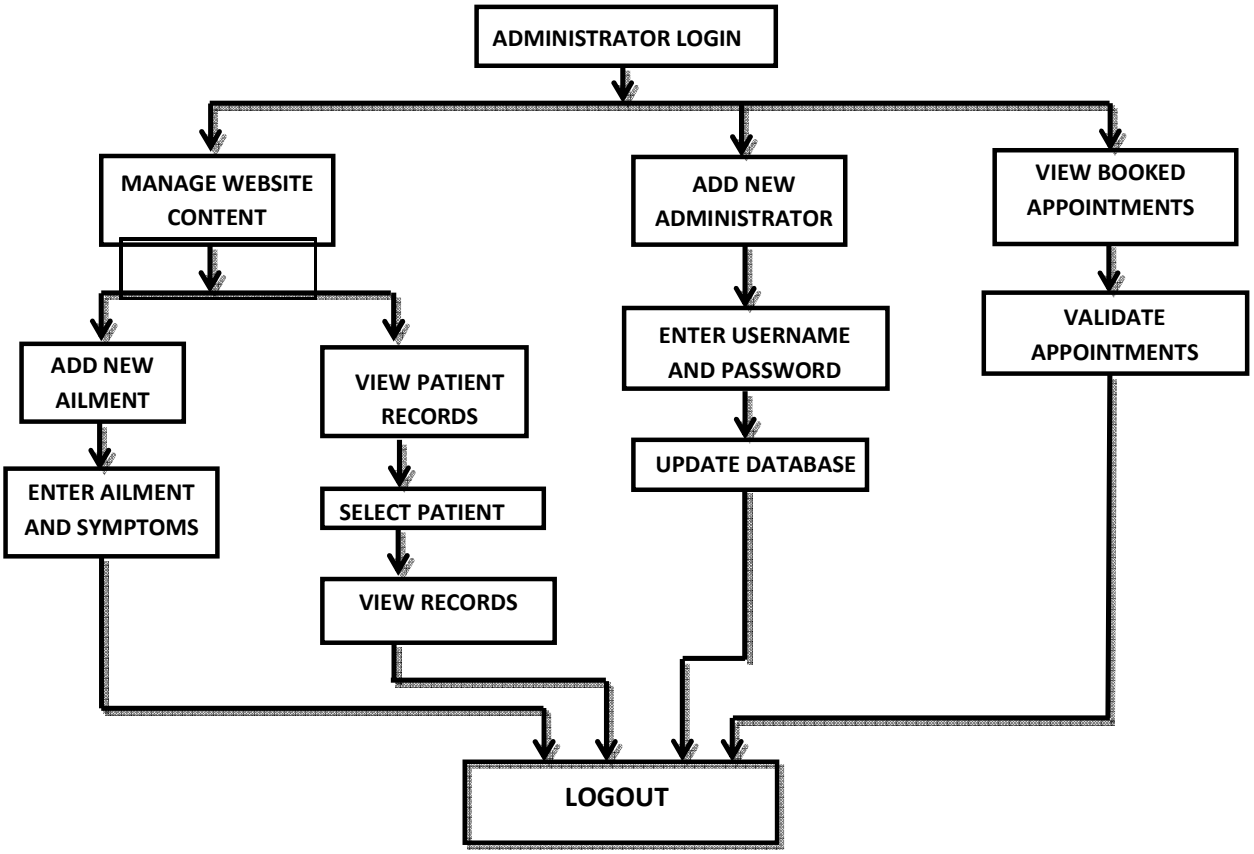


FIG 3.1: BLOCK DIAGRAM OF ADMINISTRATOR PRIVILEDGES

Patients' Accounts / Authentication:

On visit to the website, the user would be required to log in or sign up if he doesn't have an account already. This is to keep record of the doctor's assistance using the software to diagnose patients at that moment, depending on the policy followed by the medical Centre. It is to ensure that unauthorized users are not granted access to the website especially the aspect that deals with the diagnosis due to its delicate function. Although, the hospital location assistance would still be available for all to access due to the fact that it would also be used to cater for emergency cases.

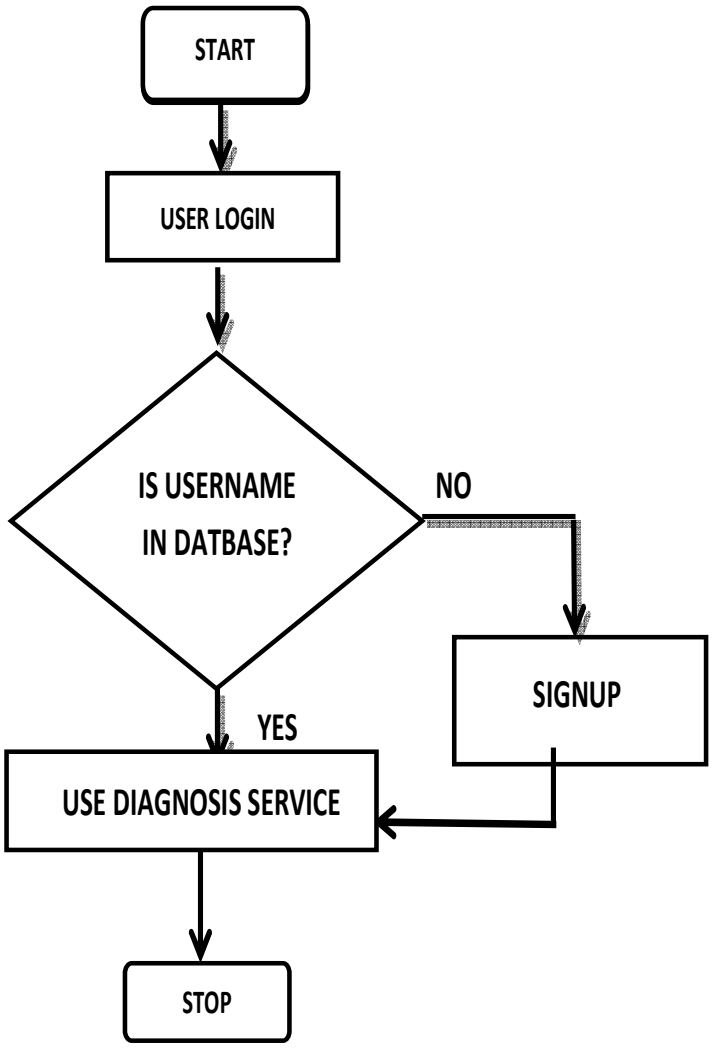


FIG 3.2: FLOWCHART FOR USER LOGIN/AUTHENTICATION

SELECTION PROCESS OF SYMPTOMS:

The program would have pre-defined symptoms in its data bank in which the user (doctor's assistant) would pick the best suited synonym(s) according to the description(s) of the patient. The symptoms used have been pre-defined to ensure that the program doesn't give errors if it doesn't recognize the symptom due to incorrect spelling or the word inputted wasn't the one used for the program.

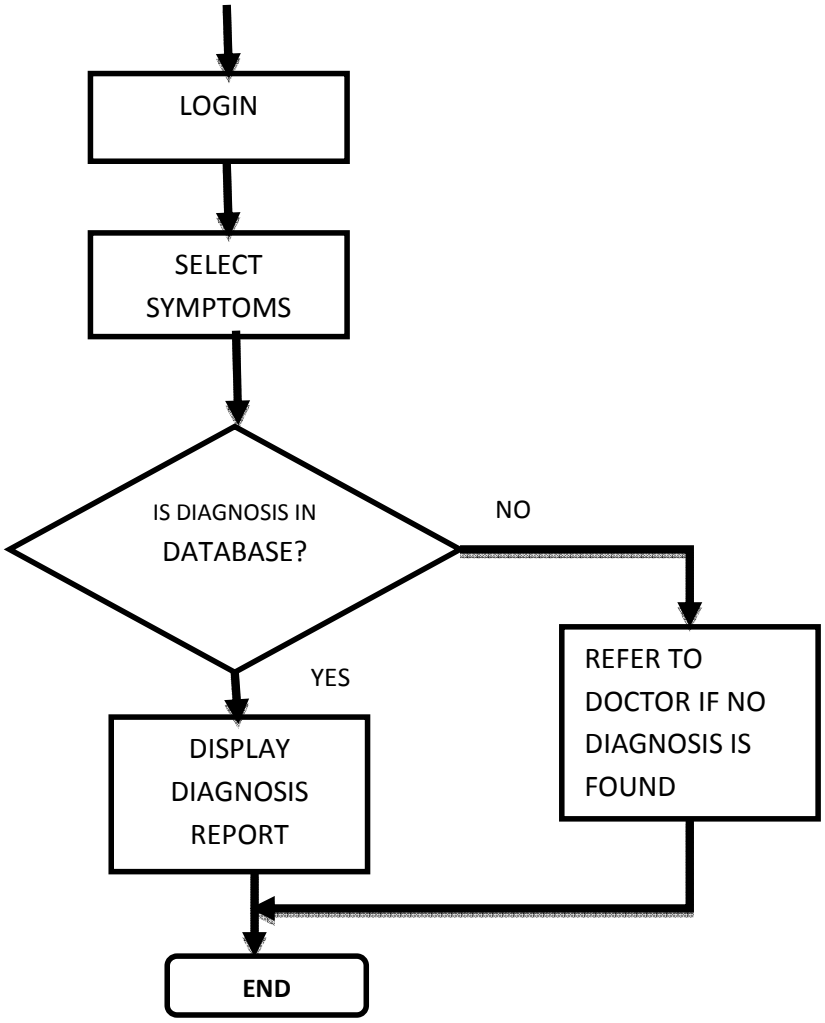


Fig 3.3: FLOWCHART FOR DIAGNOSIS

LIVE CHAT WITH DOCTOR

Due to the fact that the doctor would not always be physically present in the medical Centre, the Wi-Fi capability would help in ensuring that the program brings up an avenue to chat with the doctor online for the purpose of obtaining prescription for the diagnosed patient. Also in cases where no diagnosis would be found; the patient would be linked to a Doctor through the live chat to officially diagnose the patient from the symptoms entered that correlates to no ailment in the database.

LOCATION ASSISTANCE

The software would be incorporated with a bank of locations that would serve as a 'helper' to patients who need to be referred to other hospitals/pharmacies where they can be taken care of appropriately, as well as given the drugs they need which is not available in the medical Centre. It would also be used by persons on a rescue mission at accident scenes or people at home who have to get to the hospital due to an emergency health situation.

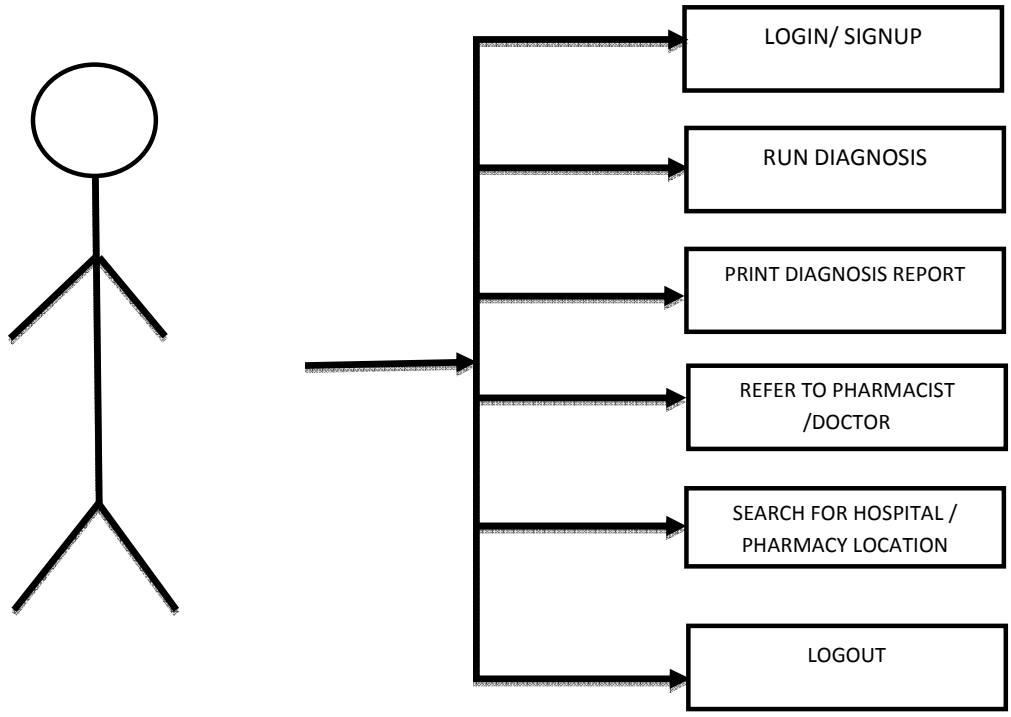
UNIFIED MODELING LANGUAGE DIAGRAMS

UML diagrams that were employed in creating formal representations of the system include:

i. Use case diagrams
ii. Activity diagrams

i. Use case diagram

Use case diagram gives a graphical overview of the users (actors) involved in a system-different function needed by those users and interaction between them.



USER / PATIENT

FIG 3.4: USE CASE DIAGRAM FOR THE USER / PATIENT

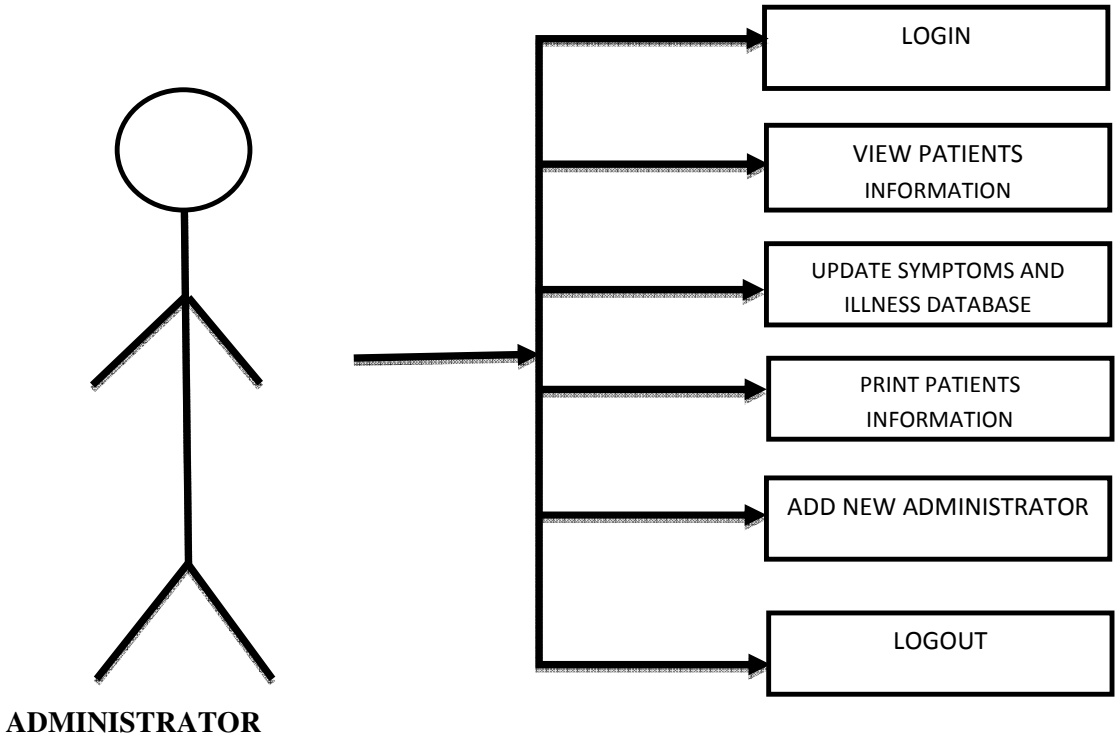


FIG 3.5: USE CASE DIAGRAM FOR THE ADMINISTRATOR

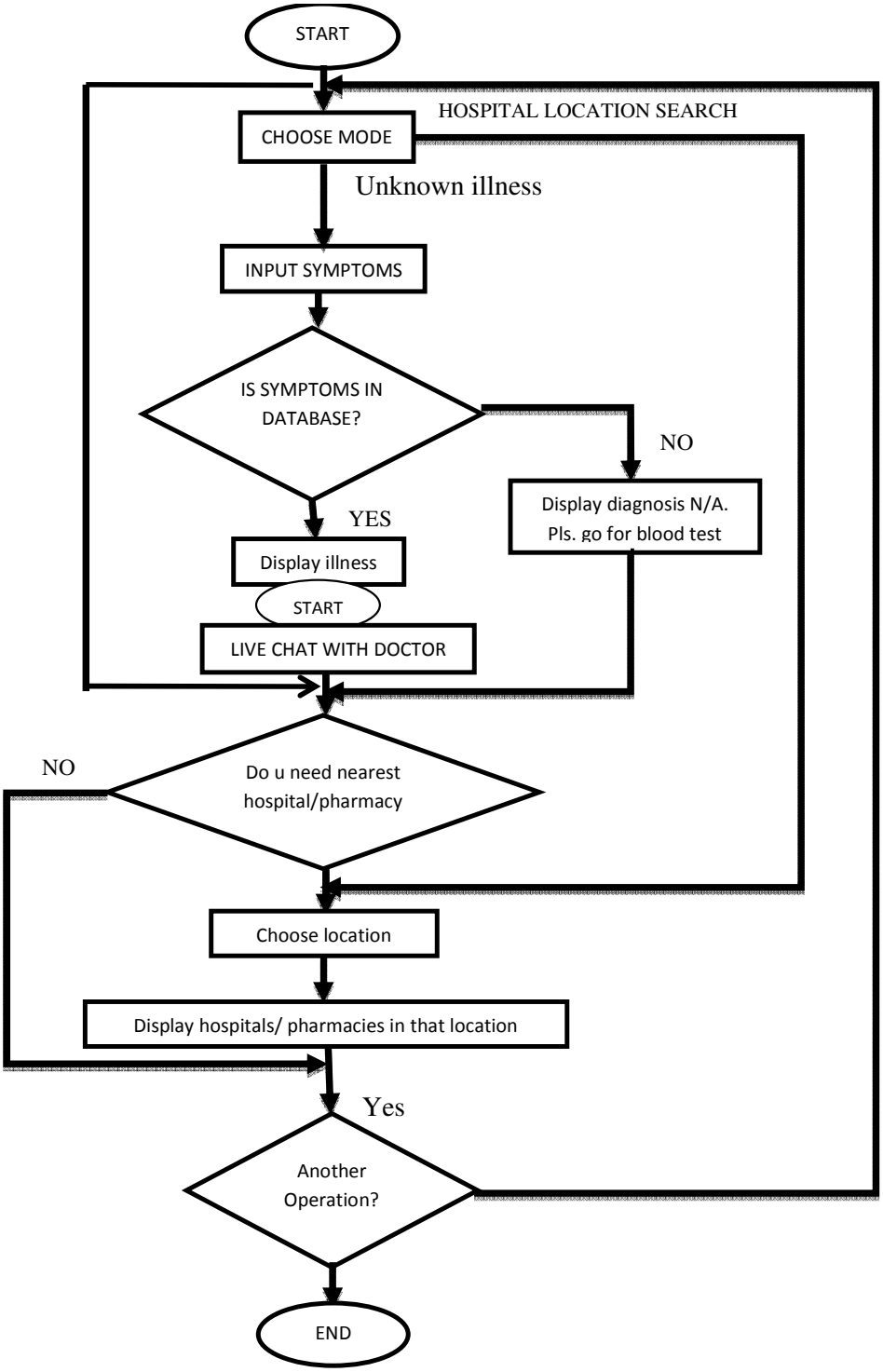


FIG 3.9: FLOWCHART FOR THE WHOLE DIAGNOSIS SYSTEM

4. RESULT AND DISCUSSION

The system specification for this software is divided into two parts:

1. The server-side specifications
2. The client-side specifications

4.1 Database Management System

After paying a visit to the medical doctors in different hospitals and conducting interviews with other medical experts, a detailed databank of ailments and their corresponding symptoms was developed as indicated in the figure below. Fig 4.1 shows the table of ailments coined out from the database. This table has 30 ailments and their corresponding symptoms that will be used to diagnose patients based on the selected symptoms.

id	ailment	symptom1	symptom2	symptom3	symptom4	symptom5	symptom6	symptom7	symptom8	symptom9
1	APPENDICITIS	abdominal swelling	constipation	diarrhea	fever	loss of appetite	nausea	painful urination	stomach pain	vomitting
2	ALPHA-1 ANTITRYPSIN	cough	fatigue	swelling of ankles and feet	yellowing of skin					
3	ANEMIA	difficulty in swallowing	dizziness	fatigue	headache	weakness				
4	ASTHMA	chest pain	chest tightness	cough	fatigue	rapid breathing	shortness of breath	wheezing		
5	BREAST CANCER	lump in breast	nipple pain	nipple retraction	pain in breast area	rash discharge from breast				
6	CELIAC SPRUE	bloating	constipation	loss of appetite	nausea	nipple retraction	vomitting			
7	CHOLERA	dehydration	diarrhea	nausea	vomiting					
8	DIABETES	blurred vision	excessive thirst	execessive urination	fatigue	itching	nausea			
9	DIARRHEA	blood in stool	dehydration	loss of appetite	nausea	stomach pain	vomitting			
10	DYSENTRY	breathlessness	chest pain	coughing with green, yellow or	fever	loss of appetite	night sweats	weight loss		

FIG 4.1: TABLE OF AILMENTS

4.2 Software Implementation

There are two active parties that would be involved in the implementation of this software

1. The site administrator.
2. The user/patient.

4.3 Administrator's Implementation

Upon accessing the website and navigating to the administrator's section of the webpage, the admin would be required to enter his credentials for authentication purposes so as to restrict trespassers from making changes to the contents of the website. This is done by selecting the staff login button on the home page.

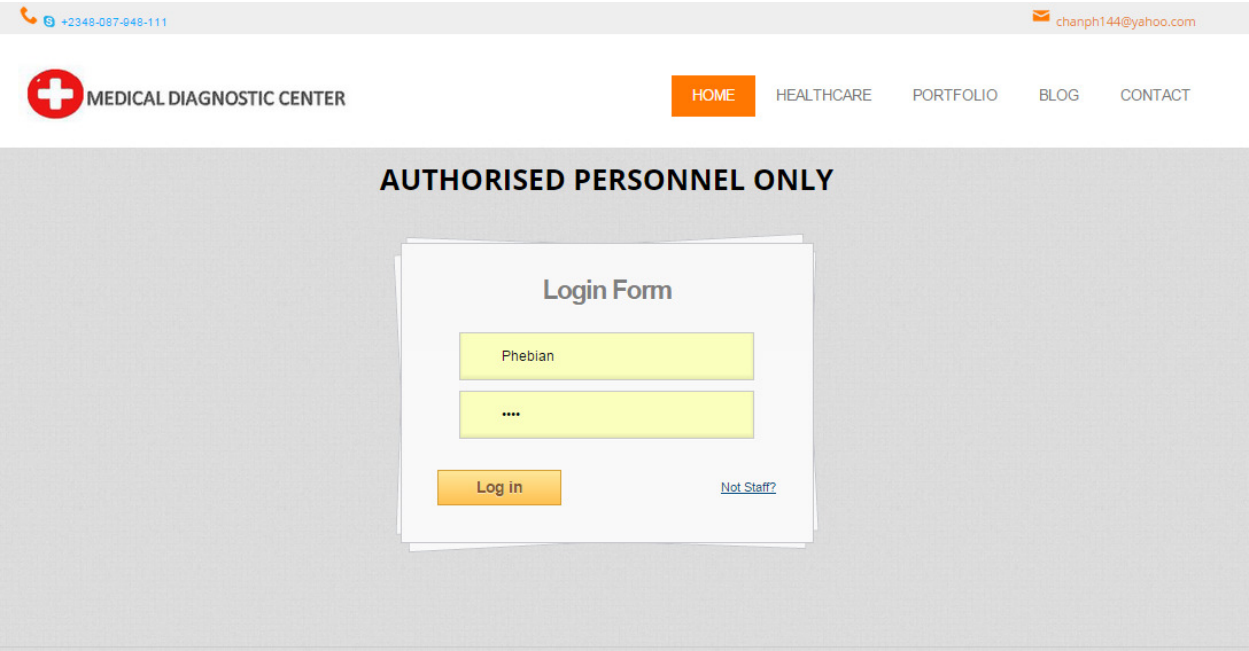


FIG 4.2: ADMIN LOGIN PAGE

Upon successful login, the site would automatically navigate to the staff area where changes can be made to the database such as adding a new ailment for diagnosis purposes and adding a new staff's authentication to grant him/her access to the staff area. The admin would also be able to view the records of the patients who have been diagnosed using this software and also have the capabilities of printing such information.

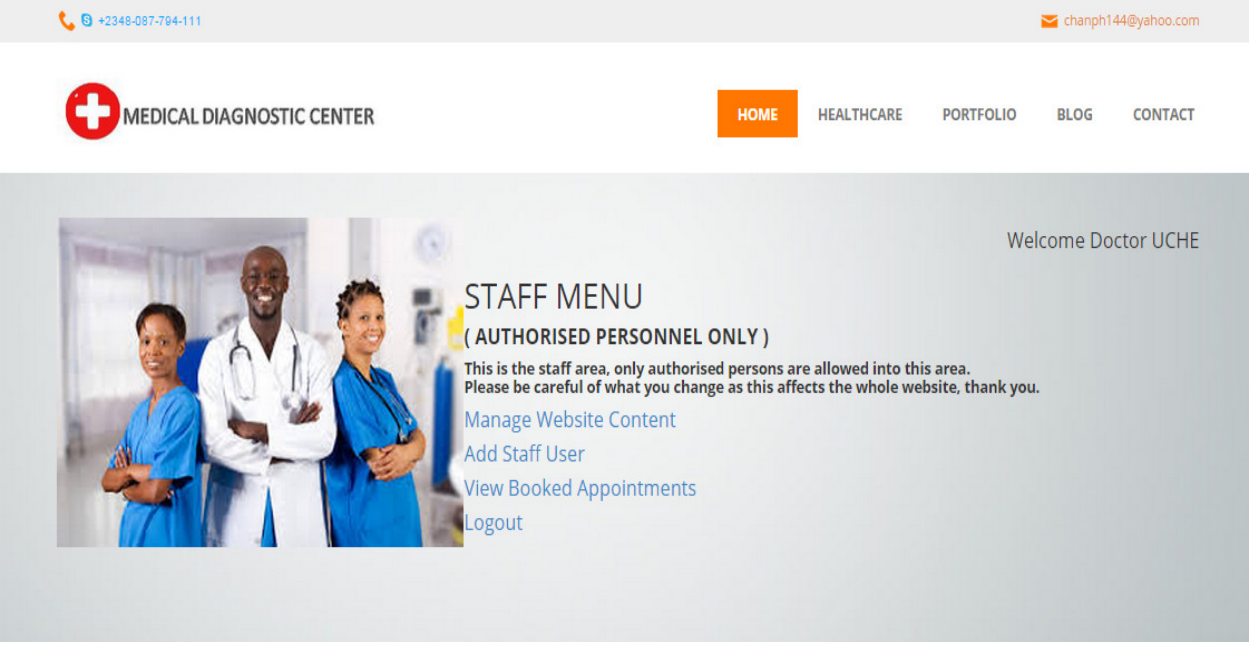


FIG 4.3: STAFF AREA

The snapshot shown in fig4.3 displays the staff menu to be accessed by the medical staff alone.it provides the medical staff with options such as

- manage website content
- Add staff and
- View booked appointments.

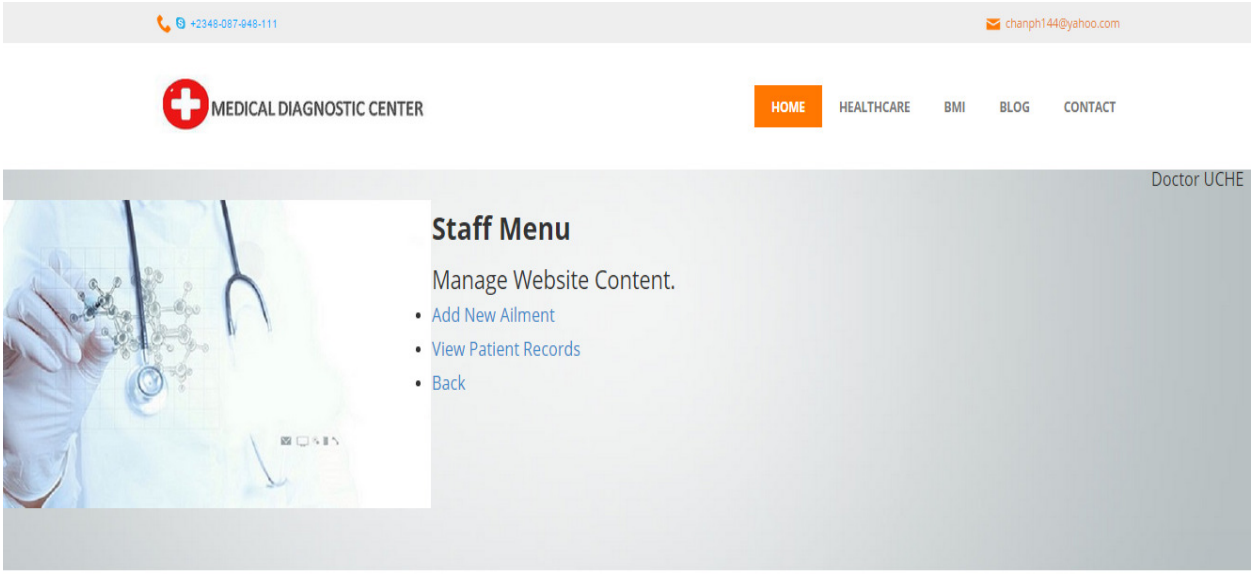


FIG 4.4: MANAGE WEBSITE CONTENT PAGE

Content management is the process of uploading and editing the content of a web site. The manage website content page as shown in fig 4.4, allows the medical staff edit and manage the content of the website without having any technical knowledge of the software tools used to develop the website. The manage website content is performed by the following actions:

- Add new ailments and
- View patient records

4.4 Diagnosis page

After the registration form has been filled, a unique username and user ID is selected and the patient is then redirected to the login page where he/she logs in with these details. The patient then proceeds to the diagnosis page where he selects the symptoms he is experiencing from the list of symptoms provided, which the software would use in querying the database to provide the diagnosis of the corresponding ailment attached to the selected symptoms. Once this has been done the patient's record is automatically updated, where access to these records are restricted to authorized medical personnel only. A comment box is provided to add whatsoever the patient would like the doctor to know also, concerning his/her health status. The patient also has the choice of locating the nearest hospital to his/her community to obtain the required treatment or the nearest pharmacy where he/she can be prescribed drugs.

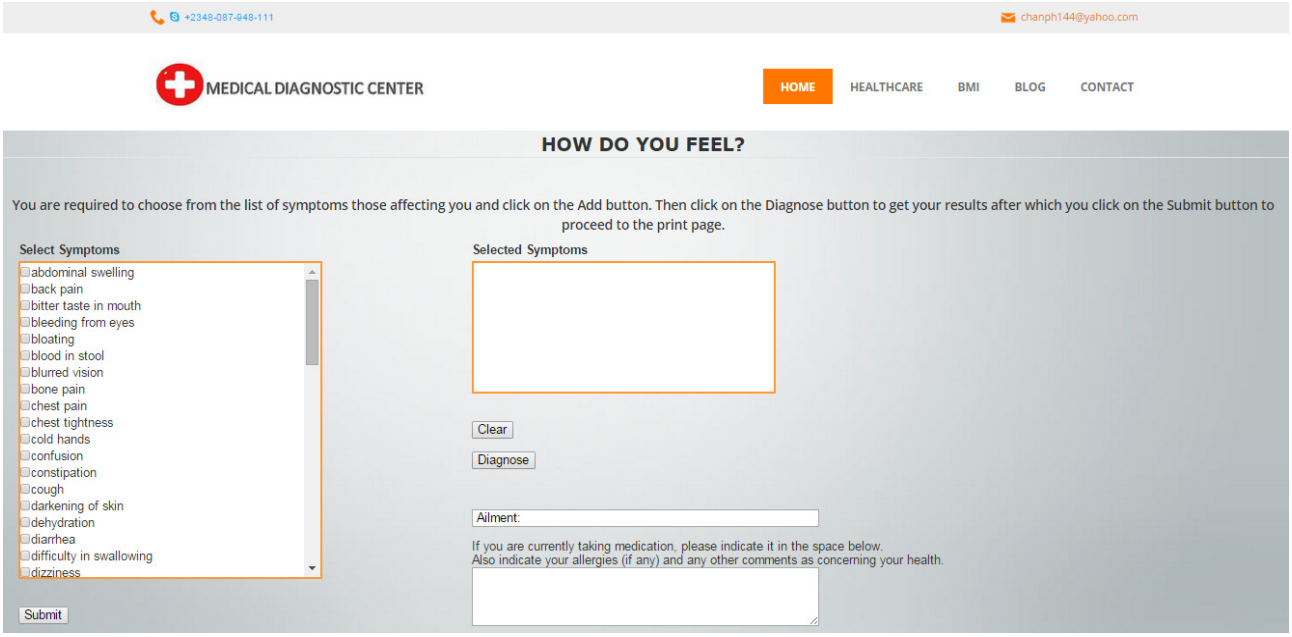


FIG 4.5: DIAGNOSIS PAGE

The diagnosis page shown in fig 4.5 depicts the ease at which patients/users can be diagnosed using this software. The patients are also required to indicate if they have any allergies and if they are currently on any medication.

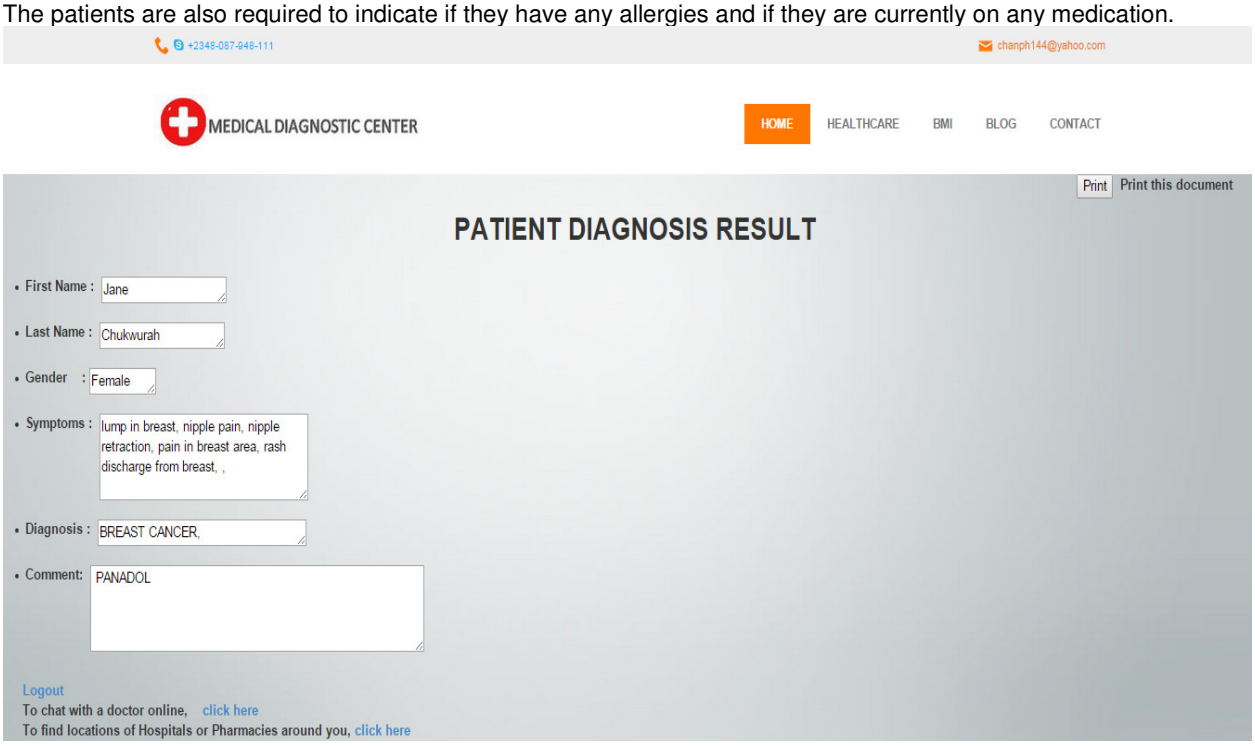


FIG 4.6: DIAGNOSIS PRINT PAGE

The diagnosis print page allows the patient print diagnosis result to enable patients' reference to medical results in future if need be or further medical treatment of the diagnosed ailment .

4.5 Hospital/Pharmacy Locations Page

In addition to the diagnosis, patients in the community and in the case of accidents, people helping the victims of accident scenes in the community have access to search their current locations for a list of hospitals and pharmacies that are around their area to ensure they are not stranded due to lack of information.

5. CONCLUSION

The existing healthcare system which lacks what the sophistication of ICT tools adoption would offer was critically analyzed, resulting to the need for the development and implementation of the diagnostic software. Considering that Many doctors still give patients prescriptions without conducting medical tests and some of the medical tests are unaffordable or not even available at all, the adoption of this medical diagnostic software in hospitals in Nigeria would not only be a step forward in the implementation of a working healthcare system but also for an e-health system in the country which would allow for a far wide healthcare accessibility to Nigerians in all communities.

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