Journal of Engineering Science 10(2), 2019, 103-109

JES
an international Journal

DESIGN AND IMPLEMENTATION OF A MEDICAL DIAGNOSTIC EXPERT SYSTEM

A. O. Oyedeji[1]*, M. O. Osifeko[1], O. Folorunsho[1], O. R. Abolade[1] and O. O. Ade-Ikuesan[2]

[1]Department of Computer Engineering, Olabisi Onabanjo University, Ago-Iwoye, Nigeria
[2]Department of Electrical Electronics Engineering, Olabisi Onabanjo University, Ago-Iwoye, Nigeria

Received: 04 August 2019 Accepted: 28 November 2019

ABSTRACT

The need for emergency medical diagnosis especially in developing countries where the access to well trained and qualified medical personnel is quite difficult and due to the very high patient to doctor ratio has given rise to the design of a Web-based medical diagnosis expert system application developed using the Waterfall Design Model. The medical diagnostic expert system has been designed to diagnose based on the individual's symptoms using knowledge base rule and suggests basic precautionary steps subject to the time the patient can access medical personnel. The medical diagnostic expert system was designed with PHP and CSS to provide a friendly User Interface and MySQL for the database. The system has been able to accurately diagnose some common ailments such as malaria, typhoid which are peculiar to the students.

Keywords: *Expert system; Knowledge Base; Medical diagnosis; User Interface; Database*

1. INTRODUCTION

In recent years, the internet which has caused a revolutionary impact on office automation is currently influencing the industrial automation systems. The rising Web-services technology has been manipulated to provide various services to mankind which has been making life easier by the day. Computer technology also has gone through significant changes which have influenced many areas of the human race. One of this aspect of life that has been affected positively by the use and application of computer technology is medicine and healthcare through the application of a branch of artificial intelligence (AI) called EXPERT SYSTEM (Nohria, 2015).

Alan Turing described intelligent behaviour as the ability to achieve human-level performance in all cognitive tasks (Daniel and Udo, 2017; Abu Naser and Alawar, 2016). An expert system is an intelligent computer program which captures the knowledge of a human expert as depicted. This information is then used to solve real-world problems in an automated fashion. The mode of operation of these systems is simply that expertise on a specific subject is transferred from a human to a computer. The main purpose of knowledge-based expert systems is to make the knowledge of a human expert and their experiences to be more commonly available, particularly in areas where they are not readily available. The quality, efficiency, and competitive control of expert system operations have increased over the years. Expert systems are applied in many diverse areas such as medicine, education, and engineering (Nohria, 2015).

An Expert system has brought about many positive changes to the field of medicine ranging from the data and file processing of patient's record, use of robotics in performing surgical operations to the use of Wireless Body Area Networks for sensing and sending information on the health of the patients. Medical expert systems have helped in creating various types of application systems to complement and support the duties of a doctor in effectively performing their duties. The main advantage of the expert system is the ready availability and easy access of patients to expert knowledge and advice at all times (Nohria, 2015; Amarathunga *et al.*, 2015). This work was carried out generally to achieve an accurate and reliable diagnosis of some common ailments encountered and frequently reported at the Olabisi Onabanjo University Ibogun Campus Health Centre. Specifically, it aims to:

i. Design a Web-based Medical Diagnostic Expert System that can speed up the rate of medical diagnosis and give access to expert advice to off-campus students.
ii. Develop a user-friendly Web-based Medical Diagnostic Expert System.
iii. Evaluate the Web-based Medical Diagnostic Expert System in terms of accuracy of diagnosis, correctness, functionality and usability.

A lot of researches on artificial intelligence and expert systems have been conducted and has led to the development of many expert systems for application in medicine. The structure of expert systems is diverse according to different underlining technologies. The very first medical expert system is the MYCIN developed to diagnose blood diseases. MYCIN utilizes the Backward Chaining Inference method to identify bacteria causing infections and to recommend a line of treatment (Buchanan and Shortliffe, 1984).

*Corresponding Author: oyedeji.ajibola@oouagoiwoye.edu.ng
ISSN 2075-4914 (print); ISSN 2706-6835 (online)

In Mrouf (2017), an expert system for long-term abdominal pain was proposed which was able to give probable causes and cure for the diseases. A medical expert system for diagnosis and treatment of hypertension among pregnant women who are patients of the Reproductive Health Division, Moi Teaching Hospital in Kenya was developed, tested and found to be effective and accurate (Gudu *et al.,* 2012). Furthermore, Asabere (2012) presented a mobile-based medical expert system deployed for medical institutions across the nation in Ghana. With the deployment of the system, it has resulted in fast and quality service delivery as licensed medical practitioners can accelerate diagnosis and attend to patient on-the-go.

This work aims to improve the health service delivery within the university's health centre especially for students who are based off-campus and in need of emergence care as the medical expert system is web-based. The system has been designed for use of the students prior to getting medical attention from professional medical practitioners.

2 MATERIALS AND METHODS

2.1 System Structure

The operation of the expert system is categorized into 3 stages as follows;

- Knowledge Acquisition: This involves the knowledge engineer liaising and consulting with professionals in the relevant field with relevant knowledge. Medical practitioners in the school health centre were consulted to acquire knowledge and information on the basic ailments most commonly encountered by students. The data captured is inputted and stored into the knowledge base of the expert system using the various interfaces (Daniel and Udo, 2017).
- Consultation or querying: The user interacts with the expert system by giving information necessary and the system responds by a method of deductive reasoning (Roventa and Rosu, 2006). The user interacts by entering data in English and the system responds using a backward chaining (deductive reasoning) process to derive an answer to the questions posed by the user.
- Results: This involves the expert system providing result and answers based on the queries entered with sufficient explanations of how it has been able to conclude, and these are provided through the interface (Mottalib *et al.*, 2016).

The medical diagnosis expert system internal structure comprises of the knowledge base which is the database that gives the context of the problem domain and what is generally considered to be a set of useful facts (Oktoria *et al.,* 2016); the rule base that holds the set of rules of inference (mostly IF-THEN rules) that are used in reasoning/decision making; and inference engine which is the 'brain' of the system, and controls how the IF-THEN rules are applied to the facts (Abu Naser and Alhabbash, 2016). This is further illustrated in Figure 1.

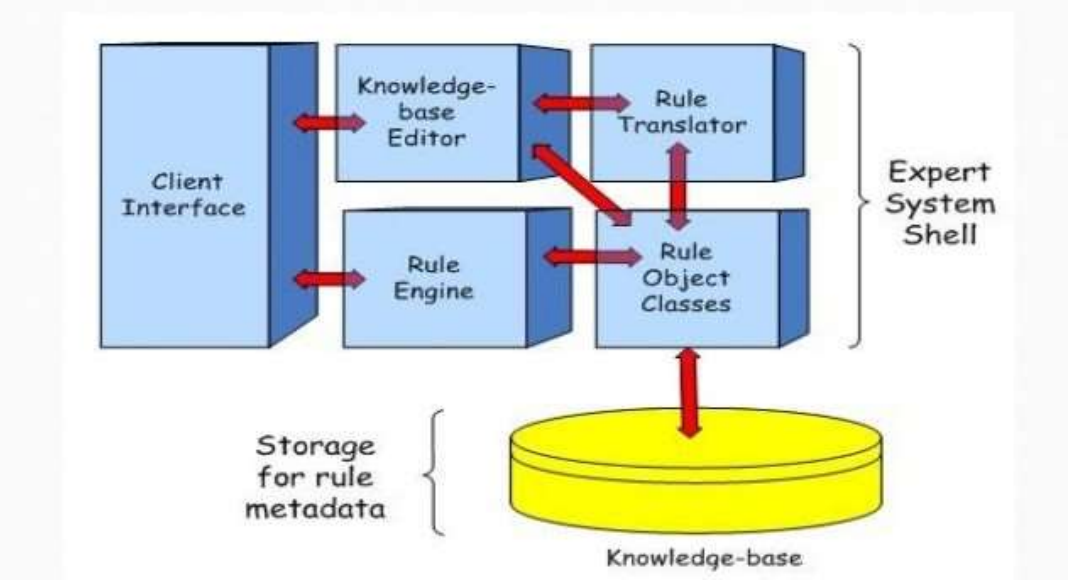

Figure 1: Structure of an Expert System

2.2 System Flowchart

The system flowchart for the design is shown in Figure 2. The system requires a new user to register and an existing user to login before its use. The user selects to either go for a daily check which calculates the Body

Mass Index (BMI) or check for diagnosis by supplying different symptoms. To access the "check yourself" portal, there is a need for user registration which would capture the basic information including demography. The user after registration is prompted to select as many symptoms the patient is having and submits thereafter.

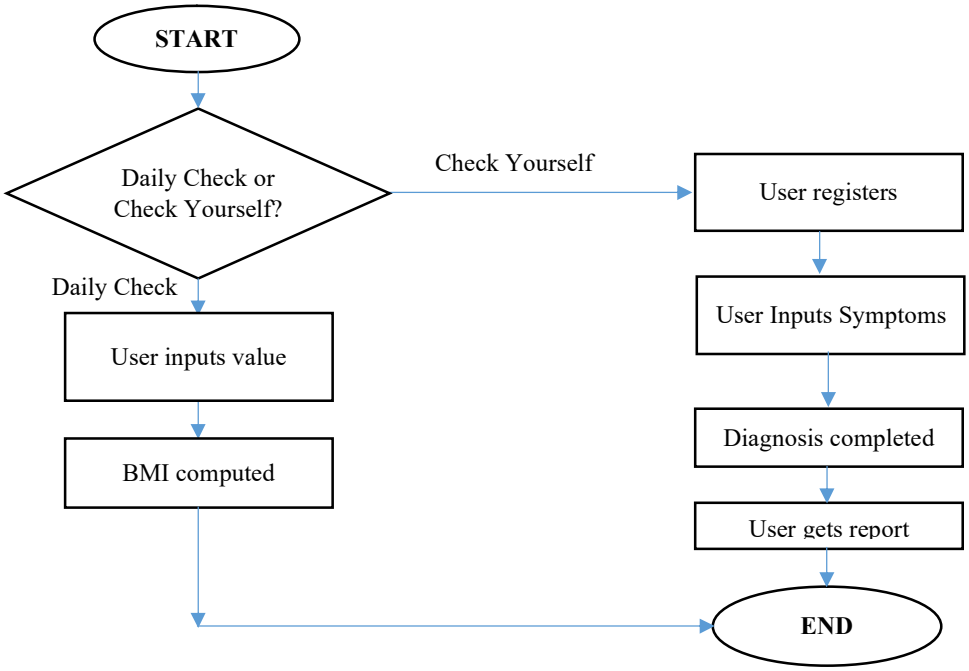

Figure 2: Flowchart of the Medical Diagnosis Expert System

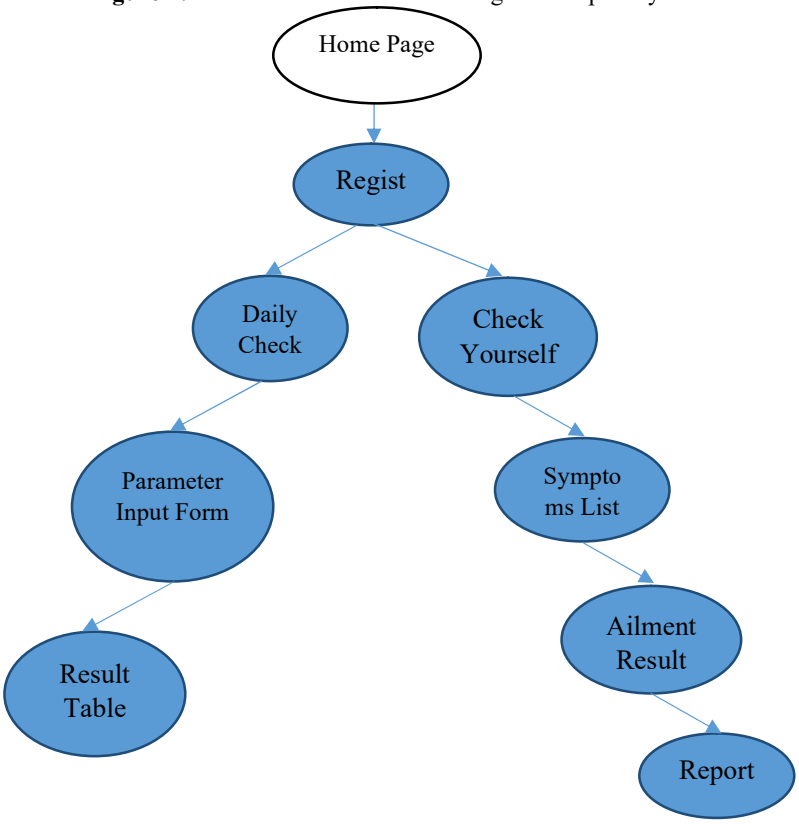

Figure 3: Use-Case Diagram

Figure 3 shows the Use-Case model of the web-based medical diagnosis expert system showing different sections and their corresponding events. This clearly shows the relationship between the different entities making up the medical expert system.

2.3 System Implementation

The Waterfall design model has been selected as the choice software development life cycle method for the development of the Medical Expert System for Diagnosing Patients of Various Ailments. The Waterfall design model process or steps are shown in Figure 4 below. It includes the following stages:

Requirement Phase: In this phase, the requirements necessary for the development of the system were gathered and analysed to determine the possibility of fulfilling the requirement taking into account the costs, risks, time and scope of the project (Munassar and Govardhan, 2010). The system is to be a web-based application. The scope of diagnosis was limited to common ailments experienced by students who register at the university health centre, such as; malaria, typhoid, arthritis, fever etc. The medical team were consulted on the different symptoms and a System Requirement Document (SRD) was written.

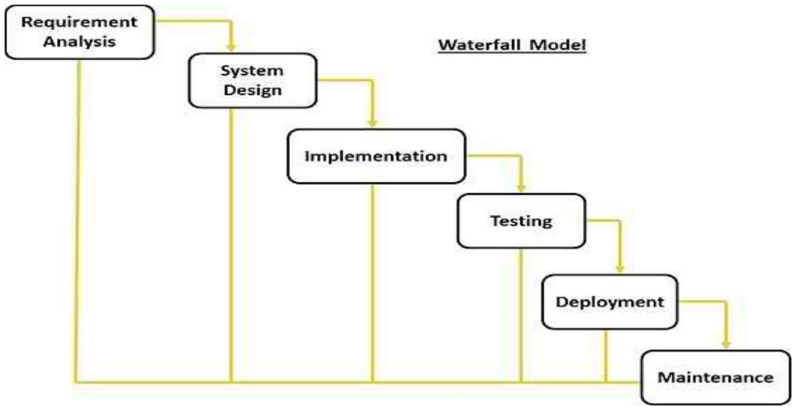

Figure 4: Waterfall Model for Software Development Life Cycle

Design and Implementation Phase*:* In the design and implementation phase, the software team designs the software and the programs are written. Using the information contained in the SRD, the knowledge database was designed and developed using MySQL (back end), and a web application developed using PHP and CSS for the User Interface (front end).

Testing: Testing of the software is performed to determine the correctness, reliability and accuracy of the system. Different values were entered into the system for different scenarios after implementation of the system to see the behaviour of the internal workings and integration.

Deployment: This is the phase for the installation and deployment of the software in its working environment. The software is installed on the host server and URL assigned.

Validation and Review: Validation and review phase is done to check the performance, the functionality and validity of the software. All the various functions from login to diagnosis and daily check were checked for correctness. In the case of unsatisfactory performance of the system, a new iteration was started from the requirement gathering phase.

Maintenance: Involves constant updating of new features and debugging. This is enhanced by having a good requirement document which can easily be referenced to better upgrade the medical diagnostic expert system. The expert system can be upgraded to accurately diagnose other ailments by updating the database and inference engine base rules.

2.4 System Development Tools

The system uses PHP and JavaScript are used for creative Graphical User Interface on the websites to give the best user experience to the user and the administrator by providing good Human-Computer Interaction capabilities. MySQL has been utilised as an open-source SQL database to store data and files which serves as the backend of the system.

Figure 5 illustrates the organized summary of all model components. This shows the relationship between different sections in achieving the overall functionality of the application. The Client-Side Web Application depends on the Server-Side Application because the client-side receives notifications coming from the server-side. Model elements coming from the Server-Side Application are required and are considered dependent on

the Client-Side Mobile Application. The Server-Side Application is also dependent on the Server-Side Model which describes the model being applied to the Server-Side Application's functionality. All other packages are dependent on the Database Model, which is the basis of the organization and collection of data which is represented by events.

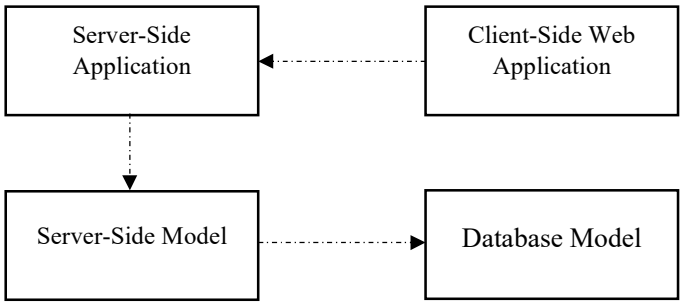

Figure 5: Component Block Diagram

3. RESULTS AND DISCUSSIONS

The Medical Diagnostic Expert System has been developed to have a user-friendly interface. The User Interface is employed to communicate between the user and the expert system. It is the technique by which the expert system interacts through the user. The various modules utilised have been integrated into a single user-friendly web interface. The user can easily access the whole application from the home page where there is a menu bar from which the user can perform the desired functions. After testing the system with varieties of symptoms, here are some results that were generated.

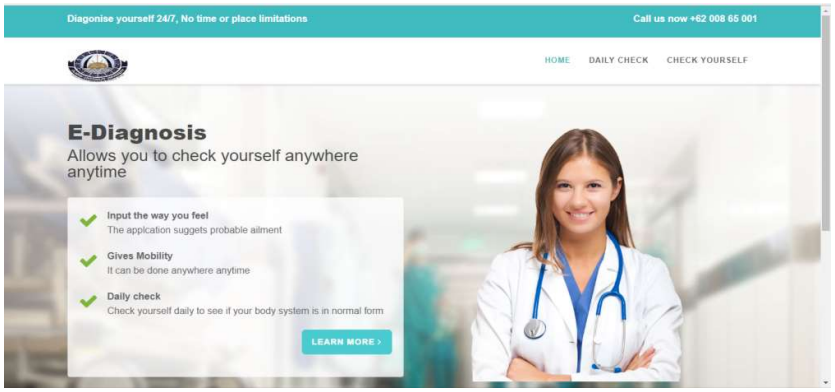

Figure 6: Web-based Medical Expert System Home Page

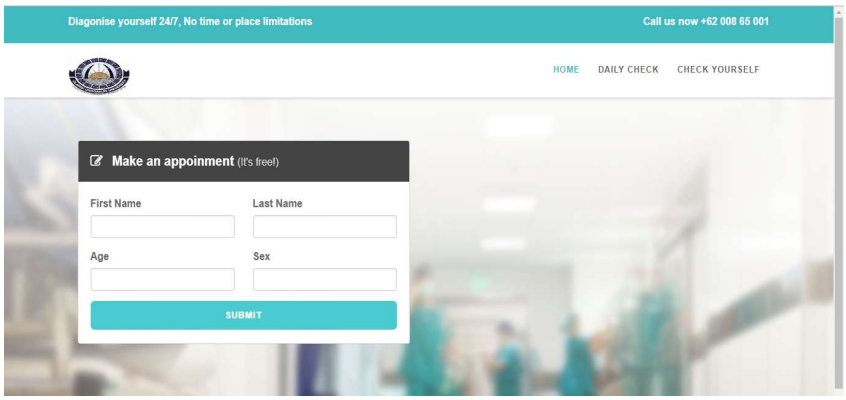

Figure 7: Registration Page

3.1 Diagnosis Input Module

This module provides the user with the interface to input the necessary information needed for a proper diagnosis as shown in Figures 6 to 9. This user interface has been made easy to use as queries are asked in plain

English language so as not to limit the users. Using this interface, the user inputs all basic information, fills desired information and symptoms.

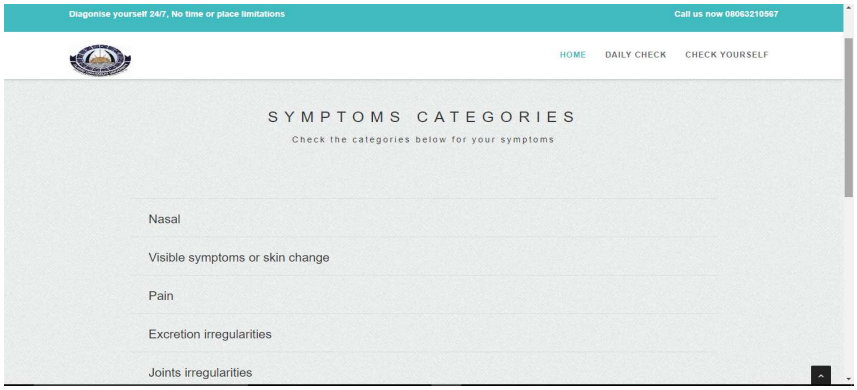

Figure 8: Diagnosis Symptoms Input Module

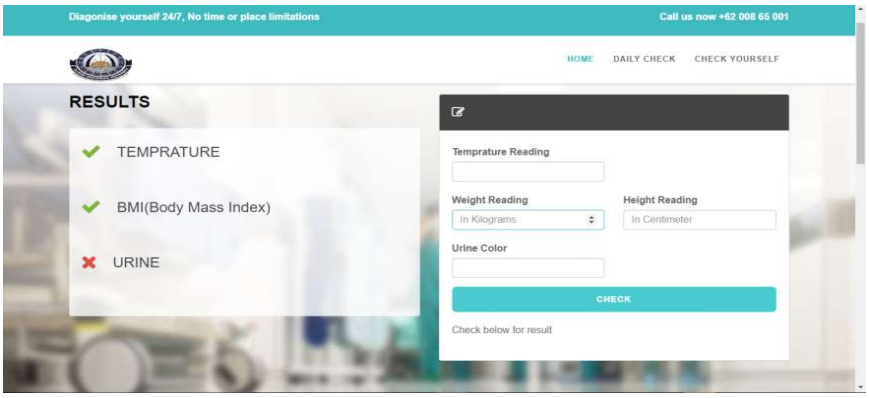

Figure 9: Diagnosis Input Module

3.2 Diagnosis Result Module

The Medical Diagnosis Expert System presents results showing the probability of chance of occurrence based on the knowledge and information entered. The medical diagnostic expert system has accurately diagnosed the patients for ailments such as malaria and typhoid as depicted in Figure 10.

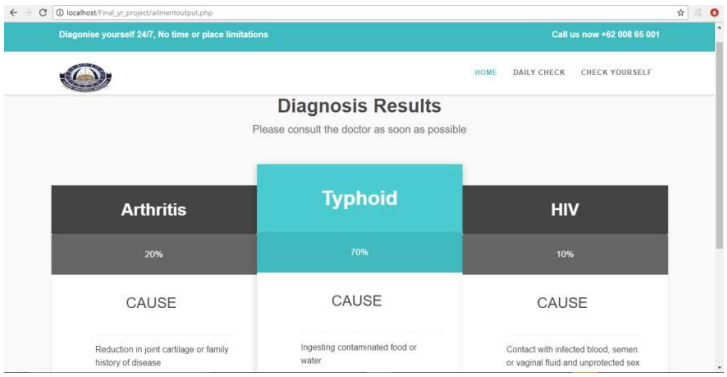

Figure 10: Diagnosis Result Module

4. CONCLUSIONS

Over the years, so many people have suffered avoidably due to lack of access to timely medical care in times of health emergencies, lack of expert diagnosis skills and knowledge of how to attend to an emergency until access to medical care is achieved. With the proliferation of the internet in developing countries with insufficient healthcare facilities, the use of an expert system is important to sustain life until appropriate medical attention is gotten. This system has been able to accurately diagnose some common ailments such as malaria, typhoid and

can be upgraded to diagnose other ailments not presently catered for. The designed system is limited and can be utilized only in environments with internet access.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the medical practitioners of the Olabisi Onabanjo University Health Centre, College of Engineering and Environmental Studies, Ibogun Campus for their unrelenting support.

REFERENCES

Abu Naser, S. S., and Alawar M. W., 2016. An expert system for feeding problems in infants and children, *International Journal of Medicine Research,* 1(2), 79-82.

Abu Naser, S. S., and Alhabbash M. I., 2016. Male Infertility Expert System Diagnoses and Treatment, *The American Journal of Innovative Research and Applied Sciences,* 2(4), 181-192.

Amarathunga, A., Ellawala E., Abeysekara G., and Amalraj C. R., 2015. Expert System For Diagnosis Of Skin Diseases, *International Journal of Scientific & Technology Research,* 4(1), 174-178.

Asabere, N., 2012. mMES: A Mobile Medical Expert System for Health Institutions in Ghana, *International Journal of Science and Technology, 2*(6), 333-344.

Buchanan, B. G., and Shortliffe E. H., 1984. *Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project,* New York: Addison-Wesley.

Daniel, M., and Udo O. K., 2017. Expert System for Medical Diagnosis of Hyperyension and Anaemia, *MAYFEB Journal of Environmental Science,* 3, 12-19.

Gudu, J., Gichoya D., Nyongesa P., and Muumbo A., 2012. Development of a Medical Expert System as an Expert Knowledge Sharing Tool on Diagnosis and Treatment of Hypertension in Pregnancy, *International Journal of Bioscience, Biochemistry and Bioinformatics,* 2(5).

Mottalib, M. M., Rahman M. M., Habib M. T., and Ahmed F., 2016. Detection of the Onset of Diabetes Mellitus by Bayesian Classifier Based Medical Expert System, *Transactions on Machine Learning and Artificial Intelligence,* 4(4), 1-8.

Mrouf, A., Albatish I., Mosa M., and Abu Naser S. S., 2017. Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment, *International Journal of Engineering and Information Systems,* 1(4), 71-88.

Munassar, N. M., and Govardhan A., 2010. A Comparison Between Five Models Of Software Engineering, *International Journal of Computer Science Issues,* 7(5), 94-101.

Nohria, R., 2015. Medical Expert Ssyetm- A Comprehensive Review, *International Journal of Computer Applications,* 130(7), 44-50.

Oktoria, Yang C.-H., and Chuang L.-Y., 2016. An Application of Expert System for Diagnosing Fever Caused by Viral Infection, *Journal of Life Sciences and Technologies,* 4(1), 17-21.

Roventa, E., and Rosu G., 2006. PROLOG Expert System: The Diagnosis of Kidney Diseases, *International Symposium on Research and Education in an Innovation Era, Section III, November 16-18, Aurel Vlaicu, University of Arad.* Romania.