Scholar J
Computational Science

Research Article

Design of Automated Medical Diagnostic Model

E. R. Ochogwu, C. Udanor and M.N. Agu
University of Nigeria, Nsuka, Nigeria.

Received 5 July 2024; Acceptance 19 July 2024; Published 5 August 2024.

Abstract

The high virulence and fatality rate of Lassa fever is a major concern which is further complicated by the non-specific modes of presentation (mimicking some other fevers). This may be why early presentation and subsequent diagnosis is usually not feasible especially in the rural areas. The contagious nature of the illness poses a big threat to the medical attendants, other hospital workers and care-givers who often are exposed to this disease unprotected, prior to diagnosis and establishment of barrier nursing. This gives rise to the need to develop a system that could aid in early and effective detection of the disease. This research uses the object-oriented methodology in its design and implementation of the system and offers a different model from the traditional software development approach that is based on functions and procedures. In simplified terms, object-oriented systems development is a way of developing software by building self-contained modules or objects that can be easily replaced, modified and reused. The programming language used was Java. At the end, data were injected in the new system, tested and discovered to give conclusive results and inconclusive results based on the data entered. This research does not intend to eliminate human physicians but that this model for Lassa fever diagnosis should be used to complement the work of doctors or to be used in remote areas where medical specialists may not be readily accessible. This model simplifies diagnosis and is less prone to error than humans and provides a faster solution to problems, faster access to information and at higher accuracy. It gives tool sets that cannot be matched by human ability.

Keywords*: Design, Automated, Medical, Diagnostic, Model.*

Introduction

Medical diagnosis, (often simply termed diagnosis) refers both to the process of attempting to determine or identifying a possible disease or disorder to the opinion reached by this process [1]. A diagnosis in the sense of diagnostic procedure can be regarded as an attempt to classify an individual's health condition into separate and distinct categories that allow medical decisions about treatment and prognosis to be made. Subsequently, a diagnostic system procedure, elucidation of the etiology of the disease or conditions of interest, that is, what caused the disease or condition and its origin is not entirely necessary. Such elucidation can be useful to optimize treatment, further specify the prognosis or prevent recurrence of the disease or condition in the future [2].

An expert system is an interactive computer based decision tool that uses both facts and heuristics to solve difficult decision making problems, based on knowledge acquired from an expert [3]. On the other hand, an expert system simply replicates the heuristic knowledge of human experts. According to [4], Heuristic

Correspondence to: Emoche Richard Ochogwu, e-mail: richard.emoche@gmail.com

How to Cite: Ochogwu et al. (2024). Design of Automated Medical Diagnostic Model, *Scholar J Computational Science,* **1(8**). DOI: 10.5281/zenodo.**13226087**

knowledge represents experience accumulated through years and concerns the way an expert uses the knowledge to make diagnoses. A diagnosis basically consists relating patient data with corresponding diseases. In order for the computer to be able to retrieve and use heuristic knowledge, expert systems are organized in three distinct levels. These are the knowledge base, the working memory and the inference engine. The knowledge base contains the domain knowledge of the system. It is typically represented as a collection of IF/THEN rules. During the execution of an expert system, new facts are derived. These facts, together with the information entered by the user are stored in the working memory. The inference engine is the part of the expert system that performs the deduction of new facts from previously derived facts and rules in the knowledge base. The user interface is usually through the use of natural language.

A user friendly expert medical system was developed for treatment and diagnosis of diabetes. This software was employed by the medical personnel as a diagnostic and reference tool. The prototype was developed as knowledge based system with a graphical interface, which permits patients and medical practitioners to enter detailed information and laboratory results. The system was developed using Java expert system shell. The researcher made use of several phases for the development of the expert system prototype for diagnosis of diabetes. The phases include; knowledge acquisition, knowledge representation, coding and testing.

The method and procedure for the development of the expert system according to [5] consist of three sections. The first section is the data identification and acquisition for the condition of diabetes. The second section consists of the analysis of the knowledge and its classification in order to be organized into facts and rules for the expert system shell syntax and structure. Finally, the third section is the creation of the user interface and web portability for the prototype expert system. According to [6] medical expert system diagnoses symptoms related to infectious diseases. It suggests the likely ailment, causes and advance possible treatment based on the system diagnosis. The aim is to create an interactive web page that helps to provide primary health care facility without human interference. The system was built with the aim of locating problems and providing immediate first aid solution in cases of emergency. The structure of the system consists of the knowledge base, the database, the inference motor, the explanation facilities and the user interfaces. The researchers adopted the use of UML tools (Use case, Activity diagram and Object diagram) to develop the diagnostic expert system. It covers six major infectious diseases (Lassa fever, Typhoid fever, Malaria fever, Diarrhea and Cholera) that are easily transmittable; the outcome was tested on several patients and desired results were achieved.

The authors [7-10] developed the e-Diagnosis which is a rule based expert system for diagnosis of malaria and typhoid fever. This system interacts with users with plain English language based on some arranged rules. These rules, which are a typical collection of IF/THEN rules, are extracted from experts in the medical fields in Nigeria. Using these rules, a knowledge base was designed for the expert system. Some programming codes were also written in Visual Basic.Net for making deduction of new facts from rules in the knowledge base. This design showed the benefits of using a rule based expert system for diagnosing sick people. According to the designers, the e-Diagnosis can also be updated if the need arises.

An expert system could also be seen as a model and associated procedure that exhibits, within a specific domain, a degree of expertise in problem solving that is comparable to that of a human expert. Expert system attempts to capture the knowledge of a human expert and make it available through a computer. An expert system consists of a knowledge base, database and an inference engine for interpreting the database using the knowledge supplied in the knowledge base [11]. To this end, this research aims to design a diagnostic model that could aid in early and effective detection of the disease and generate the desired output in a visual form. Additionally, the model shall be applied to the challenges posed by current methods of Lassa fever diagnosis.

Materials and Method

Data collection

Data were carefully collated and objectively evaluated in order to define, as well as ultimately provide solutions to the problems for which the research work is based. In gathering and collecting necessary data and information needed for system analysis, two major fact-finding techniques were used in this work which are given in the subsection below.

Interview with Experts

In this research, medical practitioners including doctors, lab attendants and pharmacists were interviewed by the researcher for the purpose of gathering information for this study. Reliable facts were got based on the questions posed to the different practitioners by the researcher.

Study of manuals

Textbooks and professional publications were studied and a lot of information concerning the system in question was obtained.

System analysis

System analysis involves the process of studying an already existing system, either computerized or manual, for a new one to be developed. To some, it is a process in which questions are answered about how the present existing system under investigation actually works. Analysis is often described as taking place after the present system has been investigated. Expert system for Lassa fever diagnosis is a computer software program that needs to be installed and run on any computer system. This software is an Artificial Intelligence model that helps in making inference (decisions) to generate the desired output in a visual form (hardcopy or softcopy) to the user.

Analysis of existing system

This aims at objectively evaluating the existing system of diagnostics and treatment in the hospital with the view to highlighting its limitations. The existing system of medical diagnosis and drug prescription in most hospitals involve manual activities. An investigation into how diagnosis is carried out revealed that anytime patients visit hospitals, they are subjected to long waiting hours just to undergo the regular card verification and clearance. Patients queue accordingly for several hours on a first come first serve (FCFS) basis. A new patient usually registers into the hospital by filling the patient form which signifies that the person is now registered with that hospital. He/she is then referred to a doctor for examination and testing. This examination helps the doctor to determine exactly what a patient may be suffering from.

It is the widespread practice that in attending to registered patients, the attending staff usually retrieves the hospital folder using the patient’s form. This form is then sent to the doctor who peruses it, before examining the patient and carrying out the appropriate therapy. The patient is either referred to the laboratory unit for a test (if there is need) or to the pharmacy unit to obtain the prescribed drugs (if the matter is not too complex). Any treatment proffered to the patient by the doctor must be recorded in the patient`s folder to aid future diagnostic references. This procedure is usually a long and tedious one.

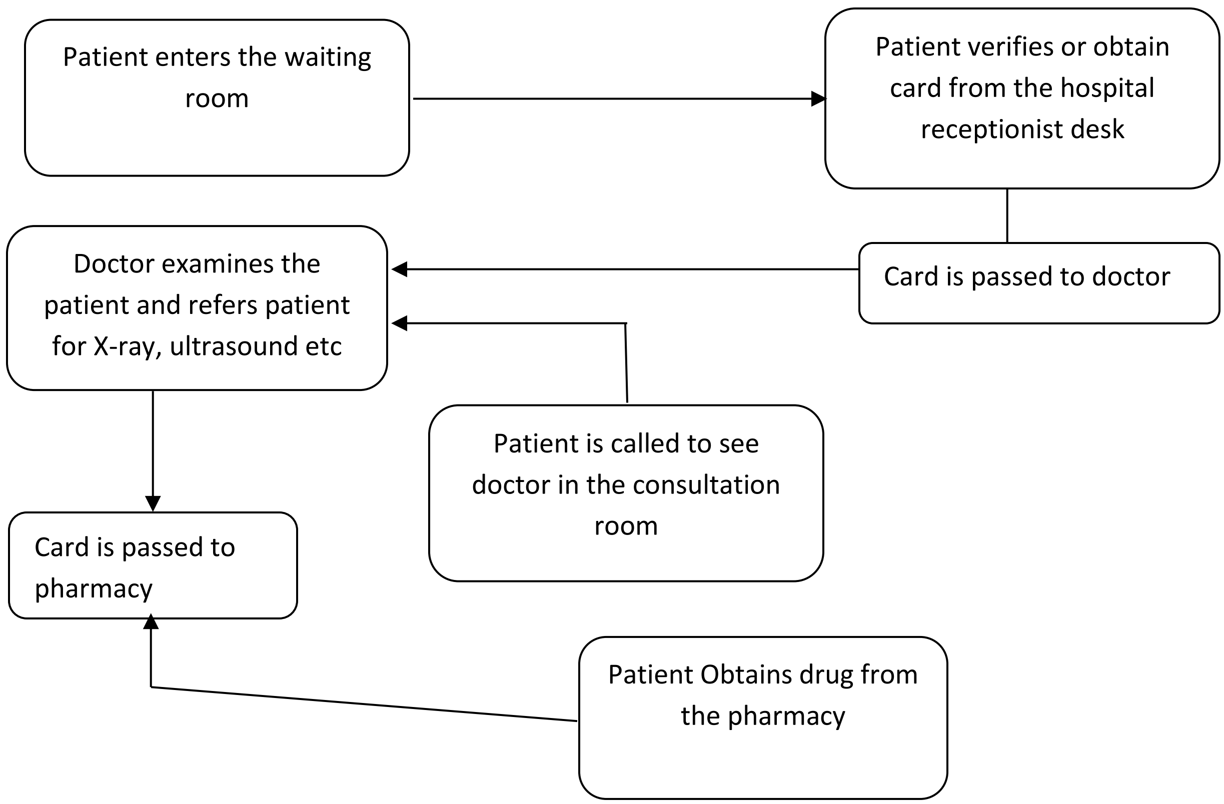

Figure 1. Process diagram of existing system

Limitations of existing system

Some shortcomings are noticed in the existing system after thorough analysis. These include manual documentation of patient's records as it is noticed in the course of investigation that the existing system is heavily dependent on manual methods of entering, storing and retrieval of patients' information. This implies patients wait for quite a long time before being referred to the doctor for diagnosis. Also, error in diagnosis which shows that in some cases, wrong diagnosis is made for ailments because they (the ailment) are relatively new and the physician has limited knowledge about it. The situation is even made worse when at the point of medical examination; the physician cannot access a wider knowledge base for guidance. Additionally, stalling of treatment due to doctors' absence is another flaw that shows that patients wait indefinitely in the event of a doctor's prolonged absence and sometimes, end up not accessing treatment which could result in death of the patient.

Procedures for Design Implementation

Input and Output Specification

Input design analysis

Input design consists of symptoms interface, where users select from the drop down list of different kinds of Lassa fever symptoms. Users are expected to tick the appropriate checkboxes thereby inputting data into the system as shown in Fig. 2.

Processing phase

In this phase of the program, inputs are processed based on the selected symptoms inputted by the user. A combination of at least five (5) of the symptoms generates an output of either a mild symptom or severe symptom via the inference engine (Expert system calculator). This is done by the help of a simple mapping function of the inference engine as shown in Fig.3. The standard UML tools used for the designing of this proposed system are use-case and activity diagram.

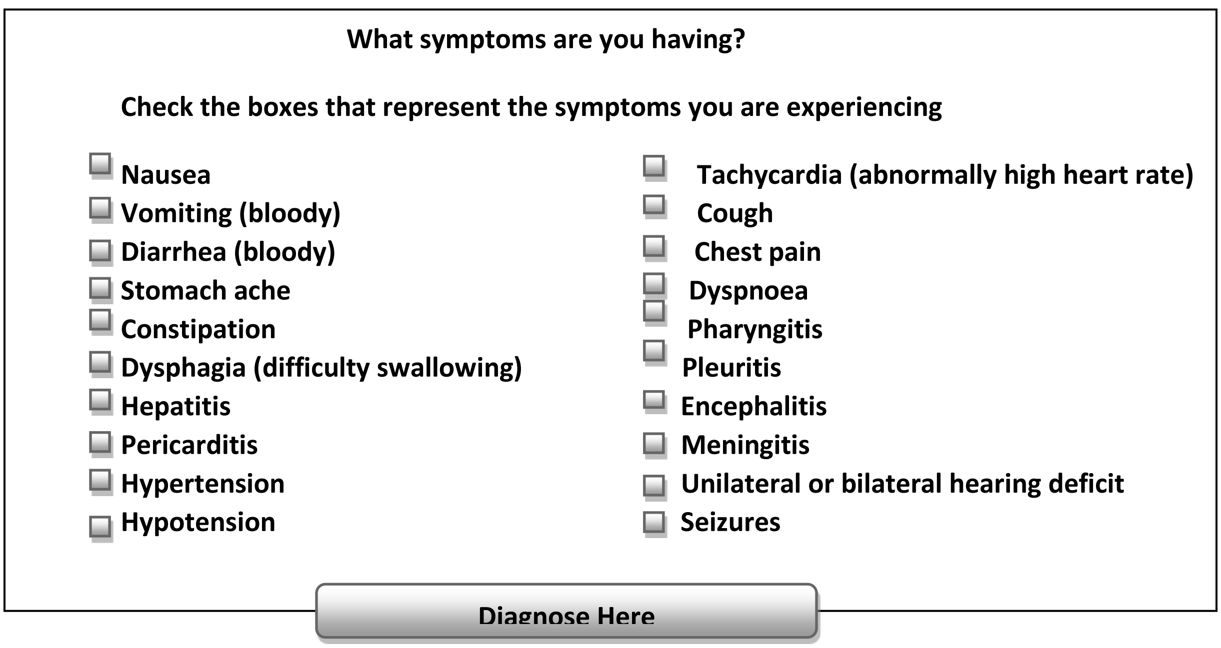

Figure 2. Diagram of symptoms

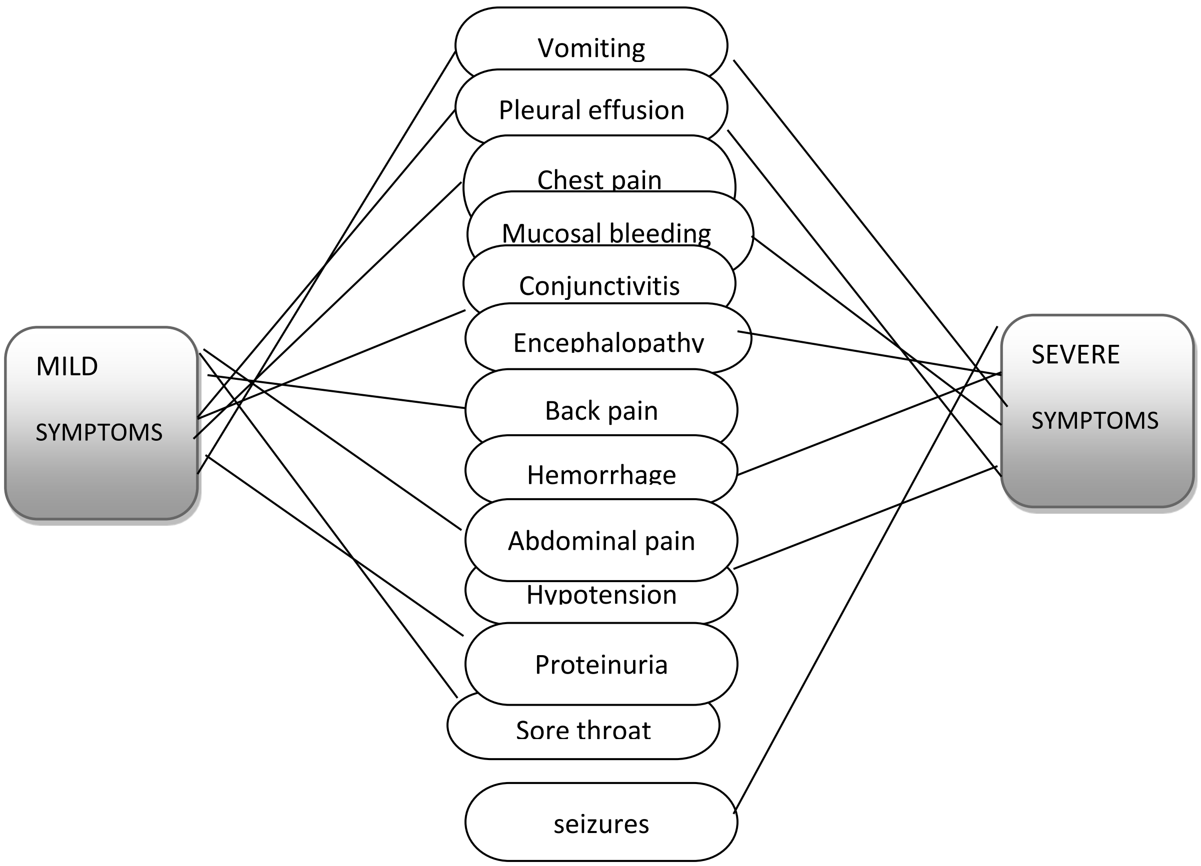

Figure 3. Diagram of mild and severe symptoms

Output phase

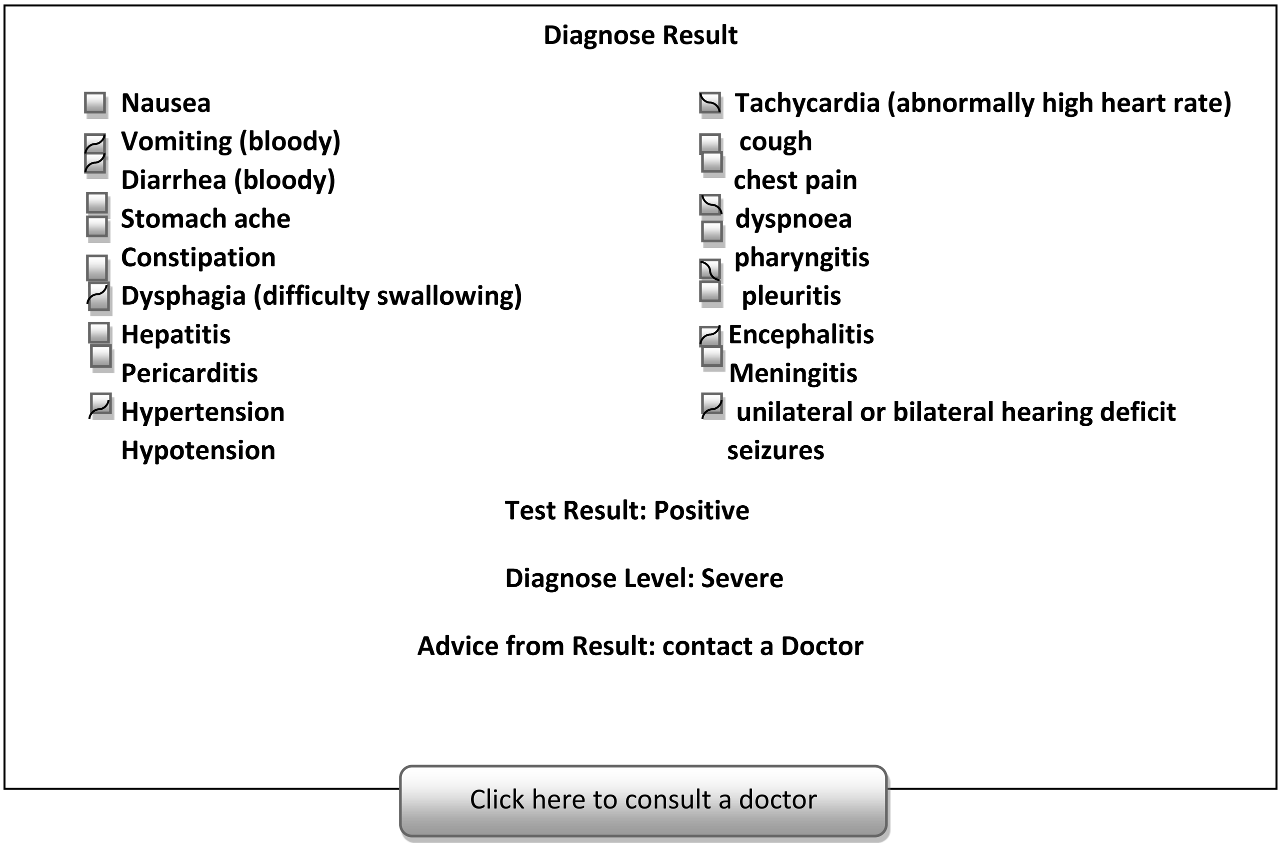

Figure 4. The output phase of the proposed system

Use case diagram

Use case diagram shows what a system does rather than how. It describes the functionality of a new system. It represents a discrete unit of interaction between users (be it human or machine) and the system (this interaction is a single unit of meaningful work). It comprises of two entities (the user and admin). Use case is the summary of scenarios for a single task or goal. User is a person that plays a role in one or more interactions with the system that is; Register, Login, select symptoms and get diagnosed as shown in Fig.5. Admin has full control of the entire system, while a user can only view his personal details by entering his username and password, the admin regulates all other activities like Register, login, Display result, symptoms combination, verify user details, save diagnosis and logout. Use case diagram shown in Fig. 5 depicts the use case activities of the system.

Activity diagram

The purpose of the activity diagram is to provide a view of flows and what is going on inside a used case or among several classes as shown in Fig. 6. The activity diagram specified for the expert system for diagnosing Lassa fever shows how the user registers his/her user name and password. The symptoms category services are then displayed for him/her to decide what he/she wishes to do.

System flowchart

The flow chart describes the flow of the system processes. It attempts to give a summary of the operations executed in the expert system for diagnosing Lassa fever. It displays the processes involved in human interface interaction of the application. The user begins by registering his/her user name and password. If he/she is already a user of the expert system and has an existing and working account with the expert system for diagnosing Lassa fever, the numerous symptoms category services are automatically displayed for him to decide what he wishes to do and then carries out his operations duly. If on the other hand, the user is not a registered customer of the expert system for diagnosing Lassa fever and does not have any existing account, access would be denied until he/she has completed all necessary registration requirements.

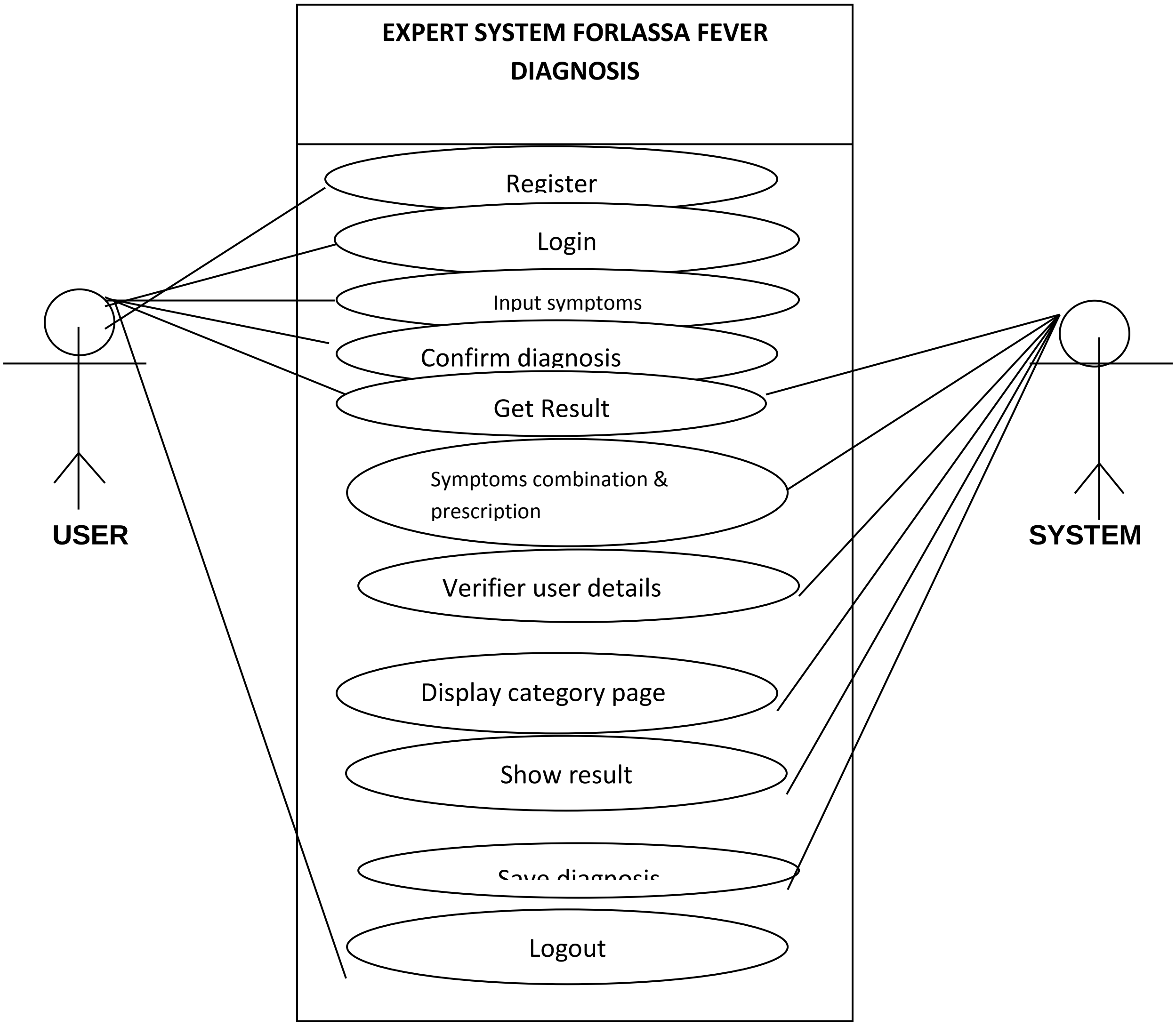

Figure 5: use case Diagram for the proposed system

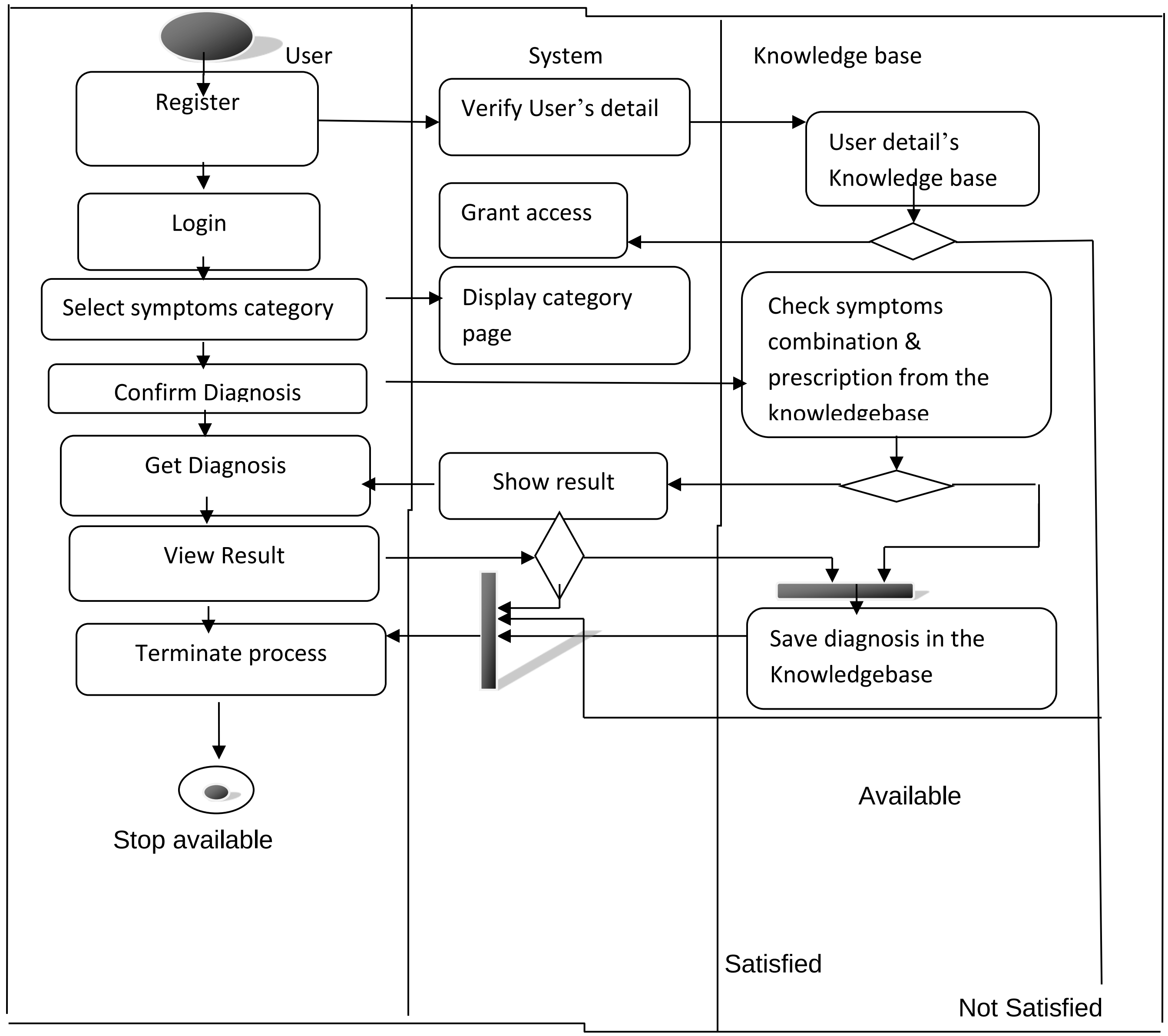

Figure 6. Activity diagrams

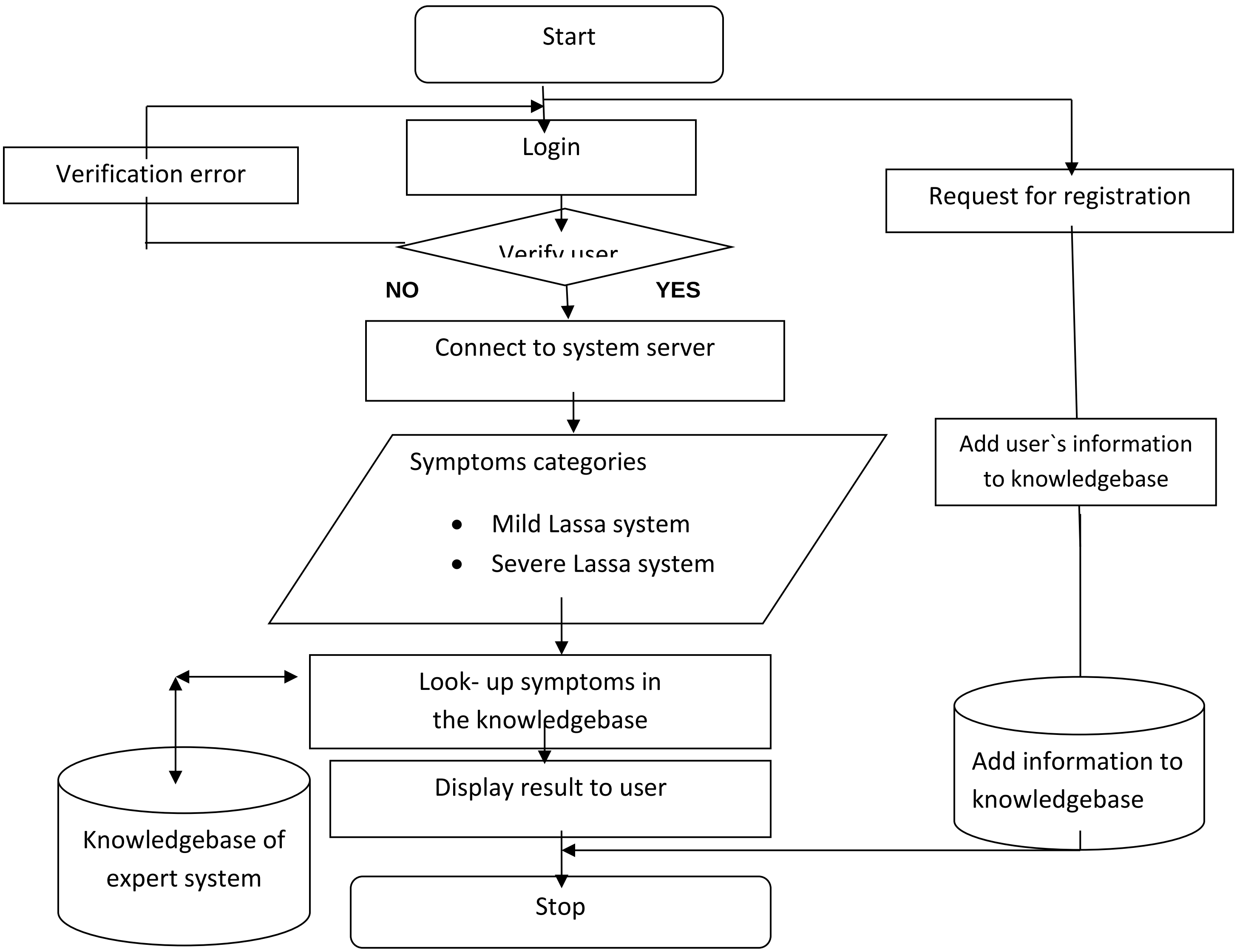

Figure 7. System flowchart

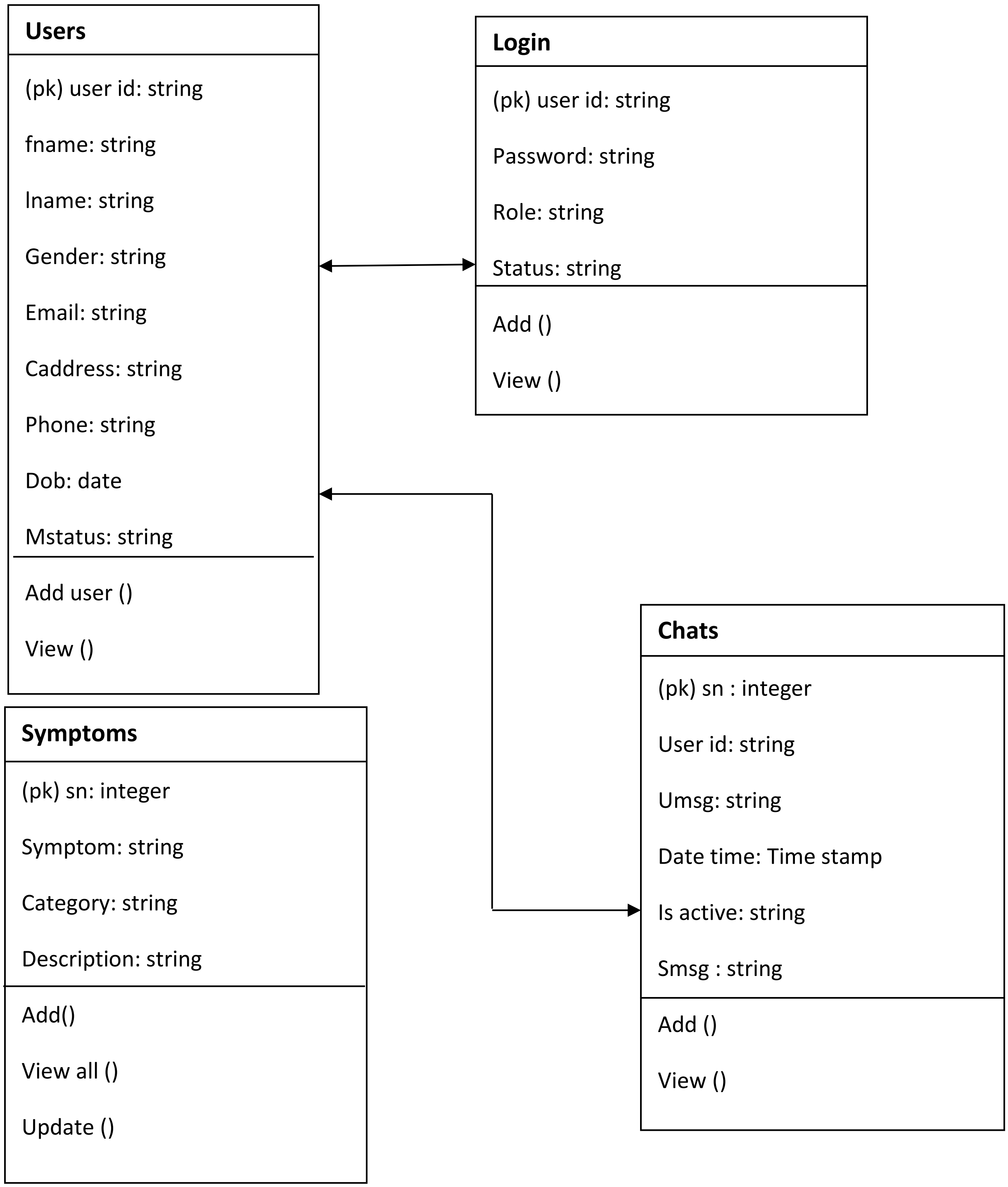

Figure 8. Class diagram

Class diagram

This provides an overview of the target system by describing the classes, objects, attributes, behaviors and the relationships among the objects of the system. It provides a wide variety of usages; from modeling the domain-specific data structure to detailed design of the target system. With the share model facilities, a user can reuse his/her class model in the interaction diagram for modeling the detailed design of the dynamic behavior. The class diagram of the system is shown in Fig. 8 above.

Results and Discussion

The process of diagnosing Lassa fever has been made easy by this application. The user logs on to the system and enters the symptoms he/she is feeling. The description is done by interaction with the system. Such a patient should have previously registered with the system so that his or her profile could be verified. The system uses a set of rules to reach a conclusion as to whether the person has Lassa fever or not.

Conclusion

Having considered the manual system of diagnosing Lassa fever in hospitals and remote villages which is ineffective, time consuming and unreliable, technology and especially this model simplifies diagnosis and treatment as well as many tasks and is less prone to error than humans. The system provides a faster solution to problems, faster access to information and at higher accuracy. It gives tool sets that cannot be matched by human ability.

References

[1] Van Bemmel, J. H., van Ginneken, A. M., Stam, B., & van Mulligen, E. (1998, January). *Virtual electronics patient records for shared care*: Studies in Health Technology and Informatics, 37-41.

[2] Russell, S., &Norvig, P. (2010). Artificial *intelligence: A modern approach* – 3rd Ed. Pearson, New jersey.

[3] Adedeji, B.B and John Y.C. (2002). *Fuzzy Engineering Expert Systems with Neural Network Applications.* John Wiley & Sons, New York.

[4] Hatzilygeroudis I., Vassilakos P.J. &Tsakalidis A. (1994, May). *Proceedings of the 1st International Conference on medical physics and Biomedical Engineering (MPBE'94)*, Nicosia Cyprus, Vol. 1, 148-152.

[5] Leonardo, B. (2003). *Predicate expression cost functions to Guide Evolutionary search for test data*. GECCO, 2455-2464.

[6] Agbo-Ajala, O., Adeyemi, T., &Makinde, O.E. (2014). A prototype Expert system for human diseases diagnosis. *Computing, information systems, Development informatics & Allied Research journal*, 5(4). Retrieved from www.cisdijournal.net

[7] Sunday, T., Oriyomi, Ayooluwa, A. &Ayodeji, D. (2013). A Rule based Expert system for diagnosis of fever. *International journal of Advanced Research*, 1(7), 343-348. Retrieved from http://www.journalijar.com

[8] Wyatt, J., & Spiegelhalter, D. (1991). Field trials of medical decision aids: Potential Problems and Solutions. PubMed, 3-7.

[9] Bankman, I. (2000). Handbook of medical imaging: Processing and analysis. Academic Press.

[10] Akerkar, R.A., & Sajja, P.S. (2009). *Knowledge- base Systems*. Jones & Bartlett publishers, Sudbury, MA.

[11] Omenyi A. S, (1997). Artificial Thinking, A tool for Effective Counseling. *Journal of Counseling textbook, in Nigeria*: Article on EXPERT SYSTEM Dictionary.