Computing, Information Systems, Development Informatics & Allied Research Journal
Vol. 5 No. 4. October 2014 – www.cisdijournal.net

A PROTOTYPE EXPERT SYSTEM FOR HUMAN DISEASES DIAGNOSIS

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ABSTRACT
In this paper, we propose a Medical expert system that diagnose symptoms related to infectious diseases, suggest the likely ailment, cause and advance possible treatment based on the system diagnosis. Its aim is to create an interactive web page that helps to provide primary health care facility without human interference. It will also help to ease location problems and provide 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. It covers six major infectious diseases that are easily transmittable gotten by a survey carried out and reliable prescriptions gotten from various medical knowledge experts. The proposed system would be useful for people who do not have access to medical facilities and also by those who need first aid solution before seeing medical consultants. Thus, the system will reduce physicians' workload during consultations and ease other problems associated with hospital consultations.

Keywords: Expert system, diagnosis, knowledge base, database, Inference motor.

1. INTRODUCTION

Advances in both computer technology and software design have permitted the development of increasingly sophisticated models since its inception over thirty years ago. An expert system is part of a general category of computer application known as Artificial intelligence. It is one of the largest areas of applications of artificial intelligence. It seeks to exploit the specialized skills or information held by a group of people on specific areas. It can either be thought of as a computerized consulting service or an information guidance system. It can also be described as a consultation system that uses Artificial Intelligence techniques for encoding knowledge and solving problems with that knowledge. (Omenyi A.S, 1997) In simple terms, it performs what would otherwise be performed by a human expert. Therefore an expert treatment for the diagnosis of infectious diseases aims at diagnosing some common infectious diseases like LASSA fever, Typhoid fever, Diahrroea and Cholera, stating its possible cause to avoid/minimize future reoccurrence and prescribing a primary solution to the problem. The internal structure of an expert system can be considered to consist of three parts: the knowledge base; the database and the inference engine). The knowledge base holds the set of rules of inference that are used in reasoning. The database gives the context of the problem domain and is generally considered to be a set of useful facts The rule interpreter (often known as the inference engine) controls the knowledge base using the set of facts to produce more facts. Communication with the system is ideally provided by a natural language interface that enables a user to interact with the intelligent system (Russel, Stuart; Norvig, Peter (2012). A wide variety of methods can be used to simulate the performance of the expert. However, common to most of all are:

1. The creation of a so called "knowledge base which uses some knowledge representation formalism to capture the subject matter expert (SME) knowledge and
2. A process of gathering that knowledge from the SME and codifying it according to the formalism which is called knowledge engineering. Expert systems may or may not have many components but a third common element is that once the system is developed, it is proven by being placed in the same real world problem solving solution as the human SME typically as an aid to human workers or a supplement to some information systems.

In like manner, developing one of such systems to represent the repository of the knowledge of a medical doctor is as essential as any other expert system. In the late 1950s, scientists first began to suggest that computers might someday play a more active role in helping medical personnel reach decisions about diagnosis and patient management (Bemmel, 1998). Instead of viewing computers merely as information sources or as tools for assisting with statistical analysis of large patient databases, researchers suggested that computers could actually use such information plus observational data about a patient to generate individually tailored advice for a specific medical problem.

2. REVIEW OF RELATED LITERATURE

Hudson (2007) reported that based on applications on expert systems in different areas of medicine, medical diagnosis remain the top priority of medical practitioners when compared to other areas such as clinical laboratories, clinical surveillance and intensive care settings. What might have prompted researchers to explore into the possibility of using computers to solve medical problems might be connected to the urgent need to find a lasting solution to occurrences of epidemics where medical personnel were not enough and there was need of assistance in form of an expert system that could perform similar task as a human expert (Hudson, 2007). In general medical expert systems focus on the diagnostic aspect of consultation involving selection of a disease from a set where the symptoms have been presented to the system using various techniques.

In the 1960s, a team headed by Edward Feigenbaum developed DENDRAL, a program for analyzing chemical compounds. Its task was to interpret the mass spectrum of organic molecules in terms of hypothesis of the structure of the organic molecule present in the instrument. The program was to perform the difficult mass spectra analysis task at the level of competence of specialist in that area. DENDRAL's knowledge base embodied the expertise of chemists and for certain classes of compounds, it performed as well as highly trained PhD's.

The chemists' techniques were refined and improved in a program called MYCIN, which can diagnose blood diseases and recommend treatments (Hudson, 2007). It is a heterogeneous program, consisting of many different modules. It is used to diagnose the presence and severity of lung disease in a patient by interpreting measurements from respiratory test administered in a pulmonary function laboratory. It works in two phases, diagnosis and therapy. In its diagnosis phase, the program's main goal is to apply its rules to determine the identity of all suspicious organisms. When it attempts to apply a rule, it queries its database to see whether the needed facts are available MYCIN works backward by attempting to prove each premise. These premises may themselves be conclusions of other rules, in which case MYCIN would then try to confirm the premise of whatever rule it is the conclusion of, or the values of these premises may be data supplied by the user from clinical observation. In this way, a chain of inference steps will lead to a value for the goal being found. MYCIN's knowledge base is composed of rules that specify a solution involving a sick patient and the conclusions that can be drawn in that situation. (Donna L. Hudson, 2006).The success of DENDRAL and MYCIN led to the development of expert systems for commercial applications.

Another expert system that assists a physician in the diagnosis of brain tumors is the Brain Tumors Diagnostic System (BTDS). It consists of an expert system and a learning system. The expert system can help in judging the causes of brain tumors according to computed pictures and the learning system is a learning method based on induction. Breast cancer diagnosis application is an expert system that was developed for early detection of breast cancer. (Wang, Ching-Hung, 1990). Also, in a project carried out at the Texas College of osteopathic medicine (Forthworth), the use of expert system as a tutor aid was demonstrated in the clinical sciences. It evaluated the use of an artificial intelligence derived measured, "Knowledge –based inference tool (Hudson, 2007). "(KBIT) as the basis for assessing medical students' diagnostic capability and designing instructions to improve their diagnostic skill. The instrument was designed to address the problem that in medicine, diagnostic expertise is problem specific and appears to be more a factor of the students' knowledge base than cognitive skills This study determined that the KBIT produced reliable and valid diagnosis (based on the comparisons of diagnostic accuracy of experts with those of novices) for four different problem areas: witness red eye, papulosquamos disorder and elevated cretin. Additionally the study shows that two experts: KBIT-derived instructional approaches significantly improved the diagnostic accuracy of treating student groups when compared to a control group and to student conventionally trained.

The ARIES laboratory in University of Saskatchewan, Canada developed several working systems that use Artificial Intelligence. The scent advisor can be used to provide robust diagnosis in a wide variety of program solving domains. The learning by teaching system inverts the usual instructional paradigm: the system acts as an inquisitive learner, thus stimulating the human to refine and extend his/her knowledge. (Hudson, 2007). Another project review is the development of a system known as PXDES which is a pneumoconiosis, a lung disease, X-ray diagnosis. This expert system incorporates the inference engine to examine the shadows on the X-ray. The shadows are used to determine the type and the degree of pneumoconiosis. Also, a diagnosis rule-based expert system, EMERGE, was designed to be used in an emergency room. The system uses a form of production rules which incorporates weighing factors which are determined by a neural network. The neural network is composed of input and output blocks with a hidden layer block in between which communicates input to the output. The network learns from examples then predicts an output based on this knowledge.

3. LITERATURE REVIEW

The application of artificial intelligence in medicine is primarily concerned with the design and implementation of intelligence information systems that diagnose and make therapy recommendations. These systems are designed based on symbolic models of diseased entities and their relationship to patient factors and clinical manifestations (Hudson, 2007)

3.1 Knowledge Engineering

This is the process of deciding which facts and rules are relevant to a particular system, and then encoding these into the knowledge base ready for use on the computer. It is defined as both the discipline that addresses the task of building expert systems and tools that support expert system development. Since the purpose of an expert system is to mimic a human expert, then the builder of an expert system must elicit the domain knowledge from the expert.(Hudson, 2007). Today there are two ways to build an expert system. They can be built from scratch, or built using a piece of development software known as a "tool" or a "shell." Though different styles and methods of knowledge engineering exist, the basic approach is the same: a knowledge engineer interviews and observes a human expert or a group of experts and learns what the experts know, and how they reason with their knowledge. The engineer then translates the knowledge into a computer-usable language, and designs an inference engine, a reasoning structure, that uses the knowledge appropriately. He also determines how to integrate the use of uncertain knowledge in the reasoning process, and what kinds of explanation would be useful to the end user. (Hudson, 2007).

Next, the inference engine and facilities for representing knowledge and for explaining are programmed, and the domain knowledge is entered into the program piece by piece. It may be that the inference engine is not just right; the form of knowledge representation is awkward for the kind of knowledge needed for the task; and the expert might decide the pieces of knowledge are wrong. All these are discovered and modified as the expert system gradually gains competence. (Edward Feigenbaum, 2003). The discovery and cumulating of techniques of machine reasoning and knowledge representation is generally the work of artificial intelligence research. The discovery and cumulating of knowledge of a task domain is the province of domain experts. Domain knowledge consists of both formal, textbook knowledge, and experiential knowledge -- the expertise of the experts. Tools, Shells, and Skeletons: Compared to the wide variation in domain knowledge, only a small number of AI methods are known that are useful in expert systems. That is, currently there are only a handful of ways in which to represent knowledge, or to make inferences, or to generate explanations. Thus, systems can be built that contain these useful methods without any domain-specific knowledge. Such systems are known as skeletal systems, shells, or simply AI tools. Building Expert systems from scratch is very time consuming because the builder has to develop the user interface from scratch and implement an appropriate inference engine. (Edward Feigenbaum, 2003).

However, building expert systems by using shells offers significant advantages. It offers an easy starting point for expert system building because they are expert systems which have been emptied of their knowledge. This means that developers can concentrate on entering the knowledge base without having to build everything including the inference engine and user interface from scratch. A system can be built to perform a unique task by entering into a shell all the necessary knowledge about a task domain. The inference engine that applies the knowledge to the task at hand is built into the shell. If the program is not very complicated and if an expert has had some training in the use of a shell, the expert can enter the knowledge himself. However, using a shell to build an expert system can seduce the builder into oversimplifying the application domain because shells are inflexible, in that it is too difficult to modify, or change the way they work, both with regard to representation of knowledge and the inference mechanism. It is important not to let the shell dictate how to represent the domain, for the result will be reflected in the performance of the system. (Edward Feigenbaum, 2003). Many commercial shells are available today, ranging in size from shells on PCs, to shells on workstations, to shells on large mainframe computers. And range in complexity from simple, forward-chained, rule-based systems requiring two days of training to those so complex that only highly trained knowledge engineers can use them to advantage. (Edward Feigenbaum, 2003). They range from general-purpose shells to shells custom-tailored to a class of tasks, such as financial planning or real-time process control.

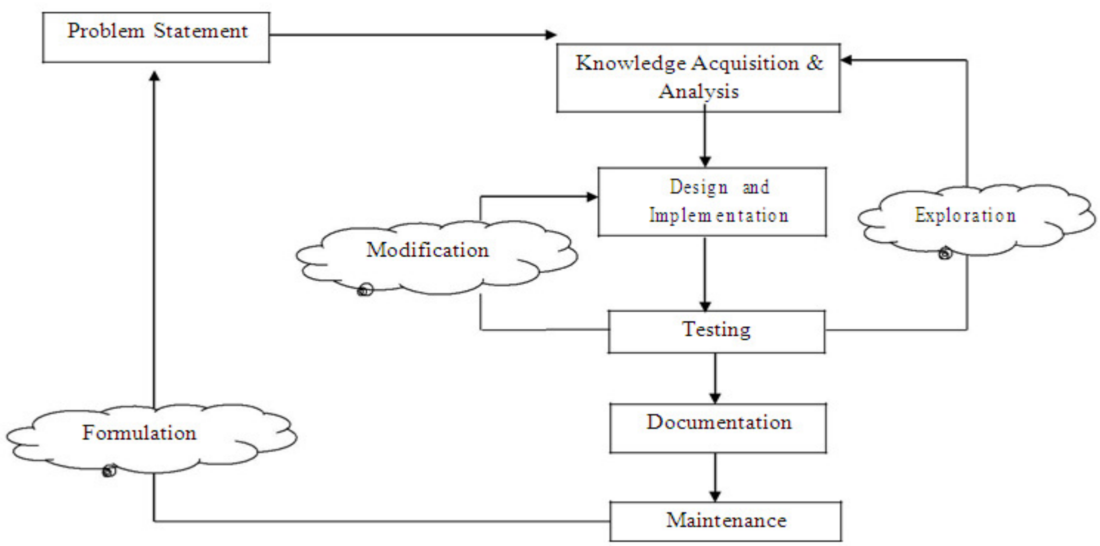

Fig 3. Knowledge Engineering Methodology

3.2 Knowledge Acquisition

The first task of the expert system builder is to gain some familiarity with the application domain by understanding basic terminology and concepts. The system must liaise with people in order to gain knowledge and the people must be specialized in the appropriate area of activity. Knowledge acquisition refers to the task of endowing expert systems with knowledge, a task currently performed by knowledge engineers. Literature refers to the scientific literature in textbooks and includes materials such as method of inquiry. Experts have knowledge that is generally not found in literature. For example, medical doctors, geologists or chemists. The knowledge engineer acts as an intermediary between the specialist and the expert system.

Typical of the information that must be gleaned is vocabulary or jargon, general concepts and facts, problems that commonly arise, the solutions to the problems that occur and skills for solving particular problems. This process of picking the brain of an expert is a specialized form of data capture and interview is the most widely used knowledge acquisition technique. The knowledge engineer is also responsible for the self-consistency of the data loaded. Thus a number of specific tests have to be performed to ensure that the conclusions reached are sensible. The power of an expert system lies in its store of knowledge about the task domain -- the more knowledge a system is given, the more competent it becomes. The knowledge acquisition phase is widely acknowledged to be the bottleneck. This is because experts frequently have difficulty articulating rules to describe their domain knowledge. Medical experts may also be unavailable, or may not have enough time to cooperate fully in the development of an expert system.

3.3 Knowledge Representation

This is an issue that arises in both cognitive science and artificial intelligence. In cognitive science, it is concerned with how people store and process information. In Artificial Intelligence, the primary aim is to store knowledge so that programs can process it and achieve the verisimilitude of human intelligence. It formalizes and organizes the knowledge for use by the inference engine. In addition to naturalness and expressiveness of the representation form, a representation needs to be very modular and flexible. The process of building base is an iterative one that has been called "an incremental approach to competence". The knowledge is tested out of the expert and the "module size" needs to be easily integrated into the existing growing knowledge base, with virtually no incremental re-programming of the knowledge base. Since knowledge is used to achieve intelligent behaviours, the fundamental goal of knowledge representation is to represent knowledge in a manner as to facilitate inference i.e. conclusions from knowledge.

One widely used representational form is the production rule, or simply the rule. A rule consists of an IF part and a THEN part (also called a condition and action). The IF part is a set of conditions in some logical combination. The piece of knowledge represented by the rule is relevant to the line of reasoning being developed if the IF part of the rule is satisfied; consequently, the THEN part can be concluded, or its action taken. Expert systems whose knowledge is represented in rule form are called rule-based systems. This kind of representation is action oriented. Another widely used representation form, called the unit or frame, or schema is based upon a more passive object-oriented view of knowledge. Systems of unit sometimes called frame-based are siblings of the object-oriented systems common in Computer Science. Typically, a unit consists of a symbolic name, a list of attributes. That is, the unit is a complex symbolic description of an entity that the ES needs to know about. One of its important functions is to handle automatically, some routine inference functions for knowledge updating and knowledge propagation. The automatic handling is called inheritance.

Another general and powerful formalism for representing knowledge is the "standard" mathematical way, given by the symbols and formulas of mathematical logic, particularly first order predicate logic and some higher order logics. In addition to naturalness and expressiveness of the representation form, a representation needs to be very modular and flexible. The process of building base is an iterative one that has been called "an incremental approach to competence". The knowledge is tested out of the expert and the "module size" needs to be easily integrated into the existing growing knowledge base, with virtually no incremental reprogramming of the knowledge base.

4. PROPOSED SYSTEM ARCHITECTURE

Artificial intelligence is widely and specifically based on knowledge. It is the science of making machines perform tasks that would require intelligence if done by people. (Charmiak and McDermott, 1985). Expert system is one of its many branches. An expert system is a package that holds a body of knowledge and a set of rules on a subject that has been gained from human experts. It helps the user make decisions by asking questions and then, based on the user's answers and the knowledge that it holds, offering advice. It is a set of programs that manipulate encoded knowledge to solve problems in a specialized domain that normally requires human expertise. (Robert S. Engelmore, 1998). The internal structure of an expert system can be considered to consist of:

- The knowledge base: holds the set of rules of inference that are used in reasoning It contains the domain knowledge useful for problem solving, represented as a set of rules. Most of these systems use IF-THEN rules to represent knowledge. Thus an action is executed when the condition path of a rule is satisfied. Typically systems can have from a few hundred to a few thousand rules.
- The database: gives the context of the problem domain and is generally considered to be a set of useful facts. These are the facts that satisfy the condition part of the condition action rules as the IF THEN rules can be thought of.
- The rule interpreter: is often known as an inference engine and controls the knowledge base using the set of facts to produce even more facts. It carries out the reasoning to reach a solution for the expert system. This is done by linking the rules given in the knowledge base with the facts provided in the database. Communication with the system is ideally provided by a natural language interface.
- Explanation facilities – it allows the user to ask how a particular conclusion is reached and why a specific fact is needed.
- User interface – it enables the user to communicate with the expert system to find a solution to the problem.

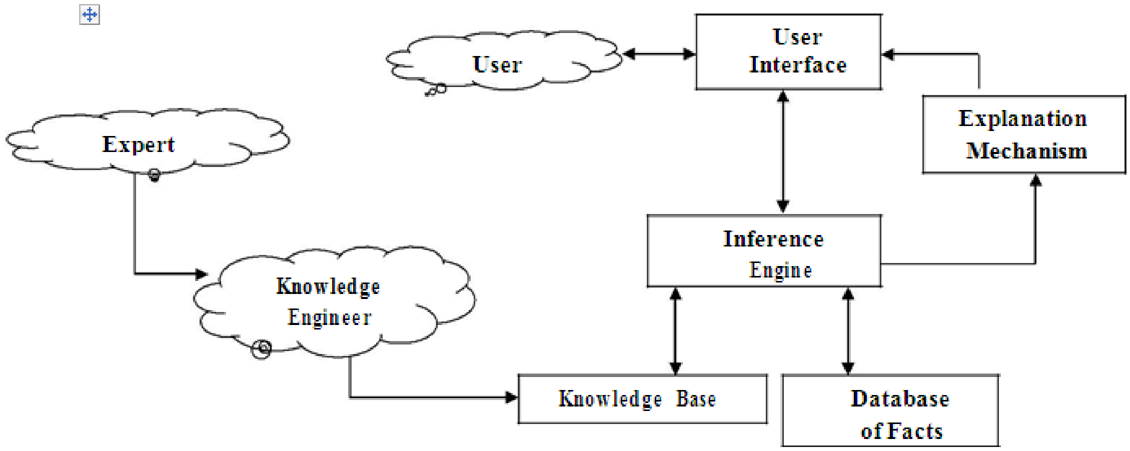

Fig 4.0: Expert System Structure

5. SYSTEM DESIGN

The concept of research design is referred to the specification of the relevant procedures for collection and analysis of information which would help solve the research problem at hand (Agbusru, 2001). We evaluate the research methodology and also explain

5.1 Use Case Diagram

The proposed system design, graphical representation of the architectural design, the data flow chart and more so explaining the various tools used for designing the system and the system requirements. The use case diagram of the study majorly explains the operations that are to be carried out by both the user and the Administrator. It illustrates who will use the system and what they will be able to do with it.

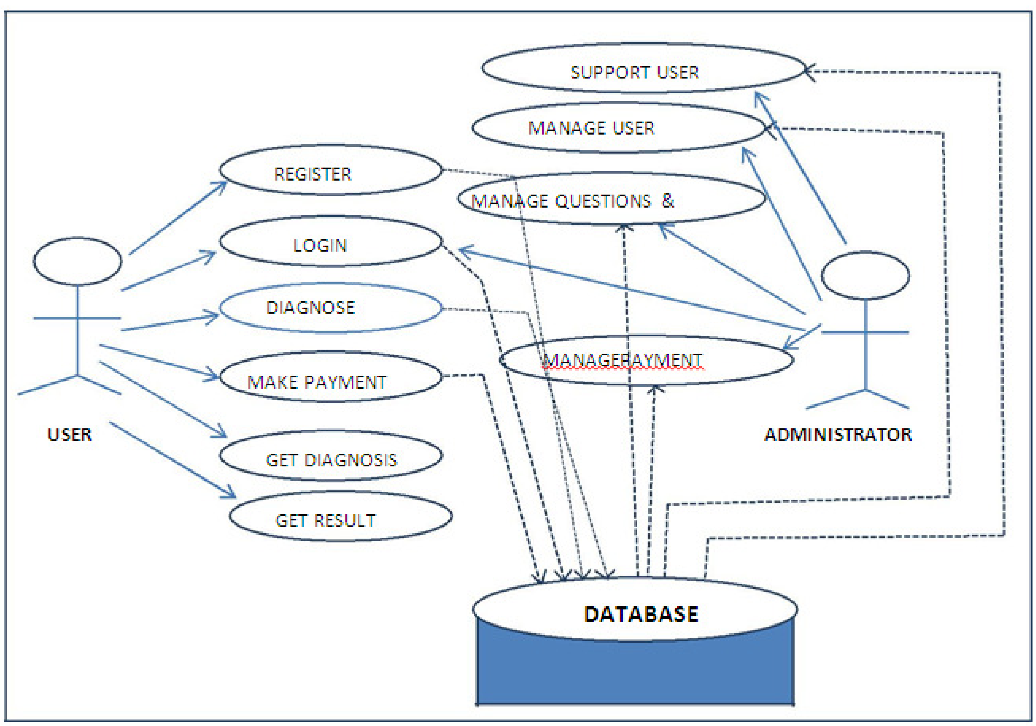

Fig. 5.1 : Use Case Diagram

The figure above explains how the users and the administrator will be interacting with the database. Before a user can be diagnosed he or she will have to register first, which will aid documentation for the respective patients that are coming for diagnosing. The records gotten from the registration will be inserted into the database which the flow is shown in the figure above. After he or she has registered, the site will automatically take them to the login page where they can login, their login details is also gotten from the database due to their registration, but the above flow show that after entering their login details the system will take their login details to the database for confirmation, to be sure if the user already exits. After the login, the user will be able to choose any of the available disease to check if their symptoms will match any of the disease available. After selecting your choice, the payment page will appear so that you'll pay before you'll be diagnosed. Note: before you can be diagnosed in any of the available disease you have to pay. Then you will enter the diagnose page where you will answer the available question, each question has its own answer for concrete result which aids FUZZY LOGIC. After which he or she will get the results. On the other hand, the administrator's jobs are listed:

Manage users, Support users, Manage payment, and manages the questions and answers. Now all these information are gotten from the database after when the user has done all the prescribed operations dedicated to the users. The direction of flow of how the information will be gotten from the database is shown in the above figure. The only relationship between the users and the administrator is that they both login, which is shown in the above diagram. The Administrator manages the user, by keeping the registered information and also views the complete details about the user; he's also given the right to delete the user or clients if necessary. They support the user based on the fact that in case the clients are finding it difficult to use the web application, they can send a message to the administrator and an auto response will be sent to the client e-mail stating how to use the software. Another support measure is that based on the results issued by the application the admin will also send him or her things to do despite the fact that her result will be given to her, i.e. an advice will be sent to the e-mail of the user. The Administrator manages the questions through the process of inserting the questions from the admin end and also removes irrelevant questions.

5.2 Activity Diagram

The activity diagram provides the much needed description of the system by allowing the reader to see the system's execution and how it changes direction based upon different conditions. It is used to model workflows for use cases. This is explained in the flowchart diagram below.

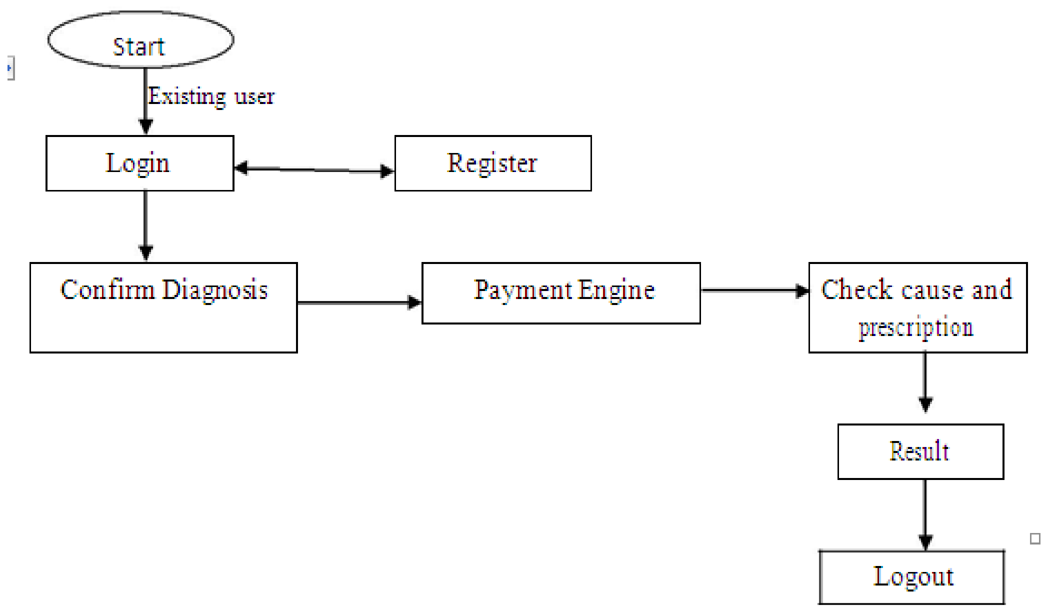

Fig 5.2: Flowchart

6. SYSTEM IMPLEMENTATION

The infectious disease diagnosis system has a user friendly interface that makes it easy for use. The entry of data is achieved via the keyboard and the mouse. Information from the patient serves as the source document. This information is supplied to the computer during run time by the patient with the aim of obtaining relevant feedback such as the ailment name, cause and the treatment that could be applied to cure the ailment.

7. DISCUSSION OF RESULTS

The database was designed by building tables such as the ailment table which contains the disease name and IDs, the questions table which contains the disease ID and questions, and the answer and response table which contains the ID, answer, response and questions ID. The system interfaces consists of the login page which serves as the system security and ensures that no unregistered user has access to the system by prompting for user name and password which has been registered in the database; the registration page filled by a new user to take in important details and register into the system database for stress free login and the home page which takes you to where you can confirm the symptoms you are having or select ailments to check for prescriptions. It is the container and link to all other pages or interfaces in the application. The proposed system also consists of a payment page which requests for your card details and pin number to debit you a particular amount because an expert system is not supposed to be free so as not to render completely useless the work of a doctor. It also contains the diagnosis pages which contain the diseases and their various prescriptions and possible causes. It has the admin login page where the administrator logs in to gain access to the various users or to add/delete/edit or change anything through the CMS

8. CONCLUSION

Health is one of the greatest issues affecting us in the society today. The world is gradually moving from ordinary information system to expert systems. Expert systems can be applied to virtually all spheres of life. These systems seem inevitably needed to make critical decisions, to work under environment conditions where human beings cannot survive. This project work presents the use of expert systems in health care. The idea is to use expert systems to provide support in common clinical problems like diagnosis of disease, causes and primary prescriptions. Such programs could be really useful in rural areas where there is a vast shortage of health personnel. The project is also to help improve cost efficiency and provide immediate first aid solution in cases of emergency. This work also has increased knowledge in medicine and helped enhance better communication skills. It has widened knowledge in expert systems, programming skills and knowledge based systems in general.

9. FUTURE RESEARCH DIRECTION

The expert system developed has no provision to query the knowledge base on how goal was reached. Future work should be made to ensure proper knowledge base query and knowledge acquisition specialist to develop data and inference procedures in some narrow areas of human experts. Also, in a world where a man cannot stop exploring their surroundings, artificial intelligence and robotics is of great need and importance. Therefore, computer scientists should be well informed about the field of artificial intelligence to probably one day get to the level of developing a fully functional medical expert system that will encompass the entire medical field and help doctors in proper diagnosis and improve the health of the whole of humanity. Furthermore, there should also be the possibility of the system to communicate by pictures and sounds which will provide extra advantage in terms of use, adding speech interface to such systems may be proved to be more beneficial to the people of remote areas. Even illiterates can interact with speech interface based system and get benefits.

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