Expert System for Diagnosis Neurodegenerative Diseases

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Abstract---**The purpose of medical expert system is to support the diagnosis process of physicians. It considers facts and symptoms to provide diagnosis. This implies that a medical expert system uses knowledge about the diseases and facts about the patients to suggest diagnosis. The primary aim of this research is to design an Expert System for diagnosing brain diseases. The scope of the work is extended to five brain disorders, namely Alzheimer's disease, Creutzfeldt – Jakob disease, Huntington's disease, Multiple Sclerosis and Parkinson's disease. The computer programming language employed was the C#.NET programming language and Microsoft SQL Server 2012 served as the Relational Database Management System (RDBMS). The results obtained showed that the expert system was able to successfully diagnose these disorders corresponding to the selected symptoms entered as query. With this finding, we believe the development of an expert system will not only be beneficial towards the diagnosis of brain disorder related cases in a more cost effective means but also in all diseases as a whole.**

Keywords: Expert System, Brain Disorder, Diagnosis, Neurodegenerative, Forward Chain Approach

I. INTRODUCTION

Computer-based methods are increasingly used to improve the quality of medical services using an artificial intelligence model. Artificial Intelligence (AI) is the area of computer science focusing on creating expert machines that can engage on behaviors that humans consider intelligent [1]. This concept is adopted using an expert system that employs human knowledge captured in a computer to solve problems that ordinarily require human expertise [2]. Expert system seeks and utilizes relevant information from their human users and from available knowledge bases in order to make recommendations [3]. An expert system can also be considered as software, which operates on a sophisticated system like a human expert. It explains their reasoning or suggested decisions, display intelligent behaviour, draw conclusions from complex relationships [4].

The main conceptual source of an expert system is knowledge based which can expand to include a knowledge acquisition component that processes data and information into rules. Expert systems has number of application areas like decision making, prediction, planning, monitoring, process control, forecasting, diagnosis etc. On the other hand, medical diagnosis is the major application of expert systems. The purpose of medical expert system is to support the diagnosis process of physicians. It considers facts and symptoms to provide diagnosis. This implies that a medical expert system uses knowledge about the diseases and facts about the patients to suggest diagnosis [5].

Physiologically, the brain is responsible for the centralized control of other organs of the body. The brain controls the rest of the body both by generating patterns of muscle activity and by driving the secretion of chemicals called hormones. This centralized control allows rapid and coordinated responses to changes in the environment. Once the brain is injured, other parts of the body will malfunction. These other parts may affect movement, memory, personality, reasoning ability and the behavior of the victim. Examples of brain diseases include Head trauma, Stroke, Migraine etc.

In this research, the point of focus is based on diagnosing Neurodegenerative diseases. Neurodegenerative diseases are motor neuron diseases which are caused by the gradual death of individual neurons, leading to diminution in movement control, memory, and cognition. The Neurodegenerative diseases include Alzheimer's disease, Parkinson's disease, Huntington's disease, Multiple Sclerosis and Creutzfeldt - Jakob disease. The implementation of the system is does not require taking in body sample but can determine the defect by analyzing it through a form of a rule based expert system. The system is implemented in Visual C# & SQL server as a database platform.

II. LITERATURE REVIEW

There are several diverse areas in medical field where expert system has been successfully implemented. Disease diagnosis of various diseases like cancer, cardio-vascular disease, endocrine diseases, diabetes, tumour, patient monitoring, treatment of illness, prognosis, determining risk of disease, determination of drug dose [8]. Though there are several expert systems used in medical field. MYCIN is one

of the earliest rule based expert system developed by Feigenbaum, Buchanan and Ted Shortliffe in 1970 for the purpose of diagnosis of infectious diseases[9]. The diagnosis process involves culturing of the specimens for the isolation and identification of the bacterial infections which takes up to 48 hours so doctors had to come up with quick guesses about likely problems. It uses LISP for implementation and consists of 450 rules. MYCIN was good in the sense that it could calculate dosages very precisely and dealt with interactions between drugs.

DENDRAL is another type of medical expert system that help chemists in identifying structure of unknown organic molecules, by analyzing their mass spectra and using knowledge of chemistry [9]. Dendral was an influential pioneer project in artificial intelligence (AI) of the 1960s, and the computer software expert system that it produced. Its primary aim was to study hypothesis formation and discovery in science. For that, a specific task in science was chosen: help organic chemists in identifying unknown organic molecules, by analyzing their mass spectra and using knowledge of chemistry. It was done at Stanford University by Edward Feigenbaum, Bruce Buchanan, Joshua Lederberg, and Carl Djerassi, along with a team of highly creative research associates and students. It began in 1965 and spans approximately half the history of AI research [10].

CADIAG-2 (Computer Assisted DIAGnosis) is based on fuzzy technology and designed for internal medicine. It is characterized by its ability to process indeterminate (vague or uncertain) information [11]. It supports the medical personnel in interpreting a patient‘s symptoms, signs, laboratory test results and clinical findings and thereby generating a complete clinical differential diagnosis.

MEDICO is a rule-base system which gives the advice to ophthalmologists about management of chorioretinal diseases. It contains general clinical knowledge and a large data base of facts about previous patients and events [5].

PUFF diagnoses the presence and severity of lung disease in a patient by interpreting measurements from respiratory tests administered in a pulmonary function laboratory. Various test results and patient history used for diagnosis purpose. It is backward chaining and rule base system developed at Stanford University [5].

Several fuzzy expert systems have been developed for the diagnosis of Parkinson’s disease only. These fuzzy expert systems were designed, by using FIS Tools of MATLAB. In the Fuzzy Expert Systems, the achieved accuracy of diagnosing the Parkinson’s disease were high. Then a system was developed to diagnose other types of brain disorders. The design was carried out with MATLAB software using the Mamdani inference method. The system can diagnose five brain diseases, namely Alzheimer’s disease, Creutzfeldt - Jakob disease, Huntington’s disease, Multiple Sclerosis and Parkinson’s disease [6].

Most expert system build recently has left the issue of blood diagnosis and focuses on other major area of medicine. This expert system helps in diagnosing blood disorders. This is to aid the doctors and other medical practioners in attending and prescribing treatment to patients. Hence, this research takes blood disorders into consideration by finding a way to solve the issue in human being. Apart from solving or diagnosing, the need to give treatment in order to make the system more useful is necessary [7].

III. METHODOLOGY

The methodology adopted here is an improvement from the previous methodologies in the field of computer science, software engineering and knowledge engineering since this expert system will be an integration of these technologies.

Generally to develop an expert system, a rule based method is required to analyze and compute the knowledge base [12]. In his research used fuzzy logic to develop an expert system for the treatment of human diseases and analyze the conditions based on some natural phenomenon. Using a rule base approach such as IF, IF THEN ELSE can also give programmers the same flexibility of incorporating some natural phenomenon like that of fuzzy logic. An analysis was conducted based on data gathered on the types of brain disorders and their symptoms. The symptoms and causes of the brain disorder were taken into consideration in order to formulate the rules of the system. The treatment recommendation by the sources was also adopted to prescribe the best possible treatment by the system.

A. Knowledge Acquisition

To develop a viable system, adequate information on the working of the particular system being developed must be obtained and represented in a format through which the rules can be applied. Acquisition of this knowledge could be from a human expert and is coded into a form that is more applicable to similar problems. The diseases and their symptoms are shown in table (Table I) below:

TABLE I. CONSULTATION TABLE

Diseases	Symptoms
Alzheimer’s Disease	Forgetfulness(FG), Memory Problem(MP), Impaired judgement(IJ), Hallucinations (HL), Speech Difficulties (SPD), Sleep disturbances (SD), Moodiness/Depression (MD)
Creutzfeldt –	Memory Problem (MP), Confusion(CO),

Jakob Disease	Involuntary Jerky Movements (IJM), Difficulty in Walking (DW), Muscle Stiffness (MS), Moodiness/Depression (MD)
Huntington's Disease	Memory Problem (MP), Impaired judgement (IJ), Lack of Muscle Control (LMC), Involuntary Jerky Movements (IJM), Difficulty in Walking (DW), Moodiness/Depression (MD)
Multiple Sclerosis	Memory Problem (MP), Lack of Muscle Control (LMC), Speech Difficulties (SPD, Urinary Problem (UP), Tiredness (TD)
Parkinson's Disease	Lack of Muscle Control (LMC), Difficulty in Walking (DW), Muscle Stiffness (MS), Skin Problems (SP), Urinary Problem (UP), Sleep disturbances (SD), Moodiness/Depression (MD)

B. System Architecture

Expert system consists of domain expert, designer, inference engine, knowledge base, user interface and user. There is relationship between these subdivisions which makes it expert system. The domain expert is connected to the knowledge base in order to give rules and fact. The domain experts are normally the expert in the body or field. The knowledge base stores the rule and fact collected. The knowledge base is also connected to inference engine in which is used to process the rule to deduce another set of rule or fact. The inference engine is normally designed by the programmer or designer. The inference engine is then connected to the user interface in which is used to collect data from the users. This is also developed by the designer. This trend can also be followed backward. The user interface gives information to the inference engine and the knowledge base for user data to be processed. Also for the knowledge base update, a need to contact the domain expert is needed. All this can be represented below (Figure 1.):

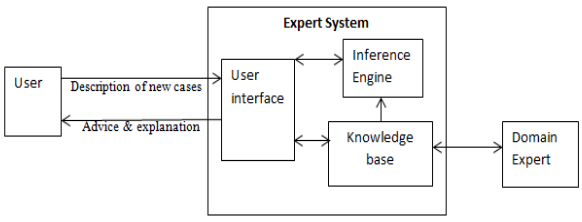

Figure 1. Expert System Architecture

IV. SYSTEM ANALYSIS

The choice of programming language was C#. This language is chosen for its ease of use, its object oriented programming (OOP) configuration and its ability to comfortably create an easy- to use graphics user interface (GUI) for the convenience of the novice computer users. The need to code the whole part of the system is highly necessary for diagnosis. The entire coding was done using C# and SQL. These software tools were synchronized together using Microsoft Visual Studio 2012. The system consists of the login pane for both doctors and admin of the system, the admin pane, the registration pane, the delete pane, the diagnosis, and treatment and prescription pane.

A. Login Pane

This is a pane or page where authentication is given to the users of the system. It asks for both the username and the password, so as to be able to authenticate (Figure 2). The same page is used for both the admin and the users of the system as also medical in the login flow (Figure 3). The admin will need to login using his/her username and password. If they are correlated, then it will open the admin pane for the admin of the system. Else, it will deny unauthorized access based on the inbuilt Microsoft SQL database so as to allow or disallow the user from moving down to the diagnoses pane of the system.

Figure 2. Login Pane

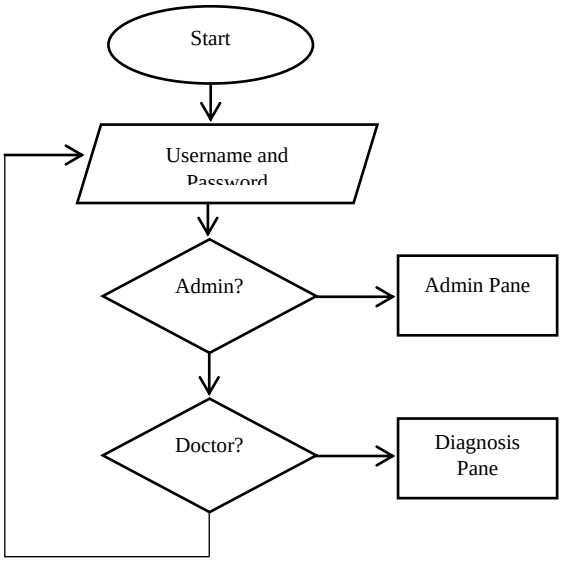

Figure 3. Login Flowchart

B. *Admin Pane*

This page is a Multiple Document Interface (MDI) form which is being managed only by the system administrator. Although, it is a desktop program where only one user can login but still requires the system administrator to administer user's access. The admin pane gives privileges to the admin to create account for the users and also delete existing records. The admin (who understood the fall system functionality and design) has the privilege to delete and edit user's record from the database (Figure 4).

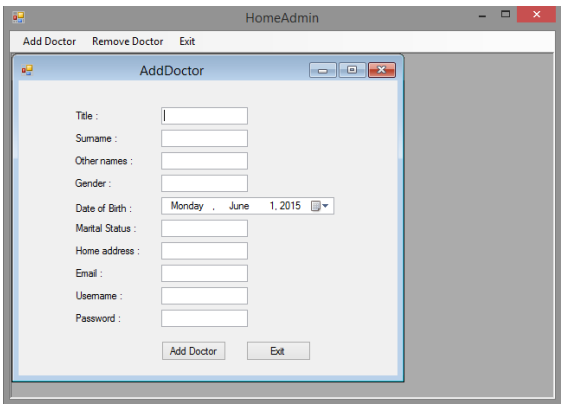

Figure 4. Admin Pane

C. *Diagnosis Pane*

This is the pane where all major research work is focused. This pane performs all diagnoses and works using the forward chain dimension. The forward chain dimension means getting a result based on the known facts (such as symptoms and causes) (Figure 5). For doctors to use this feature he has already known the symptoms and causes of the patient's ailment but without knowing the actual brain disorder (Figure 6).

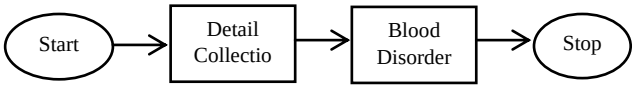

Figure 5. Forward Chain Flow

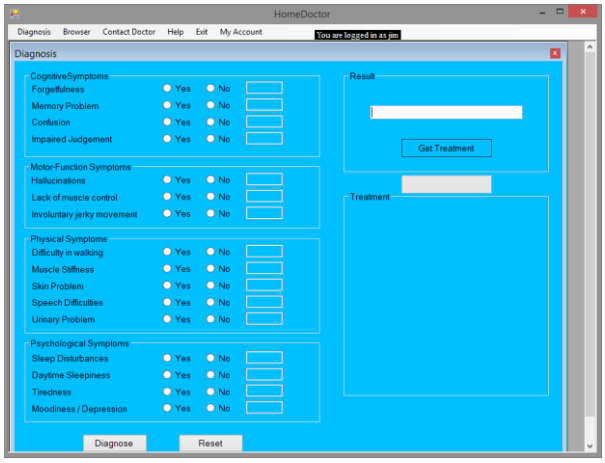

Figure 6. Diagnosis Pane

D. *Treatment Pane*

This pane basically gives the response based on the information collated from the diagnoses pane of the system. It gives response based on the collated information gathered from the diagnosis pane and also prescribes the solution/way out from the type of blood disorder. The way out may be in form of some physical exercises and drugs that will cure or reduce the pain of the disorder (Figure 7). Probably, since the system is only used by the doctors, they will know the adequate and best solution to the kind of disorder corresponding with the treatment given by the system. This pane is only operated and accessible to an expert users/doctors. The diagram is shown below:

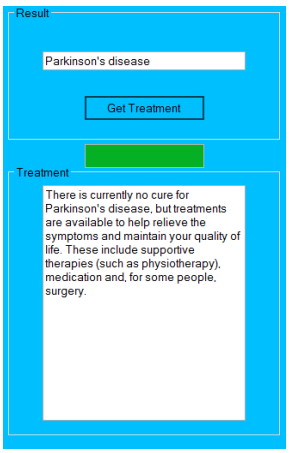

Figure 7. Treatment Pane

V. CONCLUSION

From the study, expert system in Healthcare management hospitals presents as one of the best applications for deriving meaningful diagnosis of human health challenges. From the study, this application serves as a model tool that will enable hospitals to effectively monitor patients' medical records without ambiguity. This will provide a great reduction in the hours wasted in most conventional hospitals without this tool. It is our believe that for the attainment of the millennium development goals (MDG) in terms of healthy living for the masses, adoption of this expert system must be a priority in the hospitals of countries with such an aspiration for its masses.

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