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A Medical Expert System for Tropical Diseases Diagnosis

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***Abstract*—** In Nigeria, tropical diseases such as Malaria and Typhoid are prevalent because of insects such as mosquitoes and flies, which are the common carriers of these diseases. Therefore, there is need for an expert system to help the inadequacy of the medical personnel in the diagnosis of these diseases. This paper presents the design of an expert system that aims at providing the patient with background for suitable diagnosis and treatments (Especially typhoid and malaria diseases). The system is able to give appropriate diagnosis and treatment for two diseases namely; typhoid and malaria. Fuzzy logic type 2 has proved to be the remarkable tool for building intelligent decision making for approximate reasoning that can appropriately handle both the uncertainties and imprecisions. The proposed methodology is composed of four stages: the first stage is receiving the symptoms from the patient, second stage, it uses information from the patient to make some analysis and investigation to improve correct decision in the diagnosis and the third stage, is performing diagnosis on patient according to information supplied by the patient (symptoms, analysis and investigation). The system was able to diagnose tropical diseases by the different symptoms using the fuzzy logic rule. The need to arrive at the most accurate medical diagnosis in a timely manner that reduces further complications is the main outcome of the system.

***Keywords* -** Expert system, fuzzy logic, typhoid and malaria, tropical diseases, diagnosis

I. INTRODUCTION

Computer based methods, for example, expert systems are progressively used to improve the quality of services. An expert system is a computer system that imitates the decision making ability of a human expert in solving complex issues by thinking through bodies of knowledge, represented mainly as if – then rule rather than through regular procedural code [1]. Subsequently, expert system requires detailed information about the domain strategies for applying this information to problem solving. In other to construct expert systems, knowledge must therefore be formalized, represented in the computer and manipulated according to some problem – solving method [2]. Expert system was presented by the Stanford Heuristic Programming Project driven by [3], who is at times named the 'father of expert system'. The Stanford researchers tried to identify domains where expertise was highly valued and complex, such as, diagnosing irresistible diseases and identifying unknown organic molecule. The idea that "intelligent system derives their power from the knowledge they possess rather than from the specific formalisms and inference schemes they use" [4]. An expert system is an example of a knowledge based system because, they are built on framework since they are base on a system of well established actualities and reaction to circumstances. Expert system was the first commercial system to use knowledge – based architecture [5]. Existing medical expert system do not have the current tropical diseases that are springing up in Nigeria and Africa at large. Subsequently, incorporating these new diseases into the knowledge base of the expert system informed the decision to undertake this research. Conventional ANN approaches, for example, feed forward neural systems are well known and being broadly utilized in different applications which include classification of plant species, prediction of heart diseases etc. However, conventional approaches used are not naturally predictive and also requires supervised labelling or learning [6]. The aim of this study is to develop a medical expert system to diagnose tropical diseases with particular reference to Typhoid and Malaria fever diseases. This is achieved by analysing data collected from a reputed hospital in Nigeria and developing a system that uses fuzzy logic technique to diagnose these tropical diseases.

The rest of the paper is organized as followed: section I contains introduction of Medical Expert System for Tropical Disease Diagnosis, Section II contains the Related Work of different medical expert system, section III explains the methodologies and use case diagram of the system, section IV contains the system architectural and the essential steps taken in the system, section V describes the result and discussion of the system are presented, section VI concludes the research work.

II. RELATED WORK

MYCIN was a clinical choice emotionally supportive network created in 1972 at Stanford University by Edward Shortliffe as an interview system that concentrated on fitting administration of patients who had contaminations [7]. [8], did some reviews and carried out some surveys of fuzzy expert systems for medical diagnosis that lead them to go through 124 research papers and many conference proceedings and also got some work through the web. [9] developed a system that dealt with both the inability of the patient to communicate these symptoms properly to be able to apply the fuzzy logic method abd the inability of the expert to define the relationship between the symptoms and if treatment of the patient's disease is possible. Sports Injury Clinic is an electronic system that enables a client to analyze sports wounds. It shows a graphical UI showing distinctive human body parts, and enables the client to point to tricky territories utilizing the mouse cursor. The system assembles data from the client trying to land at an end. In the same way as other different frameworks, Sport Injury Clinic offers a huge swath of wounds, medicines and suggestions. The system is constrained as in just solid skeletal games wounds are provided food for. Other than this, the usefulness and adequacy of the system has prompted surveys of examination and incredible acknowledgment by specialists in the therapeutic field [10]. In another examination, [11] connected a lot of computational apparatuses for mammogram division to improve the identification of bosom malignant growth. [12] Developed a fuzzy expert system for managing malaria which is one of the tropical diseases being looked at. They employed the Root Sum Square (RSS) fuzzy method drawing inference to understand the data from the knowledge base of the fuzzy rule. 35 patients that have malaria were selected and results computed with a predefined limit. [13] These authors included an advice system that is knowledge based processing in their computerized medical system that is knowledge based. They analyzed the responses of patients and convert them into symptoms and these symptoms are now reported as diagnosis.

III. METHODOLOGY

This study explores the use of qualitative research methodology. Qualitative research is basically exploratory research. It is utilized to pick up a comprehension of basic reasons, feelings, and inspirations [14]. It gives bits of knowledge into the issue or creates thoughts or theories for potential quantitative research and it is helpful when the exploration centers around complex issues, for example, human conduct and felt needs. The objective of qualitative research is to enable us to comprehend social marvels with the assistance of perspectives.

IV. SYSTEM ARCHITECTURE

The proposed system uses an expert system to evolve a set of system parameters from which context is built and predictions are made. The design includes the use of real time data from the field. It basically consists of an input layer, inference engine and knowledge base layer. The architectural design of the proposed expert system is shown in Fig 1.1

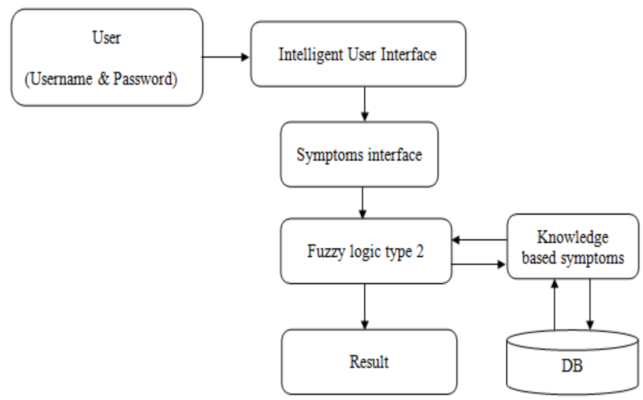

Fig 1 High level architecture design of the proposed system

The system architecture shows the overall framework of the system main modules or domain and their relationship which are user (patient), the user interface, system interface, inference engine which has two basic components connected together which are knowledge base symptoms and Database (DB). The objective of the proposed system is to help the physician or doctors for the diagnosis of the epitasis disease everywhere around the world where expert doctors will not be available.

A. The Knowledge base

This stores the permanent knowledge of the domain of the application and allows the system to act as an expert in the domain under consideration. It is this module which depends on the domain of application. it holds a set of rules of inference (production rules) that are used in reasoning. These rules form the form; if <condition>, then <action>. The knowledge base contains knowledge belonging to the domain of the system; it stimulates the activity of an expert in his/her deductive and explanatory capacity.

Typhoid and malaria diseases whose symptoms are persistent cough, constant fatigue, weight loss, loss of appetite, fever, coughing up blood, night sweats. So it will be stored in knowledge base in the form of a rule which is as follow: -

Disease (Patient, typhoid and malaria diseases): -
Symptom (Patient, persistent_cough),
Symptom (Patient, constant_fatigue),

Symptom (Patient, weight_loss),
Symptom (Patient, loss_of_appetite),
Symptom (Patient, fever),
Symptom (Patient, coughing_up_blood),
Symptom (Patient, night_sweats).

Similarly, in this way you can store maximum possible rules in the knowledge base.

- The Fact Base contains facts which are applied to match in opposition to the antecedent part of rules stored in the knowledge base.
- The foremost job of Inference Engine is to bring out the reasoning by connecting the rules with facts and deducing new facts.
- The design Interface is used to interacted with the doctor
- The Explanation Module permits the user to inquire the expert system how a finicky conclusion is reached and why a specific fact is desired.

Probability of diseases is measured using equation (1) whose value depends on the user feedback while diagnosing.

$$\text{Probability disease} = \frac{\Sigma Si*Wi-\Sigma(Smajor)j(Wmax)j)-Minth}{Max_{th} - Min_{th}} * 100\% \tag{1}$$

Where -
S_i = is i^{th} symptom selected or not
W_i = weight of symptom
$(S_{major})_j$ = j^{th} major symptom which is not selected by the user
$(W_{major})_j$ = weight of j^{th} major symptom
Max_{th} = maximum threshold
Min_{th} = minimum threshold
$\sum S_i W_i$ = total weight of a disease based on the selected symptom
$\sum (S_{major})_j (W_{major})_j$ = total weight of unselected major symptoms of a disease

The proposed expert system assist user to diagnosis diseases, he/she might have, in a fuzzy way. Based on the selection of the problem area/problem, the expert system gives some symptom from which the user needs to select symptoms, based on the selection of symptoms the user is asked some questions, according to the answer selection the fuzzy expert system diagnosis diseases based on its knowledge, add catalyst factor (if any) and do ranking and gives result in fuzzy form.

The algorithm for the system

- Start
- Input symptoms
- If symptoms =valid then
- Check if is **knowledge base**
- Load symptoms into working memory
- Diagnosis malaria symptoms by inference engine
- Diagnosis typhoid symptoms by inference engine
- Send symptoms back to **knowledge base**
- Else if symptom via **knowledge base** =invalid then
- Resend the **knowledge base** (malaria symptoms)
- Submit to database
- Stop

V. RESULT AND DISCUSSION

Figure 1 showed the result interface of the newly implemented system that with interact with the user of the system. After user have check the symptom the inference engine helps to diagnose it based on what the user selected. Each symptom is mark to a particular weight.

Table 1 Result presentation

Name	Body temp. ^{0}C	Heart beat Per second	Blood pressure mmhg	Blood level mg	Output	Result
A	35 > 37	37>59	80<10	10<17	27 %	Mild
B	41 > 54	65 > 75	20>45	10 > 15	90%	Typhoid
C	65 > 75	65 > 75	65 > 75	65 > 75	100%	Typhoid
D	37< 41	40 < 65	45>80	15 > 25	75%	Malaria
E	54>60	74 > 84	20>47	15 > 20	89%	Typhoid

The result was recorded after series of test carried out by different patient. Each of the patient's symptoms was selected for the system to diagnosis and the output result would determine the type of illness.

Table 2 Result for each Threshold value

Threshold	100percent	75 percent	45 percent	30 percent
Meaning	Very Severe	Severe	Moderate	Mild

The result table helps to diagnose the disease of the patient. The symptoms are size to a particular weight, total of the weight given is 100percent which is use to determined typhoid fever while 75 percent for malaria, 45 percent is for bad rest and 30 percent is normal health stage. The patient inputs help in determining the result of the proposed system.

When each symptom is selected the inference engine loads it into the knowledge based for decision making.

A. *Graphical* Representation

The graph shows the disease against symptoms

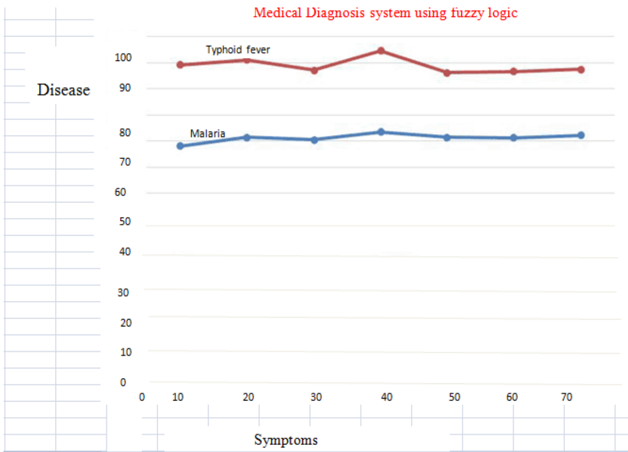

Figure 2 Diseases against Symptoms

This graph represents diseases against symptoms showing each point where the system predicts a particular illness.

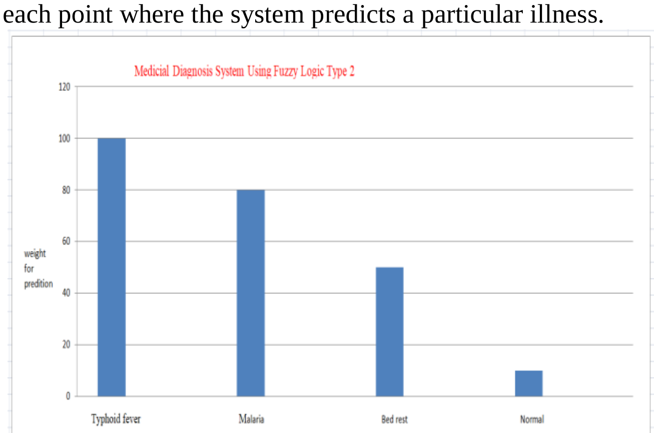

Figure 3 Testing of the Proposed System

B. *Software evaluation*

The medical diagnosis system is based on fuzzy logic model. It is designed for diagnosis of malaria and typhoid fever disease in human body. This system consists of five input variables: persistent_cough, constant_fatigue, weight_loss, loss_of_appetite and fever. The rule base of this system is used to determine the four output parameter value: Very Severe, Severe, Moderate and Mild according to the five input values. The proposed architecture for the diagnosis of malarial and typhoid fever disease shown in Fig 1 consists of two main phases. The phase 1 is used for the diagnosis of the disease and the phase 2 is used for the expert learning system where expert doctors can update their machine with knowledge for the improvement of the system. In phase 1 of the system, there are three main stages

Where fuzzy rules are applied for the stages are:

Stage 1: - (Symptoms Identification) Where disease symptoms will be selected by the user which patient has to be expecting.

Stage 2: - (Disease Identification) Medical counselling will be done, by asking question for disease.

Stage 3: - (Percentage Affected Identification) based on disease identified, questionnaire is asked by the tools by which calculation will be done giving maximum probability of the disease which patient have suffering from.

The patients are asked questions based on the symptoms selection in stage 1. These questionnaires will be contributing towards the finding of the percentage of disease in the patient.

C. *System Testing and Evaluation*

In fuzzy logic the inference mechanism decides the sequence used in the rules to obtain the desired solution. All the rules are saving in the historical database.

The fuzzy logic values set: {Mild (30), Moderate (45), Severe (75), and Very Severe (100)}, several patients were consulted by medical experts during a few consultation sessions and they were reviewed based on signs and symptoms to determine if they had malaria or typhoid fever. The severity of the malaria and typhoid fever related signs and symptoms were placed on a scale of 1 to 100 i.e. from mild to very severe. Where Mild is normal, Moderate is bad rest, Very Severe is Malarial and several is typhoid fever.

The input from the patient helps in identifying the probability in terms of percentage of diseases the patient may have. The process with repeat until the last stage of the diagnosing system; than the inference mechanism and the Defuzzification process uses a centroid method to aggregate the inference of fuzzy expert system.

D. *Graphical Representations of the Data*

The graph in figure 2 shows the relationship between the symptoms and the disease. Each symptom is trial to a particular weight; Mild, Moderate, Severe and, Very Severe. When it raises to 100-degree mean is severe, diagnose for typhoid fever when is raise to 75 percent mean very server meaning malarial and when it raises to 45 percent mean is moderate the patient need rest while when it raises to 30 percent its mild and at a normal stage. Figure 3 is graphical representation of series of test result with the dataset. The system was tested using the dataset gotten from University of Port Harcourt Teaching Hospital, in Rivers State, Nigeria. And the test showed Typhoid fever to be the highest in prediction weight of 100% and Malaria having 80% in weight.

VI. CONCLUSION

The generic fuzzy expert system has been designed for the diagnosis of Malaria and Typhoid diseases. The fuzzy expert system developed proves to be an effective diagnostic tool for the user and predicts appropriately the risk by yielding accurate finding with scaled certainty of the disease. An extensive rule base is the strength of the developed system and derives accurate output. The patient plays a significant role by supplying the right information for diagnosis and the inference mechanism is design in such a way that it handles sparseness of the response by the patient. The developed system arrives at the most accurate medical diagnosis in a timely manner which is the main outcome of the system and it reduces further complications. The medical expert system for the diagnosis of tropical diseases yields better result than the classic designed systems, because this system simulates the manner of an expert in its true sense.

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Authors Profile

Mr. N. A. Ibiobu pursed Bachelor of Science from University of Port Harcourt, Nigeria in 2015. He is currently pursuing Master of Science from Rivers State University, Nigeria. He is currently working as Systems Analyst/ programmer in the Information, Publications and Protocol Unit, office of the Vice Chancellor, Rivers State University, Port Harcourt, Nigeria since 2013. This is his first research publication. His main research work focuses on Medical Expert System. He has 1 year of Research Experience.

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