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KNOWLEDGE-BASED EXPERT SYSTEM FOR DIAGNOSIS OF SOME TROPICAL DISEASES

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ABSTRACT

The advancement in computational processes and artificial intelligence has significantly improved the precision of medical diagnoses. Successful diagnosis of Tropical diseases like Malaria, Typhoid, Cholera, and Tuberculosis has been achieved through the years. This study introduces a medical expert system inference engine employing a Case Base Reasoning Algorithm to search the knowledge base for symptoms and associated therapies matching the input query. The system retrieves information from the database, containing various symptoms and datasets related to the mentioned diseases, during both training and query phases. The Medical Expert System (MES) serves as a valuable first-aid tool for individuals with limited medical knowledge, facilitating decision-making and alleviating physicians' workload during consultations.

Keywords: Vaccine Preventable, Knowledge-base, Medical Expert System and jQuery

1. INTRODUCTION

Expert systems, defined as computer programs designed to address real-world problems, typically involve extracting knowledge from domain experts who specialize in specific fields (Inusah et al., 2023; Yanase & Triantaphyllou, 2019). The challenging task of translating domain expert knowledge into a computer program is undertaken by Knowledge Engineers, who assist in determining the representation of knowledge (Castañeda et al., 2023). Recently, attention has shifted towards medical expert systems as complementary solutions to traditional approaches in solving medical problems. The escalating demand for high-quality healthcare, coupled with the rapid expansion of medical knowledge, leaves physicians with limited time to thoroughly address each case while staying abreast of the latest developments (Malvois & Clavien, 2020).

Consequently, many medical decisions rely on spontaneous judgments, utilizing the unaided memory of physicians. Computer tools, such as expert systems, play a crucial role in organizing, storing, and retrieving relevant medical knowledge for dealing with complex cases and suggesting appropriate diagnostic, prognostic, and therapeutic decisions (Kiryanov, 2021). Expert systems incorporate a knowledge base, containing specific facts and rules, and an inference engine, providing the reasoning ability needed to draw conclusions (Nascimento & Notargiacomo, 2023).

These systems also offer user interfaces and explanation facilities, allowing users to interact with the system and facilitating explanations or justifications of conclusions (Chromik & Butz, 2021). The diagnostic process, determining a person's ailment based on symptoms, is crucial in medical practice. The proposed research suggests implementing a system applicable to any medical laboratory, utilizing software development kits (SDK) as sensors for various symptoms and the system as an actuator. This approach could enhance the performance of medical systems, potentially contributing to the advancement of global civilization, particularly in regions like Nigeria where IT resources are underutilized (Dada, 2022).

The ongoing research project explores the use of knowledge-based systems to create a comprehensive and formal representation of human knowledge, aiming to capture general knowledge and enable reasoning and inference. In summary, this work focuses on designing a system providing information on tropical diseases and offering diagnostic capabilities based on supplied symptoms.

1.2 Problem Statement

Several researches have been conducted on medical expert systems for disease diagnosis and majority of which are found promising. This is due to the consultation of medical experts for data authenticity and suitable approaches such as blood smear, peripheral blood smear examination, poliomyelitis provocation test, and stool examination. Awotunde & Adeniyi (2020) developed a hybrid MES despite tautology in parametric capture due to several similar/same symptoms used independent of each other, the system seems promising. Amanze (2019), impressively created a system with above 98.3% accuracy which lucklessly limited to Malaria. This system therefore attempts to unify common ailments by one-to-many mapping for selection and diagnosis.

1.3 The Aim and Objectives

This aim of this seminar paper is to propose a model of medical expert system that provides information on some tropical diseases and predicts the likely diseases based on the ailments selected.

1. To identify three deadly tropical diseases having common symptoms
2. To use Case Base Reasoning Algorithm for selection and examination of disease ailments
3. To integrate various symptom-based disease diagnosis parameters.

CONCEPTUAL REVIEW

1.2. Medical Expert System

A medical expert system is a computer-based application employing artificial intelligence and knowledge derived from medical experts to aid in medical decision-making and diagnosis. These systems emulate the decision-making process of human medical experts by analyzing patient data, symptoms, medical history, and other pertinent information (Sayed, 2021). They utilize this information to generate diagnoses, treatment recommendations, and provide medical advice

2.2 Tropical Diseases

In recent times, tropical regions across the globe have witnessed a more pronounced impact from infectious diseases in comparison to temperate zones. The surge of infectious diseases in these tropical areas can be ascribed to a confluence of environmental and biological factors that foster a diverse range of pathogens, vectors, and hosts. Moreover, social factors have impeded efforts to control these diseases. The collective term for these infectious diseases is 'tropical diseases,' owing to their heightened prevalence compared to non-infectious counterparts. Consequently, the field of tropical medicine has gained increasing significance in the research and management of these diseases. Notable examples of these tropical diseases encompass Trypanosomiasis, Leishmaniasis, Malaria, Cholera, Tuberculosis, African sleeping sickness, Chagas disease, Dengue, Guinea worm disease, Leprosy, Lymphatic filariasis, Onchocerciasis, Rabies, Schistosomiasis, Trachoma, and Yaws.

2.2.1 Malaria

One of the most lethal parasitic illnesses responsible for a significant number of fatalities annually is Malaria. This life-threatening disease is predominantly prevalent in tropical regions and is both preventable and treatable. However, in the absence of timely diagnosis and effective intervention, uncomplicated cases of malaria can escalate to a severe and often fatal form of the illness (WHO, 2022). Unlike contagious diseases, malaria cannot be transmitted from person to person; instead, it is spread through the bites of female Anopheles mosquitoes. Among the five species of parasites capable of causing malaria in humans, Plasmodium falciparum and Plasmodium vivax pose the greatest risk. There are more than 400 Anopheles mosquito species, and approximately 40, designated as vector species, can transmit the disease (WHO, 2022). Symptoms typically manifest 10 to 15 days after infection, and individuals may return to their home country before showing signs of the disease. In non-endemic areas, healthcare professionals may not readily identify the symptoms, leading to potentially fatal delays in diagnosis and treatment. Additionally, effective antimalarial drugs may not be registered or accessible in all countries. The symptoms of malaria include fever, chills, sweating, headache, muscle and joint pain, fatigue, nausea and vomiting, anemia, jaundice, abdominal pain, and cognitive impairment.

2.2.2 Cholera

A highly dangerous category of diseases, and notably Cholera, is an exceptionally aggressive illness characterized by severe acute watery diarrhea. The onset of symptoms occurs within a range of 12 hours to 5 days after the ingestion of contaminated food or water (Muzembo et al., 2022). Cholera can affect individuals across age groups, proving fatal within hours if not promptly treated.

While many individuals infected with cholerae may not display symptoms, the bacteria can be present in their feces for 1-10 days post-infection, posing a risk of environmental contamination and potential infection of others. Among those who do exhibit symptoms, the majority experience mild or moderate effects, while a minority may develop acute watery diarrhea leading to severe dehydration, which can be fatal if not addressed (WHO, 2020).

It is crucial to emphasize that cholera can progress swiftly, especially in regions with limited access to healthcare and clean water. Dehydration poses a significant risk, potentially resulting in severe complications. Swift medical intervention and rehydration therapy are imperative for effective cholera treatment.

Cholera manifests through symptoms such as severe diarrhea, vomiting, and dehydration. Physical manifestations include muscle cramps, rapid heartbeat, low blood pressure, electrolyte imbalances, pale and cold skin, sunken fontanelle (in infants), and shock.

2.2.3 Typhoid

Typhoid fever presents a life-threatening infection caused by the bacterium Salmonella Typhi, typically transmitted through contaminated food or water. Upon ingestion, Salmonella Typhi bacteria undergo multiplication and dissemination into the bloodstream (WHO, 2022). The global prevalence of typhoid may escalate due to factors such as urbanization and climate change, which can exacerbate the burden of the disease. Additionally, the rising resistance to antibiotic treatments facilitates the spread of typhoid, particularly in communities lacking access to safe drinking water and adequate sanitation.

Typhoid is characterized by symptoms exclusive to humans, as Salmonella Typhi resides solely in this host. Individuals with typhoid fever harbor the bacteria in their bloodstream and intestinal tract, displaying symptoms such as prolonged high fever, fatigue, headache, nausea, abdominal pain, and either constipation or diarrhea. Some patients may also develop a rash. Severe cases of typhoid fever can result in significant complications, potentially leading to death. Diagnosis of typhoid fever involves blood testing. The proposed system relies on these distinct and common physical symptoms exhibited by various tropical diseases as its primary input data.

2.3 Related Study

Several research investigations have delved into the topic of healthcare diagnosis. Rahmani (2021) recommends the utilization of machine learning to introduce medicinal researchers to technology and enhance healthcare expert systems. Although he envisions a significant transformation in the health sector through the integration of deep learning, he did not implement the system using the mentioned approach.

Amanze (2019) developed an intelligent system for diagnosing diseases, employing a questionnaire to address the issue of limited healthcare accessibility in rural areas. The study revealed that individuals in these regions often refrain from visiting healthcare centers and instead attempt to self-diagnose at home. To address this, the expert system utilizes a mobile platform where patients respond to symptom-related questions, and the system subsequently identifies potential diseases, providing initial treatment suggestions. In a similar vein, Voronenko (2021) created a static Bayesian network incorporating five key variables to ascertain the probabilistic inference of the resulting node, ultimately determining the presence or absence of disease in a patient.

Abu-Jamie (2021) has introduced a system aimed at addressing issues related to the diagnosis and treatment of cough by offering accurate solutions. The research outlines an expert system designed to assist doctors in thoroughly exploring cough-related problems, with the ultimate goal of providing simplified answers to this common ailment. Additionally, Gbadamosi et al. (2022) have proposed a hybrid learning rule that significantly improves the performance of the system in comparison to existing ones utilizing only the back-propagation learning rule. The diagnostic expert system developed exhibits decision-making accuracy on par with that of medical experts, albeit with a limitation to the diagnosis of malaria ailments. Furthermore, Idris (2019) has devised a hybrid expert system that combines Rule-Based Reasoning (RBR) and Case-Based Reasoning (CBR), surpassing the accuracy of individual methods. This approach processes symptoms to detect the disease afflicting the patient.

Gupta et al. (2022) introduced a fuzzy-based system tailored for cholera diagnosis, incorporating patient observations, medical assessments, and expert knowledge through the utilization of Mamdani's fuzzy inference system. Similarly, Al-Hakim et al. (2020) developed an Android-based expert system application for the diagnosis of COVID-19, utilizing a base algorithm with an impressive 99.96% confidence rate.

Numerous studies have delved into the creation and application of knowledge-based expert systems for disease diagnosis, typically integrating information from medical literature, clinical guidelines, databases, and expert insights. These systems leverage rule-based reasoning, probabilistic reasoning, or machine-learning techniques to analyze patient symptoms, test results, and medical histories.

A review of related works reveals that the majority of these systems are designed to diagnose either a single disease or commonly detect diseases with similar symptoms in the dataset. These implementations are often on personal computers or mobile-based platforms, ensuring easy operation even in remote areas. Notably, these systems typically utilize a maximum of seven input parameters for detection, yielding promising results.

Nevertheless, there could be challenges in overlooking less impactful symptoms, potentially leading to result distortion. While the design may appear efficient, there is a significant apprehension about the integrity of the results, despite achieving a high accuracy rate. The proposed system aims to address this concern by encompassing various vaccine-preventable diseases, such as mumps, pneumonia, and malaria, within a unified dataset. It seeks to collaboratively analyze symptoms and assign each symptom a value greater than or equal to zero, influencing all the diseases. This approach aims to mitigate the recurrence of similar symptoms across different diseases.

3 METHODOLOGY

3.1 Proposed System

Generally, patients visit the hospitals to complain about their diseases and Medical Expert System (MES) user interviews the patients regarding their diseases and then query the symptoms in the database. If symptoms match what is in the diagnostic center, then the MES gives the user the prescription to the patient.

The proposed framework in Figure 3.1 indicates that various modules are integrated to work together for achieving a complete knowledge-based medical expert system.

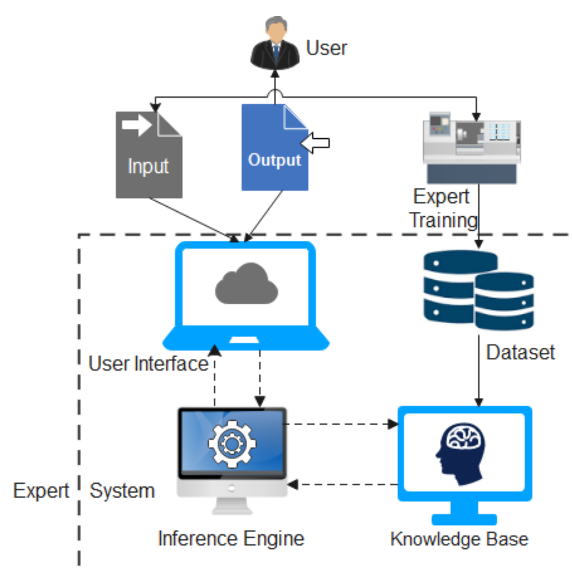

Figure 3.1: Knowledge-based Expert framework for the MES

As seen in Figure 3.1, there are n numbers of inputs which are symptoms from the three common tropical diseases from patients' physical condition. Every input (Symptom) x, maps to all diseases d, given a valued $d(x_i)$ proportional to its specific degree of effect. Therefore, a symptom with no effect on a disease is given a 0% rating while others may be above 50% per ailment. This may seem to create a redundancy of assigning 0% of the input to disease though, however, this will substantially reduce bias since no class of disease would be selected before diagnosis.

This implies that as long as the commutative fractions of symptoms effect on a disease is less or equal to 100, then the training process will keep adjusting/assigning to such a disease an effect rate as appropriate.

3.2 Algorithm

1. Begin
2. set maximum diagnostic points
3. select diseases (sample)
4. upload symptoms for all diseases without duplication
5. set for each (symptom on disease) {
6. assign points to all diseases (considering its degree of effect)

//example: points for headache in mumps may be different from that in pneumonia. thus, the same headache,

7. compare selected symptoms for all diseases
8. tally the point
9. sort accordingly
10. print output
11. }
12. End

4 Results

The proposed MES first request for username and password in order to access the facilities provided by the system and once a valid username and password are provided, the admin dashboard will appear which will enable systems operations.

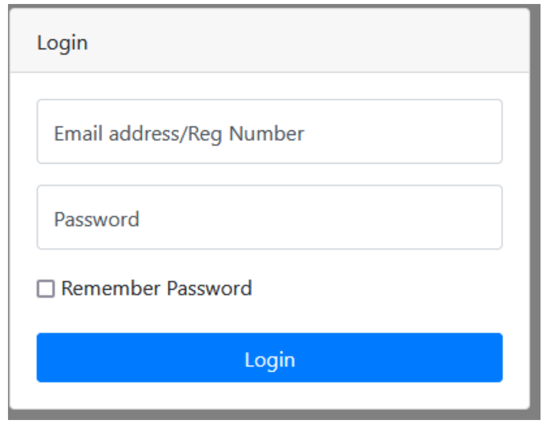

Figure 4.1: Login Page

The login interface opens the main interface if a match is found. All the system users will use this interface as a starting point of the evaluation system.

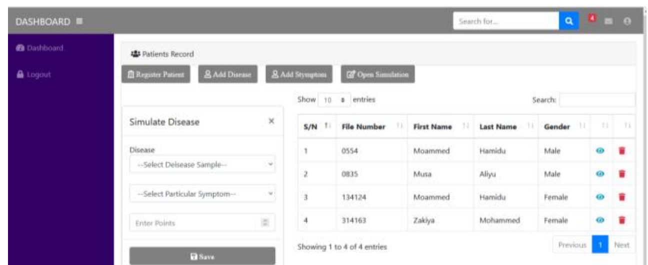

Figure 4.1: Home Page

This is the first page to visit after user authentications. It contains links for operations prerequisite for system's operations. It incorporates various functions such as register patient, add disease, add symptom and system training.

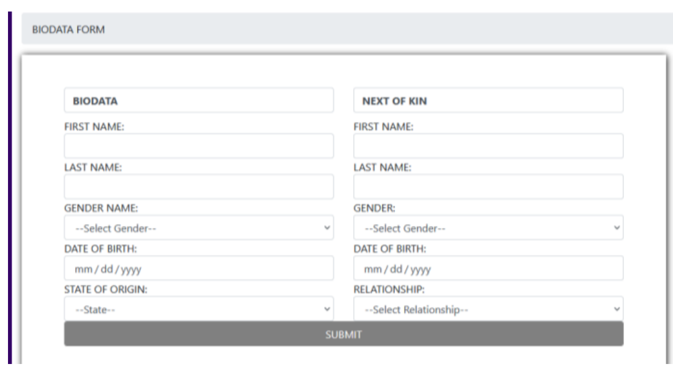

Figure 4.2: New Patient Registration

This page is used to create patients account before evaluation.

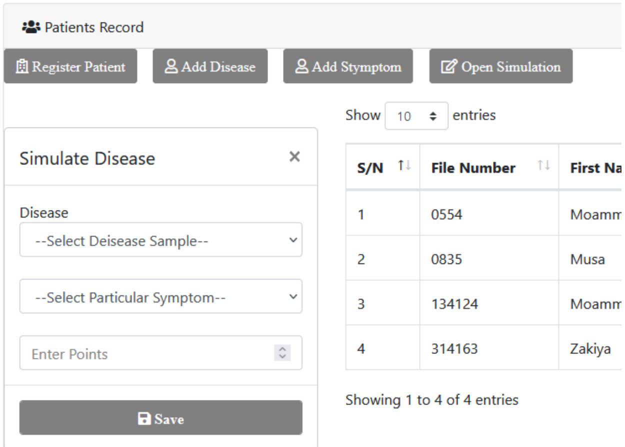

Figure 4.3: Admin Menu

The system administrator uses this page to access his stipulated basic functionalities.

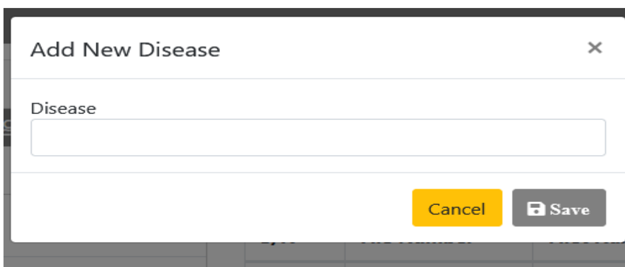

Figure 4.4: Add New Disease Page This system is dynamic and so the sample diseases are captured he

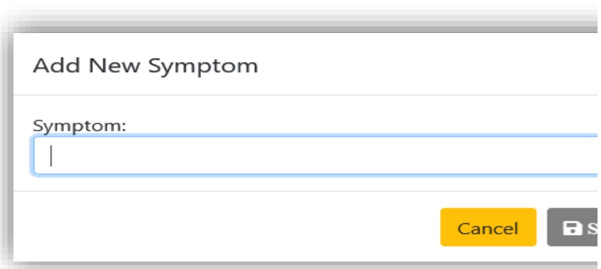

Figure 4.5: Add New Symptom Page

A symptom may be common to all polio, Measles or pneumonia and therefore we input them here.

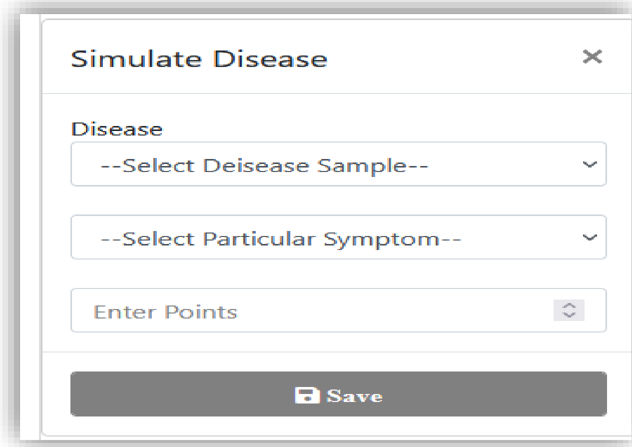

Figure 4.6: Assignment Page

To any disease, the symptom may have different effect with the other. These values are specified using a case-based expert procedure and on this form we assign to each disease (polio, malaria or pneumonia) its symptom and points.

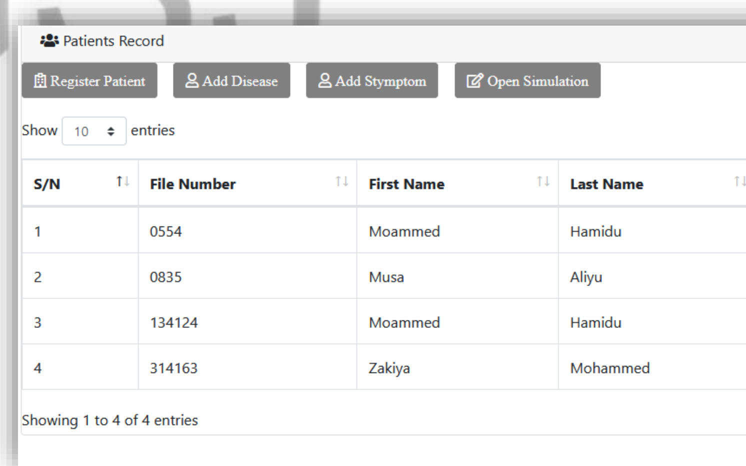

Figure 4.7: Patients Record Page

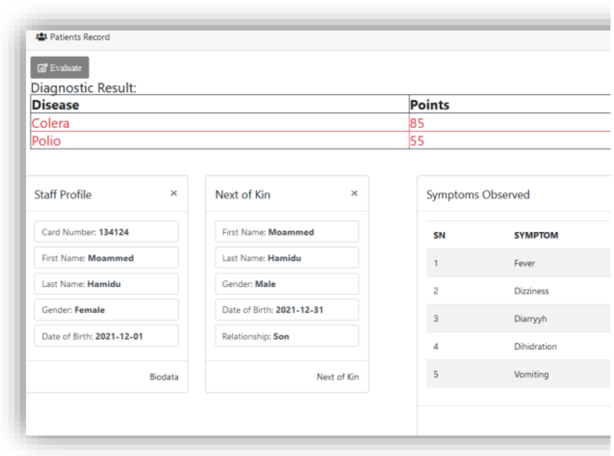

Figure 4.8: Diagnosis Report Page

As the name implies, this will serve as reference for further treatments.

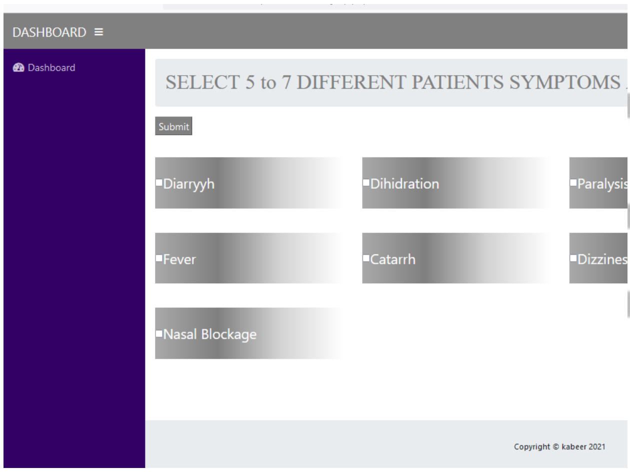

Figure 4.11: Expert Evaluator Page

This is where the core operation of this system is processed. A physician will select from the pool of symptoms corresponding the patients physical display and evaluate for the system to generate its report.

5. CONCLUSION

This research describes knowledge-based expert systems in medical diagnosis by acquiring various disease symptoms. The accuracy of the system has been attained by imposing stress on knowledge acquisition, a stage in which knowledge is gathered. These are gathered from medical specialists. Therefore, this system can be developed and tested to address the various challenges of the traditional method of diagnosing diseases. It is then expected that the medical experts will find the proposed system useful and as a tool that can assist them in reducing queues and provide accurate diagnosis of diseases.

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