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RULE-BASED EXPERT SYSTEM FOR DISEASE DIAGNOSIS

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ABSTRACT
It is moral responsibility of a nation to provide good medical services to the people because healthy people make healthy nation. Medical science field is a gargantuan and complex field that requires a large number of expertises. It is obvious that developing countries are facing challenge of shortage of medical expertise in medical science which eventually affects the traditional method of diagnosing diseases. Due to this, they are unable to provide sound medical services to patients. Patients also get to hospital to meet a huge number of queues. This paper addresses the various challenges that exist in the traditional method of disease diagnosis. A rule-based expert system is developed to diagnose Malaria, Typhoid Fever, Cholera, Tuberculosis, and Breast Cancer. The proposed Medical Expert System (MES) contains forty six (46) rules to effectively diagnose the diseases. The system is found capable of assisting medical experts in diagnosing diseases and to provide good health services to their patients.

Keywords: *Expert System, rule-based, disease diagnosis, health services*

1. BACKGROUND TO THE STUDY

Expert Systems (ESs) are computer program that are originated from branch of computer science called Artificial Intelligent (AI), which has the ability to imitate human being, make judgment and reasoning based on some facts and rules presented to it (Durkin, 1994; Gath & Kulkarni, 2012). Nowadays expert systems have been widely used in almost all the fields of man's expertise to assist the users in taking decision; where human expatriation and multifaceted decision making is required, like medical diagnosis, expert decision making, policy making, estimating strategies, analysis and soon (Gath & Kulkarni, 2012). Medical artificial intelligence is primarily concerned with the construction of AI programs that perform diagnosis and make therapy recommendations. Medical Expert Systems (MESs) are more likely to be found in clinical laboratories and educational settings, for clinical surveillance, or in data rich areas like the intensive care setting. What is now being realized is that, if they are filling with appropriate rule, intelligent programs do indeed offer significant benefits (OpenClinical, 2012). The use of MESs are in full swing since early 70's when MYCIN was designed to diagnose bacteria causing severe infections (Durkin, 1994). There are lot medical expert system such as PUFF, that was developed to diagnose lung disease; ANGY helps physicians to diagnose the narrowing of coronary vessels by identifying and isolating coronary vessels in angiograms; BABY aids clinicians by monitoring patients in a Newborn Intensive Care Unit (NICU) (Giarratano et al., 2005). ESs can be classified into two; those that based on rules, known as *rule-based expert systems*, and those that based on probabilistic graphical models, often called p*robabilistic expert systems* or *normative systems*. Rule-based expert systems (RBESs), originating from the work of Buchanan and Shortliffe on the MYCIN system (Buchanan & Shortliffe, 1984), intend to capturing human expertise in terms of rules of the form **if** *condition* **then** *action*. There is irresistible evidence that prove that this rule is capable of modelling human thought process (Newell & Simon, 1972). A set of rules can be used to capture a human expert's relevant domain knowledge and can then be used to reproduce the expert's problem solving in that domain. Probabilistic expert systems derive from research at the intersection of statistics and AI. RBES includes both conventional techniques, such as database management systems (DBMSs), and artificial intelligence (AI) techniques such as knowledge-based systems (KBSs) (Russell & Norvig, 2002). In MES, DBMSs are used for storing, retrieving and generally manipulating patient data, whereas ESs are mainly used for performing diagnoses based on patient data since they can naturally represent the way experts reason and provide solution to problem at hand (Mahesh, 2009). In this research work, RBES is used to diagnosis the following diseases such as Malaria, Typhoid Fever, cholera, breast cancer and tuberculosis.

2. DISEASES CONSIDERED

2.1 Malaria

Malaria is one of common disease and a major health problem in the world today, mostly in Africa. Malaria kills twice as many people as thought; research has shown that malaria kills about one million, two hundred thousand (1.2 million) people every year which is nearly double the six hundred and fifty-five thousand (655,000) people estimated in 2009 (Guardian, 2012). Malaria is characterized by a fever which is caused by a parasite that is spread by malaria bearing anopheles mosquito, which has become resistant to certain treatments and many insecticides (Wikipedia, 2012).

2.2 Typhoid Fever

Typhoid fever is a systemic disease contracted through ingestion of contaminated food or water. It is caused by the bacterium Salmonella enteric serovar Typhi, which is a pathogen only of humans. The illness may be mild or severe. Paratyphoid is a clinically similar illness (though often less severe), caused by Salmonella enteric serovar Paratyphi A, B or C. These conditions are sometimes referred to collectively as enteric fever (NaTHNaC, 2014).

2.3 Cholera

Cholera is an infection of the small intestine caused by bacteria called Vibro Cholerae and represents major public health problems in the tropics part of the world.

2.4 Tuberculosis

Tuberculosis (TB) is an infectious disease, transmitted and spread via aerosols (droplets from the mouth and respiratory tract) that are coughed, sneezed, or forcibly expelled from the body to the surrounding air. These droplets, when inhaled by a susceptible host, can infect another person and, within weeks to months, the disease begins to develop within the infected person. The lungs are the primary site of infection. The disease can spread to almost any other organ such as: kidneys, bladder, bones, spine, liver, spleen and brain. TB symptoms are characterized by low grade fever, coughing, fatigue, and a loss of appetite. Later, hemoptysis (coughing up blood), may occur. Tuberculosis (TB) is a global health problem. It is estimated that about one billion individuals are infected worldwide with tuberculosis, with 10 million new cases and over 3 million deaths per year (Taura et al., 2008). TB is amongst the world's leading cause of death from a single infectious disease. It commonly affects the lungs but also can involve any organ of the body. TB has been known under a variety of names during the course of history. It has been a difficult disease to diagnose and has been confused with many other diseases. The actual name "Tuberculosis" was introduced during the first half of the nineteenth century. It refers to the diseased condition caused by infectious agents known as mycobacterium tuberculosis or tubercle bacilli (Neil & Janet, 2005). The disease has also been known under other names, such as phthisis, Scrofula, tabes, bronchitis, and inflammation of the lungs, hectic fever, gastric fever, and lupus (Neil & Janet, 2005). It was also known as the great white plague or "consumption" (MedicineNet, 2011).

2.5 Breast Cancer

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the breast, it is called breast cancer. Breast cancer is the most common cancer among women; excluding non melanoma skin cancers. This cancer affects one in eight women during their lives. It occurs in both men and women, although male breast cancer is rare. Breast cancer is a malignant tumor that has developed from cells of the breast. Although, scientists know some of the risk factors (i.e. ageing, genetic risk factors, family history, menstrual periods, not having children, obesity) that increase a woman's chance of developing breast cancer, they do not yet know what causes most breast cancers or exactly how some of these risk factors cause cells to become cancerous. Research is under way to learn more and scientists are making great progress in understanding how certain changes in DNA can cause normal breast cells to become cancerous (Übeyli, 2007).

3. METHODOLOGY

The goal of this research work is to replace the manual method of diagnosing the diseases listed above by Medical Expert, with an ES which is capable of correcting all the limitations associated with the manual method (Djam et al., 2011). A rule-based expert system is a system that contains set of rules that are used to describe certain patterns. Observed data are collected and evaluate using these rules. If the rules are logically satisfied, the pattern is identified, and a problem associated with that pattern is suggested. Each particular problem (symptom) might imply a specific treatment. These rules do not take into consideration the uncertainty and the impreciseness of human observed data and reasoning and real world knowledge that characterized by incompleteness, inaccuracy, and inconsistency. The rule-based approach uses IF-THEN type rules. **IF-THEN** rules take the following form: *IF there is a flame THEN there is a fire.*

3.1 Research Design

A typical rule-based system has four basic components:

1. A list of rules base, which is a specific type of knowledge base.
2. An inference engine or semantic reasoner, which infers information or takes action based on the interaction of input (user symptoms) and the rule base. The interpreter executes a production system program by performing the following match-resolve-act cycle:
    i. Match: In this phase, the left-hand sides of all productions are matched against the contents of working memory. As a result a conflict set is obtained, which consists of instantiations of all satisfied productions. An instantiation of a production is an ordered list of working memory elements that satisfies the left-hand side of the production.
    ii. Conflict-Resolution: In this phase, one of the production instantiations in the conflict set is chosen for execution. If no productions are satisfied, the interpreter halts.
    iii. Act: In this phase, the actions of the production selected in the conflict-resolution phase are executed. These actions may change the contents of working memory. At the end of this phase, execution returns to the first phase.
3. Temporary working memory.
4. A user interface or other connection to the outside world through which input and output signals are received and sent.

3.2 Proposed System Model

Generally, patients visit the hospitals to complain of their diseases and MES user interviews the patients regarding their diseases and searches the symptoms in database. If symptoms match what is in the database then the user gives the prescription to the patient.The proposed framework for the MES is shown in Figure 1. In this figure, the various modules that work together to actually achieve a complete rule-based expert system are presented.

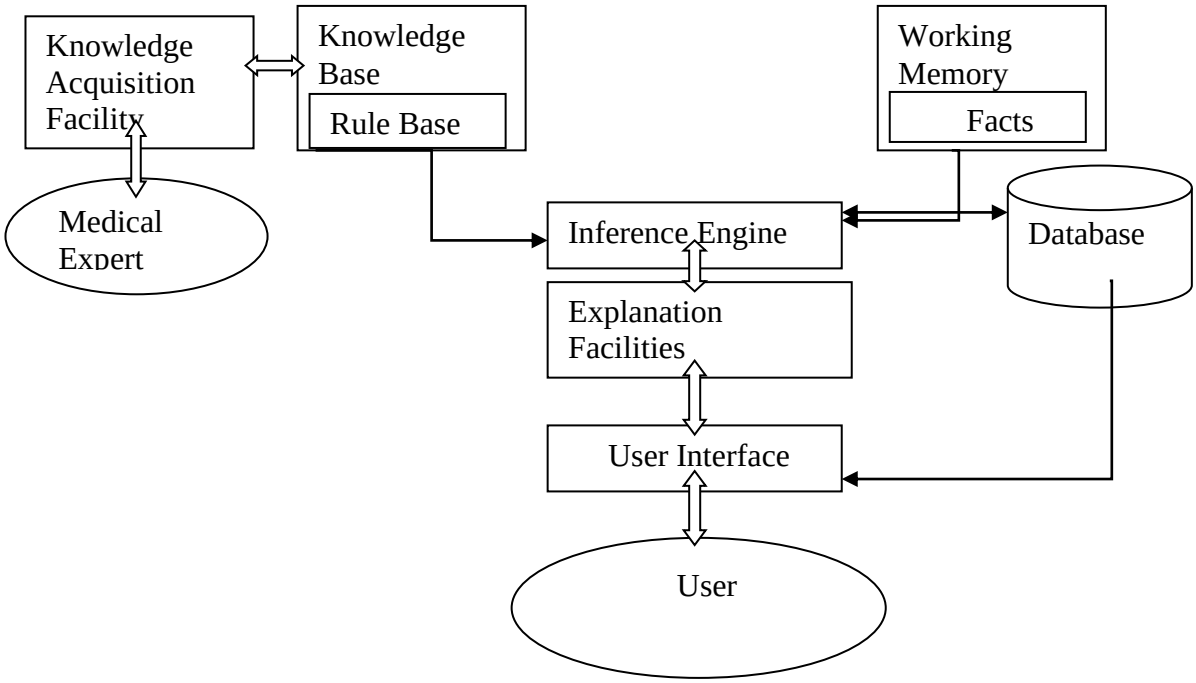

Figure 1: Proposed framework for the MES

3.3 Knowledge Acquisition Process

The knowledge base is the brainpower of the ESs as all the essential facts for constructing the rules are contained in the knowledge base. This knowledge is main source of rules for the ESs. The most important source for knowledge acquisition for the MES was consultation with general physician doctors, Internet medical website, medical books, research papers and journals. The knowledge based made up of acquiring the symptoms of the diseases (Erman, Scott & London, 1984; Rajdeep & Sugata, 2012). The knowledge is represented in the form of rules.

Table 1: Rule-base for the proposed MES

1. IF (fever (high)) THEN Malaria
2. IF (Coldness) THEN Malaria
3. IF (Throb) THEN Malaria
4. IF (Sweat) THEN Malaria
5. IF (Sometimes colour of urine is black water fever) THEN Malaria
6. IF (Headache) THEN Malaria
7. IF (Vomiting) THEN Malaria
8. IF (Muscle pain) THEN Malaria
9. IF (High temperature) THEN Malaria
10. IF (Diarrhoea) THEN Malaria
11. IF (Coma (Seizure)) THEN Tuberculosis
12. IF (Stiff Neck) THEN Tuberculosis
13. IF (Headache) THEN Tuberculosis
14. IF (AbdoIfminal Pain) THEN Tuberculosis
15. IF (Weight Pain) THEN Tuberculosis
16. IF (Fever) THEN Tuberculosis
17. IF (Masses along the neck) THEN Tuberculosis
18. IF (Draining Sinus) THEN Tuberculosis
19. IF (Small Reddish brown lesions (face, eyelid, nose, cheek and ear)) THEN Tuberculosis
20. IF (Reddish brown wart-like growth on the body) THEN Tuberculosis
21. IF (Skin lesions on hand, feet, elbow and knees) THEN tuberculosis.
22. IF (Ulcer or abscesses on the Skin) THEN Tuberculosis
23. IF (Necrosis of infected Skin) THEN Tuberculosis
24. IF (Stiffness of affected area) THEN Tuberculosis
25. IF (Blood present in Urine) THEN Tuberculosis
26. IF (Painful or uncomfortable Urination) THEN Tuberculosis
27. IF (Hemopysis (coughing up blood)) THEN Tuberculosis

28. IF (Fatigue) then Tuberculosis
29. IF (Chest pain) THEN Tuberculosis
30. IF (Night Sweat) THEN Tuberculosis
31. IF (A lump or pain in the breast) THEN Breast cancer.
32. IF (Thickening or swelling of part of the breast) THEN Breast cancer
33. IF (Irritation or dimpling of breast skin) THEN Breast cancer
34. IF (Redness or flaky skin on the breast) THEN Breast cancer
35. IF (Pulling in of the nipple or pain in the nipple area) THEN Breast cancer
36. IF (Fluid other than breast milk from the nipple, especially blood) THEN Breast cancer
37. IF (A change in the size or the shape of the breast) THEN Breast cancer
38. IF (Vomiting) THEN Cholera
39. IF (Watery diarrhoea) THEN Cholera
40. IF (Leg cramps) THEN Cholera
41. IF (Poor appetite) THEN Typhoid Fever
42. IF (Headache) Then Typhoid Fever
43. IF (Generalised aches and pains) THEN Typhoid Fever
44. IF (Fever as high as 104 degrees Fahrenheit) THEN Typhoid Fever
45. IF (Lethargy) THEN Typhoid Fever
46. IF (diarrhoea) THEN Typhoid Fever

4. RESULTS AND DISCUSSION

The proposed MES first request for username and password in order to access the facilities provided by the system as shown in Figure 2. Once a valid username and password are provided, the registration interface shown in Figure 3 is displayed. This interface is used to capture all patients' records.

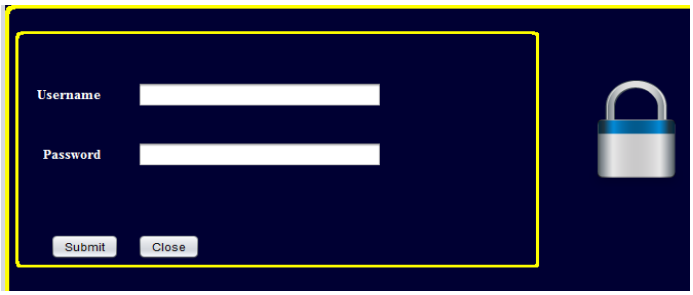

Figure 2: Login page

After registration, the patient proceeds to diagnosis centre where he/she will supply several symptoms and the MES will diagnose the patient a waste of time. The interface for diagnosis centre is shown in Figure 4.

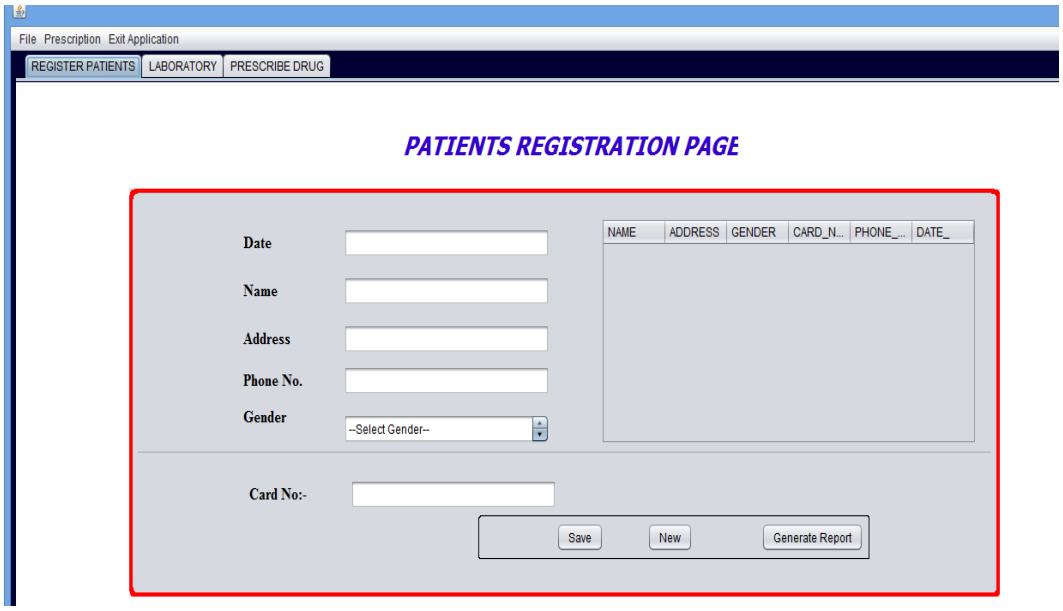

Figure 3: Patient registration page

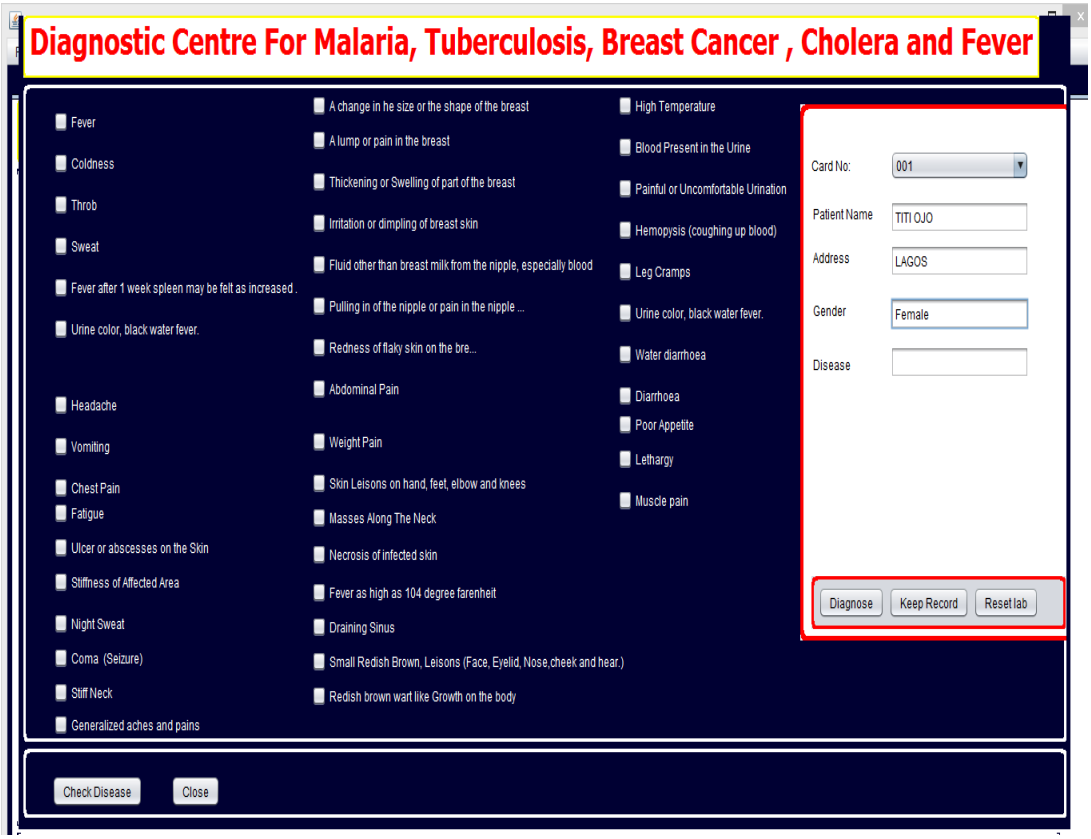

Figure 4: Diagnosis Centre for the proposed MES

Figure 5 shows interface that can be used to generate different reports including drug prescription.

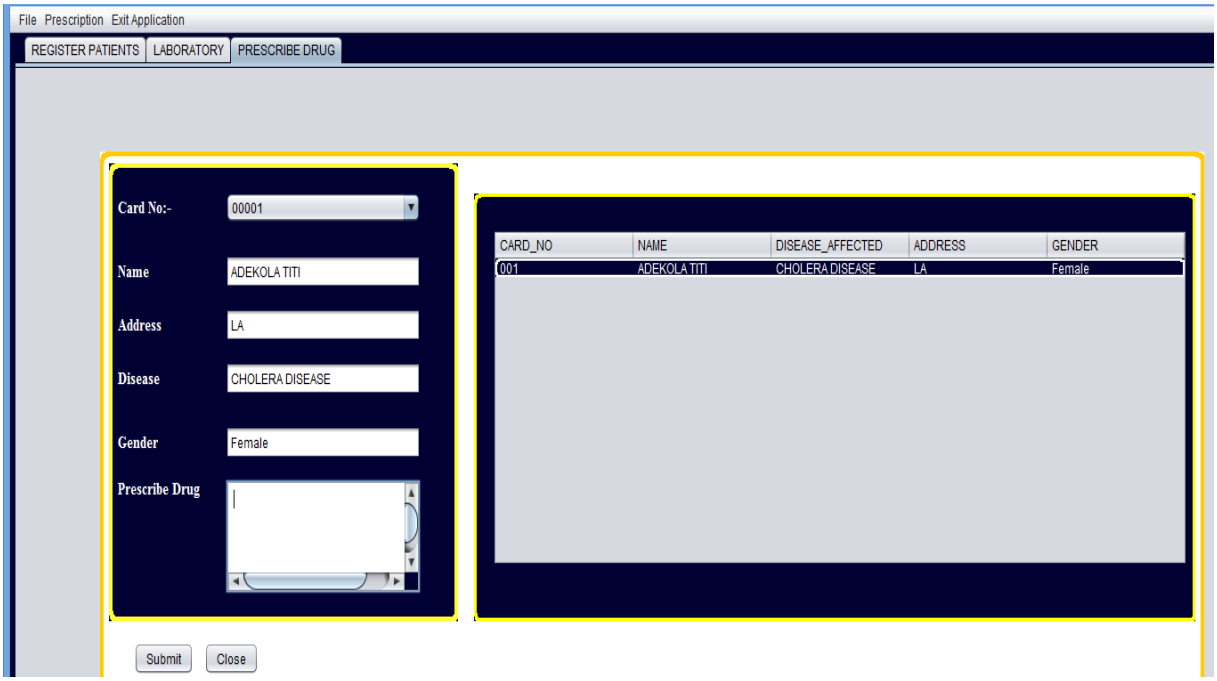

Figure 5: Report page for the proposed MES

5. CONCLUSION

Expert systems have been found to be very useful in our today's world driven by technology. When expert's knowledge is extracted and stored, such knowledge can be used to replace the expert in case of demise. Medical diagnosis will have greater part of the advantages of expert system, knowing that only a few specialties exist in the medical field. The knowledge of such specialist can be replicated and made use of in times extreme necessity. In this paper, a rule-based medical expert system is developed and tested to address the various challenges of the traditional method of diagnosing diseases. The researchers hope that the Medical Experts will find the proposed system useful and as a tool that can assist them to reduce queue and provide accurate diagnosis of diseases.

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