

## **A MODEL FOR WEB-BASED MEDICAL DIAGNOSIS AND PREDICTION**

**WAN HUSSAIN WAN ISHAK &  
FADZILAH SIRAJ**

*School of Information Technology  
Universiti Utara Malaysia*

### **ABSTRACT**

Health care is one of the major issues that has been emphasized by medical specialists from all over the world. Diseases such as heart disease, diabetes and cancer have caused many deaths particularly in Malaysia. Such consequences require more medical specialist to deal with these chronic diseases. Currently, the number of medical specialists is not sufficient. One of the solutions to overcome the shortage of medical specialists is by using a computer program to help clinicians to make the decision without consulting the specialist when necessary. As the computer program deals with knowledge, the program may not be valid in a few years as new technologies or findings change in medical research. Updating such knowledge in the system would be a difficult task as they are stand-alone applications. Hence, it is vital to design a complete system that could be shared and accessed by authorized users from any location. This paper proposes a Web-Based system for medical diagnosis and prediction. Several suitable Artificial Intelligence techniques were explored and identified for diagnosing and prediction tasks.

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### **INTRODUCTION**

Every year, many deaths have been reported due to serious illnesses of high risk diseases. A study reveals that Malaysia will suffer insufficient General Practitioners, Neurologists and Cardiologists in the coming years (Ghazali and Mulyadi, 1992). The study also indicates that the employment of General Practitioners, Neurologists and Cardiologists from 1992 to the year of 2000 was 4.5%, 7.6% and 6.5% respectively.

Medical specialist could not be produced as the manufacturers produce their goods. They need to undertake a few years of training in order to train themselves to become specialists in certain specialization areas. Therefore, the insufficient of medical specialists will never be overcome within a short period of time. The institutions of higher learning could however, take an immediate action to produce as many doctors as possible. However, while waiting for students to become doctors and the doctors to become specialists, many patients may already die. The insufficient of medical specialists in government hospitals could cause the negative impact to the society as most of them depend on the government hospitals for treatment. On the other hand, the local clinics rely on clinician to treat their patients. Generally, the clinics do not have enough specialists to treat high-risk diseases such as heart diseases, nerve, kidney, diabetes and cancer. Hence, the patients are referred to the government hospitals for treatment. The waiting time for treatments normally takes a few days, weeks or even months. By the time the patients see the specialist, the diseases may have already aggravated. As most of the high-risk diseases could only be cured at the early stage, the patients may have to suffer for the rest of their lives.

The advancement in computer technology could be used to assist the doctors in making decisions without consulting the specialists. As an example a computer program known as Medical Decision-Support System was designed to help health professionals make clinical decisions (see Shortliffe, 1987). The system deals with medical data and the knowledge domain in diagnosing the patients' conditions as well as recommending suitable treatments for particular patients.

To date, most of the systems developed were standalone applications with specific databases for certain diseases. This implies that patients' information in one system can only be used by that particular system. On the other hand, other systems require another databases for other patients or for the same patients whose records are kept in other databases. Another problem with standalone database is that, the database for the same system in another place would differ as the number of patients using the systems increases. This problem affect the knowledge acquired from the databases and thus influences the decision made by the system. For a system using artificial intelligence (AI) techniques, when the number of patients is high the system will produce more accurate results compared to the system with less number of patients.

This paper proposed a model for Web-Based medical diagnosis and prediction. Several AI techniques were explored and several suitable techniques will be identified for diagnosing and predicting the condition of the patients from a certain domain.

## ARTIFICIAL INTELLIGENCE IN MEDICINE

Limitations in conventional computer-aided diagnosis have encouraged researchers to investigate and create new computer programs that can simulate human expert reasoning (Szolovits et al., 1988). Several studies showed that AI has great potential in medical applications. For example, Hoong (1988) summarized the potential of AI techniques in medicine as follows:

- Provides a laboratory for the examination, organization, representation and cataloguing of medical knowledge.
- Produces new tools to support medical decision-making, training and research.
- Integrates activities in medical, computer, cognitive and other sciences.
- It offers a content-rich discipline for future scientific medical specialty.

Artificial intelligence (AI) techniques such as Expert System, Fuzzy Logic, Neural Networks and Case Based Reasoning have been used in medical diagnosis and prediction (see for instance Partridge et al., 1996; Goh and Abidi, 1996; Perez et al., 1998; Swartout and Paris, 1991). Early applications of AI in medicine such as Internist-1, PIP, MYCIN and CASNET have shown to be successfully applied in their domain areas (Shortliffe, 1987). Internist-1 is a large system used to assist in diagnosing general internal medicine. It has been successfully converted to run on microcomputer (also called QMR or Quick Medical Reference). Another software known as PIP, which is abbreviation of Present Illness Program was developed to explore the psychology of expert problem in diagnosing renal diseases. MYCIN was developed to assist with therapy selection for patients with bacteremia or meningitis. It was among the first systems to emphasize the explanation capabilities in medical decision support (see also Shortliffe and Buchanan, 1975). CASNET was designed to assist physicians by pursuing diagnoses or proposing management strategies to manage patients with glaucoma.

Expert system is one of the widely used techniques in medical applications. Expert system is a program that symbolically encodes concepts derived from experts in a particular domain and uses the knowledge from that domain to provide the kind of problem analysis and advice that the expert might provide (Shortliffe, 1987). However, to achieve good performance in problem-solving, expert systems require specialized knowledge and skill in a particular problem domain (Jamilin, 1992).

Expert system does not exactly duplicate human reasoning activity, yet every step in decision making corresponds to the crucial steps taken by human expert (Ganascia, 1984). The ability to ask questions, explaining and given feedback are several major important characteristics in expert systems. Expert systems have

several attractive features namely, it increases availability, reduces cost, reduces danger, permanence, increase reliability and give fast response. In addition, a well-designed expert system have high performance, adequate response time, good reliability and understandable (see Olan, 1992).

Fuzzy logic is another branch of artificial intelligence technique. It deals with uncertainty in knowledge that simulates human reasoning in incomplete or fuzzy data. Meng and Kohout (1996) applied fuzzy relational inference in medical diagnosis. It was used within the medical knowledge-based system, which is referred to as Clinaid. It deals with diagnostic activity, treatment recommendations and patient's administration.

Neural network (NN) and its ability to learn are another AI technique for making prediction, clustering and classification tasks. NN is a network of many simple processors or units (Sarle, 1999). It simulates the function of human brain model (Marzuki, 1994). In some cases, NN was viewed as a class of algorithms for statistical modeling and prediction (Jordan and Bishop, 1996). Thus, NN is a powerful tool to enhance current medical diagnostic techniques. It has been employed in various medical applications such as coronary artery (Lippmann, 1995), breast cancer (Street et al., 1996) and pneumonia (Caruana et al., 1996). Partridge et al., (1996) listed several potential of NN over conventional computation and manual analysis as follows:

- Implementation using data instead of possibly ill defined rules.
- Noise and novel situations are handled automatically via data generalization.
- Predictability of future indicator values based on past data and trend recognition.
- Automated real-time analysis and diagnosis.
- Enables rapid identification and classification of input data.
- Eliminates error associated with human fatigue and habituation.

## **WEB-BASED MEDICAL DIAGNOSIS AND PREDICTION**

The evolution of health-care records in the era of the Internet has been discussed by Shortliffe in several of his literatures (see Shortliffe et al., 2000; Shortliffe, 1998; Detmer and Shortliffe, 1997; Shortliffe et al., 1996; Shortliffe et al., 1996). The idea behind the issue is to develop a clinical workstation to store the patient's information and make it available for the patients access. The benefits of the electronic records would be many, namely enhance traditional records, fast storage and retrieval, promote telemedicine and encourage research in medical applications.

The patients' records are valuable information for the knowledge-based system. The current patients data would enhance and strengthen the validity of the system reasoning (Manickam and Abidi, 1999). The electronic record could be accessed by health-care providers and the data could be stored and updated frequently. By using this method, the system knowledge will always be updated. The interface for the interactions between the database (and the system) and the clinician (health-care providers) would be through WWW.

The proposed model for Web-Based medical diagnosis and prediction (see Figure 1) consists of four components; databases, prediction module, diagnosis module and user interface. The databases consist of patients database and patients-disease database. Patients database will be used to store patients' information such as name, addresses, and other detailed particulars. Patient's-disease database stored all the information about patients and their illnesses. The information stored in the database includes types of diseases, the treatments and other details about the test and administering therapy. Patients' information are separated in a different database to enhance the patients' record storage, so that other departments could use the records when the patients are referred to them. This method could prevent other departments or unauthorized users from accessing the information about patients diseases and provide a centralized information access for the patients records.

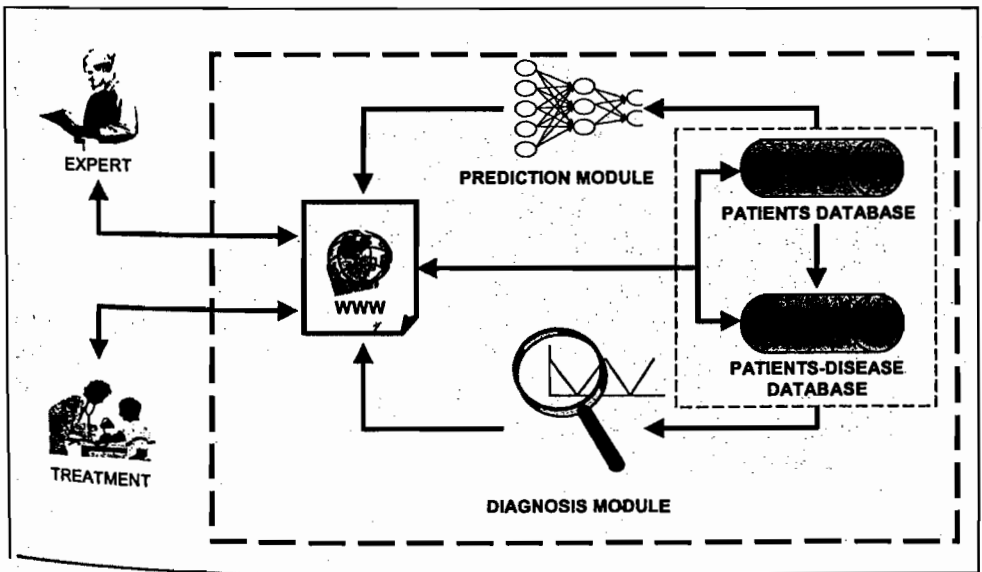


Figure 1: A model for Web-Based Medical Diagnosis and Prediction

Prediction module utilizes neural network techniques to predict patients illness or conditions based on previous similar cases. Data from the patients' and patients'-

disease database will be used for training and testing. The weight from the training will be stored to predict a new data fed into the system.

Diagnosis module consists of expert system and fuzzy logic techniques to perform diagnosis tasks. A set of rules will be defined using the patients and patients-disease databases as well as the expert knowledge on the disease domain. Expert system uses the rules to diagnose patient's illness based on their current conditions or symptoms. In addition, fuzzy logic is integrated to enhance the reasoning when dealing with fuzzy data. The combination of expert system and fuzzy logic that forms a hybrid (expert-fuzzy) system could increase the system performance.

In the proposed model, WWW acts as the user interface for the interaction between the users and the system. Several processes involved in the models are collection data (patients information and patients illness), diagnosis, prediction and managing databases or systems administering.

## CONCLUSION

Experts believe that medicine in the twenty first century will be different than medicine in the late twentieth century (Altman, 1999). At the initial stage, computer was used as an aid for medical diagnosis. AI techniques, namely expert system was then employed in medical diagnosis to simulate human expert reasoning. Consequently, the techniques were expanded in managing the patients' databases and the technique were also employed in more advanced research like molecular medicine (Altman, 1999). Altman (1999) summarized the era of AI in medical research into three eras namely, era of diagnosis, era of managed care and era of molecular medicine.

Current enhancements in information technology such as development of information superhighway inevitably encourage many organizations including government to develop electronic medical information and make it available on the Internet. The patients can use the information and monitor their risk level from their home or office without having to consult the physician (Manickam and Abidi, 1999). However, the proposed model do not meant for the patients to monitor their health, rather to assist clinician in making diagnosis and prediction of patients' illness. This will enable the clinician to access the system and provide the consultation as expert does regardless of the location.

The main features in medical diagnosis and prediction using artificial intelligence techniques will make the consultation to be more interactive. As clinical decision making inherently requires reasoning under uncertainty, expert systems (Shortliffe, 1987) and fuzzy logic (Meng and Kohout, 1996) will be suitable techniques for dealing with partial evidence and with uncertainty regarding the effects of proposed interventions. For the prediction tasks, Neural Networks

have been proven to produce better results compared to other techniques (such as statistics) (Partridge et al., 1996; Machado, 1996). Such techniques are worth to explore and integrate in the system for medical diagnosis and prediction. The Internet or the WWW will be used as the medium to provide tele-healthcare to clinician or to the public.

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