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A web-based intelligence medical-decision support software for diagnosis internal diseases

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РЕЗЮМЕ, ABSTRACT
Medical decision-support software system is designed to help health professionals make clinical decision. The system deals with medical data and knowledge domain in diagnosing patient's conditions as well as recommending suitable treatments for the particular patients. Patient-Centred Health Information Systems is a patient centered medical information system developed to assist monitoring, managing and interpret patient's medical history. In addition the system provides assistance to patient and medical practitioner. The system serves to improve the quality of medical decision-making, increases patient compliance and minimizes iatrogenic disease and medical errors. This study presents a web-based software implementation of medical decision support to diagnose internal diseases as real-time to support clinical decisions using Artificial Neural Networks (ANN). This software has an improved capacity to quickly narrow the number of diagnostic possibilities, and has very high recognition accuracy (Ukr. z. telemed. med. telemat.-2011.-Vol.9,№1.-P.52-58).
Keywords: medical decision support, neural networks, diagnosis, web-based

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ВЕБ-ПРИЛОЖЕНИЕ ДЛЯ ИНТЕЛЛЕКТУАЛЬНОЙ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ В ДИАГНОСТИКЕ ВНУТРЕННИХ БОЛЕЗНЕЙ
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Медицинские системы поддержки принятия решений разрабатываются для помощи профессионалам в клинической ситуации. Системы обрабатывают медицинские данные и знания с первичной целью определения диагноза, а также – определения оптимального лечения. Пациент-центрированные информационные медицинские системы разрабатываются для ассистирования в мониторинге, управлении и интерпретации данных. Дополнительно такая система оказывает поддержку как пациенту, так и врачу. Система улучшает качество медицинских решений, состояние пациента, минимизирует ятрогенную патологию и врачебные ошибки. В статье описано веб-приложение для интеллектуальной поддержки принятия решений в диагностике внутренних болезней, основанное на использовании искусственных нейронных сетей. Веб-приложение значительно расширяет возможности диагностики и имеет высокую диагностическую точность (Укр.ж.телемед.мед.телемат.-2011.-Т.9,№1.-С.52-58).
Ключевые слова: поддержка принятия клинических решений, нейронные сети, диагностика, веб-приложение

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ВЕБ-ДОДАТОК ДЛЯ ІНТЕЛЕКТУАЛЬНОЇ ПІДТРИМКИ ПРИЙНЯТТЯ РІШЕНЬ У ДІАГНОСТИЦІ ВНУТРІШНІХ ХВОРОБ
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Медичні системи підтримки прийняття рішень розробляються для допомоги професіоналам у клінічній ситуації. Системи обробляють медичні дані й знання з первинною метою визначення діагнозу, а також визначення оптимального лікування. Пацієнт-центровані інформаційні медичні системи розробляються для асистування в моніторингу, керуванні й інтерпретації даних. Додатково така система дає підтримку як пацієнтові, так і лікареві. Система поліпшує якість медичних рішень, стану пацієнта, мінімізує ятрогенну патологію й лікарські помилки. У статті описаний веб-додаток для інтелектуальної підтримки прийняття рішень у діагностиці внутрішніх хвороб, що грунтується на використанні штучних нейронних мереж. Веб-додаток значно розширює можливості діагностики й має високу діагностичну точність (Укр.ж.телемед.мед.телемат.-2011.-Т.9,№1.-С.52-58).
Ключові слова: підтримка прийняття клінічних рішень, нейронні мережі, діагностика, веб-додаток

The advancement in computer technology has encouraged the researchers to develop software for assisting doctors in making decision without consulting the specialists directly. In most real-life situations, medical decision making is done in absence of complete information. Diagnostic tests may be ordered to decrease uncertainty, but actions take place before all results become available. The actions which could be ordering of new tests, or prescribing a treatment may change the course of the disease. Cases that are resolved in this initial phase may never be assigned a final diagnosis [1]. Most serious clinical problems are so broad and complex that straightforward attempts to chain together larger sets of rules encounter major difficulties. Problems arise principally from the fact that rule-based programs do not embody a model of disease or clinical reasoning. In the absence of such models, the addition of new rules leads to unanticipated interactions between rules and thus to serious degradation of program performance [2]. Given the difficulties encountered with rule-based systems, more recent efforts to use artificial intelligence in medicine have focused on programs organized around models of disease. Efforts to develop such programs have led to substantial progress in our understanding of clinical expertise, in the translation of such expertise into cognitive models, and in the conversion of various models into promising experimental programs [3].

Artificial Intelligence (AI) is not a new concept, yet it has been accepted as a new technology in computer science. It has been applied in many areas such as education, business, manufacturing and medical. Employing the technology especially AI techniques in medical applications could reduced the cost, time, human expertise and medical error. Several authors have used this approach when building medical expert systems, artificial intelligence or rule-based systems [4]. Although performance may be acceptable, problems with expert systems usually occur during the knowledge-acquisition phase, when a great amount of time is spent on extracting information from the expert [5]. Furthermore, expert judgment may contain biases [6], a problem that machine-learning approaches, by extracting information from evidence, may also avoid.

A number of groups further explored Bayesian diagnostic approaches by relaxing the requirements for the independence assumption [7], exploring "mixed" Bayesian and non-Bayesian models [8], and development of a more general approach using Bayesian Belief Networks to model all conditional dependencies in a diagnostic system [9]. Some of other approaches to computer-assisted diagnosis include statistical clustering models [10] which have evolved into present-day Medical Decision-Support System (MDSS) approaches such as support vector machine systems [11], and later expanded to include multi-tiered MDSS explanatory models of the sort developed for acid-base disorders in the early 1980s [12]; heuristic MDSS based on criteria tables, with major and minor features designated to establish a diagnosis when present in certain combinations used for rule-based diagnostic systems [13-17]. All these techniques have been successfully applied to narrow medical domains, but each has serious drawbacks when applied to broad areas of clinical medicine. There are some professional programs on MDSS such as INTERNIST-1 and Quick Medical Reference (QMR) [18-21], DXplain developed by Barnett and colleagues at Massachusetts General Hospital for diagnosis in general medicine [22-23]; Iliad, which combined Bayesian and symbolic reasoning in a system developed by Homer Warner and colleagues at LDS Hospital in Utah [24-25] and, a number of more recent systems, including ISABEL [26-27] a commercially available system.

Telemedicine is the integration of telecommunications technologies, information technologies, human-machine interface technology and medical care technologies for the purpose of enhancing health care delivery across space and time [28]. Rusovick and Warner define telemedicine as any instance of medical care occurring via the Internet and using real-time video-teleconferencing equipment as well as more specialized medical diagnostic equipment [29]. In general, telemedicine means the use of computer and communications technologies to augment the delivery of health-care services [30]. Telemedicine can improve access to care, increase health-care quality and reduce the cost. Patients from rural areas can access to the same quality of health-care as those in big city. As an example patients suffered from heart-attack do not have to consult cardiologist directly. Local doctors or medical practitioners could perform the diagnosis with the help from cardiologist using communication channel such as Internet, telephone line and others. The approach reduces the cost and time for both patients and doctors. 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. As many applications are geared toward web-based, this paper proposed a model for web-based medical diagnosis and prediction, specifically for medical practitioners [31]. Any program designed to serve as a consultant to the physician must contain certain basic features. It must have a store of medical knowledge expressed as descriptions of possible diseases. Depending on the breadth of the clinical domain, the number of hypotheses in the database can range from a few too many thousands. In the simplest conceivable representation of such knowledge, each disease hypothesis identifies all of the features that can occur in the particular disorder. In addition, the program must be able to match what is known about the patient with its store of information. According to this aim, a specialized software using Artificial Neural Network (ANN) has been projected in this study.

Materials and Methods

1. Web-based medical decision support system using ANN

As it can be seen in Figure 1, the proposed model for Web-Based medical diagnosis and prediction consists of four components, they are databases, prediction module, diagnosis module and user interface. The databases consist of patient's database and patients-disease database. Patients database will be used to store patient's information such as name, addresses, and others particulars details. Patients-disease database stored all the information about patients and their illness. The information stored in the database includes types of diseases, the treatments and other details about the test and administering therapy. Patient's information is separated in a different database to enhance the patient's records storage, so that other departments could use the records when the patients are referred to them. Prediction module and diagnosis module are two of the main features in Web-Based Medical Diagnosis and Prediction. Prediction module utilizes neural networks techniques to predict patient's illness or conditions based on the previous similar cases. In this proposed model, WWW acts as the user interface for the interaction between the users and the systems. Several processes involve in the models are collection data (patients information and patients illness), diagnosis, prediction and managing databases or systems administering [31].

Artificial Neural Networks (ANN) is a study to emulate human intelligence into computer technology. ANN was implemented as a hybrid with textual description method to detect abnormalities within the same images with high accuracy. Partridge *et al* [32] listed several potential of NN over conventional computation and manual analysis:

- 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.

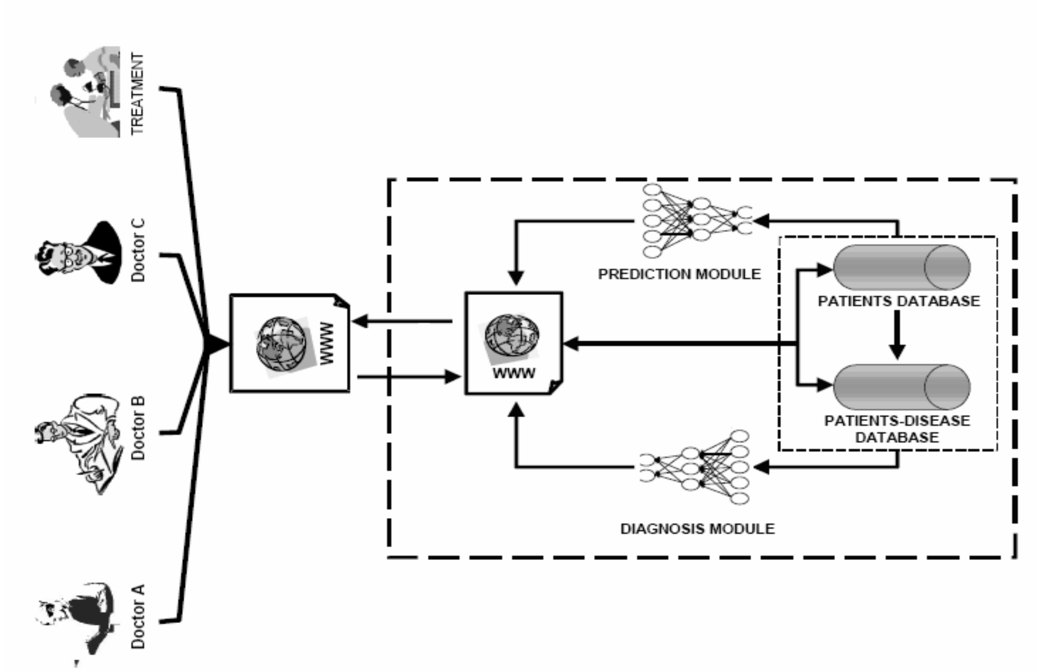

Figure 1. The model for Web-Based Tele-Medical Consultation, Diagnosis, and Prediction

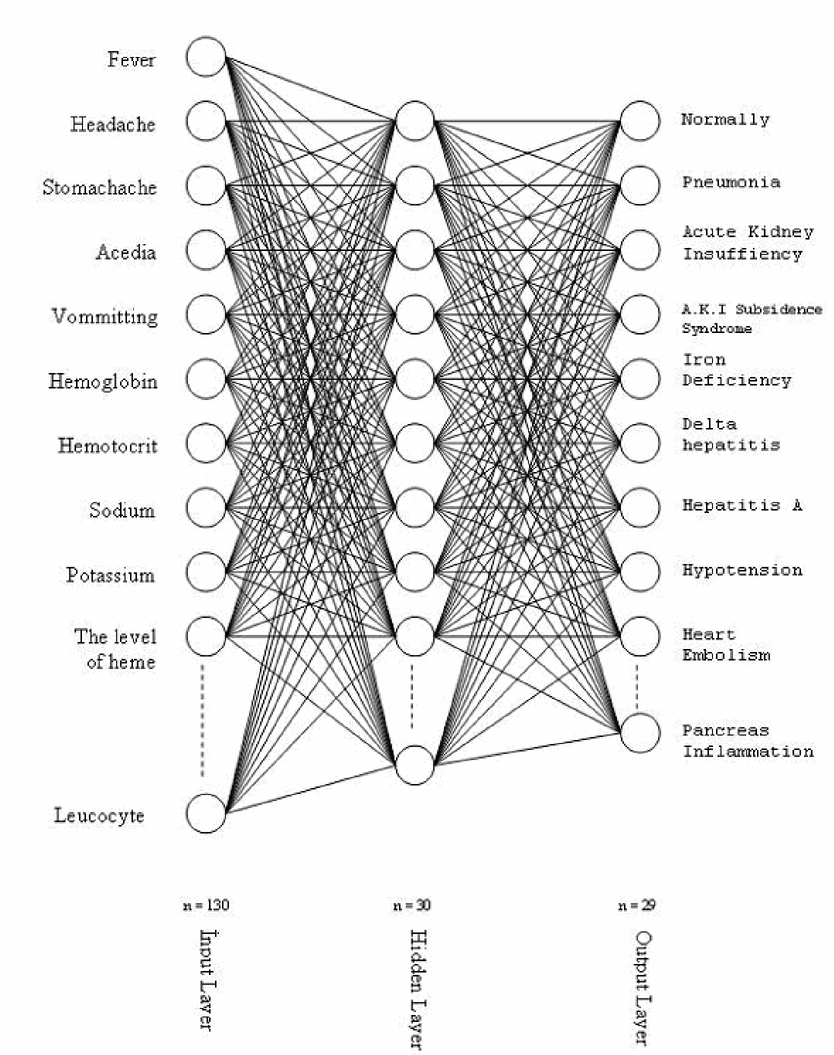

Figure 2. Used ANN architecture

The potential of ANN in medicine has been expressed by a number of researchers [33]. Hoong [34] summarized the potential of ANN 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.
- Offers a content-rich discipline for future scientific medical specialty.

In this study, a Back Propagation training algorithm which consists of a Multi Layer Perceptron (MLP) structure was used. This Back Propagation algorithm has a supervisor learning rule named Generalized Delta Rule Learning. For this reason firstly ANN has been educated by using the real educating data that are taken from the patients which are about the internal medicine. It can be seen in Figure 2; the data that used at training and testing of ANN were obtained from patient's complaints, patient's blood and urine analysis [35]. The blood analysis consists of 49 features such as albumin, acedias, LDH, LDL, cholesterol, hemoglobin etc. The urine analysis consists of 8 features which are protein, sugar, acetone, etc. These blood and urine analysis data is normalized before applying as inputs of ANN. For example; the reference data of LDH of blood are min: 135 max: 225. In our program training system LDH's reference data are normalized divided 1000 as min: 0.135 and max: 0.225. The program was educated like this. The urine test's results which are positive (+) or negative (-) are shown logically as negative 0 and positive 1 for both training and testing data. Figure 3 shows the test form of the software. Used three layered perceptron consists of 130 input units, 30 hidden units, and 29 output units which are describe different types of internal diseases. Optimum learning rate and momentum coefficients were found as 0.95 and 0.3 respectively to achieve a reasonable performance in both the training and the testing sets. As it can be seen in Figure 3, used test data belonging to a real Pneumonia patient so it means that the program has diagnosed Pneumonia as 98% accuracy after 1000 training epochs. If it is necessary, it is possible to make the same program for the different internal diseases.

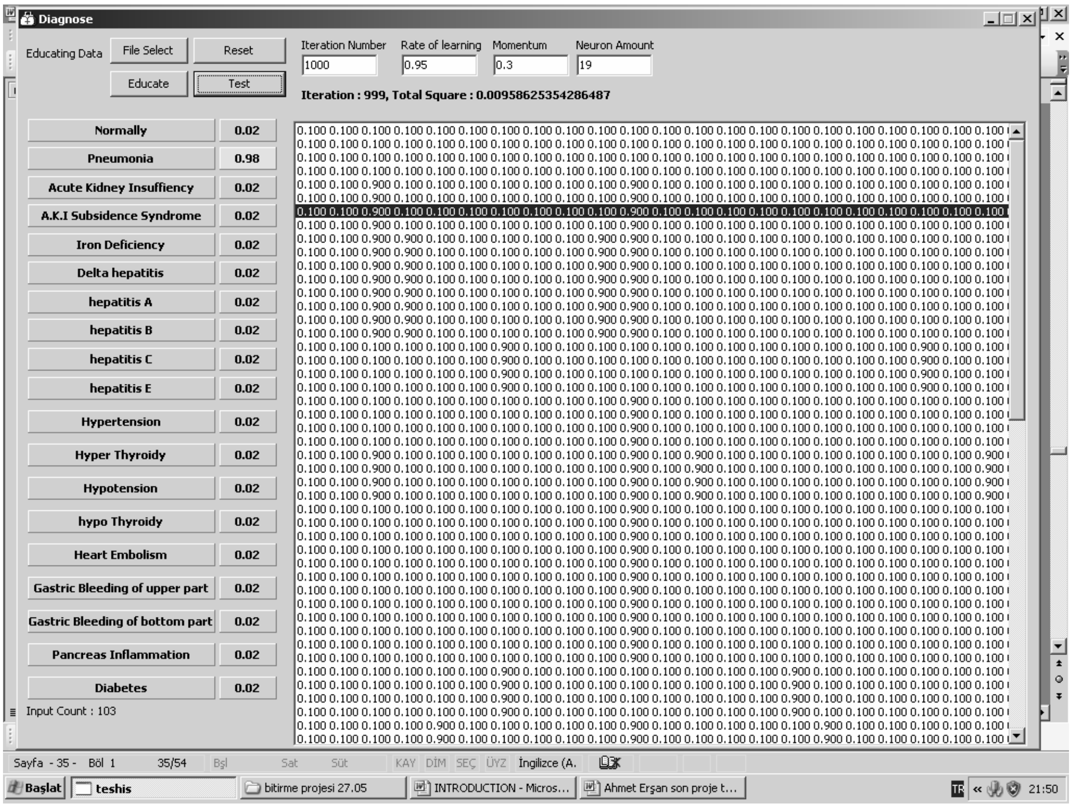

Figure 3. The test form of proposed software

Results and Dusucssions

In this study, as automated diagnostic system helped to practitioner doctor, the ANN was developed and presented to diagnosis all internal illness. Proposed study presents a real time diagnosis of the diseases for the doctors and to prevent the doctors to diagnose an illness wrongly when they are overtime period. According to this aim a computer program has been written that evaluates the patient's complaints and the results of the lab tests and it is about all the possible internal medicine that can be diagnosed at the human beings and also the computer program is quick and real timed. This program has a greater capacity to quickly narrow the number of diagnostic possibilities, and has very high recognition accuracy. The software program that we used Pascal and it is a kind of program of Delphi which has a visual programming language. The reason of using the visual programming is to know that the user of this program will be a government health official not a computer engineer. Moreover, this program helps the doctors who aren't specialized and who are get tired from the overtime periods to diagnose the illness in a short time correctly and this program helps to remove all the risks of the illnesses that can be overlooked.

In the future, this preliminary work can be developed for not only the internal medicine but also the other illnesses. It can be improve to use on tele-consultation, tele-treatment, and telemedicine systems. Moreover, this work can be applied for a simple client (patient's PDA) and server (powerful desktop PC) as two-tier pervasive healthcare architecture.

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