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Diagnosing internal illnesses using pervasive healthcare computing and neural networks

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Abstract

This paper presents a novel distributed pervasive healthcare system for diagnosing internal illnesses using pervasive healthcare computing and artificial neural networks (ANNs) and reporting healthcare results to the patients. Mobile wireless communication and information technologies have been used in new healthcare systems. The new advances in wireless communications and small mobile devices such as personal digital assistants (PDAs) and new improvements in PDA's CPU, memory and I/O components provide a particularly promising platform for pervasive healthcare applications due to PDA's central role in people's lives. Patients having internal diseases need to have many tests at hospitals, and a typical test report in some cases may have more than a hundred test results. It becomes a difficult, time consuming and error prone process for a doctor to diagnose the internal illnesses using such long reports. In this study we have been developing a distributed pervasive healthcare system which uses the hospital's main database. An ANN classifier at the hospital's server diagnoses internal illnesses and the simplified and understandable results are reported to the patients. The patients learn their analysis results anywhere and at any time using their PDA. Furthermore this system also provides the patients to learn their old and new analysis results. Our purpose in this study is not only to facilitate the work of doctors but also to provide freedom of movement for patients.

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Keywords: internal ilnesses; pervasive healthcare computing, neural networks

1. Introduction

Pervasive computing technologies have seen significant advances in the last few years because of the new developments in wireless and mobile devices and networks, sensors, wearable technologies. The goal of pervasive computing is to enable distributed systems that are available anywhere anytime and wellness management through the use of information and communication technologies [1]. One of the most important applications for pervasive computing technologies is healthcare, including wellness, disease diagnosis and management, support for independent and assisted living. Pervasive healthcare computing plays an important role in our life because of the increasing health risks and diseases and limited resources for early prevention in the healthcare systems. The recent advances provide widespread use of real-time monitoring of health-related parameters with wireless sensors [2], [3].

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In this paper we propose a novel distributed pervasive healthcare system for diagnosing internal illnesses utilizing pervasive healthcare computing and artificial neural network (ANN) techniques and reporting healthcare results to the patients. In the following sections, first, the related work is given in section 2. Then our ANN model for diagnosing internal illnesses is presented in section 3. The implementation of the ANN model on a client server architecture is given in section 4. Finally, we conclude the paper in section 5.

2. Related work

The accurate diagnosis of illnesses is one of the most important problems in medicine. To demonstrate the diagnostic performances of methods used, it is necessary to look at both diagnostic accuracy and the analysis of the patients. How accurate results are obtained must also be investigated. Practitioners to achieve their goals use various statistical techniques for data processing on the decision-making time. Because of the increasing complexity and size of the data, the efficient use of computers for data analysis is required so methods for efficient computer-based analysis are essential.

Pervasive healthcare computing and ANN techniques have become modeling tools that have found extensive acceptance and are used for solving complex problems [4]. There are many studies and projects on pervasive healthcare computing and ANNs [5]-[10]. Recent studies on pervasive healthcare computing shows that pervasive computing technologies can provide well-informed and high-quality patient care services. The medical record is generally heterogeneous and distributed. This record can be accessible from any place at any time by care providers. Pervasive healthcare computing and information systems allow overcoming the problem of heterogeneity of technologies and services. The paper [11] explains the importance of an instant notification service for a ubiquitous personal care in healthcare applications, and presents a prototype implementation. It describes implemented server and client modules enabling an instant notification service. Another study [12] identifies integration and security challenges facing pervasive healthcare systems, and proposes some solutions for these problems.

ANN algorithms such as Back-Propagation (BP), Radial Based Function (RBF), and Learning Vector Quantization (LVQ) require CPU, memory and I/O intensive operations, so using these algorithms on small mobile devices which are the main user devices of pervasive healthcare computing was difficult or sometimes impossible in the last years. Because small mobile devices generally don't have powerful CPUs, large amount of memory and high-speed I/O and networking capabilities compared to desktop PCs. However, their speeds and capacities have increased recently, and now new applications and software communication models, which require processing power, large memory, and high speed communications, can be used on these devices. In our previous study [13] we analyzed basic TCP socket connections, Java RMI distributed object technology and service oriented approaches, which are the representatives of three important generations in distributed systems. Client/server architectures were studied and the time analyses for different wireless network connections were presented. One of the results of this study was that these small mobile devices were ready for the development of more advanced applications and distributed software communication technologies including Java RMI and service oriented computing. We have observed that the recent developments in small mobile devices and wireless communications provide a strong motivation to develop new software techniques and mobile services for pervasive healthcare computing.

Our other study [14] presents the initial results for a simple client (patient's PDA) and server (powerful desktop PC) two-tier pervasive healthcare architecture. The computations of ANN operations on both client and server sides and wireless network communications between them are optimized for real time use of pervasive healthcare services.

3. The ANN model for diagnosing internal Ilnesses

Medical information systems in modern hospitals and medical institutions become larger, and this trend causes big difficulties for extracting useful information for decision support systems. Recently neural networks have become a very important method in the field of medical diagnostic applications.

In this study three-layered multilayer perception (MLP) feed-forward neural network architecture was used and trained with the error back propagation algorithm. The back propagation training with generalized delta learning rule is an iterative gradient algorithm designed to minimize the root mean square error between the actual output of a multilayered feed-forward neural network and a desired output. Each layer is fully connected to the previous layer,

and has no other connection [15]. The back propagation is one of the simplest and most general methods for supervised training of multilayer neural networks this training method is simple even for complex models (networks) having hundreds or thousands of parameters. In this method the network weights are moved along the negative of the gradient of the performance function. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by the user.

3.1. Training data for internal illnesses

The blood and urine test result's data have been used as a reference training data. One input, one hidden layer and one output layer are used in the MLP model for internal illnesses as shown in Fig. 1. The input layer has 103 nodes, the hidden layer has 104 nodes and the output layer has 19 nodes.

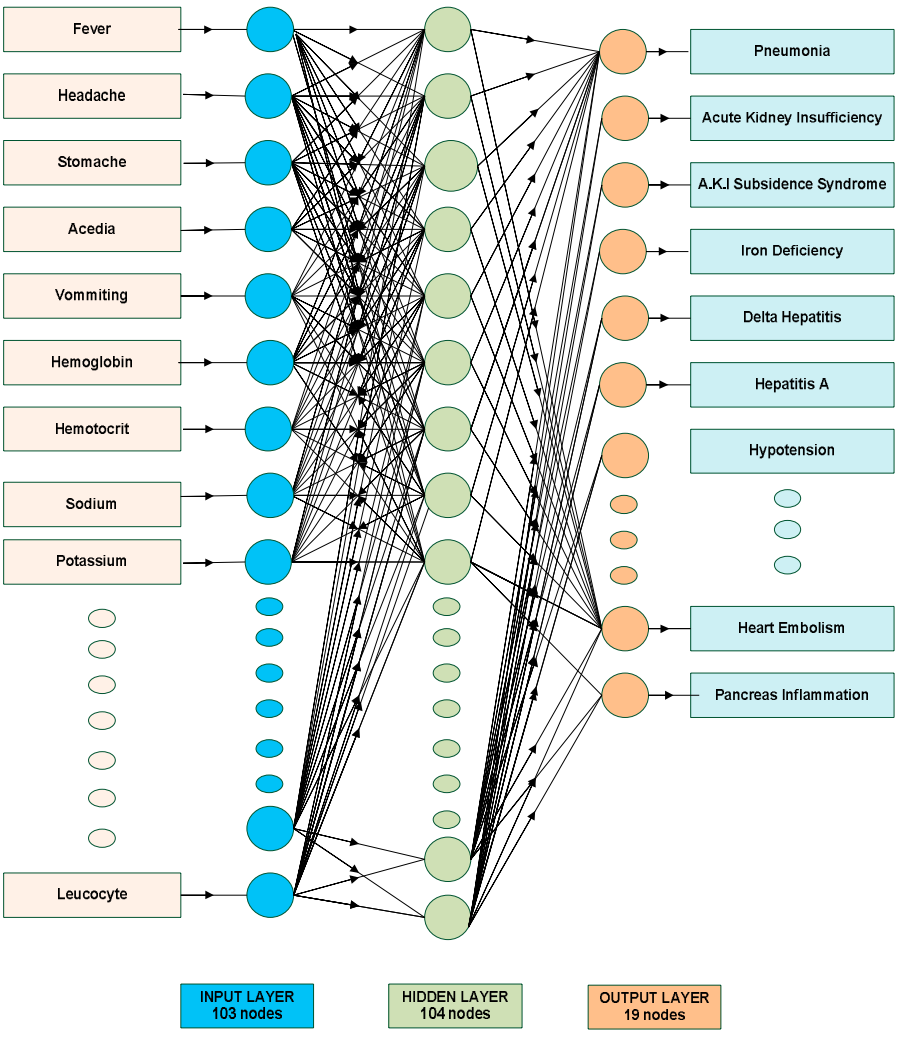

Fig. 1. The ANN model for diagnosing internal illnesses

4. The implementation of the ANN Model

The internal illnesses are diagnosed using each patient's laboratory data stored in the central database. This data come from the different departments of the hospital. We developed a hospital simulation model for the data collection to the central database. There are 2 modes, manual mode and automatic mode. In the automatic mode, the data is sent to the database from different sources automatically. In the manual mode, the data is entered by manual.

Each patient's personal information and the analysis results are stored in our database system. The stored data in the database is sent to the ANN server to diagnose the illnesses. As shown in Fig 2, for a patient's personal information, 103 illness data from the database can be seen on the ANN server screen. At the same time it is possible to see a list of currently connected patients, and personal information belonging to these patients on the ANN server screen.

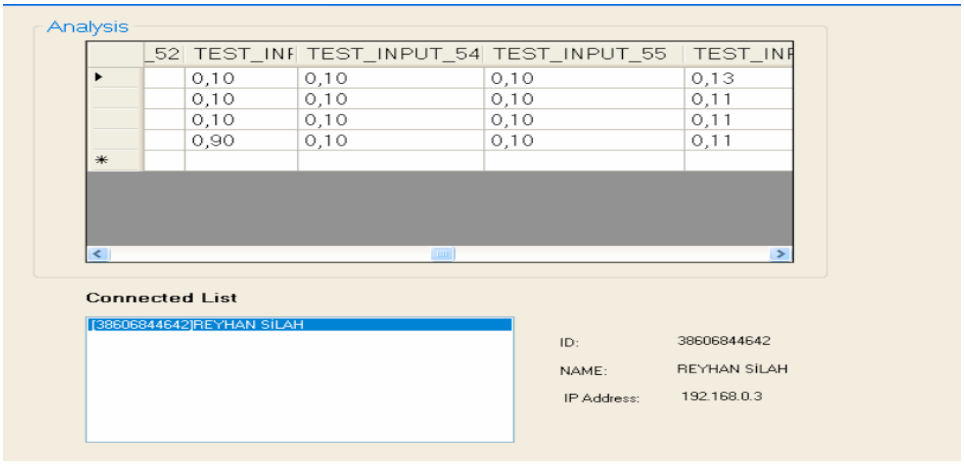

Fig. 2. A user interface of the ANN server

a) Main login screen b) Registration screen c) A result screen example

Fig. 3. The user interfaces of the PDA client application

The patients do not have to go to the hospital for learning their illness results. When they are registered to the system, they login the server simply by entering the ID number and password information, then they can learn their illness results at anytime and anywhere. When the patients connect to the server, the ANN server sent the results of the diagnosis of illnesses to the patients as shown in the Fig 3-c.

5. Conclusion

In this study we developed a client server system to diagnose the internal illnesses using pervasive healthcare computing and ANN techniques. The method of diagnosing internal illnesses used in this study is based on 19 different internal illnesses according to the 103 hospital data results from patients. The stored data from the database is sent to the ANN server. The server processes the data using the ANN model proposed in this paper. The ANN server sent the results to patients' PDAs when they are requested.

Many of these studies in diagnosing illnesses have concentrated on pervasive healthcare computing techniques, and the others only focused on ANN techniques for diagnosing illnesses. In our research study, we investigated the problems of both technologies when developing a usable diagnosing system.

References

1. M. Weiser. "The computer for the 21st century Scientific American", September, 1991.
2. V. Stanford, "Using Pervasive Computing to Deliver Elder Care", *IEEE Pervasive Computing*, 1(1): 10-13, 2002.
3. *Pervasive Computing in Healthcare*, CRC Press, 2007.
4. C. Bayraktar, B. Karlık, F, Demirezen Yağmur, "Automatic Diagnosis of Otitis Media Diseases Using Wavelet Based Artificial Neural Networks", *1st International Symposium on Computing in Science and Engineering (ISCSE)*, Kuşadası, Aydın, June, 3-5, 2010.
5. *Pervasive Healthcare Computing*, *EMR/HER, Wireless and Health Monitoring*, Springer, 2009.
6. M. Blount et al., "Remote Health-Care Monitoring Using Personal Care Connect", *IBM Systems Journal*, 46, No. 1, pp.95-114, 2007.
7. O, Boric-Lubecke, V. Lubecke, "Wireless House Calls: Using Communications Technology for Health Care and Monitoring", *IEEE Microwave Magazine*, 3(3): 43-48.
8. M. M. Nelson, W. T. Illingworth, *Practical Guide to Neural Nets*, Addison Wesley, 1994
9. L. Özyılmaz, T. Yıldırım, "Artificial Neural Networks for Diagnosis of Hepatitis Disease", *Proceedings of the International Joint Conference on Neural Networks*, vol.1, p.p. 586 – 589, 2003.
10. F. D. Yağmur, B. Karlık, A. Okatan, "Automatic Recognition of Retinopathy Diseases by Using Wavelet Based Neural Network", *First IEEE International Conference on the Applications of Digital Information and Web Technologies*, Ostrava, Czech Republic, 2008.
11. K. Kang, J.Woo Lee, H. Choi, "Application Binder: Providing Instant Application Runtime for Developing Healthcare Application", *The International Conference on Next-Generation Computing*,Volume 1, pp.190-194, Nov. 29-30, 2007.
12. K. Wang, Y. Sui, X. Zou, A. Durresi, S. Fang, "Pervasive and Trustworthy Healthcare", AINA Workshops 2008, p.p. 750-755.
13. H. Gümüşkaya, A. V. Gürel, M. V. Nural, "Architectures for Small Mobile Communication Devices and Performance Analyses", *First IEEE International Conference on the Applications of Digital Information and Web Technologies*, Ostrava, Czech Republic, 4-6 August 2008.
14. O. Karan, C. Bayraktar, H. Gümüşkaya, B. Karlık, "Diagnosing Illnesses using Neural Networks and Pervasive Healthcare Computing", *1st International Symposium on Computing in Science and Engineering (ISCSE)*, June, 3-5, Kuşadası, Aydın, 2010.
15. Simon Haykin, *Neural Networks a Comprehensive Foundation*, Pearson Education, 2001.