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U-health Expert System with Statistical Neural Network

Byoung-Ho Song
Murdoch University, INBS (intelligent NanoBio System Co-Design Centre), School of Engineering and Energy, Faculty of Minerals and Energy
Perth(Murdoch), Austrailia
cssstar@empal.com

Jang-Jae Lee
Murdoch University, INBS (intelligent NanoBio System Co-Design Centre), School of Engineering and Energy, Faculty of Minerals and Energy
Perth(Murdoch), Austrailia
vco21@naver.com

Mike Lee
Murdoch University, INBS (intelligent NanoBio System Co-Design Centre), School of Engineering and Energy, Faculty of Minerals and Energy
Perth(Murdoch), Austrailia
Mike.Lee@murdoch.edu.au

***Abstract*—Ubiquitous Health(U-Health) system witch focuses on automated applications that can provide healthcare to human anywhere and anytime using wired and wireless mobile technologies is becoming increasingly important. This system consists of a network system to collect data and a sensor module which measures pulse, blood pressure, diabetes, blood sugar, body fat diet with management and measurement of stress etc, by both wired and wireless and further portable mobile connections. In this paper, we propose an expert system using back-propagation to support the diagnosis of citizens in U-Health system.**

Keywords-Neural Network; U-Health; Expert System; Backpropagation

I. INTRODUCTION

U-Health system is recently inserted in the human body or wear a variety of possible bio-sensor signals through the human signal for a variety of real-time or periodic checks will be implemented automatically as well as manually. The human signal will be passed that to the system server that by using the Internet or wireless communication, regardless of time and space, through real-time communication network system. All data are transferred to the results of an expert system to automatically real-time analysis of the materials inside to clean up problems that require a doctor's diagnosis in the final stage will be reported to a doctor. U-Health system is configured that to the new life you need to accurately monitor the development of a bio-sensor technology, measured bio-signals accurately in real time can be passed to medical institutions of networking technology, many of data to store, analyze the data processing and standardized systems and medical services provided to patients is composed of specialized medical services by using these materials. In this time the world's population being of the aging population to treat diseases of the human aspects of the disease than to minimize the possibility of extending life and health care for the senior population is an important element of health [1]. Accordingly, concept of the ubiquitous home health care treatment such as the health care phone is accelerating the development of remote medical services medical services. U-Health system means in the biological signal instrumentation and automated diagnostics, emergency alert system means available in portable wireless biometric measurement. So potential commercial products based on our proposed U-Health system are using the mobile phone diabetes and blood sugar measurement, body fat diet with management and measurement of stress etc. U-Health systems related the country's leading research MobileWARD using the EPR(Electronic Patient Record) to check the status of each patient's room, store and manage data collected will be using the patient's condition [2]. Collection of the sensing all data that controlled a change of environment data and the patient's health status, stored in the database and sent to mobile devices will be monitored. UbiMon(Ubiquitous Monitoring Environment for Wearable and Implantable Sensors) that extracts from sensors attached to patient health information will be stored in the remote patient-database [3]. Commonness and changes according to each individual and the importance of personalized health care system is rapidly increasing because of aged population and the increase of interests in health. Specially, ubiquitous computing environment that should be combined with the medical information systems for the diagnosis or prevent a variety of health-related application services are required. To do this, firstly, a system consisting of sensors to hardware and communications infrastructure must be built. Secondly, middleware technology to integrate the different hardware and communication infrastructure is implemented. And thirdly, the user interface module, health information collection and analysis, and a variety of applications for emergency response information service are required for the U-Health system. But existing study has been active in progress focus on hardware infrastructure, such as sensors and devices. Therefore, U-Health system application service to build information system management is focused on most of our work to improve the hospital's doctor or nurse and the patient's disease. More and more studies that focus on the health of individuals and health care information services are underway. Our proposed system is the privacy personalized U-Health system actively. The U-Health systems research is also being done for the Expert System. So, using the Expert System, the results of analysis for the purpose of developing a system to transfer the data from sensors and a thorough examination obtained from the hospital database are presented.

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II. U-HEALTH SYSTEM CO-DESIGN

U-Health system is composed of Bio Sensor device, Bio-DB server, standard-DB server and Expert system where Figure 1 shows the entire system configuration. Bio-sensors can detect the device that recognizes a particular substance where a biological receptor is combined with an electric or optical transducer response to biological interactions and recognition to convert to electric or optical signals to analyze the material. Detection of biological signals goes by way of wireless network for the detection of life and then will be passed to the database server.

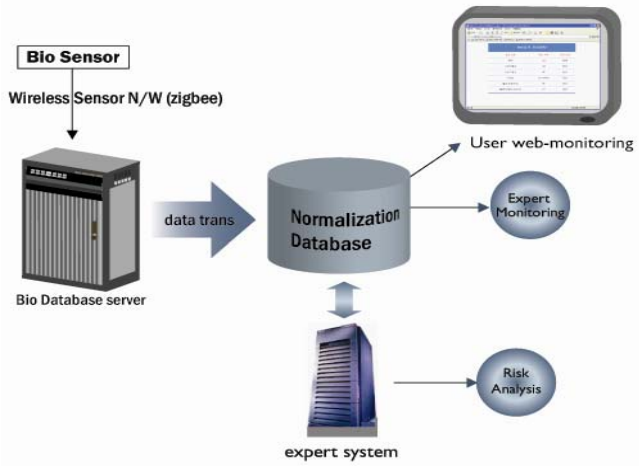

Figure 1. Overall U-Health System configuration

Wireless network technology in health care system facilitates a handy measurement for a patient's health condition and is generally one of core technologies to service advancement such as each patient's individual customized service provider and remote diagnosis and treatment together with historical check-up and repeated check-up, reducing hospital cost. In our research, our proposed U-Health system is implemented by Zigbee-based wireless sensor network in the 2.4GHz system [4]. IEEE 802.15.4 Zigbee is local wireless network technology that focuses n applications required to low speed, low cost and low power consumption. Figure 2 is the Zigbee-based wireless communications we have developed.

Table 1 show the sensing data stored in the Bio-DB temporarily. Data shown in Table 1 are the structure of the incoming data, the actual pulse data that are measured by the sensor value. MSG-type fields represent bio data type. Here the bio data type tells whether the pulse, blood pressures, blood sugar represents which types they fall into or not. And GroupID field represents sensor information. That is to say, one sensor has one GroupID. Timestamp field is the data measured time from sensor. Reading field of 11 represents real data value, 55, by two bytes as a format of hexadecimal.

Figure 2. Zigbee-based wireless communications screen

TABLE I. THE STRUCTURE OF THE SENSING DATA

7E 00 0A 7D 10 00 00 02 00 00 00 01 00 02 00 EE D3 FF FF 55 00										
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
7E 00	0A	7D	10	00 00	02 00	00 00	01 00	02 00	EE D3 FF FF	55 00
1.Address 2:MSG Type 3:GroupID 4:Data Length 5:Source address 6:Orgin address 7:Sequence number 8:Hop Count 9:address 10:timestamp 11:reading										

A. Expert System

Expert system divides into two classes: Expert knowledge, using computer program for the information necessary to act intelligently, base to store and the ubiquitous solution to save general knowledge, namely, reasoning engine [5]. Expert system structure composes knowledge base module, inference engine module and user interface module as shown in Figure 3.

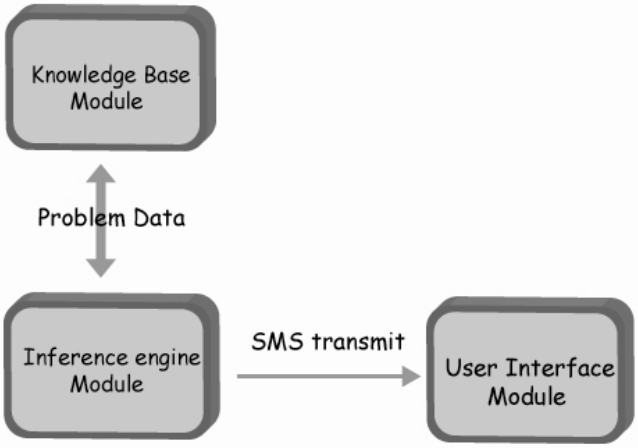

Figure 3. Expert system block diagram

Inference engine module is an inference program to solve for user's question based on knowledge registered in the knowledge base. Here the inference is a process to estimate

valid new facts logically from already known facts and regulations. The efficiency of Expert system depends upon how effectively one executes the Reasoning(or Inference) using the knowledge stored in the Knowledge base Figure 4 is a part of the Interface program.

```
//Pulse
Function  TMainForm.Get_Pulse(Value:Integer):String;
begin

      if  (Value<60) then
          Result :='Bradycardia'
  else if  (Value>=60) and (Value<=100) then
           Result :='Normal'
  else if (Value>100) then
          Result :='Tachycardia';

end; //Function

//Blood Pressure
Function  TMainForm.Get_Pressure(Value1,Value2:Integer):String;
begin
        if (Value1<100) then
            Result :='Hypotension'
    else if (Value1>140) or (Value2>90) then
            Result :='Hypotension'
    else if (Value1<120) or (Value2<80) then
            Result :='normal'
    else
            Result :='Prehypertension';

end; //function
```

```
//BMI
Function  TMainForm.Get_BMI(Value:Integer):String;
begin

      if  Value<20 then
          Result :='Low weight'
  else if  (Value>=20) and (Value<=24) then
          Result :='normal'
  else if  (Value>=25) and (Value<=29) then
          Result :='Over weight'
  else if  Value>=30 then
          Result :='Corpulence';

end; //function

//Blood Sugar
Function  TMainForm.Get_Bsugar(Value1,Value2:Integer):String;
begin

      if (Value1>=80)  and (Value1<=110) and (Value2>=80) and (Value2<=140) then
          Result :='normal'
  else if (Value1>110)  and (Value1<=125) and (Value2>140) and (Value2<=180) then
          Result :='Permit Limit Value'
  else if (Value1>=125) and  (Value2>=180) then
          Result :='Diabetes';

end; //function
```

Figure 4. Interface program

B. U-Health system with Backpropagation algorithm

In this research, we propose a backpropagation algorithm to use as a tool of Expert's decision making by diagnosing one's health condition depending on the data types for health information diagnosis. The backpropagation algorithm as the diagnosis algorithm is a kind of Multilayer perceptron in the field of typical model of supervised learning. The backpropagation algorithm is a supervised learning algorithm by massaging input values and targeted values, which is executed by controlling the weight intensity that is connected to each neuron. This means the supervised learning is performed by the process in decreasing the error between the output value and the target value. Elaborating our proposed U-Health system with the backpropagation algorithm, the principle is as follows: Backpropagation learns by iteratively processing a set of training samples, comparing the network's prediction for each sample with the actual known class label. For each training sample, the weights are modified so as to minimize the mean squared error between the network's prediction and the actual class [6][7]. The input comes as weight of the neural network to double and when some time repeats the process which becomes worse the output, y, which is a resultant price of input comes out. The output, y, given in the learning data, and the desired output, o, are not the same. As a result, the neural network, y-o, as a margin of error, e, when the error weight in proportion to the renewal of the output layer, and then update the weight of hidden layer. The weight to renew the opposite direction, the direction is the direction of the handling of the neural network. As the backpropagation algorithm is processed for the U-Health system in sequence as follows: the learning sequence of weighted value is processed by output layer → hidden layer, meanwhile the operation of the neural network is processed in the sequence of input layer → hidden layer → output layer [8][9].

Processes by the backpropagation algorithm using neural network are proposed as follows:

① Input layer nodes must be FOUR that is equivalent to Each data variables.

② Output layer node has Four due to danger level. If the first node is selected by learnt weight via the input data, it is equivalent to level 1 that indicates normal numeric value.

③ Number of hidden layer node must be 1 or more. It is important to determine the number of the proper hidden layer since the learning time increases if the number of the hidden layer increases.

④ Normalization is done by obtaining the maximum and minimum value in the input data.

Here four input data types of proposed backpropagation algorithm are I_{i1} : The contraction blood pressure Rate, I_{i2} : The relaxation blood pressure Rate, I_{i3} : Breathing Rate, I_{i4} : Pulse Rate, where N represents number of the data for learning and I_i stands for i^{th} learning data set, 1≦i≦N.

III. RESULTS AND DISCUSSION

The field implemented from user web monitoring system is that the user connects in the Webpage and selects health information, and then can monitor one's pulse rate, the blood pressure and body mass index of oneself by connecting with a normalization database, which means user can monitor one's blood glucose etc. bio information numeric value and one's diagnosis result. The user web monitoring system with state information is a screen which outputs a diagnosis result about resultant value of pulse, the contraction blood pressure, the relaxation blood pressure, body mass index, the empty stomach value with numerical values, the blood glucose after two hours of the user who is stored in user's info tables of the normalization database server as shown in Figure 5.

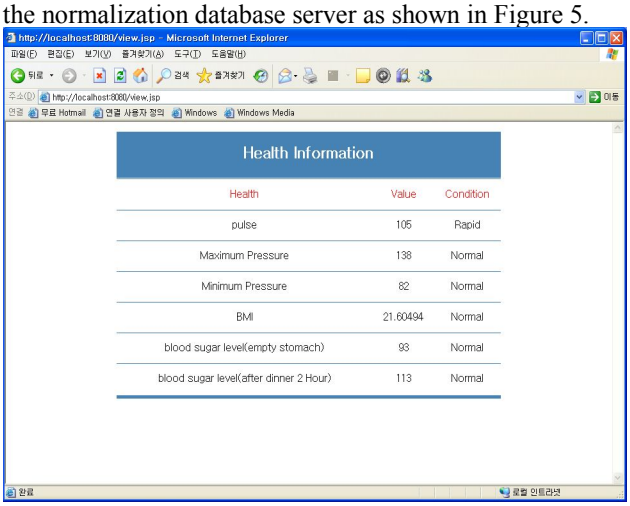

Figure 5. Result of healthy information

The expert monitoring system is implemented with normalization database server and expert system to provide the feedback sensed data information monitored by specialists. As shown in Figure 6, the numerical values indicated in the counter confirm whether the new data is added into normalization database every minute. If any sense data exist, then they are checked to be diagnosed in the expert system. Figure 6 shows the diagnosis result of expert monitoring system.

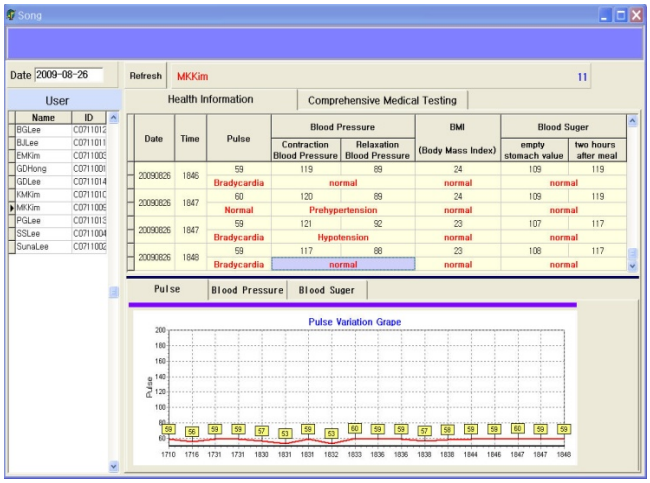

Figure 6. Diagnosis result of expert monitoring system

When the normalization database server and expert system server are connected and the bio data of a user arrive at a risk level, SMS functions are activated and then SMS message is transmitted automatically. Uses the timer and when there is a data which is new per minute at unit is inference result to send diagnosis result Figure 7. If any abnormal results are appeared through the inference module of the expert system, the SMS texts will be transmitted. Figure 7 shows an evaluated inference result when new data appear every minute using the timer.

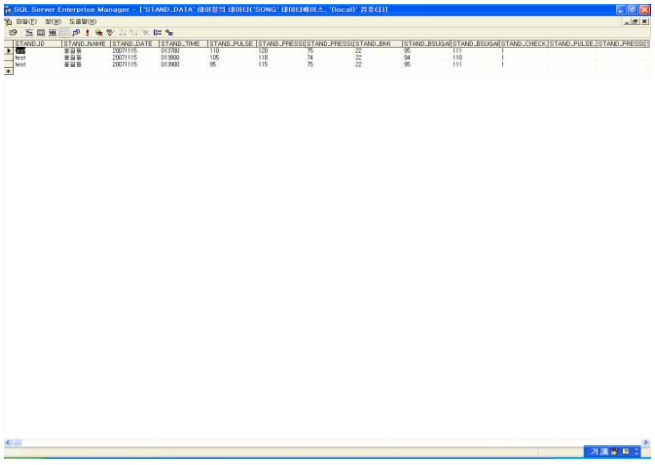

Figure 7. Inferenced result

SMS transmission first connects to data communication line via Code Division Multiple Access(CDMA) and then the SMS texts with data structure for SMS transmission are transmitted after a proper authentication under network connection as shown in Figure 8.

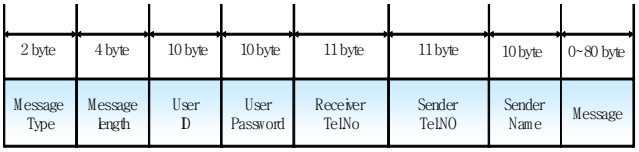

Figure 8. Data Structure of SMS transmission

Further the data structure comes with inferenced results and transmits a SMS under WIPI environments as shown in Figure 9.

Figure 9. SMS transmission results

IV. PERFORMANCES AND SUMMARY

The U-Health system has a capability of testing and then diagnosing for the sensor pulse rate of samples of 200, the contraction blood pressure and the relaxation blood pressure, breath rate using bio signals. Also each data are classified with four conditions according to diagnosis of the expert where the bio signal by conditions of the user is indicated in Table 2.

TABLE II. BIO SIGNALS CONDITION OF USER

Level	**Pulse**	**Breath**	**Contraction blood pressure**	**relaxation blood pressure**
	Unit : Count	*Unit : Count*	*Unit: mmhg*	*Unit: mmhg*
Level.1	60-90	12-20	100-130	6 0-80
Level.2	91-140	21-29	131-149	80-90
Level.3	141-180	30-34	150-180	90-100
Level.4	180 over	35 over	200 over	100 over

From the sensor from 1st data in data 200 samples acquires the 100th data used in running and from 101st data the 200th data used in evaluation. The data 100 samples are used in running passed by a normalization and pulse rate(HR), the contraction blood pressure and the relaxation blood pressure, used from the expert used three days of breath rate(BR) with input and used from the expert's

diagnosis result which reaches at target value. Input data are used as normalized values between 0 and 1 from the rest of 101st data to 200th data after supervised learning of the weight through 100 sampled data. The system diagnosis result which is used in evaluation shows in Table 3. Here, based upon Doctor's statistical diagnosis data sheet for health check-up levels, Level 1 represents "NORMAL" for health condition; Level2 "WARNING"; Level 3 "SERIOUS"; Level 4 "EMERGENCY",

TABLE III. THE SYSTEM JUDGMENT RESULT WHICH IS USED IN EVALUATION

No	Pulse	Breath	contraction blood pressure	relaxation blood pressure	Diagnosis Result of Doctor	Diagnosis Result of U-Health System
	Count	*Count*	*mmhg*	*mmhg*		
101	128	32	167	93	Level.3	Level.4(*)
145	88	18	122	79	Level.2	Level.3(*)
151	96	21	133	89	Level.1	Level.2(*)
180	81	15	121	77	Level.1	Level.2(*)

Here * represents diagnosis result by our proposed U-Health system, which clearly shows the differences from the diagnosis result of the specialist.

Four results out of total 100 evaluation data show different, resulting in about 96% accuracy in terms of final diagnosis results. According to Doctor's statistical diagnosis data sheet for health check-up levels, the results of our proposed U-Health system shows more serious Levels for occurred four cases than the ones of Doctor 's Diagnosis of as shown in the last two columns of Table 3, which means our results would protect user's health condition. The diagnosis result that is developed by proposed algorithm will be able to predict the strength which outperforms the efficiency of expert system with the knowledge base construction which is advantageous to improve the diagnosis result and to miniaturization of the bio sensor, the pressure sensors and GPS bases moving/strength tracks etc. Implementation of home networking system which uses a location tracking function and the wireless sensor, and illness history using a statistical algorithm for U-Health system would bring better improvement in the future.

V. CONCLUSIONS

In this paper, we implemented user interface module of U-Health System for Biometric Data sensing & Expert System for automatic Diagnosis and comprehensive diagnosis system in association with hospital DBs. The expert system using back-propagation to support the diagnosis of citizens in U-Health system is presented. Only four results out of total 100 evaluation data show different against Doctor's diagnosed results, resulting in about 96% accuracy. It is found that our proposed algorithm predicts the diagnosis strength that outperforms the efficiency of expert system with the knowledge base. Future remedy will be advantageous to improve the diagnosis result for the compact U-Health system if a statistical algorithm for illness history and miniaturization of the bio sensors and the home networking system using location tracking function and the wireless sensor are implemented toward our proposed system.

REFERENCES

[1] Chiu, D.K.W. Kwok, B.W.C. Wong, R.L.S Cheung, S.C. Kafeza, E. Kafeza, M.. Alberts., "for healthcare process and data integration," System Sciences, Proceedings of the 37th Annual Hawaii International Conference on:1-10, 2004.

[2] Dan Rasmus, Bill Crounse, M.D., "Future of Information Work Healthcare 2015," Microsoft Crop., White Parer, May 2005.

[3] Jesper Kjeldskov and Mikeal B. Skov., "Supporting Work Activities in Healthcare by Mobile Electronic Patient Records," APCHI 2004, Vol. 3101, pp. 191-200, 2004.

[4] V. Rajendran, K. Obraczka, and J. J. Garcia-Luna-Aceves, "Energy-Efficient, Collision Free Medium Access Protocol for Wireless Sensor Networks," SENSYS, 2003.

[5] Edwards, G., Kang, B.H., Preston, P. and Compton, P., "Prudent Expert Systems with Credentials: Managing the Expertise of Decision Support Systems.", Inter. J. Bio-Med. Computing, 40, 125-132, 1995.

[6] Yoshio K. and Keith W. and Ian Mc., "Forecasting Nonlinear Time Series with Feed-Forward Neural Networks(A Case Study of Canadian Lynx Data)," Journal of Forecasting, pp.105-117, 2005.

[7] Simon Haykin, "Neural Network(Acomprehensive foundation)," Prentice Hall International, pp.161-172, 1999.

[8] Go, J., Han, G., Kim, H. and Lee, C., " Multigradient: a new neural network learning algorithm for pattern classification." IEEE Transactions on Geoscience and Remote Sensing, 39, pp. 986-993, 2001.

[9] C. Turchetti, P. Crippa, M. Pirani, G. Biagetti, "Representation of Nonlinear Random Transformations by Non-Gaussian Stochastic Neural Networks", IEEE Transactions on Neural Networks, vol.19, no.6, pp.1033-1060, Jun. 2008.