

The Real-Time Monitoring & Analysis System for Hospitalized Patients using Zigbee Technology

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Abstract – The work introduces a real-mode analyzing system for patient. The system is made up of two different subsystems such as patient physical states data collection and communication system based on Zigbee embedded technology, and hospital monitoring and control centre. The patient physical states data acquisition and communication system monitors the main physical parameters and movement status continuously. The information from data acquisition system is forwarded to clinical monitoring system by Zigbee Wi-Fi module. The monitoring system collects required information from each patient and save it to central database, and then analyze the states of patient by fuzzy analysis. The data from patient can be shown in graphical or numerical mode, and then the surgeon can treat the patient as per the recorded stream of data.

Keyword – Zigbee, Wireless Health Monitoring, Microcontroller.

I. INTRODUCTION

Wireless sensor network is composed of a large quantity of wireless sensors based on Zigbee Embedded system. The Zigbee Embedded system provides a resolution for transmitting sensors' data by wireless communication. Zigbee Embedded system can transmit data with a rate of 250kbps, and then it is enough for the physical parameters of patient. The communication distance of Zigbee node can be over 150 to 200 meters, and can be spread by add route node, and then Zigbee Embedded system is suited to short distance wireless sensors network. Zigbee Embedded system owns many virtues, such as low power consumption, low cost, small size, free frequency, etc. To know the physical states of patient, the physical parameters need to be analyzed real-mode. The traditional medical test instrument is large size and connected by wire often, and the patient is required to be quiet during test. In most of hospital, the medical instruments need to be read by doctor or nurse, and the physical parameters are tested and recorded one or two times each day, the real -time monitoring is expensive for most of patients, and can be only acquirable for ICU by nurse. For this reason, the worsening of patient can't be found in time, and then the patient can't be helped in time. For most of patients can be analyzed real-mode in hospital, we should find new method. Consider that the movement of patient is limited in hospital, we adopted the Zigbee and wireless sensors network to acquire the physical parameters of patient.

With wireless sensors network, the patient can just take smart wireless sensors, and the real-mode physical data of the patient can be acquired and analyzed. The realmode monitoring system for patient can monitor and record the physical parameters, and then provide an auxiliary means for doctor to diagnose patient. On the other hand, with the intelligent diagnosis function, the system is helpful to find the patient be worse, and notify the doctor to help the patient [1].

II. THE STRUCTURE OF HARDWARE

The system is mainly designed with two sub-modules: patient health analysis data acquisition and communication system based on Zigbee embedded technology, and clinical control centre, it is showed in fig.1. The main function of the system include: On the basis of keeping the patient movement intact, the main physical states and movement parameters of patient can be continuously analyzed and recorded real -time with wireless multi-sensors' terminal , and then the doctor can analyze the trend of the patient with the physical parameters. The measured data can be sent to hospital monitoring and control centre with wireless communication system. The hospital monitoring centre receives the measured data from each patient and saves them to database, and then diagnoses the patient automatically with the intelligent diagnosis software to find emergency of the patient. The doctor can watch the parameter's change as graph or numeric on computer and analyze these data to get more information about the patient, thus the doctor can know the physical states or movement parameters of patient, and then it is helpful to get the correct diagnosis result of doctor [2].

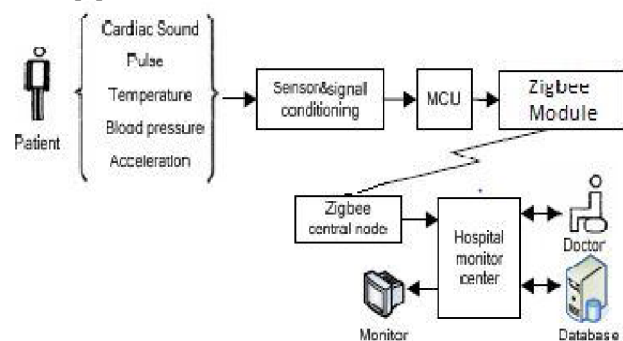


Fig.1. Block diagram of monitoring patient environment

A. Physical states acquisition system for patient

To keep the movement of the patient intact with the sensors on his body, the wireless sensors are required to be minimize and portable. Base on Zigbee wireless network communication technology, the patient physical states data acquisition system is made up of sensors, signal conditioning unit, AD converter, embedded microcontroller unit, and Zigbee communication module. According to the state of an illness of the patient, the sensors which are fixed on patient body maybe some of these sensors: cardiac sound sensor, blood pressure sensor, pulse sensor, temperature sensor, and acceleration sensor. The cardiac sound, temperature sensor, blood pressure and pulse sensor acquire the physical states of the patient. The acceleration sensor gets movement parameters of the patient, and then the patient's movement can be recognized by the intelligent movement recognition software, it is helpful to avoid false alarm. Each sensor is fasted on corresponding position of the patient's body. Each wireless sensor terminal acquires and sends data to the Zigbee centre node of the hospital monitoring and control centre.

The main hardware structure of wireless sensor node is shown in figure 2. The physical states and movement parameters are acquired with sensors at first, and then the signal is been transferred to signal conditioning unit to be amplified and filtered, the A/D converter transforms the analogue signal to digital signal, the main function of MCU is to integrate the data with the definition frame format, at last, the Zigbee communication module sends it to hospital monitoring and control centre. [3]

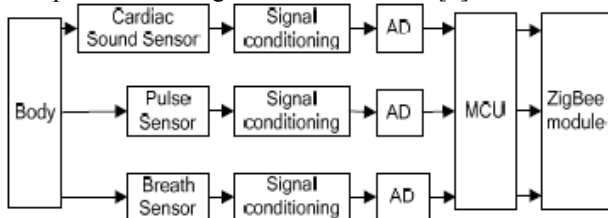


Fig.2. The proposed system block diagram

B. The sensor in the system

The system can acquire multi-sensor signal to monitor the patient physical states, the sensors which are integrated in the system may be one or several of listed sensors: cardiac sound sensor, pulse sensor, breath sensor, blood pressure sensor, acceleration sensor, temperature sensor.

The hand pulse sensor modules is produced by Taiwan Biotronic Technology Incorporation, the sensor is very low cost, good sensitivity and high accuracy, stable and consistent ability, 4.5V power supply application, With the introduction of digital signal processing filter, the sensor module can eliminate the disturb from the movement or vibration of human being.

The system adopted the cardiac sound sensor HKY-06 which is produced by HuaKe electronics, the sensor uses PVDF film to collect the cardiac sound, and signal

processing module is integrated in this sensor. The sensor is smart and encapsulate with epoxy resin, it can output anti-jamming and low impedance signal with high fidelity, and it can be integrated easily because its power supply and output is connected with electrical plug for convenient development. To acquire the accurate physical parameter of athlete, an especial method needs to be applied to fast the sensor. Blood pressure signal is acquired by pressure sensor, and then the signal is amplified and conditioned properly, at last the AD converter transforms the signal to digital. The system chooses the pressure sensor MPX5050GP which produced by Motorola company, it integrates the unit of signal amplifier and conditioner, and the pressure of artery blood to the wall of blood vessel is been converted to the electric signal of 0~4.7 voltage, the corresponding blood pressure is 0-375 mmHg. Temperature sensor get the body temperature of patient, the system used temperature sensor TA1 which is produced by Esis Company. The sensor has several output modes: digital, voltage or current. And it is low power consumption, high resolution, robust design human comfort, and multiple calibration point's temperature measurement.

The system used acceleration sensor ADXL105 which is produced by Analog Devices Corporation. The sensor is light weight, low cost, small size and high sensitivity. There is a problem should be carefully when it is been used in wireless sensor network. Because the acceleration sensor is very sensitive, the noisy signal will be introduced, as a result, the step counter and strength may be wrong. There are two methods to resolve the problem, one is to fast the position of the sensor, or deal with the primitive data by the software in hospital monitoring centre [4].

Monitoring and control centre is the heart of the realmode monitoring system for patient physical states, and it can organize, exhibit, accumulate, query and evaluate the details from each patient. The scheme structure of monitoring and control centre is shown as figure 3. It is made up of the centre node of Zigbee communication, micro-controller unit, memory, data process, real-mode monitoring terminal, database server, data query and analysis terminal, etc.

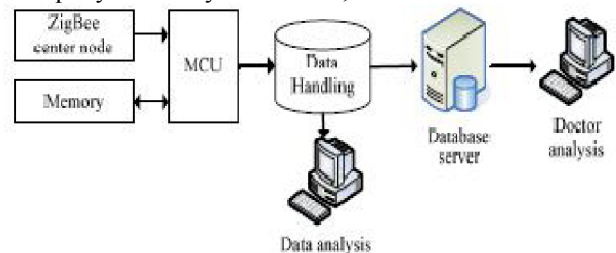


Fig.3. The hospital monitoring and control centre

Real-mode monitoring display is the important part of hospital monitoring centre. The Zigbee centre node receives the data from each of wireless sensor node, then

the micro-controller unit recognizes the patient ID and dispatches the data frames according to defined protocol format, the data process unit obtains the real-mode data corresponding to each sensor, and then the display system shows these data on screen as graph or numerical value. By the data query and analysis computer, we can control and inquire about the parameter of remote terminal on the patient body. The real-mode monitoring system need display the parameters from many patients at same time on multi-monitor. The display software in real-mode monitoring computer is developed with Labwindows CVI. To save the patient from the acute disease in time, the monitoring computer has the intelligent diagnosis function of real-mode analysis and alarm. The data analysis can be performed automatically when the physical states of patient is received, and then an alarm message can be sent to the doctor or nurse if there is any sign of acute disease for any patient.

Database server is the centre for data exchange in whole system. To assure the internality of patient information, the monitoring and control centre will store the physical states and movement parameters from all patients communication terminal, and then the data can be recovered and analyzed if it is necessary.

III. THE INTELLIGENT MONITORING BASED ON FUZZY REASONING

The monitoring computer owns the intelligent diagnosis function of real-mode analysis and alarm, and then the patient emergency can be found in time. It is performed by the recognition software based on fuzzy reasoning.

A. Hospital Monitoring Centre

Fuzzy logic is a type of multi valued logic resulting from unclear set theory to pact with reasoning that is estimated rather than precise. Just as in fuzzy theory the set membership values can range between 0 and 1, in fuzzy logic the extent of truth of a statement can range between 0 and 1 and is not controlled to the two truth values {true, false} as in standard predicted logic. The information from sensor is real-mode data, and it shows the current parameters of the patient. Sometimes we can judge the real states of the patient by one parameter. But with the complication of environment, we often can't depict a clear conclusion that the patient is in danger just according to single sensor data, and then we put forward the fuzzy analysis method based on multi sensor to identify the emergency of patient. For the hospitalized patient, the emergency may occur often, such as tachycardia, heart attack, apoplexy, hyperpyrexia, fall, etc. Some of the emergency can be identified by single sensor data, but most of them can be identified only by multi-sensor data. To identify the emergency, we define the degree of urgency as the fuzzy degree of membership, fuzzy set as {urgency}, the degree of membership function of the fuzzy set can be different for each kind of sensor.

For temperature sensor, the degree of membership function is defined as following equation (1)

$$\mu_{\alpha}(\chi) = e^{-\chi-\alpha/2/2\beta} \quad \beta \neq 0 \quad (1)$$

It may be different for each kind of sensor, a is the normal value of physical states, e.g. the body temperature for normal human being is 37.2°C, then, $a=37.2$. For hand pulse sensor and breath sensor, the degree of membership function is shown in following equation (2)

$$\mu_{\alpha}(\chi) = 2(\chi - \alpha/\beta - \alpha) \quad \beta \neq \alpha \quad (2)$$

For pulse sensor, b is the biggest value of pulse, it can be different for each person, a is the normal pulse. For breath sensor, b is the biggest breath frequency, a is the normal breath frequency.

The fuzzy degree of membership function will be different for each person and each sensor. It means that the parameters of the function will be defined only for certain patient. The parameter of the function will be refreshed when the physical states acquisition terminal is used for other patient.

After the sensor data is sent to CPU, the degree of membership is counted according to the corresponding degree membership function of each sensor, and then the data from multi-sensor are synthesized by fuzzy reasoning. If the fusion result shows that the patient may be in danger, the warning message will be sent to nurse station, and then doctor can treat the patient in time[5]. To recognize the patient whether normal or not, we should define some fuzzy rules for the multi-sensor fusion. The fuzzy rule is defined as follow format:

IF A and B Then Y (or Z)

IF A and B and C and D and E THEN Y(or Z).

For monitoring the patient, there should be many rules to identify the state of patient.

The intelligent monitoring course of the system can be described as follows: After the sensor detect the physical parameters, the sensor data is fuzzed at first, and then the MCU search and match the fuzzy rules in database, if there exists a rule which can match the input data, the result can be given by the rule, if there is not a rule, the system may be wrong, and then the data is abandoned. To avoid the uncertain case, the fuzzy rule database should be considered comprehensively [6].

IV. APPLICATION

The healthcare domain presents opportunities for a significant number of applications of wireless sensor technology. This system will be used in healthcare domains for health monitoring applications which include Disease Monitoring, Personal Wellness Monitoring, and Personal Fitness.

V. CONCLUSION

The real-mode analyzing system for heart disease patient physical states is based on Wi-Fi network communication technology. It can be taken by patient and keep the patient factions stable because it could be minute. The system can analyze and note down the physical states and movement characteristics in real-mode, and then provide an auxiliary output for the accurate conclusion for doctor. With the intelligent analyzing tool, the sign of discriminating illness of patient can be diagnosed early, and then the patient can be helped in time & the sudden damage of patient can be avoided. The Zigbee Embedded system can be appropriate for short distance communication, with distance is limited only about 150 meters, and then it can be suitable for in-patient monitoring. The system is significant to be applied to patient's health care and accurate diagnosis.

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REFERENCES

- [1] Rizzi Maria, etc. "A wireless sensor network for security systems adopting the bluetooth technology", vol.5, no.5, 2006, p652-657
- [2] Hofmann, Christian, "Wireless medical sensor network with ZigBee", *WSEAS Transactions on Communications*, vol.5, no.10, October, 2006, p1991-1994R.
- [3] Zhong zhenyu, etc. "Design of ZigBee Based Wireless Analyzing System for Medical Infusion", vol.21, no.5, 2007, p455-459
- [4] Li gang etc. "Fuzzy Logic technology to design monitoring center of mobile ECG telemonitoring system", *Automation & Instrumentation*, no.2, 2005, p18-21
- [5] Zhao fei, Si nong, "Fuzzy Rule for Real-mode Sampling, Portable Wireless Monitoring System for Collecting Human Running Status", *Control & Automation*, vol.22, no.8-2, 2006, p130-132
- [6] Ping wang, etc. "Diagnosis Method for Cardiac Patient Based on Improved Dempster-Shafer Evidence Theory", *The 2nd International Conference on Bioinformatics and Biomedical Engineering (ICBBE 2008)*, shanghai, 2008, p1935-1938