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Remote Wireless Health Care Monitoring System Using ZIGBEE

P.Murali Krishna (M.Tech)
Jnt University,Anantapur
Andhra Pradesh,India

Dr.K.Padma Priya,M.tech.Ph.D
Jnt University,Anantapur
Andhra Pradesh,India

ABSTRACT:

In recent years, the world is facing a common problem that the number of elderly people is increasing. Hence, the problem of home-care for elderly people is very important. In recently, wireless sensor networks are used to structure home-care system in many researches. Wireless sensor networks application for physiological signals communication transmission has many technologies. Such as the Infrared, Bluetooth and ZigBee, etc. Because the angle limit problem of the infrared transmission, and the infrared have not be used for Physiological signal transmission. Although Bluetooth is better than ZigBee for transmission rate, but ZigBee has lower power consumption. Hence, ZigBee is generally used for 24 hours monitor of communication transmission systems. The first procedure of the system that we use the biosensor to measure heart rate and blood pressure from human body, Using Zigbee the measured signal send to the PC via the RS-232 serial port communication interface. We can send the signal to remote PC or PDA from the internet. In particular, when measured signals over the standard value, the personal computer will send GSM short message to absent manager's mobile phone.In this paper, we presented the wireless sensor networks (WSN) to observe the human physiological signals by ZigBee, which is provided with lower power consumption, small volume, high expansion, stylization and two-way transmission, etc. ZigBee is generally used for home care, digital home control, industrial and security control. This paper developed a suite of home care sensor network system by ZigBee's characteristic, which is embedded sensors, such as the biosensor for observe heart rate and blood pressure. The biosensor transmits measured signals via ZigBee, and then sends to the remote wireless monitor for acquiring the observed human physiological signals. The remote wireless monitor is constructed of ZigBee and personal computer (PC). The measured signals send to the PC, which can be data collection. When the measured signals over the standard value, the personal computer sends Global System for Mobile Communication (GSM) short message to the manager. The manager can use the PC or personal digital assistant (PDA) to observe the observed human physiological signals in the remote place.

1. Introduction

Problem statement:

1. Controlling devices to be manual operation

2.Communication between devices for controlled to be short distance

Proposed system:

In this paper, we presented the wireless sensor networks (WSN) to observe the human physiological signals by ZigBee, which is provided with lower power consumption, small volume, high expansion, stylization and two-way transmission, etc. ZigBee is generally

used for home care, digital home control, industrial and security control. This paper developed a suite of home care sensor network system by ZigBee's characteristic, which is embedded sensors, such as the biosensor for observe heart rate and blood pressure. The biosensor transmits measured signals via ZigBee, and then sends to the remote wireless monitor for acquiring the observed human physiological signals. The remote wireless monitor is constructed of ZigBee and personal computer (PC). The measured signals send to the PC, which can be data collection. When the measured signals over the standard value, the personal computer sends Global System for Mobile Communication (GSM) short message to the manager. The manager can use the PC or personal digital assistant (PDA) to observe the observed human physiological signals in the remote place.

The structure of the wireless sensor network for home-care system illustrate in Figure 1. The first procedure of the system that we use the biosensor to measure heart rate and blood pressure from human body, the measured signal sends to the end device and than sends to the router, which is responsible for transmit the measured signal between end device and coordinator. When the measured signals send to the PC via the RS-232 serial port communication interface [3], the PC can analyze and store signal. We can send the signal to remote PC or PDA from the internet. In particular, when measured signals over the standard value, the personal computer will send GSM short message to absent manager's mobile phone.

2. ZigBee overview

ZigBee takes its name from the zigzag flying of bees that forms a mesh network among flowers. It is an individually simple organism that works together to tackle complex tasks [4]. ZigBee has built on the IEEE 802.15.4 low-rate, wireless personal area networks (WPAN) standard. The IEEE 802.15.4 defines the physical layer (PHY) and media access control (MAC) layer. The physical layer (PHY) supports three radio bands, those are

individually defined 2.4GHz ISM band (Worldwide) with 16 channels, 915MHz ISM band (Americas) with 10 channels, and 868MHz band (Europe) with single channel [5],[6], the data rates are individually defined 250Kbps at 2.4GHz, 40Kbps at
915MHz, and 20Kbps at 868MHz. The media access control (MAC) layer controls access to the radiochannel using the Carrier Sense Multiple Access with Collision Avoidance (CSMA-CA) mechanism. The transmission range is 1-100 meters. The ZigBee defines two types of devices; those are Full Function Device (FFD) and Reduced Function Device (RFD). The FFD can serve as a network coordinator or a regular device. It can communicate with any other device. The RFD is intended for applications that are extremely simple, such as a light switch or a passive sensor device. It can communicate only with the FFD [4],[7]. Theoretically, ZigBee can support up to 65,536 nodes. For security, ZigBee uses 128-bit Advanced Encryption Standard cryptography and trust-center- based authentication [5].

2.1. Network opology

ZigBee supports Star networks, Cluster Tree networks and Mesh networks illustrate in Figure 2. ZigBee supports Star networks, Cluster Tree networks and Mesh networks illustrate in Figure 2.

1) Star networks: The devices in the star topology can only communicate via the PAN coordinator.
2) Cluster Tree networks: Routers move data and control messages through the network using a hierarchical routing strategy.
3) Mesh networks: It shall allow full peer-to-peer communication [6].

2.2. ZigBee stack architecture

ZigBee stack architecture is shown in Figure 3. The IEEE 802.15.4 defines the physical (PHY) layer and the medium access control (MAC) sub-layer. The ZigBee Alliance builds on this foundation by providing the network (NWK) layer and the framework for the application layer (APL). The NWK and APL as the following:

1) Application (APL) layer: It includes application support sub-layer (APS), application framework and the ZigBee device object (ZDO). In the framework are added the user defined application object.
2) Network (NWK) layer: The network layer (NWK) handles the network level of the communication. It is managing the network structure and handles routing and security functions for the relayed messages [6].

3. Physiological signals measurement

3.1. Blood ressure

The blood pressure measurement divided invasive blood pressure measurement and Non-invasive blood pressure measurement. This paper uses the Oscillation method of Non-invasive blood pressure measurement. The method used the inflatable cuff to tie the human's arm, and aerated to the inflatable cuff. When the bladder's pressure lower systolic blood pressure value about 20~30mmHg, that the method in order to compress the artery. Then the bladder leaked out air slowly. We can measure the amplitude of pulsation of the artery, illustrated in Figure 4. In order to measure systolic blood pressure and diastolic blood pressure, we must to find the maximum amplitude value (Amax). Systolic blood pressure and diastolic blood pressure are individually equal to 0.5Amax and 0.75Amax.

We connect the measured signals to 12-bit analog to digital converter (ADC) of the sensor board of ZigBee.

3.2. Heart Rate

We must to find the time interval between two pulsations, and than heart rate is the product of the reciprocal of the time interval and 60.

4. Home-care system design

In the home-care system, we use ZigBee which is Jennic's JN5121 low power, low cost IEEE802.15.4 compliant wireless microcontroller. Jennic's JN5121 includes controller and sensor board. The home-care system is comprised of biosensors, end device, router, coordinator and PC. In addition, PC sends the signals to remote PC or PDA via internet. Furthermore, the end device and router are sensor board of ZigBee; the coordinator is the controller board of ZigBee. The transmission method in this system is illustrated in Figure 1. The design of the structure of system is as below:

4.1. End device

The end device is the sensor board which connects biosensors to the 12-bit ADC of the sensor board. In addition, this sensor board is embedded temperature sensor, humidity sensor and light sensor. When the 12- bit ADC has transformed physiological signals into digital signals, which are sent to 16MHz 32-bit Reduced Instruction Set Computing (RISC) CPU, and then, sent to 2.4GHz IEEE802.15.4 transceiver. The transceiver will send signals to router. We can expand many end devices for this system to observe human health easily.

4.2. Router

The router is used to transmit data between end devices and coordinator. The router is made by the sensor board. When the router is received signals from end devices, another routers and coordinator, it will transmit signals to the goal. When one of routers is broken, many routers can be expanded in this system because they can avoid transmitted signals which are unable to transmit to the goal.

4.3. Coordinator

The coordinator is the controller board used to control the

sensor networks. The measured data of any end devices appear on LCD panel of controller board. The buzzer of the alarm system attached to the controller board will send the warning, when the measured data is over the standard value. The coordinator stores and analyzes the measured data and minors for a long period of time by the PC via RS-232 serial. The next section present detail for PC application.

4.4. Personal computer (PC) application

When the measured data sent to PC, we use the software to analyze, record and monitor the data. Therefore, we use National Instruments LabVIEW 7.1 to analyze, record, monitor the data. It can display blood pressure and heart rate, and it can record measured results of daily data. In the blood pressure measurement, we inflate the inflatable cuff until it up to 180mmHg and deflate at a speed of two-three seconds per second, and we can find the amplitudes of systolic blood pressure and diastolic blood pressure from the waveform. In the heart rate, we can see the section 3.2. We must to calculate the time interval between two pulsations, and then the reciprocal of the time interval multiplies by 60 is heart rate. When the measured data of any measured person over the standard value, it can send the warning as well as the coordinator and sends the GSM short message to absent manager. The manager can use the remote PC or PDA to observe the measured data via internet.

5. Conclusion

In Figure 5, it is shown the real-time waveform of the three times sampled signal, and then to be saved this signal value by using excel file. In Figure 6, the excel file is analyzed in the blood pressure amplitude

waveform, it can be obtained the highest amplitude of the blood pressure, the amplitudes of the systolic blood pressure, and the diastolic blood pressure. There are occupied 50% and 75% highest amplitude of the blood pressure for representing systolic and diastolic pressure value, respectively. The dashed line is the diastolic blood pressure, and the solid line is the diastolic blood pressure.

The home-care system can be adopted to build the wireless sensor networks for home or hospital. This system is very convenient to observe every observed member. In the future, we will attach Electrocardiogram (ECG) to ZigBee to enhance the function of the Home-care system.

6. References

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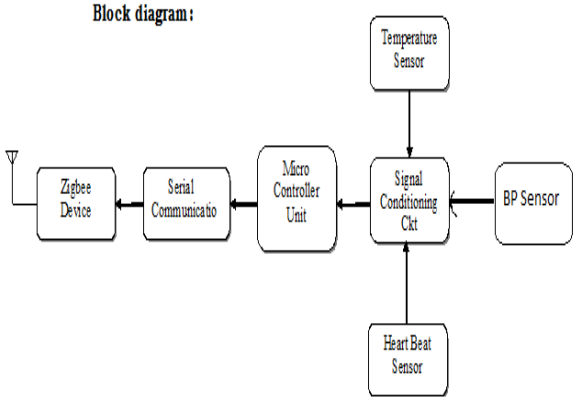
Block diagram:



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Control Room