Wireless sensor network for monitoring a patient's physical conditions continuously using Zigbee

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Abstract

We report a wireless Sensor network (WSN) for monitoring patient's physiological signal continuously using Zigbee. The output of biosensor has to be transmitted via Zigbee and the same has to be sent to the remote wireless monitor for acquiring the observed patient's physiological signal. The remote wireless monitor is constructed of Zigbee and personal computer (PC). The measured signal has to be sent to the PC for data collection. When the measured signals over the standard value, the personal computer sends Global system for Mobile communication (GSM) short message to the caretaker. 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 system. The first procedure of the system is that the biosensor is used to measure heart rate, respiration rate and blood pressure from human body using Zigbee. This measured signal is to be sent to the PC via the RS-232 serial port communication interface. It 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 care taker's mobile phone.

Keywords: Bio-sensor, Saline Sensor, SaO_2 Sensor, Zigbee, Relays, Wireless sensor network.

Introduction

Bio-informatics implies the management of healthcare through information science and technology. The term 'health informatics' is also used without entering into a fundamental discussion of the possible differences between medical informatics and health informatics. With the unraveling of the human genome, it seems that bio-informatics has a promising future, Bio-informatics is a synergy of two skills: the domain skills in the area of experimental biology and bio science and the domain knowledge of information science and technology. The mapping of the human genome has generated great enthusiasm and interest in genomics. Genetic markers will help in evolving new products and the new therapies. In bio-informatics, the mathematical, computational, and algorithmic skills mine the knowledge at the molecular, genetic and chemical level. The good algorithm is able to search out the gene sequences. The deciphering of information can help in finding the genetic aberrations. The mining of useful information can be also applied to other projects such as drug discovery (Medical informatics: A Primer by Mohan bansal, MS). In the current Hi Tech, wireless communication place the major role which led us the innovative idea of using this new technology for many applications. A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical conditions.
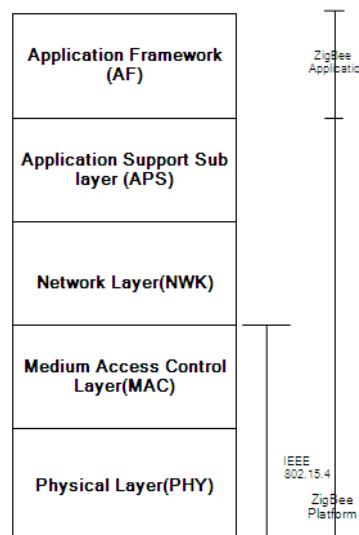
The research was done to apply this WSN using zigbee for healthcare system (Safaric & Malaric, 2006). First, a proper sensor has to be chosen for converting the physiological signals into electrical signal-in the form of analog signal (Ze Zhao & Li Cui, 2005). This analog signal has to be converted into digital signal by designing a proper circuit. This digital signal is fed into the PIC controller and its subsequent output is connected to the serial communication circuit. The output of this serial communication circuit is fed into the Zigbee device and output of this Zigbee device is transmitted via transmitting antenna. In the receiver side, the said transmitted signal is received through the receiving antenna and fed into the Zigbee unit. The output of this Zigbee unit is fed into the RS-232 serial port communication interface and output of this RS-232 is fed into personal computer (PC) sends global system for mobile communication (GSM) short message to the receiver. The receiver can use the PC or personal digital assistant (PDA) to observe the sensed signals in the remote place.

The PIC microcontrollers are supported with a full range of hardware and software development tools. The transmission section codes using various software to operate the transmission of sensed digital signals were found.

Methodology

The name ZigBee is said to come from the domestic honey bee which uses a zig-zag type of dance to communicate important information to

Fig.1. Zigbee protocol supported by IEEE 802.15.4

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other members. As shown in Fig.1   this communication dance is what engineers are trying to emulate with this protocol a bunch of separate and simple organisms that join together to take complex tasks. Zigbee is provided with lower consumption, small volume, high expansion, stylization and two way transmission, etc. The Zigbee protocol is implemented on top of the IEEE 802.15.4 radio communication standard. The Zigbee specification is managed by a non-profit industry consortium of semiconductor manufacturers, technology providers and other companies, all together designated the Zigbee alliance. The alliance currently numbers more than 150 members.

The Zigbee specification is designed to utilize the features supported by IEEE 802.15.4. In particular, the scope of Zigbee is applications with low requirements for data transmission rates and devices with constrained energy sources. The intended market spaces for Zigbee products include home control and building automation. Imagine the intelligent building, controlling the lighting and temperature as needed, monitoring the building structure and performing surveillance tasks with a minimum of user interaction. This is the potential of Zigbee.

Table 1. Comparison of wireless technologies

	Zigbee	Bluetooth	Wi-Fi
Standard Memory requirements	802.15.4 4-32KB Years	802.15.1 250KB+ Days	802.11b 1MB+ Hours
Battery Nodes per master Data rate range	65000+ 250Kb/s 300m	7 1Mb/s 10m	32 11Mb/s 100m

Two message types are defined: 1. Key value pair (KVP) service which uses a standardized way of representing messages using binary XML. 2. Message (MSG) service which gives full control over the messages being sent for application specific needs. Table 1 compares the wireless technologies

Fig. 2. Data flow diagram
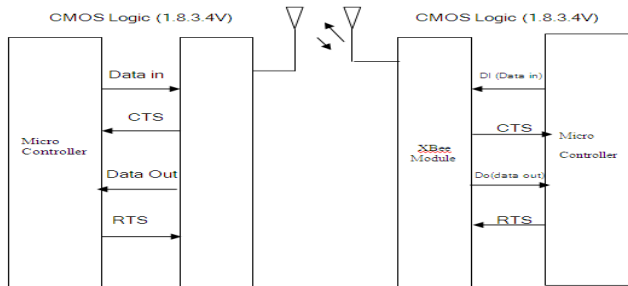
Data Flow Diagram

Data flow diagram is shown in Fig.2. The ZigBee/Zigbee-PRO OEM RF Modules interface to a host device through a logic-level asynchronous serial port.Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any serial.

Today, organizations use Zigbee to effectively deliver solutions for a variety of areas including consumer electronic device control, energy management and efficiency, home and commercial building automation as well as industrial plant management. With this comprehensive set of attributes, the nonprofit, open membership and volunteer driven alliance has become a thriving ecosystem of more than 300 members. As an ecosystem, the alliance offers everything prospective product and service companies need to develop Zigbee products and services and benefit from the alliance's competitive and stable supply chain.

The health care domain presents opportunities for a significant number of applications of wireless sensor technology. The following sections focus on broad health monitoring applications that include chronic disease monitoring, personal wellness monitoring and personal fitness. Within each of these applications, flowing describes several specific uses of wireless sensor technology.

Fig.3. Block diagram of transmitter section
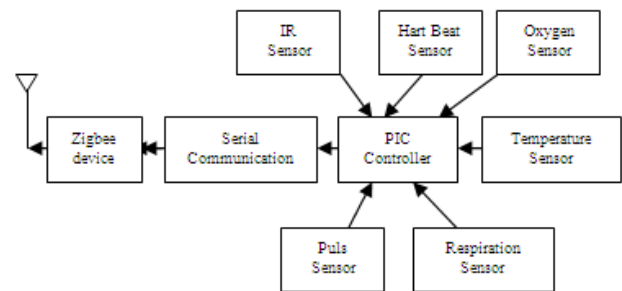
As shown in Fig.2 & Fig.3, firstly appropriate sensor was chosen for the above applications to convert the physiological signal into electrical signal which is in the form of analog signal. This analog signal was converted into digital signal by designing a proper circuit. This digital signal was fed into the PIC controller. The output of this PIC controller was fed into the serial communication circuit. The output of this serial communication circuit was fed into the Zigbee device and output of this Zigbee device was transmitted via transmitting antenna.

As shown in the Fig.4 in the receiver side, the said transmitted signal was received through the receiving antenna and fed into the Zigbee unit. The output of this Zigbee unit was fed into the RS-232 serial port communication interface and output of this RS-232 was fed into personal computer (PC) for data collection. This personal computer (PC) sends global system for mobile communication (GSM) short message to the receiver. The receiver can use the PC or personal digital assistant (PDA) to observe the sensed signals in the remote place.

Results

In the research, 3 group of persons were made to undergo the test. Person A was in the age group of 1-10 years. Person B was in the age group of 11-30 years. Person C was in the age group of   31-80 years old.

Firstly, pulse rate measurements for the persons A, B and C were taken. When abnormality is observed and the pulse drop is below the predetermined level then a call is dialed to the doctor and residence indicating the critical condition of the patient. Hence, the numbers were dialed successfully to the doctor indicating the success of the experiment. Also sensed signals were observed through personal computer (PC) or personal digital assistant (PDA).

Secondly, heart rates for persons A, B and C were taken. When the heart rate crosses 72 beats per second and when it is lower than 72 beats per second, the condition was identified as abnormal. Hence in such a situation automatically a call is dialed to the doctor, nearby hospital and to the residence. Also sensed signals were observed through personal computer (PC) or personal digital assistant (PDA). Hence, the experiment is considered successful.

Next, persons A, B and C were tested for respiration rate measurement. Respiration rates above the normal level or below the normal level (when at rest) may be considered abnormal. In such a situation automatically a call is dialed to the doctor, nearby hospital and to the residence. Also sensed signals were observed through personal computer (PC) or personal digital assistant (PDA). Therefore research is considered successful.

Next, temperature measurements for the persons A, B and C were taken. While the temperature goes below the normal condition or above the normal condition, LED (yellow) glows and automatically a call is dialed to the doctor nearby hospital and to the residence who have given their phone or cell number indicating that the patient is in abnormal condition. Hence the research is successful. Also sensed signals were observed through personal computer (PC) or personal digital assistant (PDA).

Persons A, B and C were given saline. When the bottle becomes empty, the ray passing through the bottle gets destructed and the ray is cut. So the LED glows. Now automatically call is dialed to the doctor, nearby hospital and to the residence. Hence, the experiment is considered successful.

To find oxygen level in the blood, Persons A, B and C were tested for SaO_2 level. When the ratio goes low, a call was automatically dialed to the doctor, nearby hospital and to the residence thereby considering the experiment successful.

Conclusion

Wireless Sensor network (WSN) was developed successfully to monitor the patient continuously, so that an intermediate person is not required to update and inform the condition of the patient to the doctor and the

Fig.4. Block diagram of receiver section
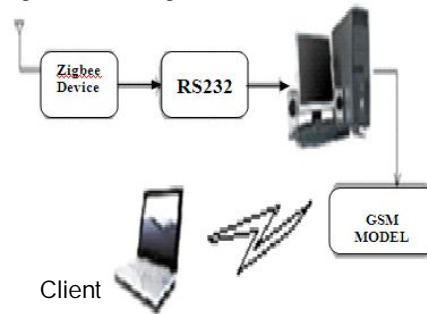
residents. Thus, this wireless sensor network using ZigBee will be very useful in a medical field.

Regarding pulse rate measurement of the person, when there was a drop in the pulse, automatically a call was dialed to the doctor, nearby hospital and also to the residence and this drop in the pulse rate was observed in the PC or PDA. Accordingly, medical treatment was given. While heart rate was checked for above and below normal level, signs of abnormal conditions were seen. In such a case a call was dialed to the doctor, nearby hospital and to the residence and also this drop in the heart rate was observed in the PC or PDA. Accordingly, medical treatment was given. While respiration rate was checked for above and below normal level, signs of abnormal conditions were seen. Hence automatically a call was dialed to the doctor, nearby hospital and to the residence and also this drop in the respiration rate was observed in the PC or PDA. Accordingly, medical treatment was given. Temperature measurement was taken for above and below the normal level. When the body temperature cross the normal level, automatically a call was dialed to the doctor, nearby hospital and to the residence and also this drop in the temperature was observed in the PC or PDA. Accordingly medical treatment was given. A ray was made to pass through the saline bottle. When this bottle was empty, the ray was destructed. Hence, automatically a call was dialed to the doctor, nearby hospital and to the residence and hence the empty bottle was replaced with a new saline bottle. When oxygen level in the blood was checked and was found low, automatically a call was dialed to the doctor, nearby hospital and to the residence and accordingly medical treatment was given. There is definitely a place on the market for ZigBee, since no global standard exists today in the wireless sensor network area. Two fully functional ZigBee//802.15.4 modules have been developed. It is possible to design a module with RF parts on a low cost FR-4 PCB substrate. By using a four layer PCB the size is reduced significantly. A reduced ZigBee protocol stack was implemented. The implementation has a code size of 29,620 bytes thus meeting our goal of a code size less than 32KB. Finally it is shown that a temperature sensor can be integrated with the developed ZigBee ready modules.

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