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Zigbee based Wireless Body Area Sensor Network for patient's physiological parameter monitoring

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Abstract- This paper, presents a Wireless Sensor Network (WSN) for monitoring patient's physiological conditions continuously using Zigbee. Here the physiological conditions of the patient's are monitored by sensors and the output of these sensors is 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, which can be data collection. Although Bluetooth is better than Zigbee for transmission rate, Zigbee has lower power consumption. The first procedure of the system is that the wireless sensors are used to measure Heart rate, temperature and fall monitoring from human body using Zigbee. Next procedure of the system is to measure saline level in bottle using zigbee. The measured signal is sent to the PC via the RS-232 serial port communication interface.

Keywords*:* wireless, network, zigbee, sensors, bluetooth

1. INTRODUCTION

Heart Beat Sensor The system consists of an infrared (IR) LED as transmitter and an IR photo-transistor as a receiver that acts as a fingertip sensor. The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified through an amplifier which outputs analog voltage between 0 to 5V logic level signal.

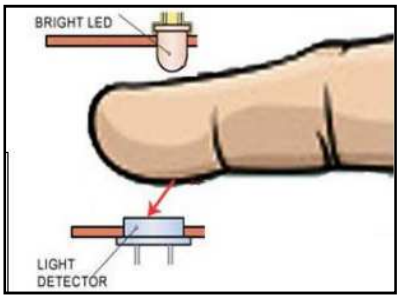

Figure 1 Heart beat sensor

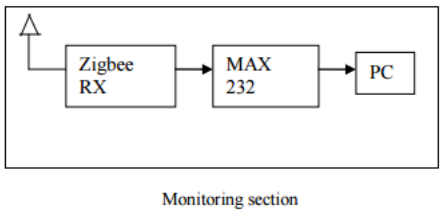

Figure 2 Monitoring section of Heart beat sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10°with improved accuracy).

The LM35 series is available pack packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is

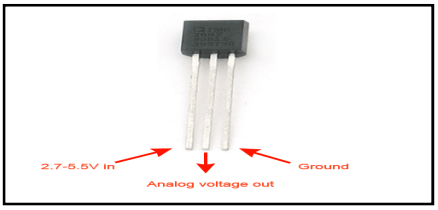

Figure 3 Figure of Body Temperature sensor

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Currently, a number of studies have been proposed to patient's physiological parameter monitoring over wireless transmission. Patient monitoring systems [1] are gaining their importances the fast-growing Global elderly population increases demands for caretaking. These systems use wireless technologies to transmit vital signs for medical evaluation**.** According to Kinsella and He's [2] report from the US Census Bureau, the global elderly population is fast growing and will outnumber the population of children in near future. The aging society is bringing its impact on many developing countries and presents a stark contrast with the low fertility rate of these countries. The changes brought about by the aging society include an increasing demand for caretaking; thus, patient monitoring systems are gaining their importance in reducing the need for human resources. Caretaking homes and hospitals have been planning on the use of biological sensors to effectively minister to their patients. Vital signs, such as body temperature, blood pressure, and sugar level, can be regularly collected and remotely monitored by medical professionals, achieving a comprehensive caretaking system. ZigBee [3] is an open standard technology to address the demands of low-cost, low-power WMNs via short range radio. ZigBee [4] is targeted at RF applications that require a low data rate, long battery life, and secure networking. Its mesh networking also provides high reliability and more extensive range. The ZigBee devices can be combined with WWANs to achieve a seamless platform of wireless patient monitoring. The ECG and heart rate data can not only help the caregivers to know the urgency of the fall-induced injury, but also show the probable reasons of falls. IEEE 802.15.4 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs). It is maintained by the IEEE 802.15 working group. It is the basis for the ZigBee.Varshney [5] proposed a framework of patient monitoring systems, including patient monitoring devices, ad hoc wireless networks, and the receivers for healthcare professionals. This framework uses four routing schemes (multicast, reliable multicast, broadcast, and reliable broadcast) and several enhancing schemes to improve the transmission reliability over wireless ad hoc networks. Jovanov *et al.* [6] present wireless distributed data acquisition system. The system uses personal digital assistant as a mobile client to acquire data from individual monitors and synchronizes collected records with existing records on the telemedical server. Each client device uses local flash memory as a temporary storage until reliable connection with a mobile client is established.

2. XBEE MODULE

The explosion in wireless technology has seen the emergence of many standards, especially in the industrial, scientific and medical (ISM) radio band. There have been a multitude of proprietary protocols for control applications, which bottlenecked interfacing. Need for a widely accepted standard for communication between sensors in low data rate wireless networks was felt. As an answer to this dilemma, many companies forged an alliance to create a standard which would be accepted worldwide. It was this Zigbee Alliance that created **Zigbee**. Bluetooth and Wi-Fi should not be confused with Zibgee. Both Bluetooth and Wi-Fi have been developed for communication of large amount of data with complex structure like the media files, software etc. Zigbee on the other hand has been developed looking into the needs of communication of data with simple structure like the data from the sensors.

2.1. W*hat is Zigbee and who all are involved?*

Zigbee is a low power spin off of WiFi. It is a specification for small, low power radios based on IEEE 802.15.4 – 2003 Wireless Personal Area Networks standard. The specification was accepted and ratified by the Zigbee alliance in December 2004. Zigbee Alliance is a group of more than 300 companies including industry majors like Philips, Mitsubishi Electric, Epson, Atmel, Texas Instruments etc. which are committed towards developing and promoting this standard. The alliance is responsible for publishing and maintaining the ZIgbee specification and has updated it time and again after making it public for the first time in 2005. Most of the recent devices conform to the Zigbee 2007 specifications has two feature sets– Zigbee and Zigbee Pro. The manufacturers which are members of the Alliance provide software, hardware and reference designs to anyone who wants to build applications using Zigbee.

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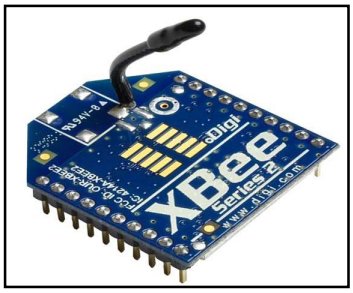


Figure 4 Figure of XBEE Module

2.2 Architectural Overview

Zigbee bases itself on the IEEE 802.15.4-2003 specifications which lay down standards for the Physical and MAC layers. The protocol stack is completed by adding Zigbee's own Network and Application Layers. Drawing analogies from the OSI protocol stack simplifies the study of Zigbee protocol. In the figure below, the two protocols are stacked up side by side to see the similarity of roles of various layers

Table1: Various type layers

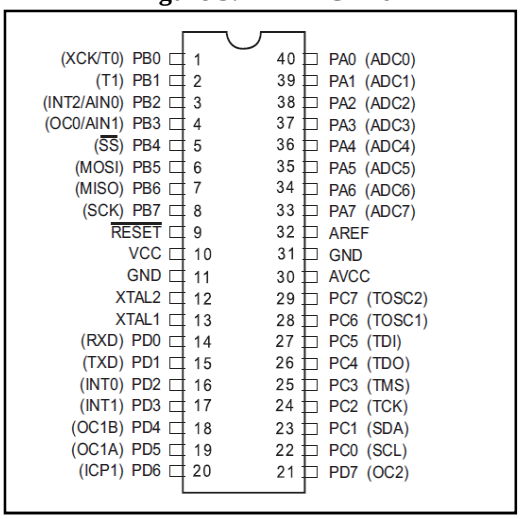
7 Layer ISO-OSI-Model	Simplified 5 layer ISO-OSI-Model	Zigbee Model	
Application	User Application	Applications	Zigbee or OEM
Presentation	Application Profile	Application Profiles	
Session		Application Support Sub Layer	
Transport		Network and Security Layer	Zigbee Alliance Platform
Network	Network		
Data Link	Data Link		
		Media Access Control (MAC)	
Physical	Physical	Physical	IEEE 802.15.4

I. History of AVR

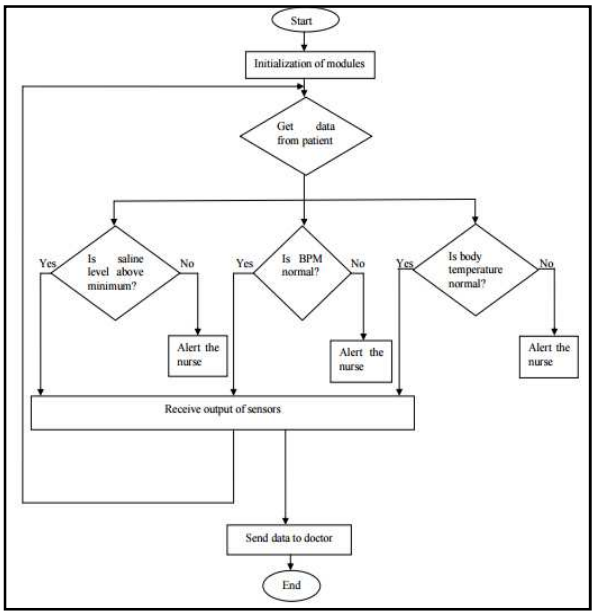
AVR was developed in the year 1996 by Atmel. The architecture of AVR was developed by Alf-Egil Bogen and Vegard Wollan. AVR derives its name from its developers and stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller, also known as Advanced Virtual RISC. The AVR was one of the first microcontroller families to use on-chip flash memory for program storage. Till that time microcontroller comes with one-time programmable ROM.

The AVR is a modified Harvard architecture machine where program and data is stored in separate physical memory systems.

Figure 5: ATMEGA16



II. Flow chart



3. RESULT

Thus the zigbee based wireless Heartbeat Body Temperature, and Blood Pressure monitoring system is designed and implemented using microcontroller atmega 16, in which all signals (heart beat in BPM, Body Temperature in ^{O}C,, & blood pressure in mmhg) directly measured from the human body and all parameters values displayed on LCD & hypertext software on computer display .This data is transmitted to the receiver wirelessly through ZigBee module. The received signal sends to pc via Data cable of patient's Physiological Parameters.

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