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Design of Wireless Medical Monitoring System

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Abstract— Medical Monitoring Systems are the most important in the fast developing nation population increases demands for caretaking. These systems use wireless technologies to transmit vital signs for medical evaluation. This paper describes the design of a wireless sensor network based on Zigbee technology. It is mainly used for collecting and transferring the various monitoring information about the patients in hospitals. This application consists of Zigbee based network, having three types of sensors connected to the transmitter section those are Heart rate sensor, Temperature sensor, Oxygen sensor. These sensors are directly connected to the patient and the status of the patient is sensed by the sensors. The same data is send wirelessly to the receiver section which is with the medical representative and by that receiver module he will get all updates of their patients. It is fast, reliable and cheap cost.

Keywords— Micro-controller; Heart rate sensor; Temperature sensor; Oxygen sensor; Zigbee technology; Wireless network; Transmitter section; Receiver section

1. INTRODUCTION

This system is proposed to be used for general ward patients as they are often associated with acute conditions that require regular supervision. The technology used here is Wireless Sensor Network(WNS). WSN is used worldwide due to its ability of self organizing and scalability. The vital signs associated with general ward monitoring are body temperature, Oxygen level, Heart pulse rate of the patient. Patients are monitored using high cost wired technology which makes difficult for the patient to move and hence it reduces mobility and introduces complexity. To overcome these limitations, Wireless technology is introduced in the hospitals. This paper describes the wireless sensor network based on Zigbee technology. It is mainly used for collecting and transferring the various monitoring information about the patients in hospital. This application consist of Zigbee based network, three sensors i.e. Heart rate sensor, Temperature sensor, Oxygen sensor.

2. LITERATURE REVIEW

Patient monitoring systems become a important topic. These systems use wireless technologies to transmit vital signs for medical valuation. Paper [1] describes the wireless sensor network based on Zigbee technology. It is mainly used for collecting and transferring the various monitoring information about the patients in hospital. This application consists of Zigbee based network, four sensors, master, two sub-master and slave combination.

The technology used in [2] is Wireless Sensor Network (WSN). The vital signs associated with general ward monitoring are body temperature, humidity, smoke and movement of the patient. Zigbee is a Wireless standard which comes under IEEE 802.15.4. Zigbee is a wireless standard used in hospitals and orphanages due to its ability of low-cost, low-power, fault tolerance and quality of service. Zigbee have the ability to connect a large number of devices into a single network. ZigBee technology uses the globally available, license-free 2.4GHz frequency band.

This paper [3] keep track on heartbeat count and temperature of patient should be easy to use, portable, light weighted, small size etc so that it give freedom of mobility for patient. The devices which can be carried everywhere to keep track on patient's health. This device that is a heartbeat sensor would help them to keep track on heartbeat counts of a patient and check for any abnormalities. If any varied change takes place it is notified. This notification would help to take an appropriate action at an instance of a time. This would save patients from the future health problem which would arise. This would also help patient's concern doctor to take an appropriate action at proper time.

3. HARDWERE

In this paper hardware used is LCD display, Zigbee, ATmega 16 Microcontroller, Heart rate sensor, Temperature sensor, Oxygen sensor.

3.1 ZIGBEE

Zigbee is a low-cost, low-power, wireless mesh networking proprietary standard [1]. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. Range of Zigbee is from 30 meters-1km.The technology is intended to be simpler and less expensive than other WPANs such as Bluetooth. Its protocols are intended for use in embedded applications requiring low data rates and low power consumption. Its current focus is to define a general-purpose, inexpensive, self-organizing mesh network that can be used for industrial control, embedded sensing, medical data collection, smoke and intruder warning, building automation, home automation, etc. Specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks.

Fig. 3.1. Zigbee Module

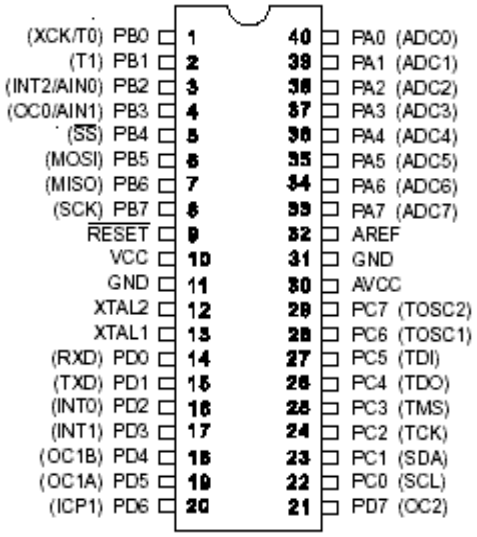

Fig. 3.3. ATmega 16 Microcontroller Pin Diagram

Zigbee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows Zigbee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices. It is targeted at applications that require a low data rate, long battery life, and secure networking. It has a defined rate of 250kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device consumer and industrial equipment that require short-range wireless transfer of data at relatively low rates. Transmission rates vary from 20 to 900, Data rates of 250 kb/s, 40 kb/s and 20 kb/s home networking, automotive networks, industrial networks, interactive toys, remote metering, battery operated products, building automation, personal healthcare, industrial control, residential or light commercial control, consumer electronics, PC and peripherals, etc.

3.2 LCD DISPLAY

The LCD display is used to visualize the output of different sensors as received the signal from the transmitter block to the receiver interfaced with the microcontroller. Thus LCD display plays a vital role to see the output and give information of the patient.

3.3 ATMEGA16 MICROCONTROLLER

The ATmega16 microcontroller used in this lab is a 40-pin wide DIP (Dual In Line) package chip. This chip was selected because it is robust, and the DIP package interfaces with prototyping supplies like solderless bread boards and solder-type perf-boards. This same microcontroller is available in a surface mount package, about the size of a dime. Surface mount devices are more useful for circuit boards built for mass production. ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family

with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively. ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD. ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals.

3.4 HEARTRATE SENSOR

The heart rate sensor is basically used to keep track on the pulse rate of the person. In programming the maximum and the minimum set point are provided for the pulse rate. If the pulse rate goes below or above the set point then the alert will be immediately issued by the microcontroller.

3.5 TEMPERATURE 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. Temperature sensor is used to sense the temperature. It can sense the temperature of the atmosphere or the temperature around it or the temperature of any machine to which it is connected or even can give the temperature of the human body. It is an analog sensor and gives the output into form of analog signal. This signal is feed to ADC which will convert it into digital form. Once converted into analog form the microcontroller can process the digital temperature signal as per the application.

Fig. 3.4. Heart rate sensor

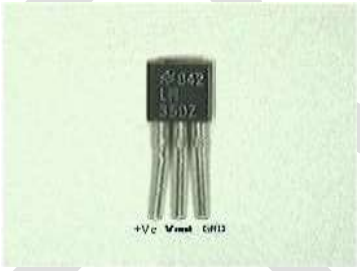

Fig. 3.5. Temperature sensor -The LM35

Fig. 3.6. Oxygen sensor

3.6 OXYGEN SENSOR

An oxygen sensor (or lambda sensor) is an electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed. It was developed by the Robert Bosch GmbH company during the late 1960s under the supervision of Dr. Günter Bauman. The original sensing element is made with a thimble-shaped zirconia ceramic coated on both the exhaust and reference sides with a thin layer of platinum and comes in both heated and unheated forms. The planar-style sensor entered the market in 1998 (also pioneered by Bosch) and significantly reduced the mass of the ceramic sensing element as well as incorporating the heater within the ceramic structure. This resulted in a sensor that started sooner and responded faster.

The most common application is to measure the exhaust gas concentration of oxygen for internal combustion engines in automobiles and other vehicles. Divers also use a similar device to measure the partial pressure of oxygen in their breathing gas. Scientists use oxygen sensors to measure respiration or production of oxygen and use a different approach. Oxygen sensors are used in oxygen analyzers which find a lot of use in medical applications such as anesthesia monitors, respirators and oxygen concentrators. Oxygen sensors are also used in hypoxic air fire prevention systems to monitor continuously the oxygen concentration inside the protected volumes. There are many different ways of measuring oxygen and these include technologies such as zirconia, electrochemical (also known as Galvanic), infrared, ultrasonic and very recently laser methods.

4. DESCRRIPTION OF TRANSMITER SECTION

Transmitter section of the monitoring health care system consists of a Zigbee network which is made up of sensor nodes as shown in fig.4. To keep the moment of the patient intact with the sensors on the body,

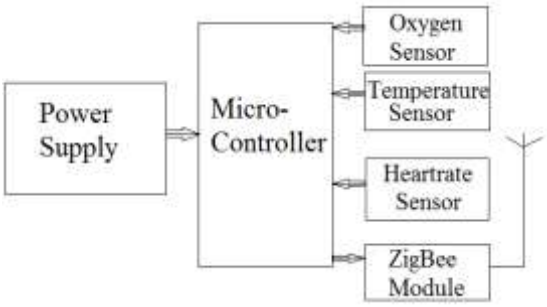

Fig. 4.1 Transmitter block diagram

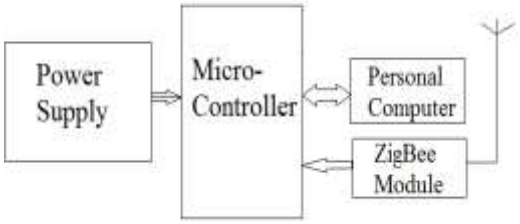

Fig. 5.1 Receiver block diagram

the wireless sensors are required to be minimized and portable. These sensors are temperature, heart rate and oxygen which are the basic requirements wards of patient. There is a microcontroller to which sensors and power supply is connected. The Zigbee module is used for transferring the data to the receiver connected to other part of circuit i.e. receiver circuit. We are using Microcontroller ATmega 16 for this project.

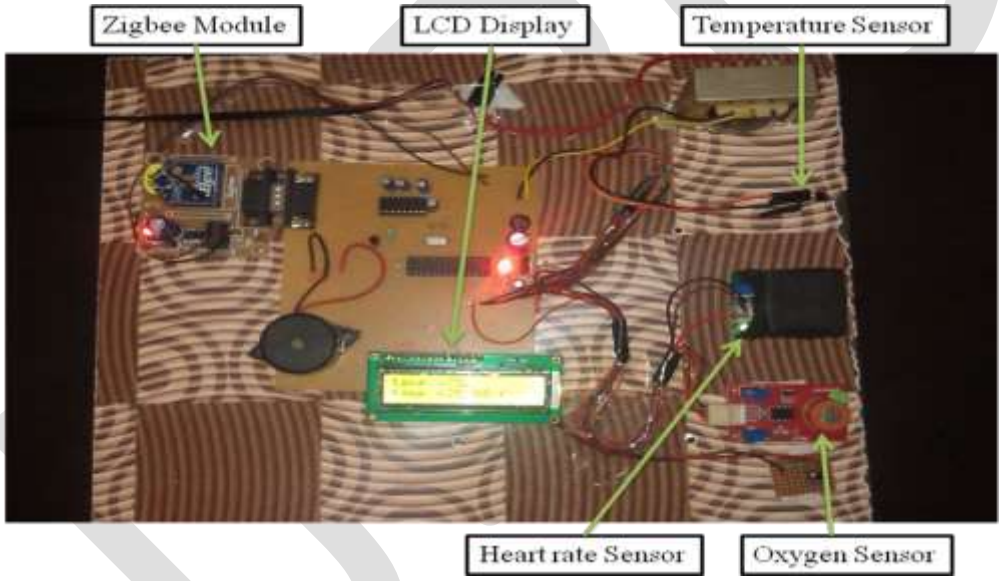

FIG. 4.2 Transmitter Block

Transformer is used for the power supply of the all microcontroller and digital sensors. As we need DC power supply for atmega16 and current sensors we used rectifier after transformer which convert 5V AC into the 5V DC which is not pure DC but contains ripples for removing the ripples we use capacitor, which remove ripples from the supply and give 5V DC. The supply is given to the circuit using transformer. The three sensors are connected to microcontroller to respective port. The Zigbee module is having four terminals Rx, Tx, ground & supply.

Rx is connected to pin no 15, Tx is connected to pin no 14. Supply 3.2V is given for making the module run. The temperature sensor is connected to pin no 40. Heart rate sensor is connected to pin no 39. Oxygen sensor is connected to pin no 38. Second terminal of all sensors is combined and connected to Vcc and third terminals of all sensors are connected to ground. All sensors sense the physiological information of patient and provide information to the microcontroller. The microcontroller sends the data to receiver side though Zigbee transmitter module.

5. DESCRRIPTION OF RECEIVER SECTION

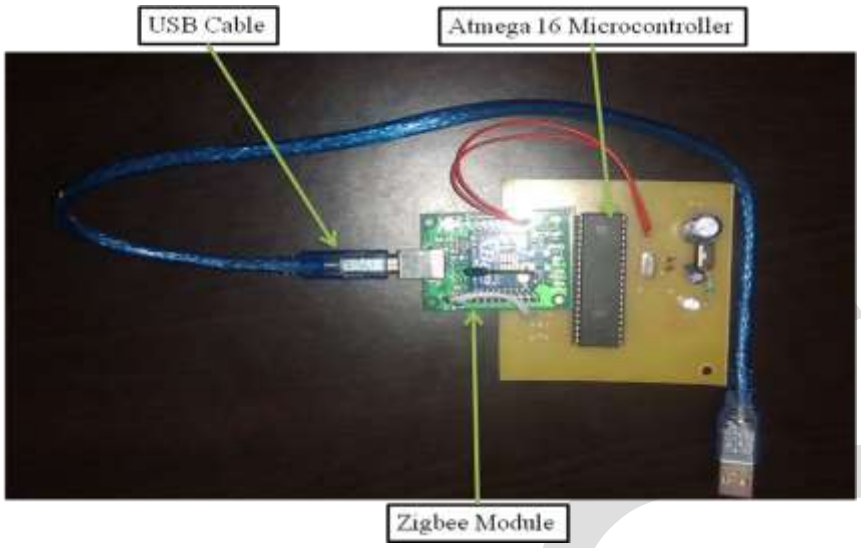

FIG. 5.2 Receiver Block

The information sent by the Zigbee Module is received wirelessly by the other Zigbee Module at the receiver section as shown in the Fig.5.1. Zigbee Module will transfer the data to the some control device. If a mismatch occurs, that is if the collected data is more than the limit defined then alert signals are issued.Alert signals are issued to alert the staff taking care of the patient and to provide better cure. If the collected data is within the limits then the value of the sensed data will be displayed on LCD and PC Display. Besides, the buzzer alarms to alert the staff, these two other alert systems are also used here. All the components are connected according to the requirements and mounted on PCB. LCD is made available for the nurses and the staff at the main receiver section. LCD is connected to the microcontroller for displaying the conditions.

The display, Zigbee module & USB port is connected to the Microcontroller. The information sent by the Zigbee module is received wirelessly by the other Zigbee module at the receiver section. Zigbee module will transfer the data to the some controlled device for controlling action ATmega 16 microcontroller is used.

Controller will match the limit predefined in the code of the microcontroller. If a mismatch occurs, i.e. if the collected data is more than the limit define then alert signal are issued. Alert signals are issued to alert the staff taking care of the patient and to provide better cure. If the collected data is within the limit then the value of sense data will be displayed on LCD Display. Besides, the buzzer alarm to alert the staff two other alert system is also used here. All the components are connected according to requirement and mounted on PCB.

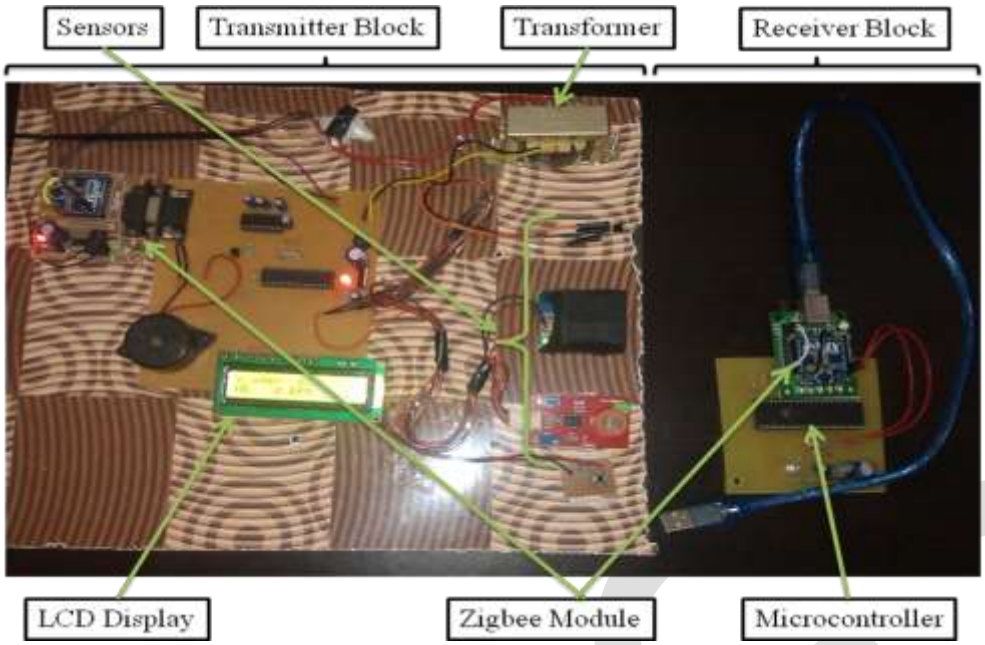

Fig. 6. Wireless Medical Monitoring System

6. RESULT

After completion of the project design the complete project is as per fig.6. In the project we have two sections transmitter section and receiver section. As we have three sensors all the sensors are working properly and it shows the status and condition of the patient which we can see on the LCD display as shown in fig. 6.1.

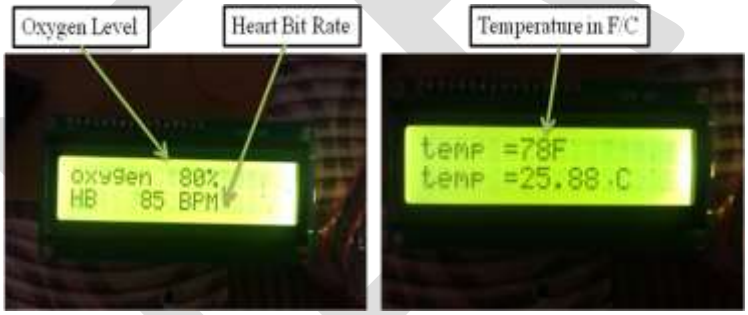

Fig. 6.1. a) Oxygen and Heart bit reading b) Temperature Reading

7. CONCLUSION

We have analyzed the wireless patient health monitoring system of temperature, heartbeat and oxygen of human being using Zigbee technology providing low cost effective solution. As it is wireless device it more comfortable and reliable for patient as well as medical representative, also the cost of cables is reduced here, high speed, low power consumption, more effective and highly efficient system. It provides continuous monitoring of the vital signs of the patient over long periods of time until an abnormal condition is captured and hence critical situations can be overcome. Any abnormalities in health conditions are informed via display as the receiver. The system to upgrade existing health monitoring systems in the hospitals by providing monitoring capability and thus a better cure. This intelligent monitoring system provides long term monitoring capability useful for the staff in the hospitals and reduces their workload.

8. FUTURE DEVELOPMENT

As we increase the sensors or development in biomedical trend more parameter can be sense and monitor which will drastically improve the efficiency of the wireless monitoring system in biomedical field. For improving the wide range of communication for the long distance web based technology can be used.

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