Arduino Based Wireless Biomedical Parameter Monitoring System Using Zigbee

Harshavardhan B.Patil[1], Prof.V.M.Umale [2]

[1] (M.E .Student in Dept. of Electronics and Telecommunication Engineering, SSGMCE, Shegaon, India.)

[2] (Associate Professor in Dept. of Electronics and Telecommunication Engineering, SSGMCE, Shegaon, India.)

Abstract *— This paper present design and implement wireless biomedical parameters monitoring system based on different biomedical sensors and microcontroller unit Arduino UNO with Zigbee.The system can be used to measure physiological parameters, such as Blood pressure (Systolic and Diastolic), Pulse rate, ECG monitoring, Temperature of a human subject. Using several sensors to measure different vital signs, the person is wirelessly monitored within his own home. There are number of techniques available for the ICU patient's health monitoring system with wired communication technology. In the novel system the patient health is continuously monitored using wireless sensor networks and the acquired data is transmitted to a microcontroller unit Arduino UNO and then to Zigbee. At the receiver side the data is collected with Zigbee and Arduino and displayed on relevant displays. The device is battery powered for used outdoors.*

Keywords— *Arduino, Bio-Sensors: Blood pressure, ECG, Temperature, biomedical monitoring system, Zigbee.*

I. INTRODUCTION

The electronics technology has entered in all aspects of day-to-day life, and the medical field is not exception for this,so The need for well-equipped hospitals and diagnostic canters is increasing day by day as the people are becoming more conscious and attentionful about their health problems. Now let's try to find some reasons behind the increasing percentage of the patients. In today's world everyone life has become very fast. The throat cut competition for success has made people to have to work for more than 10 hours per day. Also the factors like increasing population, increasing pollution has affected day-to-day life. As we observed Large number of vehicles and undisciplined traffic has invited the number of accidents every day. Also the stress on the mind is too much and brain popularly known as Blues are demanding the need for the well equipped hospitals and diagnostic canters. The today's hospitals are huge and with large areas in a building. They may occupy no. of floors in one building. Different wards are situated at different places such as men's wards,womens wards, maternity wards, general wards, special rooms, and more importantly ICU's,doctors need to keep monitoring all the patients in these wards continuously, and this requires more number of skilled nurses and other concerned employees. It is not feasible for the doctors to go to each ward and monitor each patient frequently say after each half an hour. Keeping all these aspects in the mind we have developed wireless biomedical parameter monitoring system which can be used efficiently to get rid of the problems mentioned in above paragraph.

In this system we are continuously monitoring the patient's different parameters such as body temperature, blood pressure, pulse rate, ECG monitoring and transmitting this data to the doctor's cabin continuously.

In this way it is beneficial for the large hospitals situated in the large cities to use this system. By employing this system they can reduce their manpower. Also the overhead of the doctors can be reduced up to large extent and their precious time can be utilized for the some good cause. Also since there are no human factors for the monitoring and recording purpose the errors can be eliminated and accuracy will be increased and thus overall efficiency of the concern hospital will be increased. Thus our system proves to be a useful one, for the every large-scale hospital to cure the patients quickly and creating a healthy society.

Recently wireless sensors and sensor networks plays a vital role in the research, technological community. But there are different from traditional wireless networks as well as computer networks, today the progress in science and technology offers miniature, speed, intelligence, sophistication, and new materials at lower cost, resulting in the development of various high-performance smart sensing system. Many new researches is focused at improving quality of human life in terms of health by designing and fabricating sensors which are either in direct contact with the human body (invasive) or indirectly (noninvasive).

In the current proposed system the patient health is continuously monitored by the patient monitoring system and the acquired data is transmitted to a microcontroller unit ARDUINO UNO server using Wireless Sensor Networks. A Zigbee node is connected to every patient monitor system that consumes very low power and is extremely small in size.

This paper builds an independent system that automatically logs vital parameters of patients for easy access. The data is accessible to doctors through mobile device for convenience. Data of all patients is stored in a common database. A system to monitor the overall health of welfare
facility, which needs constant care, has been reported. The data, at receiver which can be used to analyse the patients overall health condition.

II. PROPOSED SYSTEM

In this system we are continuously monitoring the patient's different parameters such as body temperature, blood pressure

- systolic, diastolic, pulse rate, ECG monitoring and transmitting this data to the doctor's cabin continuously as well as displaying data at transmitter side so that patient also observed the relevant outputs and then at the receiver side or in doctors cabin the data is collected with ZigBee and Arduino and displayed on relevant displays. The device is battery powered for used outdoors.

III. BLOCK DIAGRAM

A. *Transmitter Section:*

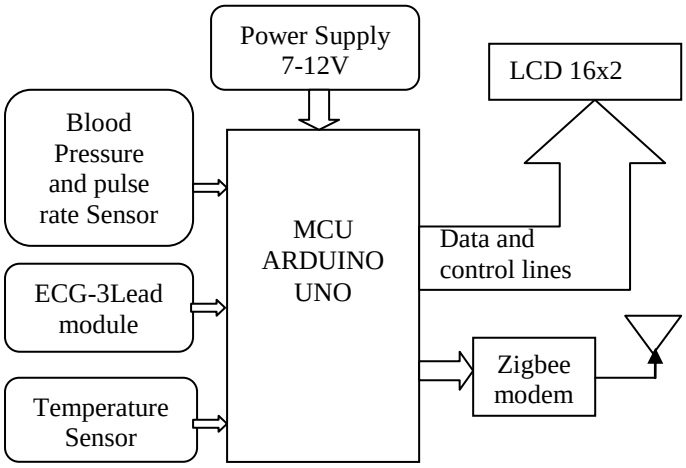

Fig 1. Block diagram of transmitter section

B. *Receiver Section:*

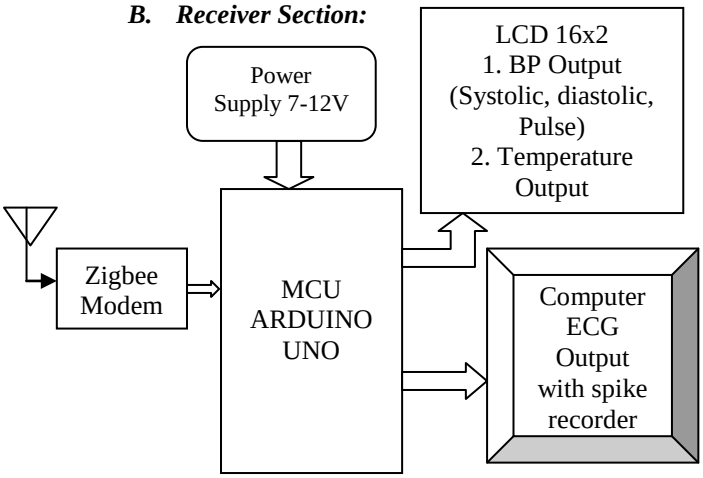

Fig 2 . Block diagram of receiver section

A. *Blood pressure and pulse rate Sensor:*

SUNROM Blood pressure sensor model no 4118 is used and the sensor consists of piezoelectric crystals which picks the mechanical vibration from the body and it convert the vibration into electrical signal. The sensor working voltage is +5V, 200 mA regulated. Sensor Pinouts are TX-OUT (Transmit output) as Output serial data of 3V logic level, connected to RXD pin of microcontrollers, regulated input of+5V and Board common GND.The output format is serial data at 9600 baud rate. Sensing unit wire length is 2m.pulse rate is also sensed and displayed on LCD as systolic, diastolic, pulse rate like as **129, 107, 095.**

B. *Temperature Sensor:*

LM35 is a precision IC temperature sensor. The output voltage of this sensor is linear relationship between the Celsius temperature scale of 0^0C, for every 1^0C increases in output voltage of 10 mV. LM35 is an integrated circuit sensor used to measure temperature with an electrical output proportional to temperature in ^{0}C and the temperature measurement more accurately than thermistor orany other temperature sensor device.The sensor circuitry is sealed and not subject to oxidation. The LM35 generates more output voltage than thermocouples and may not require that the output voltage be amplified, The scale factor is 0.01V/^{0}C.The LM35 does not require any external calibration or trimming and an accuracy of +/- 0.4^0C at room temperature and +/- 0.8^0C over a range of ^{0}C to100^0 C.

C. *ECG Module:*

To measure the electrical activity of the heart is analyze with the advanced module AD8232 Single Lead Heart Rate Monitor. The electrical activity of the heart is analog in nature and charted as an ECG or Electrocardiogram. The signals of ECG are extremely noisy so with the help of AD8232 acts as an op amp for getting clear signals from the PR and QT intervals. The AD8232 having an integrated signal conditioning block for Electrocardiogram and other biopotential measurement applications. . AD8232 is designed in such a way that it is capable of extracting, amplifying and filtering weak biopotential signals form noisy signals. Its Operating Voltage is 3.3V, output is analog in nature. The rhythm of heart is indicated by LED indicator light.

D. *Arduino UNO:*

The Arduino Uno is a 8 bit microcontroller board based on the ATmega328.It has 14 digital pins and 6 analog pins and other power pins such as, GND,VCC, It has 14 digital input/output pins (of which 6can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It has SRAM 2kb and flash memory 32kb. EEPROM with 1KB. Arduino is open source hardware board with many open source libraries to interface it on board microcontroller with many other external components like LED, motors, LCD, keypad, Zigbee, sensors and many other things one want to interface with Arduino board. Arduino is a complete board which include all things to connect with external peripheral and to program through computer. It contains everything

needed to support the microcontroller. We either need to connect it to a computer using a USB cable or power it with an AC-to-DC (7-12v) adapter. The Arduino circuit acts as an interface between the software part and the hardware part of the project.

E. Zigbee :

The Zigbee is one of the latest wireless communication technology used in many different system for wireless communication having small range, low power, low data rate for many wireless applications. Zigbee operates in three layers named as Physical layer, data link layer, and network layer. It has IEEE 802.15.4 standards for personal area networks. Zigbee is embattled at radio frequency applications and require a low data rate, extended battery life, and secure networking. Zigbee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. Zigbee network layer supports topologies named as star, mesh and tree. The Zigbee coordinator as coordinator so placed on transmission section of a system and it responsible for initiating and maintaining the devices present in the network and other end devices directly communicate with the Zigbee coordinator. The IEEE 802.15.4 (Zigbee) standard operates in three frequency bands for operation at 868MHz, 916MHz, and 2.4GHz for Zigbee. 868MHz band used in only Europe and has the 20Kbps data rate of transmission and contain only one channel with BPSK modulation technique. 916MHz band is used in Americas having the 40Kbps data rate of transmission and contain 10 channels with BPSK modulation technique. Zigbee used in 2.4 GHz frequency bands throughout the world because of ISM (Industrial, Scientific, Medical) band. It has 250Kbps data rate of transmission and 16 channels with O-QPSK modulation technique. Transmission distance is within the range from 30 meters in an indoor non-line of sight of environment and 100 meters in line of sight environment. The range problem can be solved by using various routing algorithms at the network layer. Zigbee is more advantageous and efficientful than Bluetooth, wifi and any other wireless communication system.

IV. SOFTWARE DESCRIPTION

The smart microcontroling unit named as Arduino Uno can be programmed with the Arduino software there in no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Uno from the Tools , Board menu (according to the microcontroller on your board).The IC used named as ATmega328 on the Arduino Uno comes pre burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. Communication is using the original STK500 protocol (reference, C header files).We can also bypass the boot loader and programs the microcontroller through the ICSP (In-Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

The Arduino Uno is one of the latest smart microcontroller unit and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 (RX) for receive the data and pin no1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Libc to compile programs, and for uploading the programs it uses avrdude. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino

V. SYSTEM FLOWCHART

A. *Transmitter Section Flowchart*

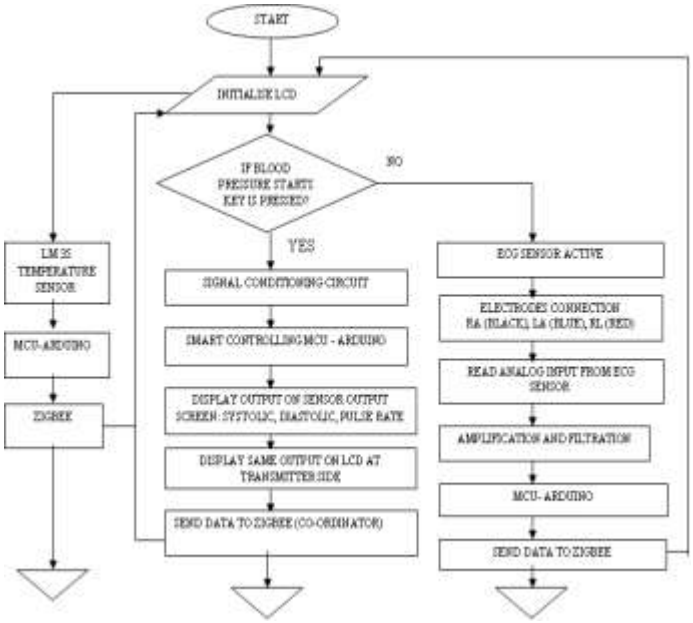

Fig 3. Transmitter section flowchart of system

B. *Receiver Section Flowchart:*

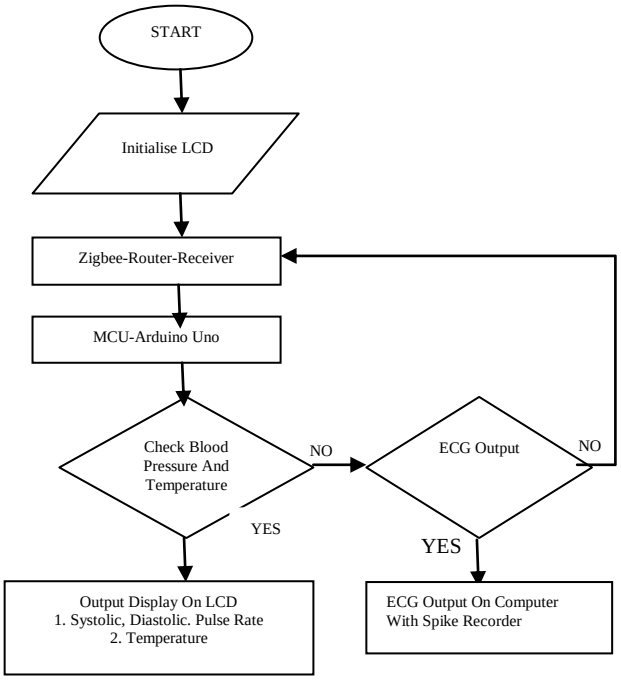

Fig 4. Receiver section flowchart of system

VI. RESULTS

A. *Hardware implementation of transmitter section*:

Hardware implementation on transmitter or patient side and receiver or Doctors side of the system is shown in figure 5and6.

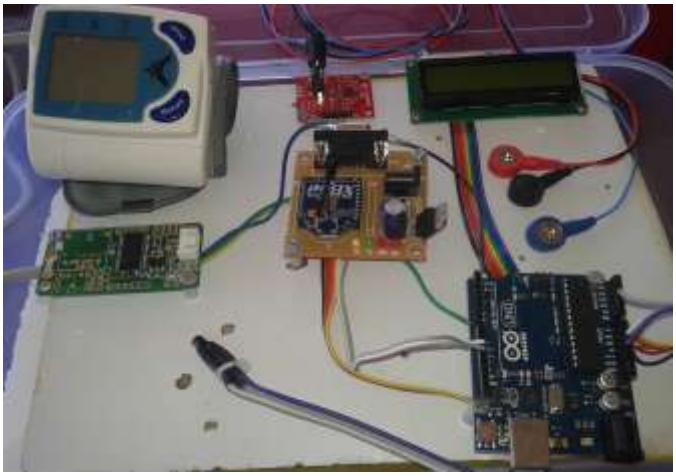

Fig 5. Transmitter hardware with Sensors, MCU, Zigbee.

B. *Hardware implementation of receiver section:*

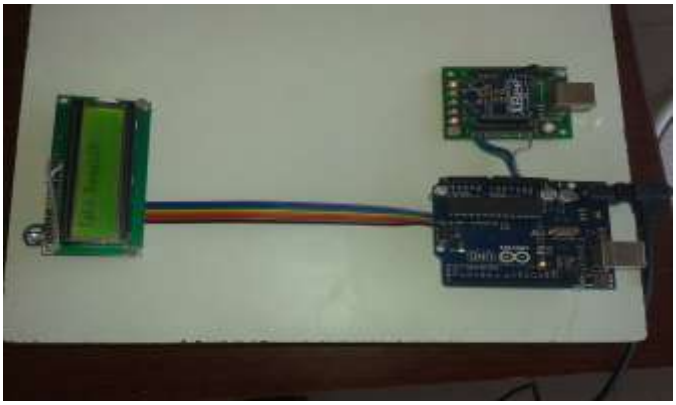

Fig 6. Receiver section hardware.

C. *Output reading on transmitter section:*

The output of blood pressure using blood pressure sensor SUNROM 4118- serial out model in the form of systolic, diastolic and pulse rate and temperature using LM35 is observed in both transmitter and receiver side as shown in figure 7 and 8 below.

At the transmitter side the reading of blood pressure and temperature are displayed and the same data transferred to receiver section of the system.

At the transmitter side the reading of blood pressure is observed to be systolic pressure 124 with diastolic pressure 081 with pulse rate 092 and temperature 31.74^0C are

displayed and the same data transferred to receiver section of the system.

Fig7. Blood pressure and temperature on LCD to the patient side

D. Output reading on receiver section:

The same output results those are observed in transmitter side are transmitted to the receiver side using Zigbee and displayed on LCD display using smart microcontroller unit Arduino.

Fig 8. Output on Receiver side-with blood pressure and temperature.

E. ECG output:

The ECG signal obtained from ECG acquisition circuit is plotted and displayed using spike recorder software on laptop

Fig 9. ECG signal obtained on laptop

VII. CONCLUSION

As this system is based on different bio-sensors, micro-controller & Zigbee technology is used to transmit data wirelessly, as great use in the field of medicine and helps the Doctor to keep a keen eye on the patient's health. So a system is used to monitor the overall health of patient, which needs constant care, the data at receiver which can be used to analyse the patients overall health condition. Thus the blood pressure, pulse rate, temperature, ECG signal is measured from the different biosensors and respective diagnosis can be done by doctors.

VIII. REFRENCES

[1] Karandeep Malhi, Subhas Chandra mukhopadhyay, Julia schnepper,Mathias Haefke and Hartmut Ewald, "A ZigBee Based Wearable Physiological Parameter Monitoring System."IEEE, Volume. 12, NO. 03, March-2012.

[2] Shyr-Kuen Chen,Tsai R Kao, Chia-Tai Chan, Chih-Ning Huang, Chih-Yen Chiang, Chin-Yu Lai,Tse-Hua Tung, and Pi-Chung Wang, "A Reliable Transmission Protocol for ZigBee-Based Wireless Patient Monitoring" IEEE transaction on Information Technology in Biomedicine Volume. 16, NO. 01,January -2012

[3] Yuan-Hsiang Lin, I-Chien Jan, Patrick Chow-In Ko, Yen-Yu Chen, Jau-Min Wong, and Gwo-Jen "A Wireless PDA-Based Physiological System For Patient Monitoring" IEEE Transactions on Information Technology in Biomedicine, Volume- 8, NO. 4, December 2004

[4] Manisha Shelar, Jaykaran Singh, Mukesh Tiwari, "Wireless Patient Health Monitoring System", International Journal of Computer Applications (0975 – 8887), Volume 62,No.6, January- 2013.

[5] Ramu R, A. Sukesh kumar," Real time monitoring of ECG using Zigbee technology", IJEAT, Volume3, AUGUST 2014.

[6] ATMEGA328 Datasheet by ATMEL Corporation.

[7] AD8232 Datasheet by sparkfun technology.

[8] LM35 Datasheet.

[9] Blood pressure sensor by Sunrom 4118 model.