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IMPLEMENTATION OF GSM BASED ECG AND TEMPERATURESENSOR SYSTEM USING IOT

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***Abstract*- Health monitoring system has become an necessary field in many applications such as military, home care unit, hospital, sports training and emergency monitoring system. In this proposed system, a portable real-time wireless health monitoring system is implemented using Arduino uno which contains the configurable integrated analog and digital peripherals. Developed acquisition system is used for remote monitoring the patient's physiological values. This system allows the physician to understand the patient's scenario on the computer screen by a Zigbee module. The sensor unit consists of temperature sensor, and an ECG sensor. The output from the sensor unit is given as input to the Arduino uno, in which the signals are conditioned using analog circuits and it is processed using Arduino processor using the program. This output is provided as input to the Zigbee transmitter. The Zigbee module at the other end will receive these data and the biomedical sensor values will be displayed. This system consists of Zigbee modules which will be able to send the data from one end to another end. In future the current process can be implemented using IOT which is an more advanced technology and also has more advantage than Zigbee.**

Keyword- temperature sensor, ECG sensor sensor, multi patient monitoring system,Arduino uno.

I.INTRODUCTION

Remote patient monitoring (RPM) is a technology to enable monitoring of patients outside of conventional clinical settings (e.g. in the home), which may increase access to care and decrease healthcare delivery costs. It allows patients to maintain independence, prevent complications, and minimize personal costs. Key features of RPM, like remote monitoring and trend analysis of physiological parameters, enable early detection of deterioration; thereby, reducing number of emergency department visits, hospitalizations, and duration of hospital stays. The time saved as a result of RPM implementation allows healthcare providers to allocate more time to remotely educate and communicate with patients.In this proposed work the physiological parameters such as the patient's body temperature, ECG sensor will be monitored using the vital sign sensors of the body area network. These physiological datas will be sensed and it will be provided as input to the Arduino uno which contains many integrated configurable analog and digital peripherals. The sensed physiological data will be converted to digital data using the system on chip ADC block, of Arduino uno to minimize the total area consumed, and the digital data is processed using the Arduino.In the proposed system microcontroller is used for processing. For transmission of message Zigbee technique of messaging can be used. Message can be sent any time any where in the world using Zigbee. The proposed system is very cost effective and the vital parameters are measured and sent accurately to the numbers which are already store in the system . Programming the microcontroller is done in assembly language and AT commands of Zigbee is used for transmission of message. The board was designed for low power operation at the minimum output data rate. To this end, maximum measurement (ECG sensor) were considered. The proposed patient monitoring system would be beneficial for medical practitioners to do proper and better treatment; also it would be useful for health care providers to improve disease management. The patient is monitored from ICU and the data transferred to the pc is wired. Recent work includes using Bluetooth technology coupled with the GSM technology to report signs to PDAs held by the patient or his doctor. In this proposed system a portable real time wireless health monitoring system is implemented using Arduino uno which contains the configurable integrated analog and digital pheripherals. The developed acquisition system is used for remote monitoring of patient's physiological values. Thus in this current process by using GSM we can increase the distance by sending the information from the current location to any where at any time .Thus The proposed system has a number of benefits namely, Reducing the cost of service delivery. Easy and quick access to the specialist. Cost effective post treatment consultation. Travel time reduction and Enhanced quality and efficiency of medical care.

II. ARDUINO UNO

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control the physical world. The project is based on a family of microcontroller board designs

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manufactured primarily by Smart Projects in Italy, and also by several other vendors, using various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The first Arduino was introduced in 2005, aiming to provide an inexpensive and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors. An Arduino board consists of an Atmel 8- 16- or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU board to a variety of interchangeable add-on modules known as *shields*. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus—so many shields can be stacked and used in parallel. Official Arduinos have used the mega AVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. A handful of other processors have been used by Arduino compatibles. Most boards include a 5 volt linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants), although some designs such as the Lily Pad run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, opti boot loader is the default boot loader installed on Arduino UNO. At a conceptual level, when using the Arduino software stack, all boards are programmed over an RS-232 serial connection, but the way this is implemented varies by hardware version. Serial Arduino boards contain a level shifter circuit to convert between RS-232-level and TTL-level signals. Current Arduino boards are programmed via USB implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Unos, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware (itself reprogrammable via its own ICSP header). The Arduino integrated development environment (IDE) is a cross-platform application written in Java and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a sketch .Other variants, such as the Arduino Mini and the unofficial Board uino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods. (When used with traditional microcontroller tools instead of the Arduino IDE standard AVR ISP programming is used). There are many Arduino-compatible and Arduino-derived boards. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education to simplify the construction of buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use completely different processors, with varying levels of compatibility.The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C, C++ and Java programming languages.

Figure 1- Arduino uno development board.

III. PROPOSED SYSTEM

In this proposed system temperature sensor and ECG sensor are interfaced with arduino uno where the data received are analog data's which are then converted into digital by using ADC converter and the data will be send to the Zigbee Transmitter.

A.Transmitter section

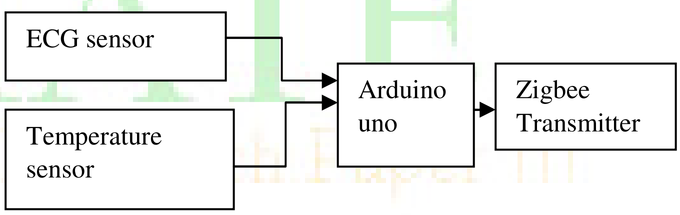

Figure 2 - Block diagram of transmitter section

B.Receiver section

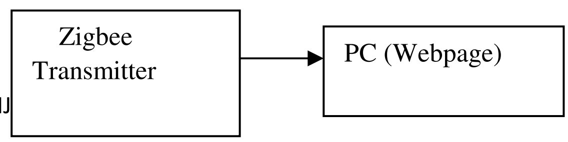

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Figure 3. Block diagram of receiver section

In this receiving section the data's taken from the transmitter side through the Zigbee Transmitter where the data's from the patient is sent to PC for every 24 hours .

C. Principle of operation

The biomedical sensor will sense the patient's physiological parameters and it will be provided to thearduino uno which contains as in built in ADC block.. Thus the sensed data's are converted into digital and it is processed in to a centralized ARM server and the data's are stored in the region of the processor. The data's are provided as input to the zigbee module through the port pins. The zigbee receiver receives the data and it will be stored in the AT89S52 microcontroller in the receiving section. Now the data's will be displayed in the LCD display.

IV. SENSOR UNIT

A. Body temperature monitoring

Normal human body temperature, also known as normothermia or euthermia, depends Up on the place in the body at which the measurement is made, the time of day, as well as the activity level of the person. Nevertheless, commonly mentioned typical values are: Oral (under the tongue): 36.8±0.4 °C (98.2±0.72 °F). Internal (rectal, vaginal): 37.0 °C (98.6 °F). Different parts of the body have different temperatures. Rectal and vaginal measurements taken directly inside the body cavity are typically slightly higher than oral measurements, and oral measurements are somewhat higher than skin measurements. Other places, such as under the arm or in the ear, produce different typical temperatures Although some people think of these averages as representing the normal or ideal temperature, a wide range of temperatures has been found in healthy people.

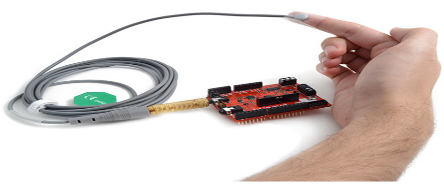
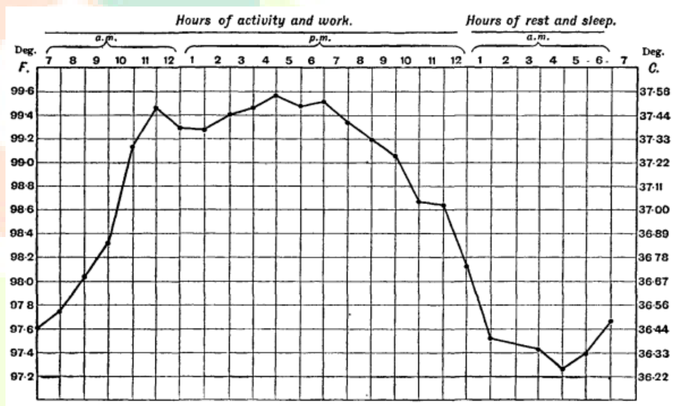


Figure 3-Body temperature sensor

Different parts of the body have different temperatures. Rectal and vaginal measurements taken directly inside the body cavity are typically slightly higher than oral measurements, and oral measurements are somewhat higher than skin measurements. Other places, such as under the arm or in the ear, produce different typical temperatures Although some people think of these averages as representing the normal or ideal temperature, a wide range of temperatures has been found in healthy people. The body temperature of a healthy person varies during the day by about 0.5 °C (0.9 °F) with lower temperatures in the morning and higher temperatures in the late afternoon and evening, as the body's needs and activities change. Other circumstances also affect the body's temperature. The core body temperature of an individual tends to have the lowest value in the second half of the sleep cycle; the lowest point, called the nadir, is one of the primary markers for circadian rhythms. The body temperature also changes when a person is hungry, sleepy, sick, or cold.



Diurnal variation in body temperature, ranging from about 37.5 °C from 10 a.m. to 6 p.m., and falling to about 36.4 °C from 2 a.m. to 6 a.m.

B. ECG sensor

The electrocardiogram (abbreviated as ECG or sometimes EKG) is a skin surface measurement of the electrical activity of the heart over time. Doctors use ECGs to detect and diagnose conditions such as arrhythmias (abnormal heart rhythms) and myocardial infarctions (heart attacks). It has become a routine part of any complete medical evaluation and has been used as a diagnostic test for over 70 years. An ECG detects the movement of ions through heart muscle known as the myocardium, which changes with each cardiac cycle. The atria depolarizers, which results in the small hump of the ECG known as the P wave. The ventricles depolarize next, which results in the QRS complex. Finally, the ventricles repolarize, resulting in the T wave. The spaces between the waves also have physiological significance. The time between the P and R waves (the P-R interval) indicates how much time there is between the atria depolarizing and the ventricles depolarizing. A long P-R interval could be indicative of a conduction delay between the atria and ventricles known as heart block.

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Electrocardiography is the process of recording the electrical activity of the heart over a period of time using electrodes placed on a patient's body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle depolarizing during each heartbeat In this way, the overall magnitude and direction of the heart's electrical depolarization is captured at each moment throughout the cardiac cycle. The graph of *voltage* versus *time* produced by this noninvasive medical procedure is referred to as an **electrocardiogram.**Elevations and depressions of the S-T segment maybe indicative of a conduction abnormality or loss of blood to the heart. cardiac cycle repeats itself about once in a second and a normal resting heart rate is60-100 beats minute. The heart rate can be represented in beats per minute (bpm) as an average number of beats over several beats, or as an instantaneous heart rate, which is calculated in bpm equal to T_{RR} 60, where T_{RR} is the time between R peaks known as the R-R interval. The below graphical representation shows the ECG waveform.

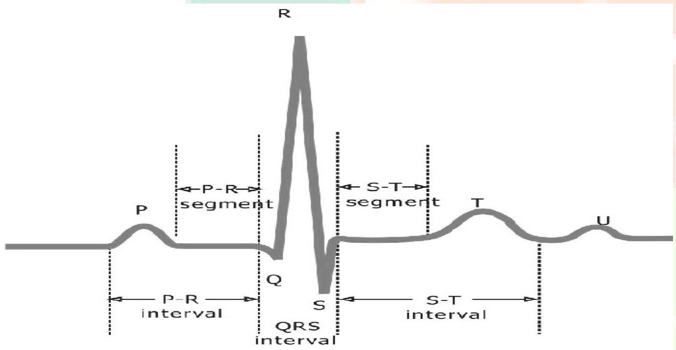

Figure-4- An example ECG waveform.

Heart rate variability (HRV), or the variability of the R-R interval, can be calculated in a number of ways, but is often calculated as the standard deviation of the R-R intervals in a given time period. HRV is related to the relative activation of the sympathetic and parasympathetic nervous systems and changes in HRV are associated with changes in cardiovascular health such as increased fluid retention in patients with congestive heart failure. Electrodes are placed on the body for different views of the heart known as ECG leads. An ECG lead is the projection of the ion movement vector in a particular direction at the surface of the skin. Each ECG lead is a differential measurement, or a measurement between two points on the skin. A standard clinical ECG includes 12 different leads or projections. They form a triangle known as Einthoven's Triangle and involve different combinations of electrodes placed on the Right Arm (RA), left arm (LA), and left leg (LL). A reference electrode is placed on the right leg (RL) that relates the potentials of the body and the circuit to one another. For example, to measure a lead II ECG the voltage difference between the left leg (LL) and right arm (RA) electrodes is measured.

Before calculating the heart rate, we must processing the ECG in the analog (amplification, common mode voltages suppression and filtering) and digital (digital filtering) domains. Most of these functions can be performed by the microcontroller in real time. **Figure 7.1** shows an implementation of a ECG heart rate monitor. The INSAMP rejects the CMRR and the signal is pre-amplified to improve noise immunity. An antiphase signal is also used. This circuit consists of a buffer amplifier.

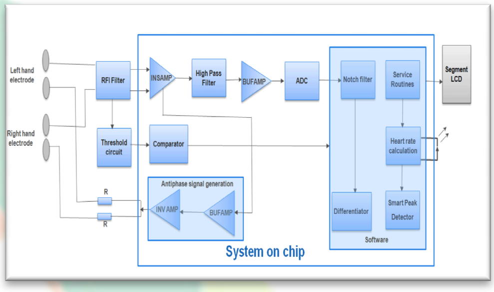

Figure-5- System on chip for ECG sensor

(BUF AMP) and an inverting amplifier (INV AMP) that applies an inverted version of the common-mode signal to the hands, with the aim of cancelling interference. On the output of this circuit there is a voltage level shift to automatically detect the moment hands are placed on the electrodes. The threshold circuit and comparator detect this moment. From the output of the INSAMP, the EKG signal passes through a high pass filter and is buffered bythe BUF AMP. Then the signal is digitized via an ADC. Later the digitized signal passes through various filters and pulse calculation routines to calculate the heart rate.

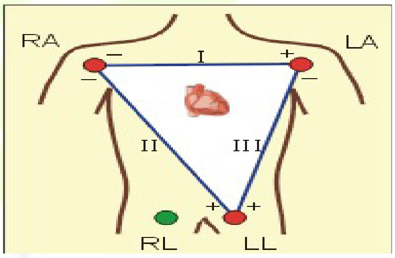

Figure-6- ECG leads I, II and III

The ECG signal is a small voltage difference between two electrodes on the order of a few milli volts. An instrumentation amplifier (IA) can be used to take the difference between the voltages of two electrodes and gain up the resulting difference so it can be seen on an oscilloscope and sampled by an Analog-to-Digital converter (ADC). The INA114 is made up of 3 op-amps: two op-amps at the inputs that buffer the input signals and a third op-amp that acts as a differential amplifier. Because the IA has high input impedance like an op-amp, little current flows from the input voltages V_1 and V_2 and little voltage is dropped across its source resistance, so you can assume that it takes the difference between the voltages placed at its inputs.

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V. EXPERIMENTAL SETUP

Figure 7. shows the hardware setup of transmitter section which contains the Arduino uno and the biomedical sensors such as temperature sensor, and ECG sensor. All these sensors are integerated and it is interfaced with Arduino uno. It also contains a Zigbee module which receives the data from the Arduino uno. The sensor reads and digitally filters ADC data. It calculates the pulse rate and body temperature of the patient and it displays the values on the LCD.

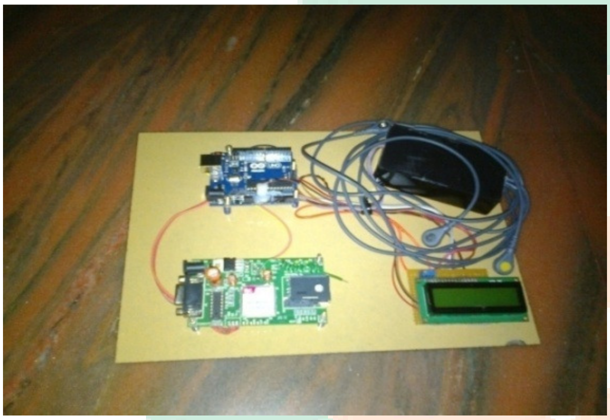


Figure 7 - Hardware result

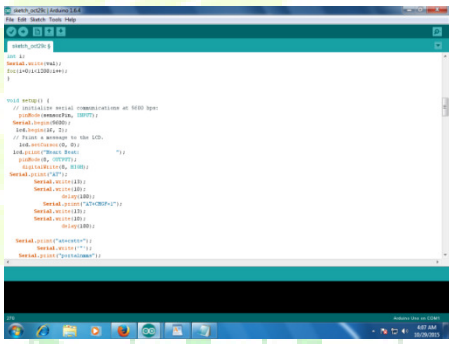
Figure 8- Hardware result

Figure 8. shows the hardware setup of transmitter section which contains the Arduino uno and the biomedical sensors such as temperature sensor, , and ECG sensor. All these sensors are integrated and it is interfaced with Arduino uno. It also contains a Zigbee module which receives the data from the Arduino uno. The sensor reads and digitally filters ADC data. It calculates pulse rate and SpO_2. Displays values on the LCD. The ADC samples are divided into IR LED streams and independently filtered by a second order IIR LPF and a first order HPF. Note that after every ADC sample, the LEDs are switched in the following manner: the IR LED is switched on, the red LED is switch and vice versa. Therefore, each channel sampling frequency is only 25 Hz. The differentiated infrared signal is used for beat detection. When the absolute magnitude of the differentiated signal is higher than the threshold value, the beat is detected and the time interval between beats is calculated.

The SpO_2 is calculated each time a beat is detected. The calculation includes minimum and maximum estimates of infrared and red waves and calculates the SpO_2. The value of SpO_2 is then passed through the fourth order moving average filter to reduce possible fluctuations. After detecting 11 beats, the array of 11 time intervals is passed through a median filter that yields the duration value of time between beats integrated over the 11 samples. This operation is also performed with an array of SpO_2 values. The value is then passed through the second order moving average filter, and the pulse rate is scaled to units of beats-per-minute and displayed on the LCD. To reduce detection of false beats after every detected beat, the Pulse Oximeter performs automatic threshold level adjustments and noise detection during a 320-msec search window. The maximum of the absolute value is searched in an interval of t_1 = 200 ms after the detected beat and the threshold value is updated. The threshold value is decreased for every 200 ms until it reaches a lower limit. Consider an interval of 200 to 240 ms after the last beat detection, the abs(E) is greater (than threshold value), then noise is detected and the time interval measurement is restarted.

VI. RESULTS AND DISCUSSION

The screenshot for the coding used in this project is given below.



A.OBSERVATIONS FROM THE EXPERIMENTAL SETUP

From the below table it is inferred that the biomedical sensors were interfaced with the processor and the following values were displayed in the LCD module of the hardware set up.

Number of patients	Body temperature in degree celsius	Pluse rate value per minute
Patient 1	*37*	*84*
Patient 2	*39*	*72*

Patient 3	***42***	***83***
Patient 4	***42***	***61***

VII. CONCLUSION

In this proposed model of monitoring physiological parameters such as temperature, heartbeat, ECG, blood sugar, are more powerful than currently available system. Currently available systems for monitoring physiological signals suffer from technical limitations. The proposed system is an enormous improvement over existing commercial methods, the present system can support up to twenty patients with real-time, low-power, low-cost, long-distance, and dual-mode monitoring, from the above designed project. The Keil C software is used for developing application programming. Health monitoring application is mainly proposed to provide alerts for medical health monitoring staff for the patients when needed. The real-time monitoring system for cardiac patient physical states is based on wireless sensor network technology. It can be taken by patient and keep the patient movement intact because it is miniature and portable. The system can monitor and record the physical states and movement parameters real-time, and then provide an auxiliary means for the correct diagnosis of doctor. With the intelligent diagnosis software, the sign of acute disease for patient can be found early, and then the patient can be helped in time, the sudden death of patient can be avoided. In future other health monitoring module such as EMG, EEG for brain signal analysis are to be added for completing the system, and the system should be adapted for minimizing the device's size and allow for daily life usage.

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