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Real Time Health Monitoring System Using IoT

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Abstract

Today chronic diseases are the fastest rising diseases in the humans; this may be caused due to a lot of reasons like dietary habits, physical movement and unhealthful habits such as alcohol and cigarettes use. The design of this system creates integration of the real time continuous and long term health monitoring system to observe the biomedical parameters like heart-rate, blood pressure, ECG, body temperature and pulse oximetry using biomedical sensor in the patient. The sensors are attached to the patient body; the parameters acquired from the patient are processed using Arduino Uno controller board and transmitted to a healthcare centre via wi-fi module. The received biomedical parameters are compared with the predefined threshold values. If the parameter is normal, then the parameter is stored in the database or else the alert message is sent with data to the doctor or to the patient caretaker via wi-fi module.

Key words: Arduino Uno, Heart-rate, Pulse oximetry, Temperature, Blood pressure.

Introduction

It is hard to focus on health in our hectic life; hence improved technology in medical sector proves to be very supportive for an individual. Current technology introduced most of smart or medical sensors in market that constantly observe individual patient health status and analyze the abnormality in the health. Bio-medical sensors are designed to forecast the heart attack or any other changes in the health status before the patient falls sick [1].

The main motivation for the improvement of biomedical sensor is illness, health hazards of worldwide population and enhancement in aging of the people because of climate changes, global warming. Patients are observed by wearable biomedical sensors (WBS), a lot of elderly people desire to live separately, and they are capable to observe their health status, if essential immediate medical help will be offered by healthcare centre.

Wearable biomedical sensors implemented to monitor health of patient constantly [2]. The major technology of the healthcare system is as shown in the figure 1. It assists the patient for long term monitor of her/his physiological parameter changes and also provides tele-feedback to maintain their optimal status of the health. The biomedical sensors intended to offer emergency aid to physically challenged people, elderly people and rehabilitation patients [3].

The proposed system integrates biomedical sensors to keep away from the anxiety of the elderly people with a precise, noninvasive consistent, comfortable, inexpensive and flexible monitoring that fulfils all these medical necessities. The system comprises multi-sensors like heart-rate sensor, ECG, blood pressure and pulse oximetry sensor. All these sensors are attached to the patient. Signal processing is required to process the signals from the various sensors. Arduino Uno control board with ATmega328 microcontroller is used to process the signal acquired from the biomedical sensors and transmit the parameter to the healthcare centre via wi-fi module [4]. The healthcare centre accepts this parameter and stores it in the patient database. The biomedical parameters accepted from the patient are compared with the threshold value to make a decision whether the health condition of the patient is normal or abnormal. If the abnormal condition of the patient is detected, the emergency message is sent to the doctor and patient via wi-fi module for immediate medical care [5].

Methodology

Everyone is more worried about their health status so that day-by-day technology is improving making life easier and more comfort. There are number of advanced biomedical sensors introduced in the biomedical market for continuous monitoring of health condition. Many biomedical sensors are user friendly or digital in nature; hence it is not necessary for doctor to examine the parameter or any vital sign change in the health [6].

In the proposed system, integration of different biomedical sensors is implemented to monitor the health status of the patient. Basically biomedical sensor are analog in nature, the analog data from the sensors are required to be converted into a digital data for further processing, Arduino Uno is a controller board used to convert the analog data from the biomedical sensors into digital data, the conventional parameter has to be analyzed by the healthcare centre, the parameter received at the healthcare centre is stored in the respective patient database, if the abnormal condition is detected an alert message is sent to a doctor via wi-fi module. The figure1 shows block diagram which gives the overview of the proposed system. The system consists of mainly microcontroller (ATmega328), ESP8266-wi-fi module, sensor networks and control switches [7].

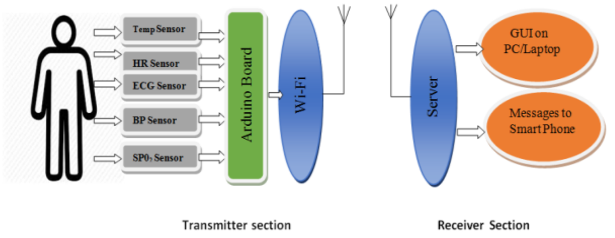

Figure 1: Integrated Wireless Instrumentation System for Biomedical Parameters

Arduino UNO Board

The Uno is a microcontroller board based on the ATmega328P. "The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now developed to new versions. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for a wide list of current, past or outdated boards see the Arduino index of boards as shown in the figure 2.

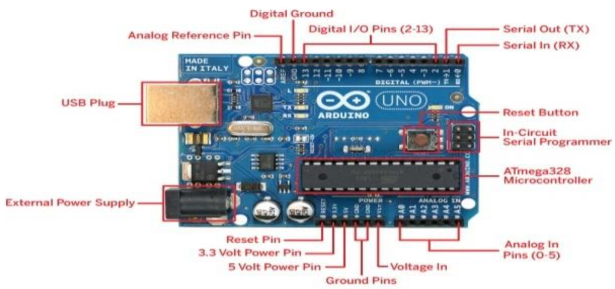

Figure 2: Arduino Uno Board with pin details

Microcontroller ATmega328

Arduino UNO is an open source prototyping platform based on ATmega328 microcontroller. It consists of 14 digital input/output (I/O) pins, six analogue inputs, a USB connection for programming the on-board microcontroller, a power jack, an ICSP header and a reset button. It is operated with a 16MHz crystal oscillator and contains everything needed to support the microcontroller [8].

Pulse Oximeter (SPO2) Sensor:

The measurement starts when the MCU produces a PWM signal that varies the LED intensity. The switch control pin on the MCU chooses which LED is turned on at that time. Light from Red and Infra-Red LEDs on the sensor moves through the finger and the non-absorbed light are received in the photo-detector. The signal passes through a current to the voltage converter where it is filtered, amplified, and converted into a voltage. The signal is now multiplexed to its respective filter and amplification stage, depending on whether it is Red or Infra-Red LED. At this stage, the signal is treated and most of the noise is removed. The signal is also amplified in order to be detected simply by the MCU ADC. The filtered signal is then sent to an ADC channel on the MCU [9].

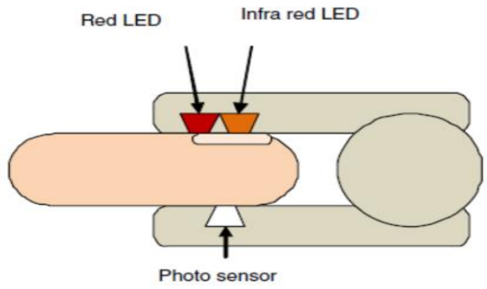

Figure 3: SPO_2 Sensor

One sample of the Red filtered signal, Red baseline, Infra-Red filtered signal, and Infra-Red baseline are taken every 1 ms. A peak detection algorithm is used to determine the AC constituent of the signal that is generated by the pulsatile arterial blood absorption. This is the element of the signal which is used for SpO_2 and beats per minute (bpm) computation. The samples taken and the measured data (SpO_2 and bpm) are sent to a GUI on a computer.

LM35 temperature sensor

The LM35 series are accurate integrated circuit temperature sensors. Their output voltage is linearly proportional to the Celsius temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in °K, as there is no requirement to subtract a huge constant voltage from its output to get Centigrade reading. It does not necessitate any external calibration or trimming to provide typical accuracies of $\pm 1/4$°C at room temperature and $\pm 3/4$°C over a full −55 to +150°C temperature range. It draws only 60 µA from its supply, so it has very low self-heating, less than 0.1° C in still air [10]. It 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) as shown in figure 4.

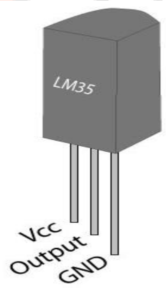

Figure 4: LM 35 Temperature sensor

Heart-rate sensor

A person's heartbeat is the sound of the valves in his/her heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

The heartbeat sensor is based on the principle of photo plethysmography. It observes the modification in the volume of blood throughout any organ of the body which will causes a modification in the light intensity throughout that organ. The flow of blood volume is determined by the speed of heart pulses and because light is absorbed by blood, the signal pulses are corresponding to the heart rate pulses. There are two types of photo-phlethysmography [11].

Figure 5: Heart-rate sensor

The sensor and its principle are shown in the figure 5. The basic heartbeat sensor includes a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses changes a variation in the flow of blood to various organs of the body. When a soft organ is enlightened with the light source, i.e. light emitted by the led, it either reflects or transmits the light. Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The quantity of light absorbed depends on the blood quantity in that organ. The detector output is in form of electrical signal and is proportional to the heart-rate [12].

Blood Pressure Sensor

Blood pressure is the force of blood on the walls of arteries. Blood pressure is measured as two numbers—the systolic pressure over the diastolic pressure.

Figure 6: Blood Pressure sensor

The measurement is written one above or before the other, with the systolic number on top and the diastolic number on the bottom. For example, a blood pressure measurement of 120/80 mmHg is expressed verbally as "120 over 80." The Blood Pressure Sensor is used to calculate systemic arterial blood pressure of the persons. When used with the suitable software, it can calculate mean arterial blood pressure and calculate both the systolic and diastolic blood pressure by means of the oscillometric method [13] as shown in figure 6.

LCD Display

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating characteristics of liquid crystals (LCs). LCs does not emit light directly. These are used in a broad range of applications including: computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. These are common in customer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have displaced cathode ray tube (CRT) displays in most applications.

IoT Server

IoT is the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that facilitate these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things defined the IoT as "the infrastructure of the information society." The IoT allows objects to be sensed and/or controlled distantly transversely accessible network infrastructure. Creating chances for maximum direction corporation of the physical world into computer-based systems, and resulting in improved efficiency [14].

Node MCU (ESP8266):

Node MCU is a microcontroller which is associated to IOT server through internet. MCU will obtain the ON OFF packets from server and switches appliances reverence to server signal. Espressif Systems' Smart Connectivity Platform (ESCP) is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed wi-fi abilities within other systems, or to function as a separate application, with the lowest cost, and minimal space requirement [15].

ESP8266 presents a complete and self-contained wi-fi networking solution; it can be used to host the application or to offload wi-fi networking functions from an additional application processor. Serving as a wi-fi adapter, wireless internet access can be added to any microcontroller based design with simple connectivity. ESP8266 is among the most integrated wi-fi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area [16].

Results

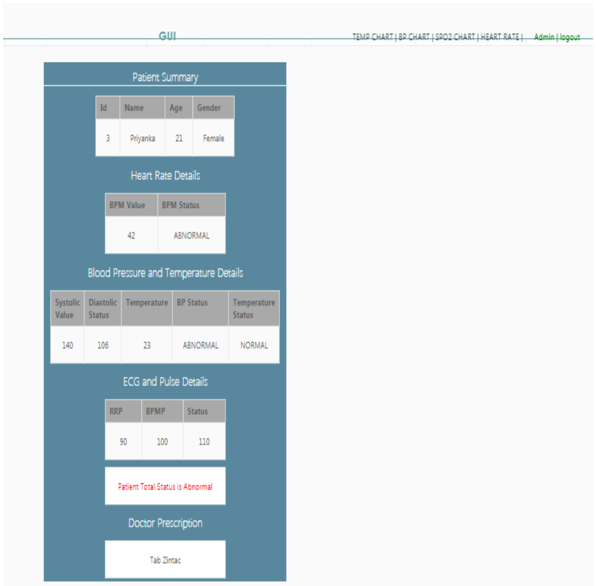

Figure 7: Summary of the patient physiological parameters.

The integrated health monitoring system with the different sensor performances are described in this section. The Graphical User Interface (GUI) is designed in such way that, the complete detail information of the patient and the doctor can be viewed to reduce the system complexity and to make it user friendly. The wireless body sensors obtain the data from the patient body and the data is processed through arduino uno controller board which is connected to the sensors with wi-fi module. The wi-fi module transmits the data to the healthcare centre.

As shown in figure 7, the admin at the healthcare centre receive the patient health condition parameters through server. The details of the patients and the doctors are stored in the database for further use. The parameters such as heart rate, blood pressure, ECG and pulse oximetry are measured; the complete summary of the patient health condition is generated. The patient health condition is compared with the predefined threshold value. If the condition or status of the patient health condition is abnormal, it is necessary to provide a prescription for respective health issues and also an immediate message has been sent to patient about his/her health status. The figure 8 and 9 shows the graphical representation of the body temperature and pulse (SpO_2) in percentage.

Figure 8: GUI of the Patient's body temperature.

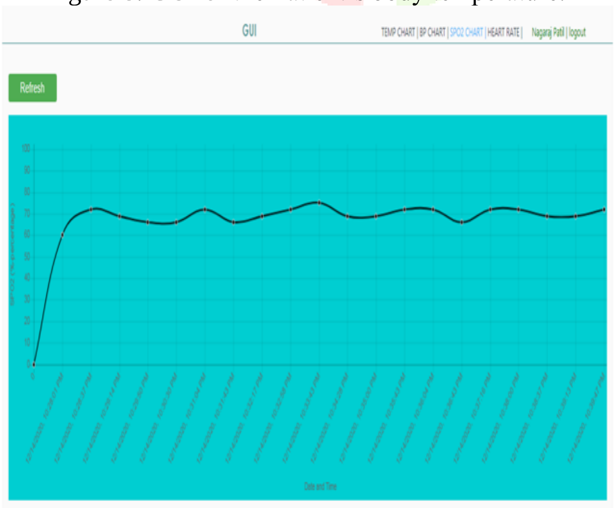

Figure 9: GUI of the Patient's SpO_2.

The figure 10 shows the graphical representation of the ECG and figures 11shows the blood pressure.

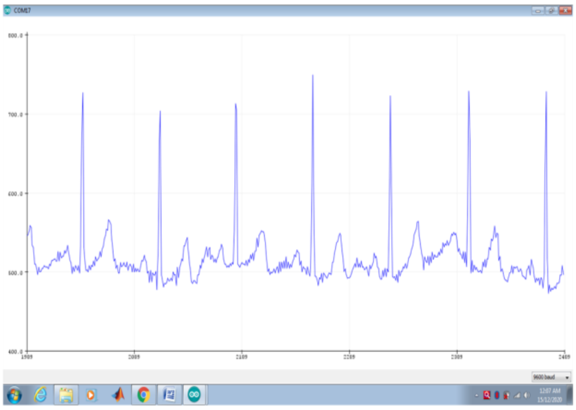

Figure 10: GUI of the Patient's ECG.

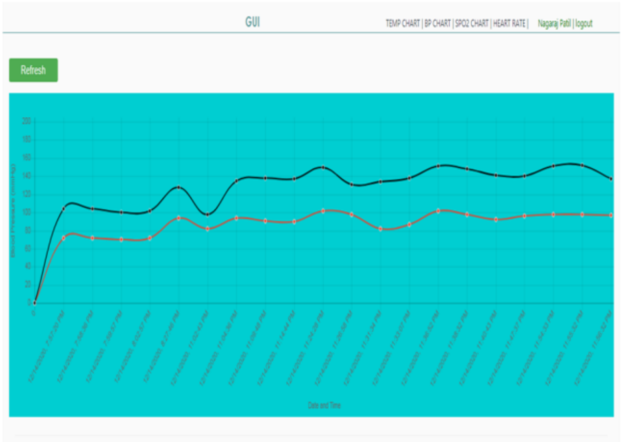

Figure 11: GUI of the Patient's blood pressure.

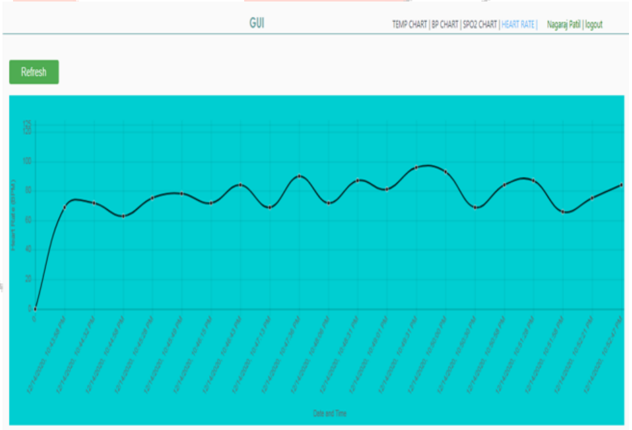

Figure 12: GUI of the Patient's heart-rate.

Figure 13: Integrated Wireless Instrumentation System for Biomedical Parameters

The figure 12 shows the graphical representation of the heart-rate and figure 13: Integrated Wireless Instrumentation System for Biomedical Parameters

Conclusion

The real time monitoring and immediate assessment of the patient health condition plays a very important role in saving the life of the human. The proposed system includes five biomedical sensors which are more primarily required to measure the vital sign changes of our body anytime. The patient module integrated with temperature sensor, heart rate sensor, ECG sensors, blood pressure sensor and pulse oximetry sensor. These necessary parameters are continuously monitored, usually the sensors signals are analog in nature, to process the signal, arduino uno board is used. The physiological parameters of the patient transmitted to the healthcare centre through wi-fi module are used for examining or to determine the patient health condition. The data received is compared with the threshold value to predict the health status, if any abnormal condition is determined via wi-fi an alert SMS is sent to respective physician for diagnosis and also to the patient. The system helps in the early detection of many medical issues and help full for pre-diagnosis.

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