Automated Wearable Cardiac Pulse Regulator

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Abstract- *The heart rate changes according to age and physically and psychologically impacts the body. Higher pulse rate indicates the presence of abnormality in the body which can also be caused by other reasons such as anxiety, anger, excitement, emotion, and heart disorders. The pulse rate of an individual can help in determining various problems within the body, but it cannot be used alone to diagnose an abnormality. Heart rate is affected by body temperature, heat is an important indicator that needs to be monitored so that any abnormality can be detected early enough to allow treatment. There is a need for a portable device of a suitable size for daily activities of the measurement and control the vital parameters. The aim of this project is to design and develop a device that continuously monitors the vital parameters, as it periodically measures heart rate and temperature. It also triggers an alarm in case the signal has been measured above or below predetermined values. The scope in this project includes the hardware and software parts. For the hardware part, ECG circuits have been designed in order to interpret data from ECG simulator, which act as a patient. Then, a temperature sensor is developed to measure the temperature of the human being. Both systems are controlled by Arduino Nano board, which is connected to the bluetooth module and needs some programming. For the software part Arduino IDE software have been used. The GSM module has been connected in order to send messages if any abnormalities are detected.*

Keywords- Arduino IDE Software, ECG Sensor, GSM Module, Heart Rate.

I. INTRODUCTION

Cardiovascular disease is one of the main causes of death in the many countries, it accounted for over 15 million deaths worldwide. In addition, several million people are disabled by cardiovascular disease. The delay between the first symptom of any cardiac ailment and the call for medical assistance has a large variation among different patients and can have fatal consequences. One critical inference drawn from epidemiological data is that deployment of resources for early detection and treatment of heart disease has a higher potential of reducing fatality associated with cardiac disease than improved after hospitalization.

Hence new strategies are needed in order to reduce time before treatment. Monitoring of patients is one possible solution. The scopes in this project include the hardware and software parts. For the hardware part, ECG circuits have been designed in order to interpret data from ECG simulator, which act as a patient. Then, a temperature sensor was developed to measure the temperature of human being. Both systems are controlled by Arduino Nano board, which connected to the Bluetooth module and need some programming works. For the software part As and Arduino IDE software have been used.

II.HARDWARE DESCRIPTION

AD8232 ECG SENSOR

The AD8232 ECG Module is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. Additionally, this board includes pins like the right arm (RA), left arm (LA) & right leg (RL) pins to connect custom sensors. An LED indicator in this board is used to indicate the heartbeat rhythm of humans. The AD8232 ECG module comprises a function like quick restore used to decrease the length of long resolving tails of the HPFs. We found that "Instant Heart Rate Monitor" received the highest accuracy and "Cardiograph" received the lowest accuracy. From this study we can conclude that "Instant Heart Rate Monitor" is more accurate application compared to the digital heart rate monitor and other applications.

ARDUINO UNO BOARD

The ArduinoUno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and

Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

GSM MODULE

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. An GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like an GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

III. SOFTWARE DESCRIPTION

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.Arduino IDE is a derivative of the Processing IDE, however as of version 2.0, the Processing IDE will be replaced with the Visual Studio Code-based Eclipse Theia IDE framework.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open-source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers.

IV. PROPOSED METHODOLOGY

A device to monitor the person's Heart Rate variation continuously is developed. It alerts through the messages through the GSM module in case abnormalities detected. The ECG leads placed at any place (arms or chest) receives the ECG signals and transmits those signals to the AD8232 ECG sensor. The Arduino UNO board is already programmed based on the signal range sensed by the ECG sensor to alert. The GSM module connected to the Arduino board sends alert messages to the phone number which is given in the program in case of any low or high pulse detected. The serial plotter will plot the graph of normal pulse ranges and also the abnormal pulse ranges with certain values. In addition to that, the serial plotter will also plot the graph and values of temperature measured through the sensor.

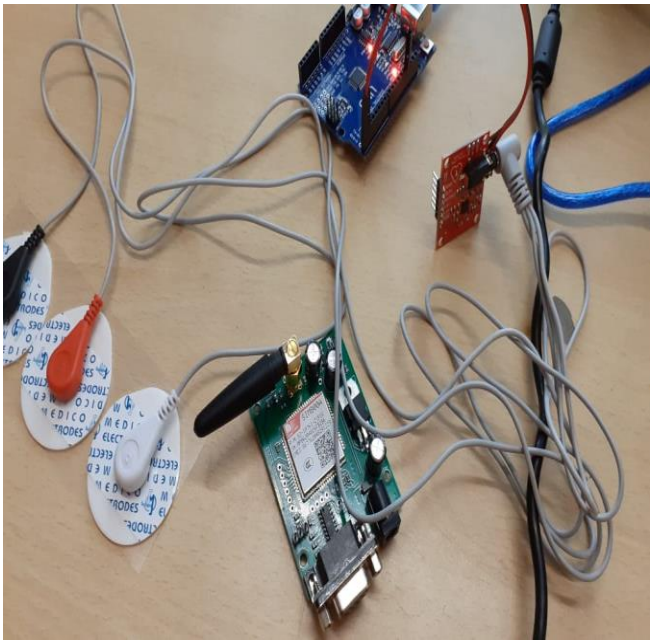

Figure 1. Project Circuit

The project circuit used is been given as shown in the Figure 1 above.

V. RESULTS

Once the circuit has been built codes have been uploaded into the Nano Arduino then the project is ready for testing. The following results were obtained.

HEART RATE RESULT IN SERIAL PLOTTER

The heart rate was obtained using two methods, the manual method and using the pulse sensor to determine the accuracy of the project's circuit. The circuit is supplied by 5V power. For accurate reading as much as possible, the finger or the wrist needs to be placed close to sensor. The output result as an ECG in the Serial Plotter was represented to a certified doctor to determine its accuracy.The certified doctor examined the signal shown in Figure2 below. The doctor stated that the signal is noisy and it is hard to determine the HR from it as it is measured from at least three successive peaks which are not existing within these signals.

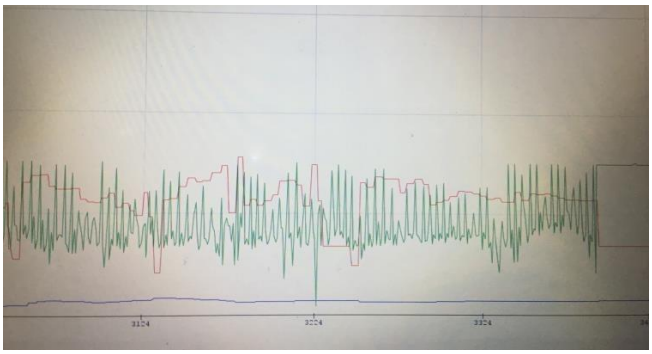

Figure 2. HR Results in Serial Plotter

After that, the same experiment was repeated but this time results were outputted via the Serial Monitor as shown in Figure3 below.

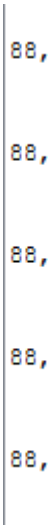

Figure 3. HR Values in Serial Plotter

As shown in the Figure 4, the alert messages will be sent to the mobile phones if any abnormalities detected.

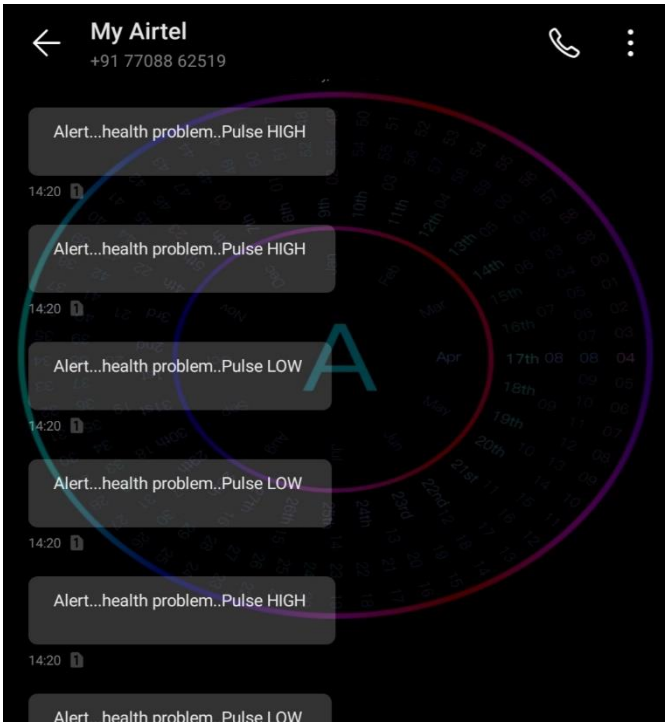

Figure 4.Output on Mobile Phone

VI. DISCUSSIONS

The pulses calculated manually, to determine the accuracy by comparing the manual with Serial Monitor value. Error was calculated to be:

e = (91 – 88) / 91 = 0.032, which means an accuracy of 96.8%.

VII. FUTURE SCOPE

Further improvements can be applied to this project to enhance its performance

- Design robust system to improve measuring efficiency even in the presence of noise. In addition to propose a new method for efficient transmission of data between the MCU and the Android application.
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- To ensure the accuracy of heart rate monitor device, more testing can be performed to larger number of people with different ages and weights.
- Replace the LM35 with specific temperature sensor of body measurement in order to make it more accurate and more functional to use.

- More vital signs parameters should be added to increase the value of the project to the patients. These can include: Blood Pressure, Respiratory Rate and other parameters.
- Implement pulse and other parameters measurements using the mobile phone camera along with other built-in sensors in order to obtain these parameters on demand if the patient started experiencing some symptoms or abnormalities.
- The MCU should send a control signal along with the measured data when detected a heart attack and the buzzer is turned ON. The control signal should enable GPS, instruct the application to send an SMS containing the measured data and the patient's location to the medical emergency and emergency contacts of the patient in order to get an ambulance and notify his relatives.
- The device should be miniaturized into a PCB making its weight lighter in order to make the device commercial for public use.
- Portable battery unit for the device to provide required power by the sensors and MCU.

VIII. CONCLUSION

In this chapter, the proposed system design was demonstrated in details for both the hardware and software units of the project. This design was proposed in such a way to make it available and suitable for use by most people. Furthermore, there are many arm-bands today that people actually buy and use. Hence this project's function can be simply added to one of these bands along with the main services it offers such as: Monitoring Fitness and calculate steps walked daily.

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