https://www.overleaf.com/project/6252ee2e3d3a8c3940e05ed5

Pulse Rate or Heart Rate Monitor

Izuchukwu George Enekwa
dept. electronics engineering
Hochschule Hamm-Lippstadt
Germany
izuchukwu-george.enekwa@stud.hshl.de

***Abstract*—This paper documentation presents the design and simulation of a medical device, which is designed to be a heart rate or pulse rate monitor. This heart rate or Pulse rate monitor is designed to provide users easy access to checking their heart rate or pulse rate wherever they find themselves more efficiently. The system was designed and simulated using Fusion 360 for the device prototype, tinkercad for the schematic circuit design and the hardware simulation provided with the required tools. The code was written in C programming language on the Arduino IDE, which was then uploaded to the Arduino Uno. These simulation results were in accordance with the design specifications and requirements.**

A. JANE

I. Introduction

Electronic devices such as smart phones, computers tablets etc, which can communicate wirelessly or physically, are becoming an integral part of everyday life in the new era of technology and communication. The latest technology makes it possible to monitor patients remotely instead of physically visiting the hospital. Small wireless solutions connected to the IoT make this possible. There are a variety of sensors that can be attached to a patient's body to collect health data securely, and that data can then be analyzed. There are so many people in the world whose health suffers due to the lack of access to hospitals and health monitoring. In this project, I worked on a Heart rate or Pulse rate device, using a pulse rate sensor, an Arduino and an LCD screen display, which collects and transmits data to its monitoring station for display, interpretation, and storage of patient heart rate. Using these parameters you can interpret some important information about the health of your body, for instance high heart rate, while a fluctuating heart rate indicates a heart issue. By working on this project, it allows patients to monitor their heart conditions in real time more efficiently and effectively. Human body is getting more prone to heart-related diseases, and there are an increasing number of deaths due to heart diseases in today's fast-paced world. The purpose of this paper is to describe the design and development of a heart rate monitoring system that tells the heart rate of an individual. By determining the exact heartbeat of a person, problems related to the heart can be detected and cured.

.

II. The Systems Modeling

To approach the task, I had to first of all make a requirement elicitation, systems approach, UML Diagrams and design sketches.

A. Requirement Elicitation

The process of identifying and specifying user needs is part of user requirements engineering. As such, requirements elicitation is a central part of user requirements engineering. In this project, I define requirements elicitation as the process of integrating a variety of information sources (including end-user input) in order to discover the current requirements and agree upon the vision and goals of the targeted project. From the user's perspective, effective elicitation leads to better understanding of their needs; from the designer's perspective, it leads to a clear, high-level description of the problem that needs to be solved, ensuring that the solution is feasible, and that it is being developed for the right problem.For my work, I made the following requirement elicitation.

- Establishing Objectives:
  Here I decided on approach to take in order to have a good systems design, to create or Make reliable products that will be able to read human heart rate/pulse rate efficiently.
- Organize Knowledge:
  Here I have the goal prioritizing, which is the ability to collect human pulse data, read it and display to user. The domain knowledge filtering, which is where the device would mostly be used; Homes, health care centers, gyms etc.
- Collect Requirement:
  For the domain requirements, device must be made with harmless materials. Develop and launch new software and user interface because, It is quite obvious that with time technology evolves and we will too.

B. UML Diagrams

This is where a more visualised details of my systems design is provided, with its main actors, roles and classes in a Unified modelling language.

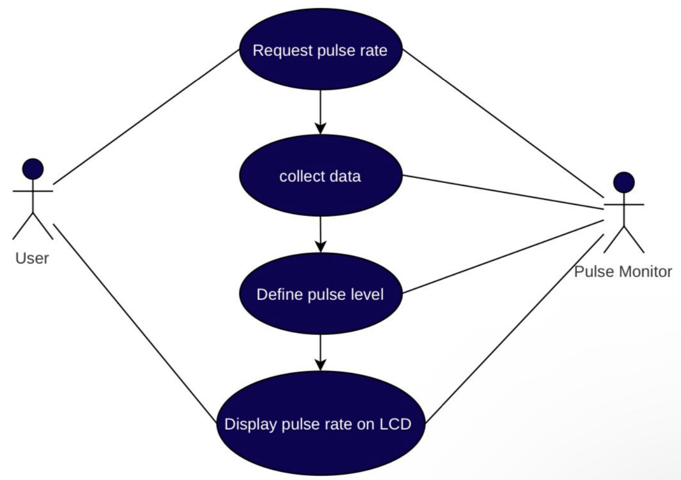

Fig. 1. Usecase Diagram.

For the use case diagram, the user requests for their pulse rate by simply placing the index finger on the pulse rate sensor. The Pulse monitor then collects this data, interprets and defines the pulse level, then sends this data back to the the LCD Display screen for the user to access.

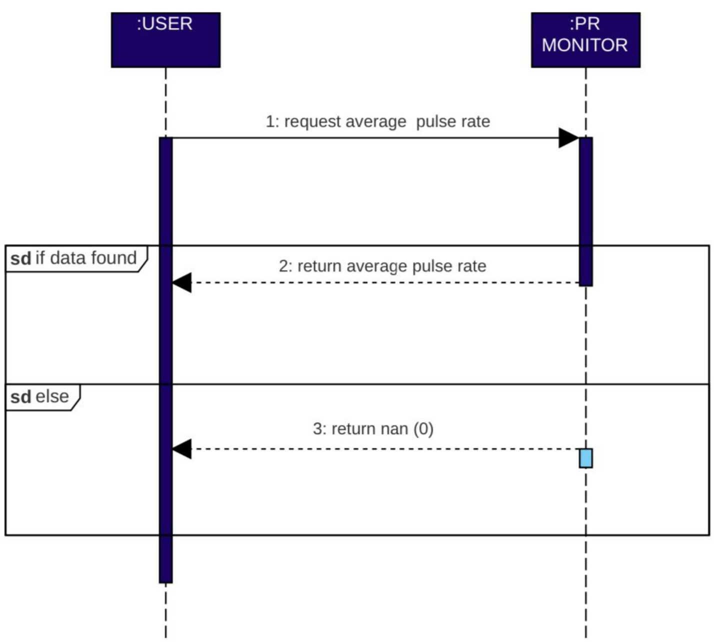

Fig. 2. Sequence Diagram.

This defines the sequential flow of the system. The two block sequential states as seen, the User and the Pulserate monitor. For the first sequence numbering, which is where the user sends a message to the Pulse monitor requesting for average pulse rate. The Pulse rate monitor then responds inform of a loop as seen in fig.2. If pulse rate data is found, the pulse monitor then sends the second sequential number which is the ”return average pulse rate”. But if data is not detected, it returns nan (not a number) to the user.

C. Schematic design

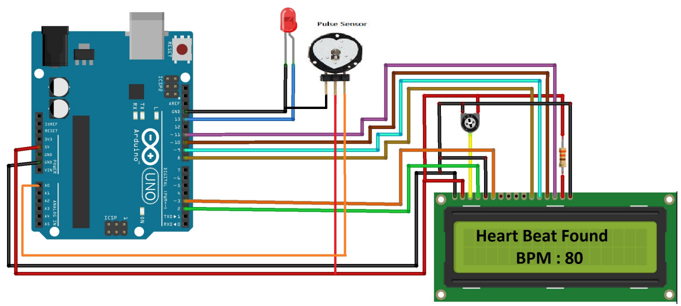

Fig. 3. Schematic design.

This is the schematic circuit design of the system, it consist of the Arduino Uno, LED Light, a pulse sensor, 10K Potentiometer, a 330 ohms Resistor and a 16x2 LCD display.

- Arduino Uno:
  Arduino Uno is a microcontroller board based on an ATmega328 (datasheet).Among its features are 14 digital input/output pins (of which 6 are PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB communication port, a power connector, an ICSP header, and a reset button. The microcontroller kit contains everything you need to get started; simply connect it to your computer with a USB cable or power it with a DC adapter or battery.There is an open source physical computing platform with a simple microcontroller board, as well as a development environment for writing software for the board [6].

- Pulse Sensor:
  One can use a Heartbeat sensor to measure his or her heart rate in real time or to record it for later analysis.Using it is a simple way to study the heart’s function. It measures the flow of blood through a finger and generates a digital output of the heartbeat when a finger is placed on it. The LED flashes on with each heartbeat when the sensor is working. To measure Beats per Minute (BPM), this digital output can be directly connected to the microcontroller. At every pulse, light is modulated by blood flow through the finger. The Pulse Sensor is a well designed plug and play heart rate sensor for Arduino[1].

- LCD Display:
  The LCD screen is everywhere in this digital age, from simple calculators to smartphones, computers and television sets. These LCDs use liquid crystals to produce images, and are divided into categories based

on factors such as manufacturing process, colour or monochrome, and whether it is a graphical LCD or a character LCD.

The 16x2 LCDs are very popular. Moreover, they can also be found in many laboratory and industrial equipment. It can display up to 32 characters at a time. Each character segment is made up of 40 pixels that are arranged in a 5x8 matrix. We can create alphanumeric characters and custom characters by activating the corresponding pixels. There are 16 pins on the display module. Two which are for power (VCC, GND), one for adjusting the contrast (VEE), three are control lines (RS, EN, R/W), eight pins are data lines(D0-D7) and the last two are for the backlight (A, K) as seen in the schematic circuit design in fig 3.
The 16x2 LCD screen has 32 character areas, which consists of a 5x8 matrix of pixels. By controlling and turning on or off these pixels we can create different characters. The LCD display Library was uploaded to the Arduino IDE code I used for this project[2].

- Potentiometer:
  What is a Potentiometer and How Does It Work?
  As a 3 terminal variable resistor, a potentiometer (also known as a pot or potmeter) controls the flow of electricity by varying its resistance. It functions as a voltage divider. Potentiometers are passive electronic components. A potentiometer works by varying the position of a sliding contact across a uniform resistance. An output voltage is created when the voltage applied across a potentiometer's entire length is subtracted from the voltage applied across its fixed and sliding contacts[3].

- Resistor:
  The electrical resistance of resistors, which are electronic components, does not change over time. Through a resistor, electrons are limited in their flow. It is a passive component, which means that it can only consume power (and not generate it). Circuits with resistors complement active components like op-amps, microcontrollers, and other integrated circuits. Resistors are commonly used to limit current and divide voltage[4].

- LED light:
  Described as a semiconductor device that emits visible light of a specific color, a Light Emitting Diode (LED) differs from conventional light sources such as incandescent, fluorescent, and gas discharge lamps. In that case, it has no gas or filament and consumes low energy[5].

By connecting these components, I was able to arrive at my desired outcome and fulfil the requirement specifications. The LCD code library and the pulse sensor Code library was also uploaded to the Arduino Uno, Which helps the device interpret the data and display on the LCD,this compiler has internal libraries which provide ease to the user. Moreover the user can create own libraries in it. These libraries are refrecenced here [1][2].

III. Prototype Design

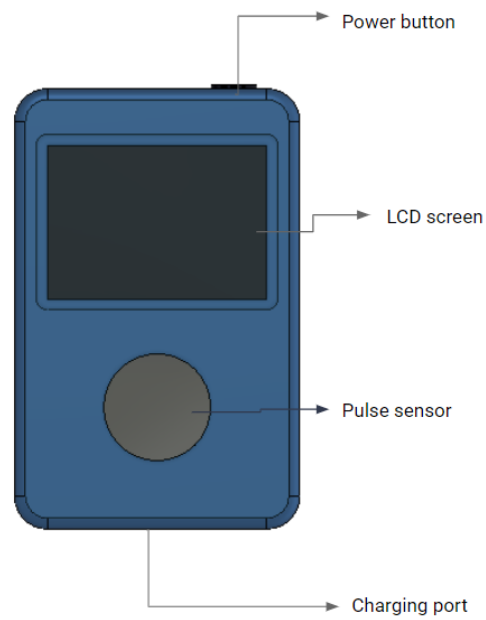

Fig. 4. Prototype labelling.

This prototype design was made using Fusion 360. The labeling in fig 4. describes the functionality of each part of the system which is mapped out from the schematic circuit design in fig 3.
Here we can see the power button, to turn on or off the device, the LCD screen for the display of the pulse rate, the pulse sensor area, and a charging port.

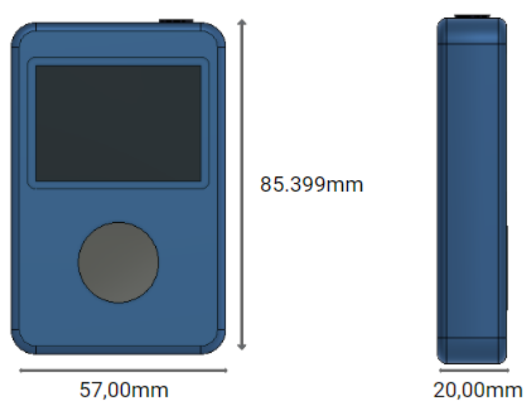

Fig. 5. Device Size.

The device can perfectly fit into the palm of the user, the size was picked based on the circuit requirement, I considered the length/height of the Arduino Uno also as the width and the thickness, also considering the size of the LCD screen and battery housing.

IV. Hardware simulation

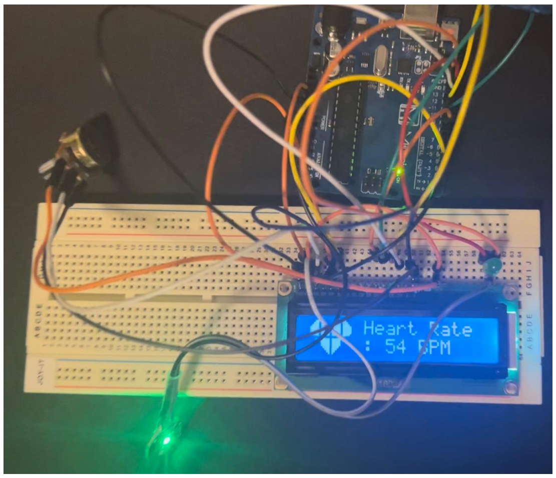

Fig. 6. Device Size.

The hardware simulation was done based on the required components connected. the out come result was in accordance with the design specifications, I also measured my pulse rate, the estimate was around 87bpm. Of course, this result was also tested using an iPhone pulse rate checker and the estimate was about the same. The full video of this illustration can be found under the GitHub repository :
https://github.com/georgeEn/Medical-device-ISD2

V. Conclusion

The number of heart diseases is rising, and heart attacks are also on the rise. With our proposed system, we can detect the heart rate of a person even if they are at home by using heartbeat sensors. The sensor is connected to a microcontroller, which enables the readings of the heart rate. These results are then transmitted to the LCD display. A live heart rate is also displayed every time the user logs on for monitoring. Thus, people can monitor heart rate so they can keep track of their heart rate and exercise routine. If there should be any form of problem with too low or too high heart rate, issues would then be reported for medical care. The simulation results as well as the hardware results of "Pulse Rate Monitoring system" are presented in this paper. Using the simplest and cheapest method, I outlined how to accurately measure the pulse rate of humans. Furthermore, I have provided a circuit diagram for this system so that engineers, hobbyists, and young researchers can build their own versions.

VI. Affidavit

I ENEKWA IZUCHUKWU GEORGE herewith declare that I have composed the present paper and work myself and without use of any other than the cited sources and aids. Sentences or parts of sentence quoted literally are marked as such: other references with regard to the statement and scope are indicated by full details of the publications concerned. The paper and work in the same or similar form has not been submitted to any examination body and has not been published. This paper was not yet, even in part, used in another examination or as a course performance.

References

[1] ttps://www.arduino.cc/reference/en/libraries/pulsesensor-playground/
[2] ttps://www.arduino.cc/reference/en/libraries/liquidcrystal-i2c/
[3] ttps://www.electrical4u.com/potentiometer/
[4] ttps://learn.sparkfun.com/tutorials/resistors/all.pdf
[5] HE BASICS of LEDs DEVELOPED BY: Eric Strandberg, LC Jeff Robbins, LC, MIES PRESENTED BY: Jeff Robbins Fall, 2012
[6] Y - BOOK AU - Malav, Vaibhav PY - 2019/04/06 SP - T1 - Research Paper On Home Automation Using Arduino