Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th June 2023. Vol. 2. No. 3; e-ISSN : 2808-4519

Design and Development of a Realtime Human Heart Rate Measurement System Using IOT-Based Pulse Sensors

Surja Arafat [1*], A M H Pardede [2], Husnul Khair [3]

[1,2,3] Informatics Engineering, STMIK Kaputama
Jl. Veterans No. 4A-9A, Binjai, North Sumatra, Indonesia
surjaarafat@gmail.com[1], akimmhp@live.com [2], husnul.khair@gmail.com [3]*

Abstract

The heart is one of the important organs that humans have, whose function is to pump blood throughout the body and accommodate it again after cleaning the lungs. Heart rate beats per minute (bpm) is a parameter to show the condition of the heart, and the way to find out the condition of the heart is to know the frequency of the heart rate. This heart rate monitoring tool is designed based on the NodeMCU ESP8266 and a pulse sensor to detect heart rate. This study aims to make it easier to know the heart rate frequency in realtime. A heart rate monitoring tool based on NodeMCU ESP8266 has been designed with a pulse sensor to detect heart rate. Heart rate data from monitoring results will then be sent via a wifi network connection and displayed on the Smartphone.

Keywords: *Heart rate, NodeMCU ESP8266, pulse sensor*

1. Introduction

With the development of technology in everyday life has been felt by everyone. Developments in the field of electronics occur all the time, starting from very simple things, such as health control tools, healing aids and others. For the initial stage of a medical examination, a medical check-up is usually carried out before a person's illness is diagnosed. In general, the first medical check-up that will be carried out at the hospital is the heart rate.

If we use the manual method, we need careful calculations and have previously understood the basic principles of measuring heart rate. As is known, heart disease is one of the highest causes of death in the world. The heart is one of the important organs in humans, which functions to pump blood throughout the body and accommodate it after being cleaned by the lungs. Since 1996 heart disease is the number one cause of death in Indonesia. The increase in the number of deaths from heart disease is due to the scarcity of cardiologists in Indonesia, the lack of tools to detect heart disease, the lack of routine heart health checks, and the poor lifestyle of people with heart disease.

2. Theoretical basis

2.1 Heartbeat

In general, the maximum heart rate for healthy people when exercising is 80% x (220-age) for fitness needs. Sally Edward provides a formula for calculating the maximum pulse rate 210-(0.5 x age) – (0.05 x body weight (in pounds)) + 4 for men, while for women it is 210-(0.5 x age) – (0.05 x body weight (in pounds)). Note 1kg = 2.2 pounds [1] .

2.2 Microcontroller

Microcontroller is a functional computer system on a chip. It contains a processor core, memory (a small amount of RAM, program memory, or both), and input-output equipment. In other words, a microcontroller is a digital electronic device that has input and output as well as control with a program that can be written and deleted in a special way, how the microcontroller actually reads and writes data.

Microcontrollers are used in automatically controlled products and devices, such as machine control systems, *remote controls* , office machines, household appliances, heavy equipment, and toys. By reducing the size, cost and power consumption compared to designing using a microprocessor memory and separate input output devices, the presence of a microcontroller makes electrical control for various processes more economical. [2] .

2.3 NODEMCU ESP8266

NodeMCU is basically a development of ESP 8266 with e-Lua based firmware. The NodeMcu is equipped with a micro USB *port* which functions for programming and *power supply*. Apart from that, NodeMCU is also equipped with push buttons, namely reset and *flash buttons*. NodeMCU uses the Lua programming language which is a package from esp8266. The Lua language has the same logic and programming structure as C, but *the syntax is different*. If you use the Lua language, you can use the Lua *loader* and Lua uploader *tools*.

Apart from the Lua language, NodeMCU also supports the Arduino IDE *software* by making a few changes *to the board manager* on the Arduino IDE. Before being used , this *board must be flashed* first so that it *supports the tools* to be used [3] .

2.4 WI-FI

" *Wireless Fidelity"* or abbreviated WiFi is a technology that uses radio waves to connect devices (PC, Laptop, *smartphone*) to a computer network. Or the definition of *WiFi* is a technology that uses radio waves so that computers can access the internet.
For a *WiFi connection*, a wireless adapter (without cables) is needed to build *a hotspot*, so that with a certain coverage, users can access the internet.

2.5 Understanding the Blynk Application

Blynk is application for iOS and for Android OS control Arduino, NodeMCU, Raspberry Pi and the like via the Internet. Application This can used For control hardware devices, display sensor data, store data, visualization, and others. The Blynk app has 3 components main. that is Applications, Servers, and Libraries. Blynk server is working For handle all communication between smartphones and hardware. The widgets available on Blynk include: are Button, Value Display, History Graph, Twitter, and Email. Blynk no bound with a number of kind of microcontroller however must selected hardware supported. NodeMCU controlled with the Internet through WiFi , chip ESP8266, Blynk will made online and ready for the Internet of Things [4] .

2.6 Androids

Android is a Linux-based operating system for mobile phones such as smartphones and tablet computers. Android provides an open platform for developers to create their own applications for use by a variety of mobile devices. Initially, Google Inc. buys Android Inc., a newcomer that makes software for cell phones.

2.7 Heart Rate Sensor (Pulse sensor)

The pulse sensor works by utilizing light. When this sensor is placed on the surface of the skin, most of the light is absorbed or reflected by organs and tissues (skin, bones, muscles, blood), but some of the light will pass through the body's tissues which are quite thin. As the heart pumps blood through the body, with each beat that occurs, there is a pulse wave (kind of like a shock wave) that travels along the arteries and travels down the capillary network where the Pulse Sensors are attached. The Pulse Sensor is designed to measure IBI (Inter Beat Interval). IBI is the time interval between the heartbeat in milliseconds and the instantaneous moment of the heartbeat. BPM (Beatper Minute) derives each beat from the average of every 10 times IBI. So, when the arduino microcontroller is turned on and running with the Pulse Sensor plugged into analog pin 0, it continuously (every 2 mS) reads the sensor value based on the measured heart rate [5] .

2.8 Li-Ion Batteries (Lithium-Ion)

Li-Ion (Lithium-Ion) type batteries are the most widely used type of battery in portable electronic equipment such as digital cameras, cellphones, video cameras or laptops. Li-Ion batteries have a high cycle life and are also about 30% lighter and provide about 30% higher capacity when compared to Ni-MH Batteries. Self-discharge ratio is about 20% per month. Li-Ion batteries are more environmentally friendly because they do not contain the harmful substance Cadmium. Just like Ni-MH (Nickel-Metal Hydride) batteries, although they do not contain the harmful substance Cadmium, Li-Ion batteries still contain a small amount of harmful substances that can damage human health and the environment, so they need to be recycled and should not be thrown away. in any place.

2.9 Regulation

The regulator is a series of regulators or regulators of the output voltage of a power supply so that the effects of rising or falling grid voltage do not affect the power supply voltage so that it becomes stable. A rectifier circuit is fine if the voltage ripple is small, but there are stability problems. If the PLN voltage increases/decreases, then the output voltage will also increase/decrease. Like the rectifier circuit above, if the current is getting bigger it turns out that the output dc voltage also drops. For some applications this voltage change is quite disturbing, so an active component is needed that can regulate this output voltage to be stable.

3. Results and Discussion

The implementation method in this study is generally divided into 5 stages as shown in the following diagram:

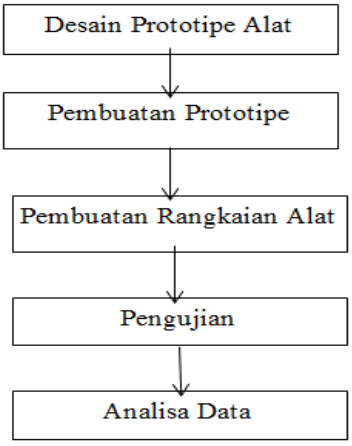

Fig 1: Research Workflow

3.1 Research Materials

The materials used for the Design of a Realtime Human Heart Rate Measurement System Using IOT-Based Pulse Sensors are as follows:

1. USB data cable and rainbow cable
2. Heart rate sensor
3. NodeMCU ESP8266
4. LCDs 16x2
5. Wi-Fi network
6. Smartphones
7. Battery
8. Glue
9. Solder
10. Tin
11. PCB board
12. Some bolts and nuts

3.2 Tool Making

Tool making done manually. The *PCB* manufacturing process is as follows:

1. Make *PCB schematic* using *eagle software*. The finished *schematic is then created to Board*.
2. In the create to Board process, the ready *Schematic will be re- designed* in such a way by drawing paths according to the *Schematic series* following the PCB size.
3. The PCB layout is printed using glossy paper or *glossy paper*.
4. Screen print *glossy* paper *layouts* on plain *PCB* using an iron, until the ink sticks to the PCB.
5. printed *PCB is then dissolved using a ferrite chloride* (*FeCl*) solution so that the unused copper layer is lost.
6. *PCB* path check.
7. After the PCB path is neat, drill holes in *the PCB* according to the printed pattern using a drill.
8. Clean *the PCB* from screen printing ink.
9. After the PCB is clean, install the required PCB components in the designated places.
10. Install all components according to the design of the tool to be made.

3.3 Current System Analysis

This chapter discusses the working principles of the circuit designed to realize the tool system namely. the discussion focuses on the design of the tool which is made based on the author's thinking referring to reference sources related to the tool.

3.4 System Block Diagram

The block diagram of the designed system is shown in Figure 2.

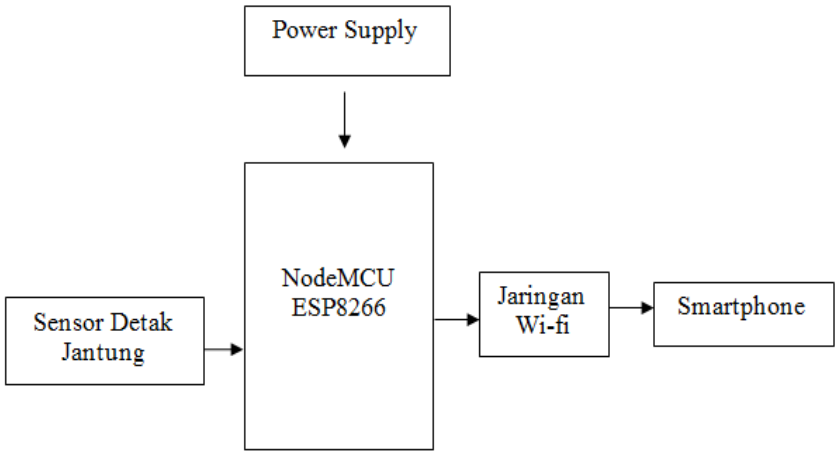

Fig 2: System Block Diagram

3.5 Functions of Each Block

1. The power supply functions as a power source to turn on the tool system.
2. NodeMCU ESP8266 functions as a processor, receiver and sender of data on the tool system.
3. Pulse sensor The heart functions as a sensor input for reading the heart rate value in the body
4. The Wifi network functions as a communication medium between the device system and the smartphone
5. The smartphone functions as an output display of the readings of the heart rate sensor on the smartphone

3.6 NodeMCU ESP8266 Suite

The NodeMCU ESP8266 suite It serves as the control center of the entire existing system.

Fig 3: The NodeMCU ESP8266 circuit

NodeMCU is basically a development of ESP 8266 with e-Lua based firmware. The NodeMcu is equipped with a micro USB port which functions for programming and power supply. Apart from that, NodeMCU is also equipped with push buttons, namely reset and flash buttons. NodeMCU uses the Lua programming language which is a package from esp8266. The Lua language has the same logic and programming structure as C, but the syntax is different. If you use the Lua language, you can use the Lua loader and Lua uploader tools. Apart from the Lua language, NodeMCU also supports the Arduino IDE software by making a few changes to the board manager on the Arduino IDE. Before being used, this board must be flashed first so that it supports the tools to be used. If using the Arduino IDE, use the appropriate firmware, namely the output firmware from AiThinker that supports AT Command. To use the firmware loader tool that is used is the NodeMCU firmware [3] .

3.7 Voltage Stabilizer Circuit (Regulator)

This circuit serves to provide supply voltage from the battery throughout the existing circuit. The output of this regulator circuit is 5 volts.

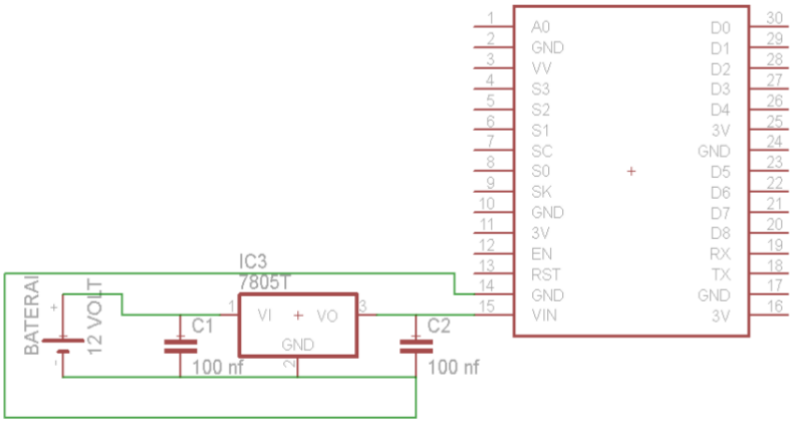

Fig 4: Regulator circuit

In the circuit above a 12 volt battery is connected to a 100 nf capacitor, then connected to the input voltage regulator ic 7805 to get a 5 volt dc output, this 5 volt dc output will serve to supply the NodeMCU ESP8266 system [3] .

3.8 Pulse Sensor Design

In this circuit the sensor input is connected to PORTB.A0 NodeMCU ESP8266, namely as sensor reading data that enters the microcontroller will be processed and calibrated.

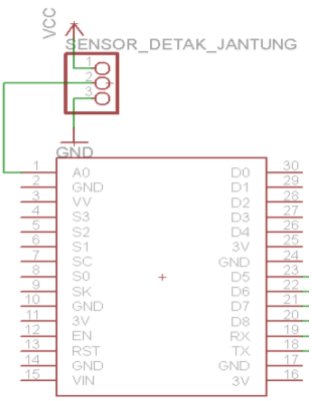

Fig 5: Pulse Sensor Circuit

3.9 Overall sequence Tool System

On the network This The 7805 regulator circuit functions to provide a voltage supply from the battery throughout the existing circuit. The output of this regulator circuit is 5 volts. NodeMCU 8266 functions as a processor, data receiver, and WI-FI signal transmitter on the tool system, and then the heart rate sensor reads the heart rate value which is then displayed on the smartphone display.

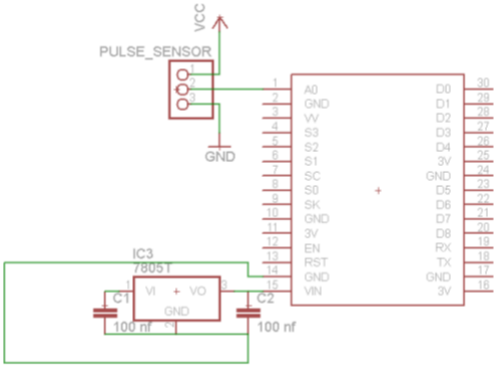

Fig 6: Overall series Tool System

In this study the researcher will explain about *the flowchart* so that the researcher can represent the steps that must be carried out in the design.

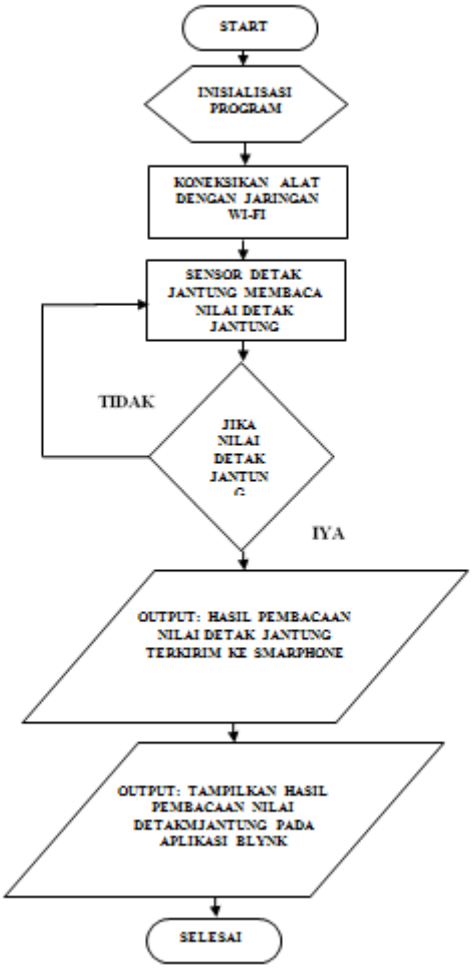

Fig 7: Flowchart Sistem

3.10 Flowchart Algorithm

1. Start.
2. Device Initialization, this means whether the device is installed correctly according to the circuit schematic.
3. The next process is to connect the device to the WI-FI network so that the device system can be connected to the smartphone.
4. The next process is the heart rate sensor will read the heart rate value of the test results
5. If the heart rate value is read by the sensor then, the result reading mark tick heart will sent to smartphone as outputs.
6. Furthermore, the heart rate value that has been sent to the smartphone will be displayed on the BLYNK application as display output.
7. If the heart rate value is not read by the sensor, the heart rate sensor will return to read the heart rate value from the test results.
8. Finished.

4. Conclusion

After carrying out the design and manufacturing stages of the sister, which is then followed by the testing and analysis stage, conclusions can be drawnas follows:

1. The 7805 regulator circuit functions to provide a voltage supply from the battery throughout the existing circuit. The output of this regulator circuit is 5 volts. NodeMCU 8266 functions as a processor, data receiver, and WI-FI signal transmitter on the tool system, and then the heart rate sensor reads the heart rate value which is then displayed on the smartphone display.
2. This tool can be used easily to measure or monitor heart rate with the help of a sensor. The results of the pulse sensor measurements will be controlled via a NodeMCU ESP8266 microcontroller. Then it will be sent via an internet network connection and displayed on the Smartphone.
3. NodeMCU ESP8266 functions as a processor, receiver and sender of data on a mobile system-based heart rate monitoring device system

Reference

[1] FA Sinaga and SB Ginting, "The Effect of Giving Tomatoes on Pulse Rate Recovery After Doing Maximum Physical Activity," *Health. and Sports* , vol. 2, no. 1, pp. 1–12, 2018.

[2] MZ Elfirman and M. Alkaff, "Utilization of Internet of Things-Based Wireless Sensor Networks for Remote Monitoring of Peatlands," *J. Ilm. Computing Science.* , vol. 13, no. 1, pp. 56–59, 2018.

[3] A. Anggraini, AM H Pardede, and B. Serasi Ginting, "Design of an Attendance System Using an Id Card with Sending Data Via Telegram Based on Nodemcu Esp8266 Using the Fuzzy Logic Method," J. Tek . *inform. Kaputama* , vol. 6, no. 2, pp. 587–596, 2022.

[4] T. Electro, U. Sam, and JKB Manado, "Implementation of Internet of Things-Based Store Security Systems," *J. Tek. inform.* , vol. 15, no. 4, pp. 325–332, 2020.

[5] BA Hamdan Heruryanto, Wira Bahari Nurdin, "ATmega8535 Microcontroller-Based Heart Rate Measurement System," *J. Progr. Studs. Fis. FMIPA Univ. Hasanuddin* , no. september, pp. 1–10, 2014, [Online]. Available: http://repository.unhas.ac.id/handle/123456789/10869