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# Design and Build Uno Android-Based Heart Rate Detector to Support First Aid Performance at PMI Kebumen Regency

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**Abstract**

PMI is a humanitarian organisation with legal entity status, governed by Law 1 of 2018 concerning Red Cross activities. In community services, primarily first aid services, PMI still requires first aid equipment to support the performance of volunteers and their services. One such tool is used for emergencies, such as handling sudden cardiac arrest victims. This study developed a prototype heart rate detection device. This heart rate detection prototype is based on ATmega328. The sensor used is a Heart rate Sensor that measures and detects heartbeats. Additionally, an ATmega328 Arduino Pro Mini microcontroller is used to process the incoming signals and display the heart rate per minute on an OLED screen. Based on tests conducted on 10 respondents, this heart rate detection prototype has an average relative error of 0.32% compared to the Elitech Mobile Fox 1 Pulse Oximeter.

**Keywords:** ATmega328, Heart Rate, Heartrate Sensor.

***Abstrak:***

*PMI merupakan organisasi kemanusiaan yg berstatus badan hukum, dengan Undang-Undang nomor 1 tahun 2018 tentang Kepalangmerahan guna dalam menjalankan kegiatan-kegiatan Pelayanan Kesehatan dan Kesejahteraan Masyarakat dan lainnya. Pada layanan masyarakat saat pelayanan pertolongan pertama PMI masih banyak dibutuhkan peralatan pertolongan pertama demi menunjang kinerja relawan dam pelayananya. Salah satu diantaranya alat yang di gunakan untuk pertolongan saat terjadi emergency atau saat kondisi darurat contohnya saat menangani korban serangan jantung mendadak. Pada penelitian ini dibuat suatu purwarupa alat pendeteksi detak jantung. Purwarupa alat pendeteksi jantung ini berbasis ATmega328. Sensor yang digunakan adalah Heartrate Sensor yang berfungsi untuk mengukur dan mendeteksi denyut jantung yang dihasilkan jantung. Selain itu digunakan mikrokontroler ATmega328 arduino pro mini yang akan mengolah sinyal yang masuk dan menampilkan data detak jantung per menit pada layar OLED. Berdasarkan pengujian yang telah dilakukan terhadap 10 responden, purwarupa alat pendeteksi jantung ini memiliki kesalahan relatif rata- rata 0.32% yang dibandingkan dengan Pulse Oxymeter Elitech Mobile Fox 1.*

***Kata Kunci: ATmega328, Detak Jantung, Heartrate Sensor***

## 1. INTRODUCTION

The formation of the Red Cross began with difficult situations and conditions such as wars and natural disasters. The Red Cross was formed in the 19th century. The struggle was carried out to establish the Indonesian Red Cross since 1932. Dr. RCL Senduk and Dr. Bahder Djohan spearheaded the activity. With widespread support from all circles, especially among Indonesian students, they continued to try their best to bring the draft to the 1940 Nerkai Conference even though it was rejected. Unyieldingly, during the Japanese occupation, they again tried to form the National Red Cross Agency, but their efforts were also rejected.

In 2018, PMI is a humanitarian organization with legal entity status, promulgated by Law number 1 of 2018 concerning Heading Red, to carry out Heading Red Flag activities with the aim of preventing or avoiding and alleviating the suffering of prisoners of war and disaster victims regardless of religion, nation, ethnicity, skin color, class, gender, and political views.

Not only that, but PMI also has a task that makes the PMI members become Volunteers, such as Disaster Preparedness Volunteers for Disaster Relief and Management, First Aid Training for Volunteers, Health Services, blood donation transfusion unit services, Community Welfare, and others **[1]**.

The development of technology related to the medical world today is increasing rapidly. Many electronic technology-based devices are used in health units in hospitals, health centres, clinics, and various other agencies and organisations such as INAFIS, SAR, BPBD, and PMI. In community services, during first aid services, for example, at PMI, there is still a lot of need for first aid equipment to support the performance of volunteers in their services. One of them is a tool used for help during an emergency or an emergency, for example, when dealing with a sudden heart attack victim **[2]**.

Heart disease is often realized too late by sufferers because they feel reluctant to check whether their body is healthy or not. A health expert states that among the symptoms of heart disease that often receive less attention is an atypical heart attack, which has symptoms like a common cold. For this reason, a simple tool is needed that is easy to operate and can be used during first aid services. This motivates the research community so tools to support health service performance emerge.

Previous research on tools for monitoring heart rate has developed quite a lot. The heart rate measuring device has been created using an Arduino Uno R3-based pulse sensor.[3] The pulse sensor will detect the heart rate in humans and then the Arduino Uno R3 will process that

data. According to the inventor of the Heart Rate Detection Device With Arduino Uno-Based Sound Detector Sensor (Marvin Frans Sakti Hutabarat) **[4]** And another research entitled Designing a Heart Rate Measuring Device Using a Pulse Sensor and LCD Based on Arduino Uno Atmega 328 (Anwar Fattah and Ginanjar Putra Wardana) the device has also been successful; the researcher explained that the heart rate measuring device using a Pulse Sensor and LCD (Liquid Crystal Display) based on Arduino Uno Atmega 328 can be realized and function properly even though there are errors when compared to manual measurements and testing The overall average difference/error is 1.2%. In making the tool, the researcher hopes that there will be additions or developments, such as Timing Diagrams and sound indicators **[5]**.

## 2. Method

In this study, the research method used by the author is the qualitative method, this research method focuses on information that is non-numeric (not numeric). This method emphasizes conceptually a research problem. Qualitative methods consist of five types: phenomenological research, grounded theory, ethnography, case study, and narrative research. (Creswell in the book Research Design) [6].

From the results of observations made by researchers at PMI (Indonesian Red Cross) Kebumen Regency that in the services of First Aid Disaster Preparedness and Management in emergencies, Health Services, blood donor transfusion unit services and Community Welfare in every day PMI Kebumen Regency always participates in community services. As in first aid health services, for example, emergency ambulance services, lakalantas emergencies, services in event activities such as the championship Olympics in silat matches, karate, football, futsal, volleyball and others. In the data, PMI Kebumen Regency as of August, September and October 2024 in three months is almost 85% more in its services, this is related to the importance of equipment and equipment that support its services [8].

Overall, the process of making a heart rate detection device based on ATmega328" is divided into four main parts: the power supply block, input block, process block and output block. The power supply block consists of a battery voltage of 3.7 VDC. The input block consists of two components such as the Pulse Sensor and the Buzzer. The process block consists of a 3.3V/8MHz Arduino pro mini Microcontroller. The output block consists of an OLED Monitor. The diagram block of the Atmega328-based heart rate detector is shown in Figure 1. [4]

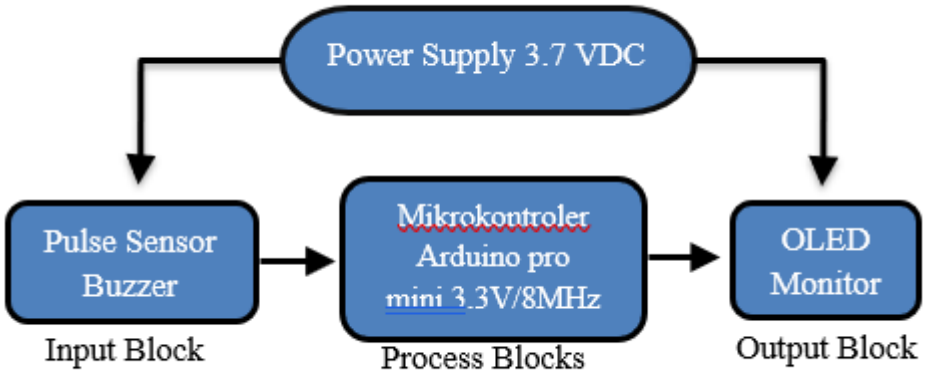


**Figure 1.** Diagram Block

Figure 2 shows the entire tool range followed by the images shown on the tool's input block, process block, and output block.

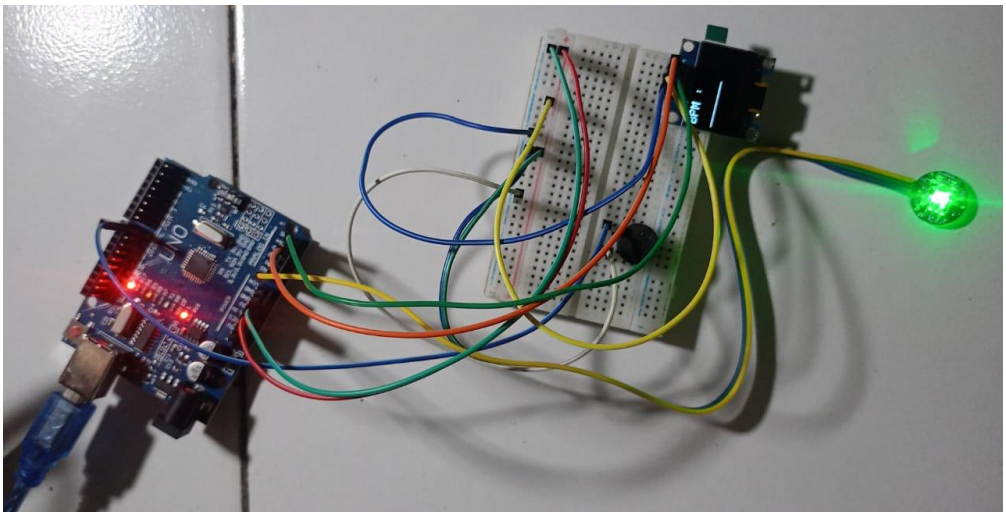

**Figure 2**. Entire Tool Range

**Figure 2** shows a picture of the entire tool range. This circuit uses a voltage of 3.3V from Arduino. A voltage of 3.3V activates components in the circuit to produce output. The sound is a buzzer from Raspberry Pi continuous Tone (5V) and a Heartrate Sensor from Avago (APDS-9008). The buzzer serves as a sound that will help detect the heart rate the heart rate sensor receives. The output value of the sensor depends on the speed of sound received by the heart rate sensor. The output from the sensor is connected to pin A0 on the Arduino Pro Mini microcontroller. The output signal from the sensor is processed based on a program embedded inside the Arduino Pro Mini microcontroller. The microcontroller's output is displayed on a 128×64 pixel OLED screen, and the sound emitted by the Buzzer [9]. The flowchart is shown in Figure 3. shows the working process of the ATmega328-based heart detector.

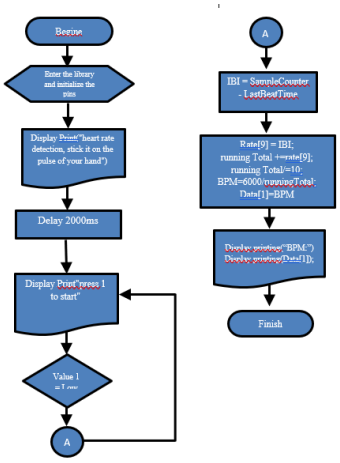


**Figure 3.** Flowchart System

**Figure 3** is explained that the program must initialise after the program starts. Process initialisation is used to declare libraries and assign pins to be used on the microcontroller, whether used as inputs or outputs. In the next stage, the OLED screen will display "Heart Rate Detection When Attached to the Pulse of the Hand" on the first and second rows. Then there is a 2-second delay before the OLED screen displays "Press 1 To Start". When the push button or button one is pressed, the microcontroller will process the input from the herd sensor, which is entered in the variable "data". Then the OLED screen will display "BPM" and the variable "data[1]" on the second row **[10]**.

## 3. Results and Discussion

The purpose of the output test on the Heartrate Sensor circuit is to find out the signal generated by the Heartrate Sensor circuit and the output signal of the SCL/SDA pin on the OLED layer.

**Table 1.** Observation Data Results from Pulse Sensor

| | Result | |
|---|---|---|
| No. | Battery A0 | SCL/SDA Batteries |

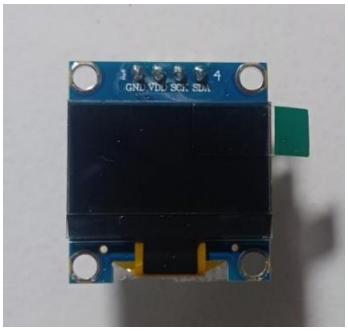


**Figure 5.** OLED Display Test Data Capture Points

In **Figure 5**, point A is a data series while point B is a serial clock. Data collection was carried out by connecting the SCL/SDA pin to the oscilloscope, which aims to see the output results when the device detects the heart rate, as presented in Table 2.

| No. | Result | |
|---|---|---|
| | *F(Hz)* | *Vpp(V)* |
| 01.00 | 01.35 | 01.48 |
| 02.00 | 01.37 | 02.52 |
| 03.00 | 01.10 | 03.08 |

**Table 2.** Measurement Results of Observation Data on Pin A0

**Table 2** shows the oscilloscope's frequency and voltage output results on pin A0. Based on the data taken, the signal at pin A0 can be displayed on the oscilloscope because the signal has gone through the amplification process by the Op-Amp circuit. If it is not amplified, the signal will not appear on the oscilloscope.


**Figure 6.** Timing Diagram

In **Figure 6**, it is explained that the data transmission starts with a start (S), characterised by a low signal of SDA, while the SCL signal remains in a high condition. The SDA signal then sets the first bit of data when the low SCL signal is marked with a blue line. The sample data is received when the SCL signal goes up (green) for the first bit (B1). The process repeats when the SDA signal switches while the SCL signal is low, and the data will be read when the SCL signal goes up (B2, Bn). The stop bit is marked with (P) when the SDA signal goes up while the SCL signal stays in a high condition **[12]**.

The next test is accuracy and precision in heart rate calculations. Accuracy is the degree of proximity of a measurement from the amount obtained to the actual number of values. Precision is the degree to which the measurement results are repeated and show the same results. The test is carried out by comparing the measurement results of the device that has been made with the Heart Oxymeter Elitech Mobile Fox 1. Comparison will be displayed in the form of a percentage error by comparing various measurements (Δbpm) with Measurement of the Heart oximeter

(oxbpm) as in Equation %error=(Δbpm/oxbpm)×100%. The equation is used to calculate the percentage error (%error) in pulse rate (bpm) measurements when compared to the reference value given by the Heart oximeter. Here is a brief explanation of the components:

- Δbpm: This is the difference or difference between the pulse value measured by another device or other method and the reference value given by the Heart oximeter.
- oxbpm: This pulse value measured by the Heart oximeter is considered a reference or standard value.

The equation for calculating the percentage of error is:

$$\% \text{error} = \left( \frac{\Delta \text{bpm}}{\text{oxbpm}} \right) \times 100\% .$$

This means that pulse measurements with other instruments have an error of -6.25% compared to the reference value of the Heart oximeter. A negative sign indicates that the measurement of other instruments is lower than that of a Heart oximeter **[2]**.

**Table 3.** Measurement results of 10 respondents (Heart Oxymeter Elitech Mobile Fox 1)

| It | Name | Gender/Age | BPM Value | Oxymeter Value | Relative Grade (%) |
|---|---|---|---|---|---|
| 1. | Hudha | L/26 | 89 | 89 | 0 |
| 2. | Noor | P/20 | 76 | 76 | 0 |
| 3. | Wildan | L/20 | 94 | 95 | 1,10 |
| 4. | Catur | L/21 | 102 | 102 | 0 |
| 5. | Fajar | L/ 25 | 73 | 73 | 0 |
| 6. | Erlina | P/20 | 106 | 107 | 0,93 |
| 7. | Kholqon | L/23 | 87 | 88 | 1,03 |
| 8. | Yusuf | L/22 | 82 | 83 | 0,97 |
| 9. | Nur | P/36 | 87 | 86 | 1,15 |
| 10. | Monica | P/25 | 92 | 92 | 0 |
| Average Relative Error (%) | | | | | 0,51 |

**Table 3,** the measurement results of 10 respondents are shown. The results vary from person to person due to the condition and age of the respondents. Based on the data table, the comparison results between the heart rate sensor and the oximeter have an average relative error of 0.51%. Some of the average relative errors of the respondents were quite small because the measurements were taken in 10 seconds. Therefore, if the difference produced is small enough. Precision testing is carried out twice. The first step of testing three respondents' heartbeats was repeated five times. The precision value of each finger measurement can be obtained using the relative standard deviation (RSD). RSD is a measurement statistic that describes the distribution of data concerning the average value and the result expressed as a percentage. The formula for determining RSD is given in Equation (2) and Equation (3).

$$s = \sqrt{\frac{1}{N}\sum_{i}^{N} = 1\,(xi - \bar{x})^2} \quad (2)$$

$$RSD = \frac{s}{\bar{x}}\, x\ 100\% \quad (3)$$

Heart rate sensor measurements performed the one-finger precision test from three respondents on their index fingers. The test was carried out ten times for each respondent.

**Table 4.** Measurement results from 1 - 5 respondents (Relative Standard Deviation)

| | 1 | 2 | 3 | 4 | 5 | Right Hand | Left Hand | Average |
|---|---|---|---|---|---|---|---|---|
| Gender/Age | L/26 | P/20 | L/20 | L/21 | L/25 | - | - | - |
| STDEV | 86 | 84 | 87 | 80 | 77 | 4,21 | 3,58 | 0,77 |
| RSD (%) | 78 | 78 | 86 | 81 | 84 | 5,08 | 4,04 | 0,91 |
| | | Result | | | | | | 1,68 |

**Table 5.** Measurement results from 6 - 10 respondents (Relative Standard Deviation)

| | 6 | 7 | 8 | 9 | 10 | Right Hand | Left Hand | Average |
|---|---|---|---|---|---|---|---|---|
| Gender/Age | P/20 | L/23 | L/22 | P/30 | P/25 | - | - | - |
| STDEV | 77 | 81 | 78 | 78 | 78 | 1,52 | 1,71 | 0,32 |
| RSD (%) | 78 | 79 | 78 | 78 | 77 | 1,93 | 1,91 | 0,38 |
| | | Result | | | | | | 0,7 |

Based on the data in **Table 4** and **Table 5** of the RSD (Relative Standard Deviation), the test of respondents 1-5 is 1.68%, and the test of respondents 6-10 is 0.7%. The test with a total of 10 respondents' result is 2.38% **[13]**. The second precision test measured the respondent's two hands: the pulse on the right hand and the pulse on the left hand. The test was carried out by male and female respondents with different relative ages. Based on the data in **Table 4** and **Table 5**, the average RSD (Relative Standard Deviation) in the pulse of male and female respondents' right and left hands is 60 – 100 times per minute. This aligns with the WHO's statement that the normal pulse of adults and adolescents is 60-100 times per minute. Meanwhile, the normal pulse rate for children varies, depending on their age, Normal heart rate or heart rate is the number of heartbeats within one minute. Everyone's heart rate can be different, and it can be lower at rest or increased during exercise, a heart rate that is more than 100 times per minute is called tachycardia. A heart rate that is too fast can make the heart unable to pump blood throughout the body properly. A heart rate less than 60 beats per minute is called bradycardia. A normal RSD value per minute will result in a better average value. OLEDs and features can also be used

to detect arrhythmias disease. Arrhythmias are a medical term for conditions in which the heart rhythm is abnormal, be it too fast, slow, or irregular. Arrhythmias occur due to a disturbance in the heart's electrical system, which regulates the heart's rate **[14] [15].**

## 4. CONCLUSION

After designing and testing on an Arduino-based heart rate monitoring device, the selection of Arduino is based on the conditions when volunteers provide first aid in the field to be efficient in using it in emergency conditions and the ease of installing other hardware such as Heartrate Sensors, Buzzers, and OLED screens. Researchers have succeeded in developing a heart rate detector which in the manufacture of this device the researcher developed a tool using a microcontroller with the addition of a sound indicator so that the rhythm is by the rhythm of the heart rate and also using a timing diagram displayed on an OLED screen to display the data output to be more flexible. Based on the tests that have been carried out on ten respondents, and the test on the respondent's hand pulse carried out on the right hand pulse and also the respondent's left hand pulse, the measurement on the right hand pulse has an average RSD value of 1.68% and for the left hand pulse is 0.7% with a result of 2.38%. The author can classify the condition of the heart by using the variables of age, gender and BPM (beats per minute) obtained from the device, several developments can be made to make the device better.

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