Smart Helmet Control System Using Heart Pulse Indicator

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Abstract. The increasing number of traffic accidents are dominated by motorcycle accidents, which also account for the highest portion of fatalities and major injuries. Careless driving and unruly behavior such unhealthy body condition or riding in sleepy conditions are the main causes of accidents in Indonesia. Facts prove that traffic accidents are one of the biggest causes of death in Indonesia. Based on those problem we want to made a system to detect a heart pulse for riders to know if they riding in a good condition or not. This control system using arduino nano R3 as a microcontroller. The device is places on helmet which using pulse sensor to detect the heart pulse on neck arteries, When a person's pulse is detected in a drowsy/sleepy state, then the DC motor vibrator will vibrates in the fontanel (crown of head) and the buzzer sounds in the ear. The test results on the pulse detection system that was applied to the male rider's helmet the average delay of the actuator was 4.3 seconds with a success percentage is about 98%. The average response delay of the actuator used by female riders is 4.5 seconds with a 96% success rate. From the results of the test, smart helmet system has run and work properly.

Keywords—Pulse Sensor, Motor DC Vibrator, Buzzer

1. Introduction
WHO (World Health Organization) data shows that nearly 1.2 million people die each year from accidents, 50 million suffer severe injuries. Around 90% of traffic accidents happen in low- or middle-income countries like Indonesia. The number of traffic accidents has increased every year. The large number of traffic accidents in Indonesia is in line with the increasing number of motorbikes. The increase in the number of motorbike has the highest number among other types of motorized vehicles [1].

One of the factors causing the accident is the condition of sleepy riders on the road. Sleepiness while driving is one of the conditions that is often ignored by the riders, especially when they have a long trip. Usually before have a long riding, the would drinks energy drinks to reduce drowsiness, but it excessively has a dangerous impact can trigger heart palpitations, seizures, strokes, and sudden death.
On previous research about drowsiness prevention system uses pulse sensors only using vibrator as an actuator. Those system is not perfect because the system is not optimal, it is feared that the riders still feel sleepy if the actuator is only vibrator[2]. Other studies on drowsiness prevention systems did not use pulse sensors but use the concept of timer system to work, every 15 minutes the vibrator,buzzer and speaker will works. This system this system causes the driver to be disturbed when the driver is not feels drows [3]. Another study on this drowsiness prevention system uses a pulse sensor to detect the heart pulse, then the vibrator actuator vibrates. The vibrator will vibrates when the pulse sensor detects a pulse <72 per minute [4].

From these problems, the researchers want to make a pulse detection system on helmets for motorcycle riders. This system uses pulse sensors to detect pulses. If the pulse sensor detects heart pulse rate ≥72 per minute, then the heart pulse is normal. If the pulse sensor detects a heart pulse above <72 per minute, then the pulse is classified that the riders feel drowsy. If the driver is classified as sleepy/drowsy, the vibrator will vibrate on the fontanel, and the buzzer as a sound marker. This control system uses the arduino nano R3 as microcontroller

2. Literature Review

The Previous research of this device using pulse sensors which are placed on the fingertips as a pulse detection, the device that will be processed by an Arduino Uno as a microcontroller,it also used Android Smartphone as a basis system which implemented to operating and showing the heart rate pulse data. The connection system between devices and smartphone using module bluetooth,it also saving data of the heart rate pulse in Smartphone android apps, so that it can be processed for further purposes[5].

Another Previous research on heart rate and body temperature measuring instruments was designed based on Arduino and Android smartphones using DS18B20 as temperature gauge and pulse sensor to detect heart rate. Heart rate data and body temperature are displayed on 16x2 LCD and Android smartphone via HC-05 bluetooth connection. This study aims to facilitate in knowing the frequency of heart rate and body temperature [6].

Another Previous research used ultrasonic sensors to detect signals or objects, in the room of obstacles, there were two conditions that prevented the distance and distance from being blocked, the shortest distance was less than 50 cm and the distance between obstacles was 50 cm to 150 cm. Arduino microcontroller will then be processed. The result of detecting data from the sensor, if there is a challenge or object then the DC motor vibrator and buzzer will turn on as a hint [7].

Another Previous research said that the device run when the device is turned on, the pulse sensor will detect the heart rate and temperature sensor MLX90614 detect body temperature. The results of the sensor will be sent to the arduino then displayed on the android interface as the viewer via HC-06 bluetooth communication. Data is able to be stored in a SQ database storage table lite and into the website display in graphical form. In this study it was successful [8].

Another Previous research has made an apps for heart rate detection, built from the Bayesian Network expert system, pulse sensors, bluetooth HC 05 and Arduino Uno and android-smartphones. Bayesian Network expert systems are built from priot probability and processed into posterior values on 29 symptoms of all three heart diseases [9].

Another Previous research of this device system has a function as Tx (sender) and as RX (receiver), each Tx and Rx has a component part, namely the pulse sensor as a measure of the baby’s heart rate, DHT11 as measuring temperature in the incubator, X-bee series 2 as the sender of data via wireless networks and Arduino Uno as processing analog data or digital data while Rx is X-Bee series 2 and Arduino Uno [10].

Another Previous research analyzed pulse rate in ages category, as follows: Age under 1 month is 110 times per minute, 1-6 months of age is 130 times per minute. 6-12 months of age is 115 times per minute. 1-2 years of age is 110 times per minute. 2-6 years old is 105 times per minute. Age of 6-10 years is 95 times per minute. Age 10-14 years 85 times per minute. Age 14-18 years is 82 times per minute. Age 18 years and above is 60-100 times per minute [11].
3. Method

a. Flowchart System

Flowchart describes the flow in the heart pulse detection system that is applied on helmets. The flowchart is shown in Figure 1.

![Flowchart System](image)

**Figure 1. Flowchart System**

The pulse sensor which applied on helmet has a stage start on the process to turn on the switch by pressing the button, then the pulse sensor will detect the pulse of the person. The first condition is the Pulse sensor detects a heart pulse about <72 per minute. If the it condition is not fulfilled then the sensor will detect the pulse again. If it condition fulfilled, the vibrators 1&2 and the buzzer 1&2 turn on and vibrates the fontanel, so the driver will stay awake.

b. Diagram Block

The block diagram describes about sensors, microcontrollers and actuators are used. The block diagram is shown in Figure 2.

![Diagram Block System](image)

**Figure 2. Diagram Block System**
From *Figure 2* it can be seen that some of inputs used as switch to turn on and turn off the system. Pulse sensor used as the heart pulse detector on the neck arteries. Meanwhile, microcontroller used as processing the output signal. The output of this system is the DC Vibrator 1 as the actuator vibrates on the right fontanel and the DC Vibrator 2 vibrates on the left fontanel. Buzzer 1 will sound on the right side and buzzer 2 on the left side when the pulse sensor detects the heart pulse is less than specified.

c. Electronics Design

Electronic design is an electronic circuit which will placed on the helmet using heart pulse detection system by combining several components into solid electronic circuits. Basically, electronics circuit is the important part on this research, because it will affect the automation process of the system. This electronics circuit consists of 1 power supply, 1 pulse sensor, 2 buzzers, 2 vibrator DC motors. Sensor and actuators is plant on Arduino Nano. Arduino Nano choosen as a microcontroller because it has 14 I/O digital pin ports and small size make it more flexible. We can make the electronics design using open source fritzing which shown in *Figure 3*.

![Figure 3. Electronics Sircuit](image)

**d. Mechanical Design**

The prototype of heart pulse detector system can be seen in *Figure 4, Figure 5, Figure 6*. In Figure 4 represent where the battery, arduino nano R3, DC Vibrator 1, DC Vibrator 2 placed. Battery used as a power supply, Arduino nano as a controller the whole system, DC Vibrator 1 & 2 as a vibrates the fontanel when the pulse sensor detected the heart pulse less than <72/minute.

![Figure 4. Electronics Component Design](image)

**Figure 4. Electronics Component Design**

In *Figure 5* represent where buzzer 1 and Button placed. Buzzer 1 used as a soundmaker/hint when the pulse sensor detected the pulse less than <72/minute. Button used as a switch to turn on and off system.

![Figure 5. Electronics Component Design (Saklar and Buzzer)](image)
In *Figure 6* shows where the pulse sensor, sensor strap, buzzer 2 placed. Pulse sensor used as a pulse detector, strap to binding sensor on the neck.

![Figure 6. Electronics Component Design (Sensor)](image)

### 4. Result and Analysis

The results of the device are shown in Figure 7 which the real implementation of system and design. Then the trial was done by testing the source code on the pulse sensor, buzzer, DC motor vibrator is implemented.

![Figure 8. The real implementation of system and design](image)

The trial test of the pulse sensor is done by connecting the sensor module to the Arduino nano according to the pin on the sensor:

1) Pin 1 Analog: Power 5V on Arduino nano
2) Pin 2 VCC : Pin A0 on Arduino nano as an input
3) Pin 3 GND : Pin GND Arduino nano

| Trial Test | Result   | Time Response |
|------------|----------|---------------|
| 1          | v        | 5s            |
| 2          | v        | 6s            |
| 3          | v        | 4s            |
| 4          | v        | 5s            |
| 5          | v        | 3s            |
| 6          | v        | 0s            |
| 7          | v        | 5s            |
| 8          | v        | 4s            |
| 9          | v        | 3s            |
| 10         | v        | 5s            |

| Time Avarage | 4s |

*Table 1. Pulse sensor testing on male riders aged about 17-22 old*
Based on table 1 testing is done by male with ages about 17-22 old, in the 6th attempt there was unsuccessful test due to error on system, the successfull rate of this test is about 90% with an average time response is about of 4.8 seconds.

Table 2. Pulse sensor testing on female riders aged about 17-22 old

| Trial | Test | Result | Time Response |
|-------|------|--------|---------------|
| 1     | v    | v      | 6s            |
| 2     | v    | v      | 5s            |
| 3     | v    | v      | 7s            |
| 4     |       | v      | 0s            |
| 5     | v    | v      | 5s            |
| 6     | v    | v      | 4s            |
| 7     |       | v      | 0s            |
| 8     | v    | v      | 6s            |
| 9     | v    | v      | 4s            |
| 10    | v    | v      | 6s            |

Time Average 4.3s

Table 2 shown the pulse sensor testing carried out by females aged 17-22 years, in the 4th and 7th attempt there was unsuccesfull test due to error on system, the successful rate is about 80% with an average time response of 4.3 seconds.

Table 3 pulse sensor testing by men aged 23-26 years, in the 3th and 4th attempt there was unsuccesfull due to error on system, the success rate is 80% with an average time response the average is 4.6 seconds.

Table 3. Pulse sensor testing on male riders aged about 23-26 old

| Trial | Test | Result | Time Response |
|-------|------|--------|---------------|
| 1     | v    | v      | 5s            |
| 2     | v    | v      | 6s            |
| 3     | v    | v      | 0s            |
| 4     |       | v      | 0s            |
| 5     | v    | v      | 4s            |
| 6     | v    | v      | 7s            |
| 7     | v    | v      | 6s            |
| 8     | v    | v      | 5s            |
| 9     | v    | v      | 7s            |
| 10    | v    | v      | 6s            |

Time Avarage 4.6 s

Table 4 shown the pulse sensor testing carried out by females aged 23-26 years, in the 4th attempt there was unsuccessfull test due to error on system, the successful rate is about 80% with an average time response of 4.7 seconds.
Table 4. Pulse sensor testing on female riders aged about 23-26 old

| Trial Test | Result Successful | Result Unsuccessful | Time Response |
|------------|-------------------|---------------------|---------------|
| 1          | v                 |                     | 4s            |
| 2          | v                 |                     | 6s            |
| 3          | v                 |                     | 7s            |
| 4          | v                 |                     | 0s            |
| 5          | v                 |                     | 5s            |
| 6          | v                 |                     | 4s            |
| 7          | v                 |                     | 6s            |
| 8          | v                 |                     | 7s            |
| 9          | v                 |                     | 5s            |
| 10         | v                 |                     | 3s            |

Time Average 4.7s

5. Conclusion
Based on the analysis and discussion of the results of this research, obtained the some conclusions:
1. The BPM (Beat Per Minute) values generated in several pulse sensor tests because every person’s has different and the BPM value is not always fixed.
2. Buzzer manages to run according to the program, when the pulse sensor detects pulse rate <72 BPM buzzer will turn on.
3. The DC motor vibrator manages to run according to the program that vibrates in the fontanel when the pulse sensor detects less than <72 BPM.

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