INTERNET OF THINGS USES NODEMCU FOR PULSE DETECTION ON SMART HELMETS

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Abstract

Safety and security while driving, especially for motorcycle riders, are crucial aspects of everyday life. Accidents often occur due to riders feeling tired or drowsy while operating their vehicles. Statistics indicate a high rate of traffic accidents in Indonesia, with motorcycles being one of the most frequently involved vehicles in accidents. This research aims to design a device that can detect the drowsy state of motorcycle riders using sensors on NodeMCU and the MAX30105 Sensor to measure their heart rate. When the device detects signs of drowsiness, the rider will receive a warning through a buzzer, enhancing traffic safety. Thus, this study proposes the concept of developing a smart helmet based on the Internet of Things (IoT) to reduce the risk of traffic accidents caused by drowsy riders

1. Introduction

Safety and security while driving is important in everyday life, especially when traveling or doing activities outside the home, there are many factors that can contribute to the risk of accidents that motorcyclists will face while driving a motor vehicle, the main factor of problems that often occur in traffic accidents for motorcyclists who feel tired or are sleepy while riding a motorcycle(Mujahed et al., 1990)

Many accidents occur due to the negligence of motorcyclists caused by drowsiness while riding a motorcycle, based on statistics from the Ministry of Transportation reported on laman.kompas.com there is a high level of traffic accident victims in Indonesia there are still quite high there are 25,266 accident victims in Indonesia during 2020 to 2021, where this number is relatively high and has increased from before where Motorcycles are a type of vehicle that is often involved in traffic accidents(Choi & Kim, 2021)

Therefore, it is necessary to increase safety that can support the safety of drivers and passengers in the form of additional security needed to avoid fatal accidents when driving with the use of helmets. In this regard, the Indonesian government is reviewing several regulations on Law Number 22 Year 2009 yang harus disertai dengan perlengkapan kendaraan bermotor seperti helm Standar Nasional Indonesia(Eldeib, 2022)

This needs to be emphasized so that traffic accidents do not occur to remind motorcyclists of their safety, and information technology can help and facilitate human work, such as helping or reminding to rest while riding a motorcycle. when feeling tired or sleepy, remind drivers to rest when they feel tired or sleepy so that they can drive safely and can reduce the occurrence of traffic accidents(Narayan, 2021)

This research aims to make a device that can detect when the driver is sleepy, the tool serves to bind the driver, when the driver is sleepy and the pulse sensor detects the driver's pulse, the sensor will capture it and produce these information signals. Signals such information. (Patel et al., 2023)

The purpose of this study is to design a system that can detect drowsy riders when using a motorcycle, by implementing sensors on the NodeMCU, the tool will warn riders when drowsy with MPU-6050 to detect pulse while driving (R.Yoganapriya et al., 2023)

Basically this study proposes a tool to detect sleepiness in motorcyclists by using the NodeMCU, as well as a Buzzer that can provide important feedback to indicate rider sleepiness and an audible form of warning. Looking at the background above, an idea emerged to make this study entitled Internet of Things using pulses for smart helmets(Francis et al., 2019)

2. RESEARCH METHODOLOGY

2.1 Stages of Research

Below is the design of a drowsiness detection helmet system or device. These stages are what the authors carried out in the study.The methodology section typically has the following sub-sections:

Table 1. Design fo Drownsiness

Level 1 : Communication
At this stage the author identifies problems such as interviews, journal reading, and guidance.

Stage 2: Rapid Planning

At this stage the author collects materials and tools that will be needed during research.

Level 3 : Fast Planning Modeling
At this stage the author creates a flowchart, creates a program for research.
Level 4 : System Plan
At this stage tool design, system design, and tool manufacturing
Stage 5: Evaluation of tools and systems
At this stage the author evaluates the system and tools, before being implemented directly.
Level 6 : System-to-user submission
At this stage the author of the tool or system that has been evaluated first to reduce errors in the system when used. After that the system or tool is ready for use.

2.1 Flowchar

A System Flowchart is a chart that shows the workflow or what is being done in the system as a whole and explains the sequence of procedures in the system. In other words, this flowchart is a graphical description of the sequence of combined procedures that form a system. This research can be seen from(Datta, 2021)

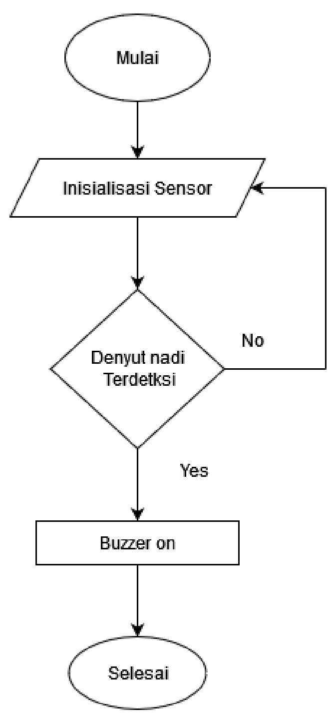

Fig 1. Plant sprinkler system flowchar

2.2 Interface

This system is IoT-based with an interface in the form of a WEB interface to display the average value of the rider's pulse rate and the status of the rider's sleepiness. The system interface image can be seen in figure 2 as follows.

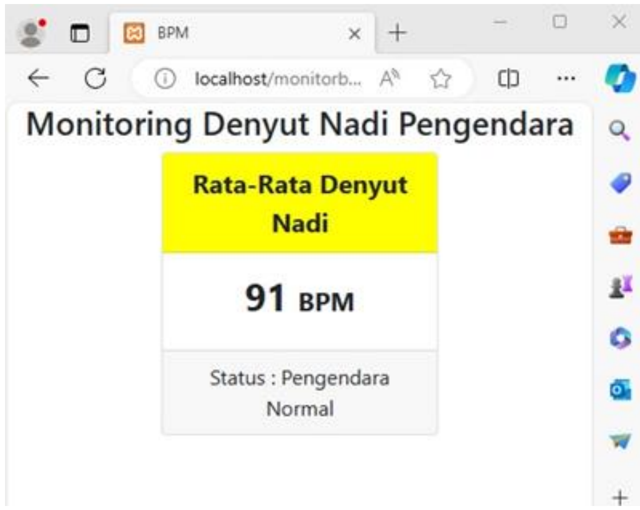

Fig 2. System interface

2.3 Schematic Tools

The schematic series of tools is designed using Fritzing software in the form of an overall picture to be subsequently implemented in real form. The series can be seen in figure 3 as follows.

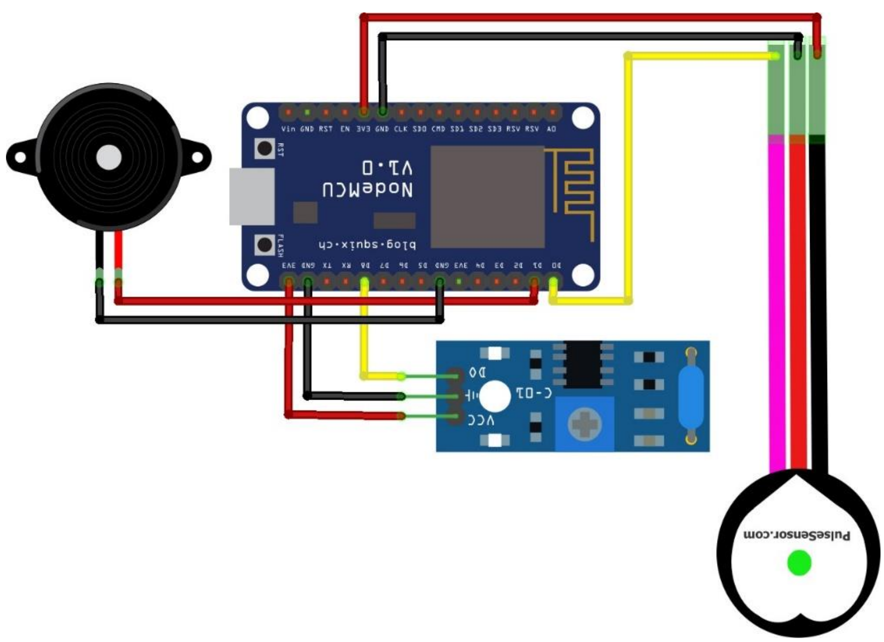

Fig 3. Schematic

Information:

The microcontroller uses pulse ESP8266 as a controller and connecting components also acts as a receiver of *wi-fi* signals to access the internet connection. When the microcontroller gets data from the sensor, it will be used as feedback to the *buzzer* which will produce bunyi suara sebagai indikasi The rider was sleepy. So that motorists can take one appropriate first step when there is a warning.

2.4 Tool Design

The design of the tool is made to get a 3D picture of the tool to be designed with the aim of being a guide in making the tool. The design of this tool is made *with SketchUp software* in the form of 3D modeling with such a design to get a real picture. The following is the design of the tool in this study can be seen in figure 4

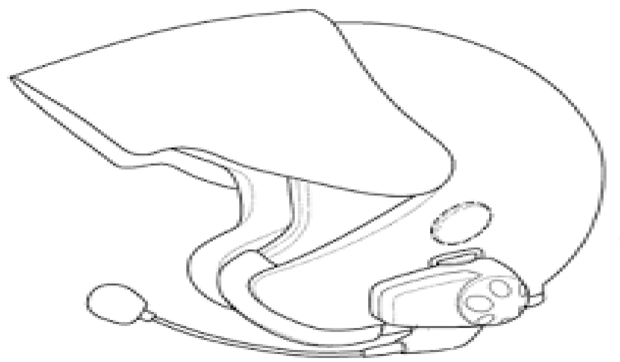

Figure 4. Tool design

3. Result and Discussion

This chapter describes in detail about the hardware installations used in this study. Hardware installation is an important step in ensuring the system is operating properly.

3.1 Tool Design

The following are the results of hardware installation on this system can be seen in figure 5 as follows.

Fig 5. Smart helmet tools

Information:

1. is a helmet used as head protection when driving. In this study, helmets are used as the main object of research, which involves the development, design, and implementation of smart helmets.
2. pulse sensor. This sensor is an important part of the smart helmet and is used to detect the user's pulse.
3. is a buzzer used to stabilize the user's consciousness when the pulse sensor detects signs of sleepiness based on the pulse.
4. is a black box used to put a series of electronics

3.3 Tool Testing

Every study needs to be tested to find out whether the research carried out can achieve the goals or not. Testing is carried out in several stages, namely testing *of output and input components in the system, WEB* testing, logic testing *and Test Subjects.*(Rohan et al., 2022)

3.3.1. *Buzzer Testing*

Testing on the buzzer is done by varying the input voltage on the buzzer to find out whether the buzzer can turn on when getting voltage. Here is a photo of the calibration on *the buzzer* component can be seen in figure 6.

Fig 6. Buzzer Testing

The results on this *buzzer* calibration are displayed in tabular form which can be seen in table 2 as follows.

Table 2. Buzzer Calibration

No	**Input Voltage**	**Condition**
1	3.3V	Active
2	5V	Active
3	9V	Active
4	12V	Active
5	>12V	Broken Buzzer

Information :

- Voltage 3.3V: At this voltage level, the *buzzer* operates well and produces sound according to the expected parameters. The resulting sound has an intensity corresponding to the voltage level.
- 5V Voltage : *The buzzer* continues to function well at 5V, producing a louder sound compared to 3.3V. *This response* corresponds to an increase in voltage.
- 9V Voltage : *The buzzer* still works at 9V, and the sound produced is getting louder. At this point, the *buzzer* is still operating under normal conditions.
- 12V voltage: At this voltage, the *buzzer* continues to operate properly and produces sound in accordance with expectations. No damage occurs to the *buzzer* at this voltage level.
- Voltage over 12V : At voltage over 12V *the buzzer* starts to show signs of damage. The resulting sound is very loud and distorted, indicating that this voltage is beyond the operational limits of the *buzzer* and causes damage to the component.

3.3.2. Sensor *Testing*

Testing the sensor is done by calibrating the pulse sensor. This calibration process is carried out by comparing the basic measurement process on the subject to be measured manually and with the sensor with 1 minute. The measurement process can be seen in figure 7 as follows.(Motorbike & Detection, 2022)

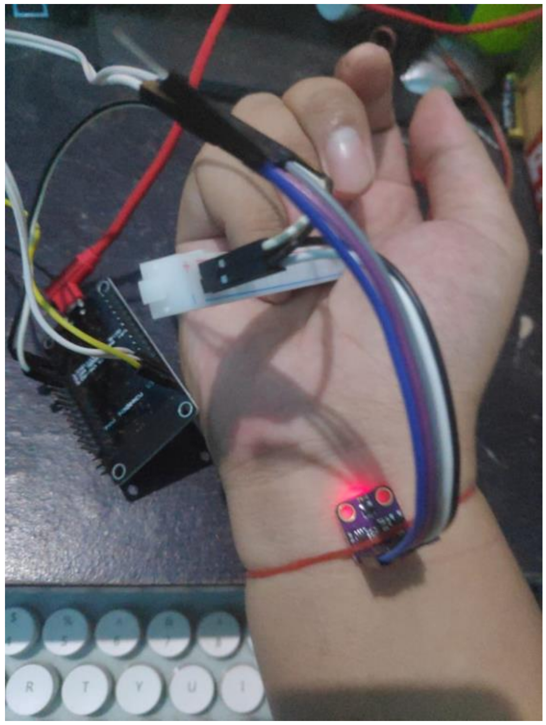

Figure 7.. Sensor Calibration

The results on sensor calibration can be seen in table 3 below.

Table3. Sensor Calibration

No	BPM		*Error*
	Manual	System	
1	85	85	0
2	90	89	0.99
3	85	85	0
4	86	86	0

Table 3 shows the results of pulse sensor calibration with manual calculations of 4 attempts. The table shows the same values in nos. 1, 3 and 4, an *error* occurs in no. 2. So that the sensor can be concluded to have given a near-accurate reading with an *error* in one of the experiments.(Alita, 2021)

3.3.3. WEB *Testing*

WEB *Testing* is done by sending BPM data that has been read by sensors to WEB automatically then checking the serial monitor, WEB interface and database whether the data produced is the same or not. Here are the test results on WEB testing can be seen in the picture 8**.**

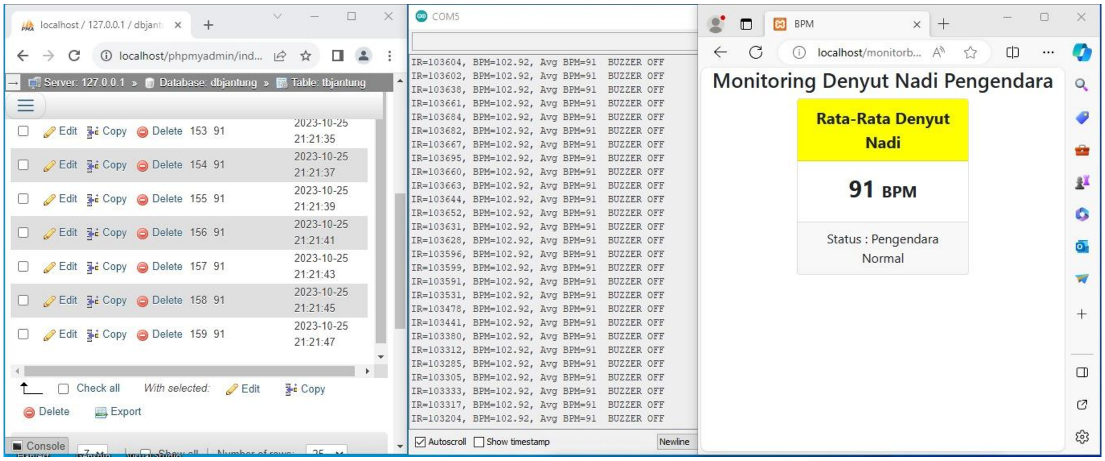

Fig 9. WEB testing

The results in figure 8 show that the data that has been generated by the sensor on the serial monitor, *database* and *interface* has the same value of 91, so it can be concluded that sending data to WEB was successfully done without *error.*(Telkar et al., 2020)

3.3.4. Logic *Testing*

Logic Testing is the process of testing and verifying logic in the system. The main purpose of logic testing is to ensure that the logic applied in the system works correctly and produces results that are in line with expectations. This testing process is carried out by running the system and observing the performance of the system in accordance with the *flowchart* in figure 3.5. The following results of *logic testing* can be seen in Table 4.

Table 4. Logic testing

No	Logika program	Hasil pengamatan
1	Sensor **MAX30105** membaca BPM pada denyut nadi dan mengirimkan data yang telah dibaca ke *database* kemudian ditampilkan pada *interface* WEB	Hasil pengamatan menunjukan bahwa Sensor **MAX30105** berhasil membaca BPM pada denyut nadi dan mengirimkan data yang telah dibaca ke *database* kemudian ditampilkan pada *interface* WEB.
2	*Buzzer* sebagai aktuator aktif ketika BPM <60 dan akan berhenti ketika BPM >= 60	Hasil pengamatan menunjukan bahwa *buzzer* aktif ketika BPM <60 dan berhenti ketika BPM >= 60

3.3.5. Test Subjects

This test is a test that involves test subjects in order to evaluate the performance of smart helmets in this study. The following test subject results can be seen in table 3.

Table 5.. Test subjects

No	Name	*Beat per minute*				*Avarage*	Indication
		1	2	3	4		

1	Anton	90	91	93	90	91	Succeed
2	Anggi	85	85	86	85	85.25	Succeed
3	Dani	79	80	79	81	79.75	Succeed
4	Yoga	80	80	80	81	80.25	Succeed
5	Who's Who	95	96	96	96	95.75	Succeed
6	Like	99	100	100	99	99.5	Succeed
7	Gifts	90	89	90	91	90	Succeed
8	From	84	83	83	83	83.25	Succeed
9	Selenium	92	92	92	93	92.25	Succeed
10	Andi	101	101	101	99	100.5	Succeed

Information:

During the testing of the smart helmet with various test subjects, the system was successful in detecting and recording the pulse (BPM) with varying results. In BPM measurement of test subjects, the system successfully generates data that reflects the pulse response of each subject during the test with the calculation of the success rate as follows.

$$\frac{jumlah\ berhasil}{jumlah\ subyek\ uji} x100\%$$

Known:
Number of successes = 10
Number of test subjects = 10
So that $\frac{10}{10} x100\% = 100\%$

These results showed that the system was able to record the entire pulse of the test subjects with a 100% success rate during the test. The data reflects the smart helmet's functionality in measuring and recording pulse data well, which is an important step in achieving research goals. During the smart helmet test, there was a variation in the average heart rate (BPM) recorded in the test subjects. Anton, Andi, Iza, and Dika showed BPM above 90, with Andi reaching the highest value of 100.5 BPM. Meanwhile, Anggi, Mei, and Selen have an average BPM that is in the range of 80 to 85, while Dani, Yoga, and Doni have an average BPM of around 79.75 to 83.25. These variations reflect differences in an individual's pulse response to the use of a smart helmet, as well as other factors that affect physical and emotional state during testing. The difference between their mean BPM scores illustrates differences in individual comfort levels, anxiety, or reactions to smart helmets and different test conditions between subjects. Further analysis may be needed to understand the factors influencing these differences.(Kurniawan et al., 2019)

4. Conclusions

4.1 Knot

The conclusion of this study is based on the test results of each system component, both hardware and program logic used, has been tested and proven to work according to its function. This ensures that the study has been successful in solving two major research problems, namely:(Saifuddin Dahlan, 2013)

1. This research has been successful in developing a system capable of sending heart rate data (BPM) to the web using MAX30105 pulse sensor. Web testing has also verified that BPM data can be uploaded correctly to the web server. It provides a solution to the first question of how to create a tool or system that can communicate with the web.
2. This research was successful in developing a smart helmet equipped with a pulse sensor MAX30105. This system has been tested and proven to detect whether the rider is sleepy or not based on pulse data. This provides a solution to the second question of how to make a helmet capable of detecting the condition of the rider.
3. Based on the results of tests carried out on each test subject, a 100% success rate was obtained during the test so that it can be stated that the helmet can work according to the purpose and function.

Thus, this research successfully integrated MAX30105 pulse sensor technology with web communication to create a solution useful in improving driving safety and comfort. These conclusions also show that the developed system is reliable and can be used in a wide range of applications, including health monitoring, transportation, and security(Khadidja, 2021)

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