Helmet Detection Device for Motorcycles for Safety Riding Porpuses

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ABSTRACT

In today's rapidly advancing technological landscape, the proliferation of motorized vehicles, particularly motorcycles, continues to grow. Motorcycles play a crucial role in facilitating transportation for a broader community. As more daily activities become reliant on road networks, the volume of road users has escalated significantly, resulting in an increased risk of accidents. Unfortunately, many motorcycle riders neglect the importance of wearing helmets, a fundamental safety measure. To address this pressing issue, we propose the development of a helmet detection system for motorcycle riders. This system aims to encourage responsible helmet usage and minimize negligence among motorists. Our research employs an Arduino Uno microcontroller and various components, including the NRF24L01 wireless module, Limit Switch, battery, charger module for input, and Arduino Uno, NRF24L01, and Relay for output. Our study demonstrates that the designed system functions effectively. It operates only when the rider is wearing a helmet, enabling the motorcycle to start by activating a relay that connects power to the motorcycle socket. The Arduino status is triggered when both Limit Switch 1 and 2 are pressed. The maximum distance between the two NRF24L01 modules is found to be 2 meters. Through our experiments, we have successfully demonstrated that the motorcycle can be started only when the rider is wearing a helmet and securely fastens the helmet strap. This innovation promotes driving safety and encourages responsible helmet usage.

KEYWORDS: Arduino Uno, Helmet, Motorcycle, Safety, Limit Switch.

1. INTRODUCTION

Currently, progress in the field of technology is very rapid. The growth of motorized vehicles from year to year is growing, one of which is motorcycles. The number of motorized vehicles in 2020 is 136,137,451 units. From these data, the types of motorcycle vehicles amounted to 115,023,039 units (bps.go.id) [1]. The wider community cannot be separated from motorbikes to facilitate transportation. Considering that more and more community activities are connected to roads, the number of road users is increasing day by day with various means of transportation, both four-wheeled and two-wheeled. [2].

Traffic Accidents are a global problem, the number of vehicles on the road today is quite at risk for accidents. According to the World Health Organization (WHO) there are around 1.24 million people die and around 50 million people experience serious and minor injuries every year due to traffic accidents. WHO estimates that by 2030 road accidents are the seventh largest cause of death in the world with the death rate increasing threefold to 3.6 million per year. [3].

Often motorcyclists do not wear helmets even though helmets are very important for the safety of riders. A helmet is a tool used to protect the head from impact when riding a motorcycle [4]. Most of the

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increase in the number of deaths in motorcycle crashes is attributable to drivers not wearing helmets. The cause of the accident was triggered because the driver was too trivial about using a helmet while driving. Therefore, a helmet is one of the attributes that must be used when riding a motorcycle, both short and long distances. Wearing a helmet can reduce the risk and severity of injury and death from head injuries [5].

Even though there are regulations to make it mandatory to wear a helmet while driving, there are still motorcyclists who ignore these rules which are regulated in Article 57 paragraph (1) to paragraph (2) and Law No. 22 of 2009 concerning traffic and road transportation [6], Every motorized vehicle operating on the road must be equipped with motorized vehicle equipment, the equipment referred to in Paragraph (1) for motorcycles is in the form of an Indonesian national standard helmet. It is also stated in the law Article 106 Paragraph 8 that everyone who drives a motorcycle and motorcycle passengers must wear a helmet.

It can be understood from the explanation of the law that the regulation regulates the obligation of all motorists to wear helmets. However, it is undeniable that every rule that is made must have challenges in its application, the lack of public awareness in driving without using a helmet can endanger oneself and others.

Based on this background information, the authors will design a tool called "Design of a Motorcyclist's Helmet Detection Tool for Safety Riding Based on Arduino Uno" in order to reduce the fatality rate due to accidents and to increase public awareness of the importance of safety. wear a helmet at all times. driving on the road.

The design of this tool uses a microcontroller chip that can be programmed and connected wirelessly. If the motorcycle user is not wearing a helmet, the Arduino Uno on the motorcycle will receive data from the wireless transmitter inside the helmet and trigger the relay, disconnecting the motorcycle's power cable, and allowing the motorcycle's starter button to be turned on and off.

2. THEORY

Safety Riding is a concept created to make road users aware of existing road markings, comply with existing traffic regulations, and complete vehicle documents and permits to drive, in essence, namely to make them aware of the importance of driving safely on the highway. The goal of safe riding is to raise awareness of road users, both two-wheeled and four-wheeled drivers, to always comply with traffic regulations so that the number of road accidents can be reduced, traffic jams can be reduced and most importantly, driving safety on the road can be created. [7].

A helmet is part of motor vehicle equipment in the form of a head protective cap which functions to protect the wearer's head in the event of a collision [8]. Helmets are usually made of metal or other hard materials such as Kevlar, resin fibers, or plastic. Helmets are mandatory for motorcyclists when riding.

Limit Switch or Limit Switch is a type of switch that is equipped with a valve that functions to replace the button. The working principle of the limit switch is that it is activated by pressing the button on a predetermined boundary or area so that the circuit is disconnected or connected. The limiting switch has 3 contact terminals namely Central terminal, Normally Open (NO) terminal and Normally Close (NC) terminal where one of the contacts will be active if the button is pressed [9].

NRF24L01 is a long-distance communication module that works on the 2.4-2.5 GHz RF band. This NRF24L01 plays a role as a sender or receiver of signals in communication. The working voltage of this module is 5 Vdc. Consumption on this module is very low, namely 9 mA at power output -6dBm and 12.3 mA at Rx mode [10]. The NRF24L01 has an Ultra Low Power (ULP) solution, which allows it to last months or even years using only AAA or AA batteries. Usually, the NRF24L01 is used in wireless keyboards, mice, joysticks, wireless data communications, alarms and systems, security, and wireless-based household appliances [11].

Arduino Uno is a live board microcontroller that has open source properties. Arduino Uno can function as a microcontroller that is used to get some data from the circuit. The microcontroller is programmed using the Arduino programming language which has syntax similarities to the C programming language.

The Arduino Uno has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16MHz Crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino Uno contains everything needed to support a microcontroller, easily connect it to a computer with a USB cable, or supply it with an AC to DC adapter or use a battery to start it [12]. Charger Module is a device that uses a USB connection from a computer or other device to charge a 1-cell Ion or Li-ion battery with a charging current of 1A. This device uses a Lippo battery to allow for charging while it is being charged. Therefore, a TP4056 Lithium Battery Charger Module is needed for helmet detection for motorcyclists. This small module can be used to recharge a small 3.7V battery.

This module is quite easy to use because of the simple way of making it. Its straightforward module design is complemented by superior armor settings and highly accurate charging. To find out the battery charge status, there are two LED levels that display the status of charge (blue) and full battery (red). SketchUp is a 3-dimensional (3D) graphics program that is most widely used today and has recorded more than 30 million users. This graphics program has succeeded in becoming a

respected newcomer in the world of 3D graphics and is able to match the advantages of various other 3D graphics software. Besides the easy-to-use features, sketchUp is also available for free except for the pro version.

In starting Arduino Uno programming, Arduino IDE is needed. Arduino IDE is software that writes using Java. The Arduino IDE consists of a program editor, compiler and uploader. An open-source program called Fritzing is used to design electronic circuits. This software helps electronics hobbyists develop Arduino microcontroller-based circuits into prototype products. enabling the creation of unique PCB layouts even by inexperienced electronics designers. Someone using Fritzing for the first time will have no trouble understanding its displays and explanations.

3. RESEARCH METHOD

3.1 Research Stages

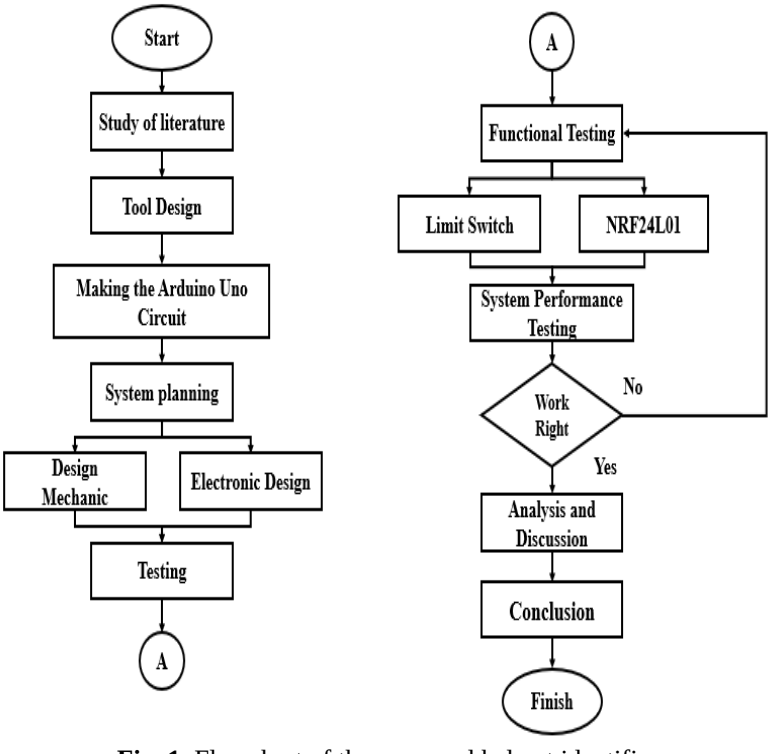

Fig. 1. Flowchart of the proposed helmet identifier.

The requirements used in this study are hardware and software requirements. The hardware consists only of the Helmet and the control box while the software consists of the Arduino IDE.

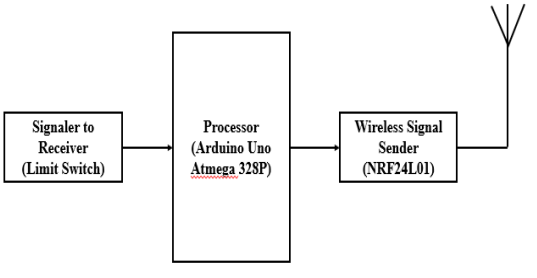

Fig. 2. Block Diagram of the system on the helmet.

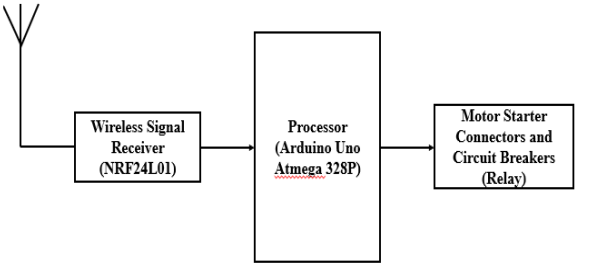

Fig. 3. Block Diagram of the system on the motorcycle.

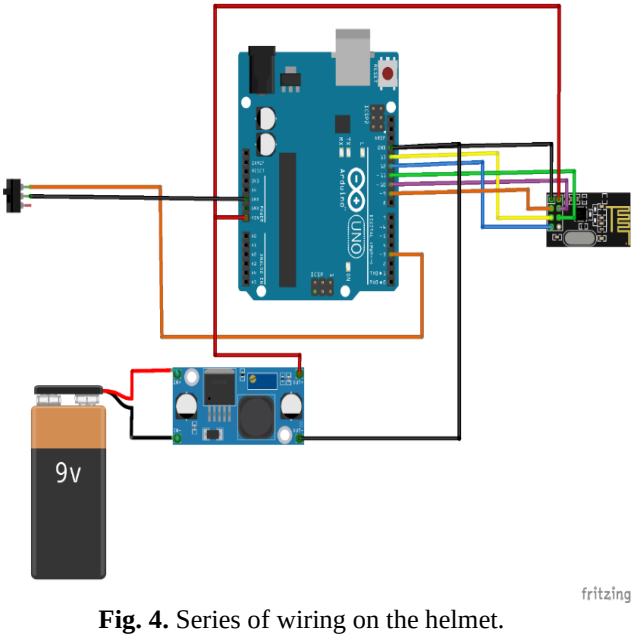

Fig. 4. Series of wiring on the helmet.

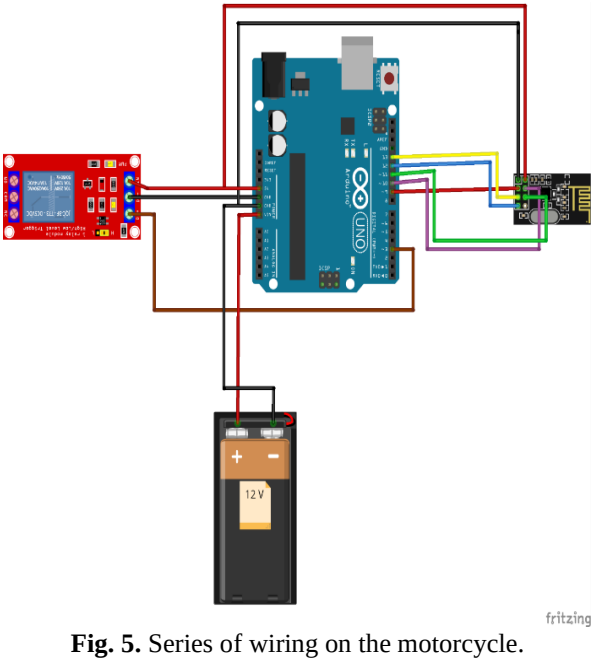

Fig. 5. Series of wiring on the motorcycle.

Realization of design is a process of making design become a real embodiment. The definition of realization is an action to achieve something planned or expected. In the development stage of this system, there are 3 stages that will be carried out, namely preparing a design draft, procuring components, manufacturing, and combining components.

The stages of testing aim to determine the level of success in research. The testing phase is carried out functionally. This test is carried out to determine the level of the system being built which will be explained in more detail in the following: (a) Functional testing is carried out to determine the usability level of the components in terms of their function. This test was carried out on a microcontroller consisting of Arduino Uno. (b) Realization is the real result of the tool being run in accordance with the work systematics of the tool and aims to see the level of success of the system being built. Testing by installing a limit switch on the helmet that is connected to the Arduino Uno and using the NRF24L01 module while on the motorcycle Arduino Uno and the NRF24L01 module are installed and the output is located on the relay.

If the installation of the tool is complete, a circuit check is carried out for the safety of the device, after which testing can be carried out. After testing, to see success it can be seen directly at the output of the relay, the resulting output is the current flowing at the motorcycle contact so that it can be turned on.

4. RESULTS AND DISCUSSION

The realization of the system has 2 places for placing tools, namely helmets and motorbikes. The research realization of this system consists of mechanical and control realization which can be seen below.

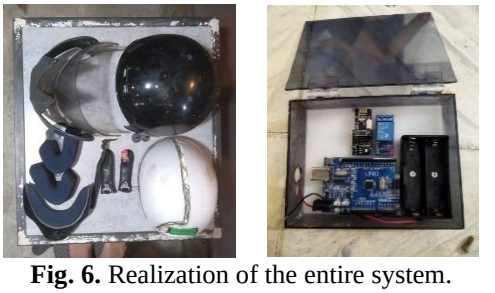

Fig. 6. Realization of the entire system.

The mechanical realization of this tool consists of a helmet and a control box which are explained in the description as follows: The helmet functions as a container for components such as Arduino Uno, Batteries, Charger Modules, Charger Adapters, Limit Switches, and Nrf24l01. These components are placed on the helmet foam and adjusted to the shape of the helmet. The rectangular control box is made of 2 mm thick acrylic material. Functional control box as a container for placing components such as Arduino Uno, Nrf24l01, and Relay.

The results of the Arduino Uno test are the realization of control carried out by looking at the connections and functionality between Arduino Uno and other components. Arduino Uno testing went well. This can be seen from the test table presented. So this research can be continued with the level of validation that has been successful in each component.

Table 1. Arduino Uno Test Results on Helmets

No	Component	Pin Arduino	Scenario	Status System Performance
1.	*Limit Switch* 1	3,GND	Can perform on/off process on Arduino Uno to give orders	It works
2.	*Limit Switch* 2	4, GND	Can perform on/off process on Arduino Uno to give orders	It works
3.	NRF Pengirim	CE (D2), CS (D10), SCK (D13), MOSI (D11),MISO (D12)	Can send data from Arduino Uno to receiver NRF24L01	It works

Table 2. Arduino Uno Test Results on Motorcycles.

No	Component	Pin Arduino	Scenario	Status System Performance
1.	*Relay*	5V, GND, D2	Can perform on/off process on Motorcycle contact	It works
2.	NRF Penerima	CE (D2), CS (D10), SCK (D13), MISO (D12)	Can receive signals from the sending NRF so that the next command can be executed by Arduino Uno	It works

The results of source testing were carried out using lithium batteries with a capacity of 3700 mAh and 6800 mAh which were placed in the helmet and control box of the motorcycle, respectively. This battery is used to supply the microcontroller system circuit and also to supply all modules. In this test, the results of the voltage, current, and power required for all the modules used in this study were obtained. The following are the results of the source testing performed:

Table 3. Source Testing Results.

No	Source	Voltage (DC)	Current (A)	Power Consumption (W)	Status System Performance
1.	Battery In Helmet	3.92	0.02	0.078	Good
2.	Battery In Control Box	3.81	0.01	0.038	Good

The results of the limit switch test are carried out to determine whether the helmet is used or not by touching the limit switch. The limit switch here functions to give on/off commands to the Arduino to give further commands. It can be said that the limit switch is an indicator of the running of the program in this study. The following results of the limit switch test carried out can be seen in the table below.

Table 4. Limit Switch Test Results.

No	Order	Condition	Status Arduino	Status System Performance
1.	*Limit Switch* 1 dan 2	Touch	ON	It works
2.	*Limit Switch* 1 dan 2	Untouch	OFF	It works
3.	*Limit Switch* 1 dan 2	One Touched	OFF	It works

Results of the NRF24L01 Reading Test were carried out to determine the distance that could be accepted by the two systems in this study in order to maintain the distance between the helmet and the motorcycle. The following results of the NRF24L01 reading test can be seen in Table 6 below.

Table 5. Distance Testing Table.

No	Range Distance	Signal Status	Status System Performance
1.	20 cm	Accepted	It works
2.	40 cm	Accepted	It works
3.	60 cm	Accepted	It works
4.	80 cm	Accepted	It works
5.	100 cm	Accepted	It works

The results of the relay test were carried out to determine its functional level which was assembled with Arduino Uno and motorbike contacts. Testing is carried out by uploading the test program to Arduino Uno via the Arduino IDE. After uploading, the test is continued by paying attention to the current in the motorcycle contacts and the relay. After there is a response from the relay, documentation will be carried out so that the test results can be seen in the table below.

Table 6. Relay Test Results.

No	Condition of Relays	Condition Motorcycle Contact	Status System Performance
1.	Active	ON	It works
2.	Not active	OFF	It works

Performance testing or overall testing is the final stage of testing carried out on helmet detectors with motorcycles. Testing is done by assembling and installing all the results of the design into one system.

This test is also carried out 2 times and this is in accordance with the conditions of use, the test, and the results of testing the performance of the entire system. This is done on the motorcycle and helmet control boxes so that they can be connected, as shown below.

Table 7. Overall Test Results.

No	Order	Condition	Status Relay	Condition Motorcycle Contact	Status System Performance
1.	*Limit Switch* 1 dan 2	Touch	Active	ON	Berhasil
2.	*Limit Switch* 1 dan 2	Untouch	Not active	OFF	Berhasil
3.	*Limit Switch* 1 dan 2	One Touched	Not active	OFF	Berhasil

In the table above it can be seen that the tests carried out on the entire system have been carried out and succeeded without any problems. In the Table, it can also be seen that the status of the relay will be active if limit switches 1 and 2 are pressed. If limit switches 1 and 2 are not depressed or only one of the limit switches is depressed, the status of the relay is inactive so that the motorcycle cannot be started.

Acceptable signal after testing for NRF range between helmet and motorcycle control box at distances of 20 cm, 40 cm, 60 cm, 80 cm, and 100 cm. Testing at a predetermined distance can be stated that the transmission of the signal from the helmet to the motorcycle is declared successful with evidence that can be seen on the serial monitor giving rise to the word signal received which can be seen in the attachment. The maximum range that can be received by NRF without obstructions is 5 meters. While the maximum range that can be received by NRF with obstructions is only 2 meters. The barrier in question is the motorbike seat and the cloth cover on the helmet.

5. CONCLUSION

The conclusions from the results of the research Design and Build of a Helmet Detector Tool for Motorcycle Riders for Arduino Uno-Based Safety Riding are as follows. The design of a helmet detection device for motorbike riders for safety riding based on Arduino Uno has been successfully designed with the realization of the design and development of a helmet detection device for motorbikes based on Arduino Uno successfully built. As for some of the test results, the first is that the Arduino Uno test has been successfully realized, shown by the functioning of the Arduino Uno in this study, then the source testing can also be realized with the functioning of Arduino in this study, then the Limit Switch test has also been successfully realized with the success of the Limit Switch being detected. both to be able to start the motorcycle, then the NRF24L01 test was successfully carried out which was demonstrated by the successful sending and receiving of data and finally, the relay test was successfully carried out which was demonstrated by successfully starting the motorcycle when all components were connected. After the design, development, and testing of this tool has been completed, the level of effectiveness of this tool compared to the use of an ordinary helmet is very effective with riders always using a helmet while driving. This makes riders more aware of their own safety and reduces negligence in these activities.

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