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Motorcycle security system based on Internet of Things (IoT)

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ABSTRACT

In response to the increasing cases of motorcycle theft, a more advanced and reliable security system is needed. This research aims to design and build a motorcycle security system integrated with Internet of Things (IoT) technology. The system combines the use of a microcontroller, RFID module, GSM/GPRS/GPS module within the SIM808, relay, servo motor, and vibration sensor to create an effective security solution. With the implementation of IoT, this system allows motorcycle owners to monitor the vehicle's position in real-time through a smartphone application. The GPS module provides accurate coordinate information, while the GPRS modules facilitate communication using internet for data transmission. The relay functions to cut off the power supply to the vehicle's engine, turn the servo motor on and off, and activate and deactivate the buzzer, thus preventing motorcycle theft. The software used include Blynk for use on the user's smartphone. Testing shows that the motorcycle security system prototype is effective using Blynk application for long-range, with a time of 1 to 2 seconds to receive and process commands.

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1. INTRODUCTION

In Indonesia, motorbikes are becoming tool transportation main for public middle to lower class. However, motorbikes are also one of the main targets act crime , with around 60 thousand cases of theft in the Polda Metro Jaya area during period 2019-2021 [1]-[5]. For overcome problem This , the solution to prevent motorcycle theft can be done by utilizing Internet of Things (IoT) technology. IoT technology allows interaction and control devices via the internet, as well as the application of IoT Security for secure device design [6]-[12]. Several studies have shown that the use of SIM800L and GPS modules to control and track motorcycles via SMS has limitations in signal reception and dependence on pulses. Therefore, further development with GSM/GPRS modules that can use the internet is needed, the use of IoT technology in motorcycle security systems can increase the effectiveness and efficiency in preventing theft. In addition, integration with RFID technology can provide an additional layer of security by allowing more accurate user identification [13-[17]

Other studies have shown that the use of Arduino Mega with Huawei E5372 MiFi and Ublok Neo 6m GPS modules for motorcycle security systems has high accuracy but is constrained by internet speed and space required, while the use of RFID modules instead of conventional keys offers a practical and secure solution. In addition, the integration of IoT technology in motorcycle security systems can increase the effectiveness of remote monitoring and control, the use of specially designed *mobile applications also allows users to monitor the location of the motorcycle in real-time* and give commands to turn the engine on or off, thereby increasing user safety and comfort [18]-[20]. There is also a study showing that the use of the SW-420 vibration sensor module to turn on the buzzer as part of a motorcycle security system is effective in detecting vibrations, although there are variations in the delay in sensor response, the integration of vibration sensors with IoT systems allows for more efficient remote monitoring and control, improving motorcycle

security. In addition, the use of this technology can provide a quick response to potential theft, thus providing additional protection for motorcycle owners [21]-[25].

The author sees the weaknesses and opportunities of previous studies, so that they can be used to improve the security system and prevention of motorcycle theft , the author conducted a study by integrating the SIM808 module which has GSM/GPRS/GPS module inside , servo motor, and vibration sensor . This research aims to design and test effectiveness system motorcycle security using GPS module, GSM/GPRS, servo motor, vibration sensor , and Arduino Mega 2560 as a microcontroller. And research This beneficial For provide A more integrated motorcycle security system provides early prevention against theft , as well as help user save time and cost in searching for a lost motorbike.

2. METHOD

In this research method, the GPS module owned by SIM808 tracks the position of the vehicle with output in the form of latitude and longitude coordinates. The Arduino Mega 2560 microcontroller receives commands from the user via a smartphone application sent via the internet network with the help of the GPRS module. This microcontroller also receives data from GPS. The voltage source of this prototype comes from a motorcycle battery that enters the Arduino Uno Mega 2560 power jack with a 12-volt input. The SIM808 GPRS module functions as a medium for receiving and sending data between the device and the user's smartphone via the internet; the SIM808 GSM module functions as a warning message sender if the buzzer relay is on. The 4-channel relay module controls the on and off of the motorcycle, servo motor, and buzzer. The servo motor itself functions as an autolock feature that pulls the rear brake of the motorcycle, triggered by the servo relay later, and the vibration sensor triggers the buzzer relay connected to the motorcycle horn. And the smartphone functions as a controller and monitoring device for the motorcycle remotely via the internet network. The complexity system can be seen in Figure 1.

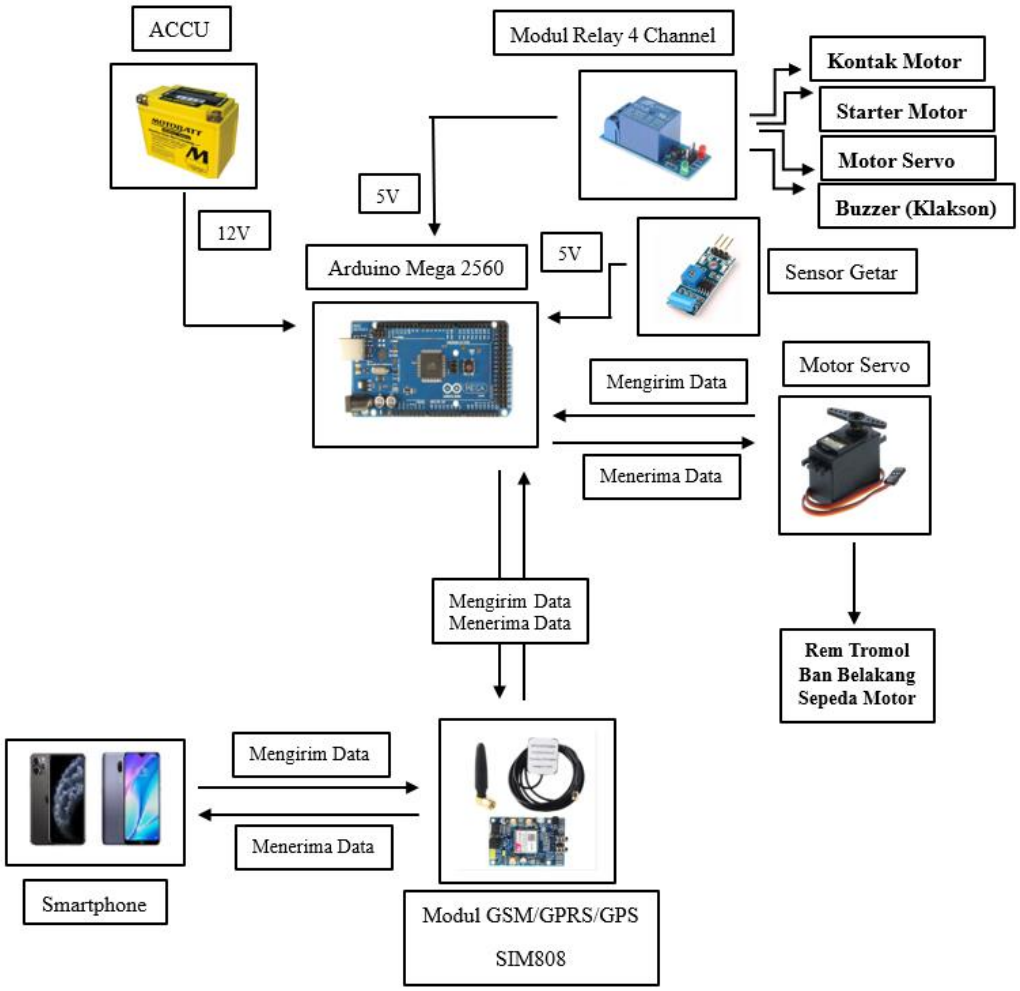

Figure 1. Block diagram of proposed motorcycle security system

Based on Figure 1, the principle work of this system is that the Arduino Mega 2560 gets source power from the motorcycle battery, and then smartphones are used to send data in the form of messages to the GPRS module. The GPRS module is used to receive data from smartphones and send the received data. to Arduino. Arduino will process data from the GPRS module and will match it with the data that has been stored inside Arduino. If the data from the GPRS module is not the same as that on the Arduino, the motor will not run. will life. If the data from the GPRS module is the same as that on the Arduino, the motor will be ON, and if the Arduino receives data for the second time, the motor engine will be OFF. The GPS module is used to send location data to the Arduino. Arduino will process data from the GPS module and will send data to the GPRS module. The GPRS module forwards data from Arduino to the user by sending data in the form of a message. If the motorbike is moving with vibrations that exceed the limits of the specified value, then the buzzer relay and servo relay will live, and then send a message warning through the GSM module to the user. And features autolock, also possible, are used by the user sending commands to the GPRS module via smartphone.

3. RESULTS AND DISCUSSION

This motorcycle security system is built with the use of a device hard in the form of an Arduino Mega 2560 microcontroller, SIM808, servo motor, vibration sensor, and relay module. Figure 2 shows the proposed hardware. The software that Blynk uses to give commands from the user's smartphone to the device that has been installed . built , and Arduino Ide *software* for programming microcontroller . Figure 2 is display on the Blynk application that will be used.

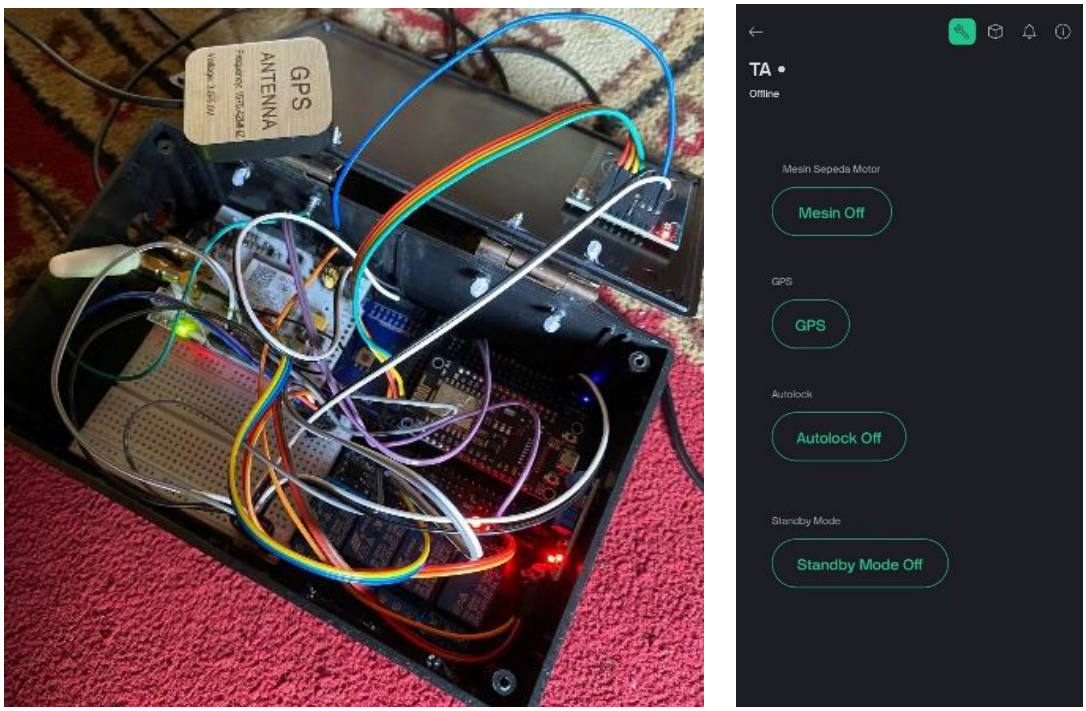

Figure 2. The proposed hardware and software of motorbike security system

Implementation system security this motorbike use battery motorbike for source voltage connected to the Arduino Mega 2560 *power jack* with mark 12 VDC voltage . Figure 3 is the prototype used in this study and has been connected to a motorbike. Testing was carried out using the Blynk application using a smartphone, the function being tested that is turn the motorcycle on and off, and track the location of the motorcycle, turn it on and off feature *Autolock* which is how this feature works that is with connect the servo motor to the rear brake of the motorbike and later this servo motor will triggered with relay, when the relay is on then the servo motor will rotate 90º, and when the relay turns off the servo motor will return turn to 0º. And turn *Standby Mode on and off,* the way this mode works is when turned on then the vibration sensor will live and will accept mark vibration that will become reference For turn on the buzzer relay that has been connected to the motorbike horn, and when turned off then the vibration sensor will dead and not will Can accept mark vibrate.

Table 1. Testing response turning motorcycles ON and OFF using smartphones via blynk

No	Keyword	Response Time	Reply to Message	Reply Time Message	Results
1	Machine On	1 second	Motorcycle Engine Started	6 seconds	Turn on the contact relay and after 5 seconds turn on the starter relay
	Engine Off	1 second	Motorcycle Engine Turned Off	6 seconds	Turn off the contact relay and engine relay
2	Machine On	1 second	Motorcycle Engine Started	6 seconds	Turn on the contact relay and after 5 seconds turn on the starter relay
	Engine Off	2 seconds	Motorcycle Engine Turned Off	7 seconds	Turn off the contact relay and engine relay
3	Machine On	1 second	Motorcycle Engine Started	7 seconds	Turn on the contact relay and after 5 seconds turn on the starter relay
	Engine Off	2 seconds	Motorcycle Engine Turned Off	8 seconds	Turn off the contact relay and engine relay
4	Machine On	1 second	Motorcycle Engine Started	6 seconds	Turn on the contact relay and after 5 seconds turn on the starter relay
	Engine Off	2 seconds	Motorcycle Engine Turned Off	6 seconds	Turn off the contact relay and engine relay
5	Machine On	2 seconds	Motorcycle Engine Started	9 seconds	Turn on the contact relay and after 5 seconds turn on the starter relay
	Engine Off	2 seconds	Motorcycle Engine Turned Off	8 seconds	Turn off the contact relay and engine relay

Response time from testing using the Blynk application to turn the motorbike on and off on the system range between 1 second up to 2 seconds , and time reply message to SMS range between 6 seconds up to 9 seconds . And for test turn on machine motorbike using Blynk application successfully as many as 5 out of 5 attempts and for Turning off the motorbike using the Blynk application was successful as many as 5 out of 5 attempts , can seen in the experiments that have been done based on Table 1.

One of the parameters that determines the reliability of the proposed IoT-based motorcycle security device using the blynk application is the message response time from the device. Based on the results of the tests carried out, the response time from testing using the Blynk application to find out the location of the motorcycle ranges from 9 seconds to 10 seconds. And for testing the location of the motorcycle track using the Blynk application, it was successful 5 out of 5 times with an error of 1 - 10 meters, as can be seen in the experiments that have been carried out based on Table 2.

Table 2. GPS testing via Blynk

No	Keyword	Reply Message In the form of a Google Maps link	Reply Time Message	Error (m)	Results
1	Location	http://maps.google.com/maps?q= -0.8904, 100.3445	10 seconds	10 m	Send reply message in the form of location coordinates with google map format
2	Location	http://maps.google.com/maps?q= -0.8905, 100.3445	9 seconds	5 m	Send reply message in the form of location coordinates with google map format
3	Location	http://maps.google.com/maps?q= -0.8905, 100.3446	9 seconds	1 m	Send reply message in the form of location coordinates with google map format
4	Location	http://maps.google.com/maps?q= -0.8904, 100.3446	9 seconds	2 m	Send reply message in the form of location coordinates with google map format
5	Location	http://maps.google.com/maps?q= -0.8905, 100.3446	9 seconds	1 m	Send reply message in the form of location coordinates with google map format

This motorcycle security device is also equipped with motorcycle location information using a GPS module. Testing to track a motorcycle that has been fitted with a GPS module is done using a smartphone by sending a “Location” message. Figure 3 shows the display when sending a “location” message. Figure 3(c) shows the location of the motorcycle. The actual location of the motorcycle is different from the location given by the SIM808 GPS module. The difference in distance can be examined by looking at the distance error given by the SIM808 GPS module. The difference in distance can be found by using the “measure distance” feature in the Google Maps application, as shown in Figure 3(d). The resulting distance difference is still within the permissible error tolerance. The maximum distance difference is only about 10 m. The difference in distance that far can still be monitored by human vision. So if the motorcycle is stolen, we can still be sure of the position of the motorcycle.

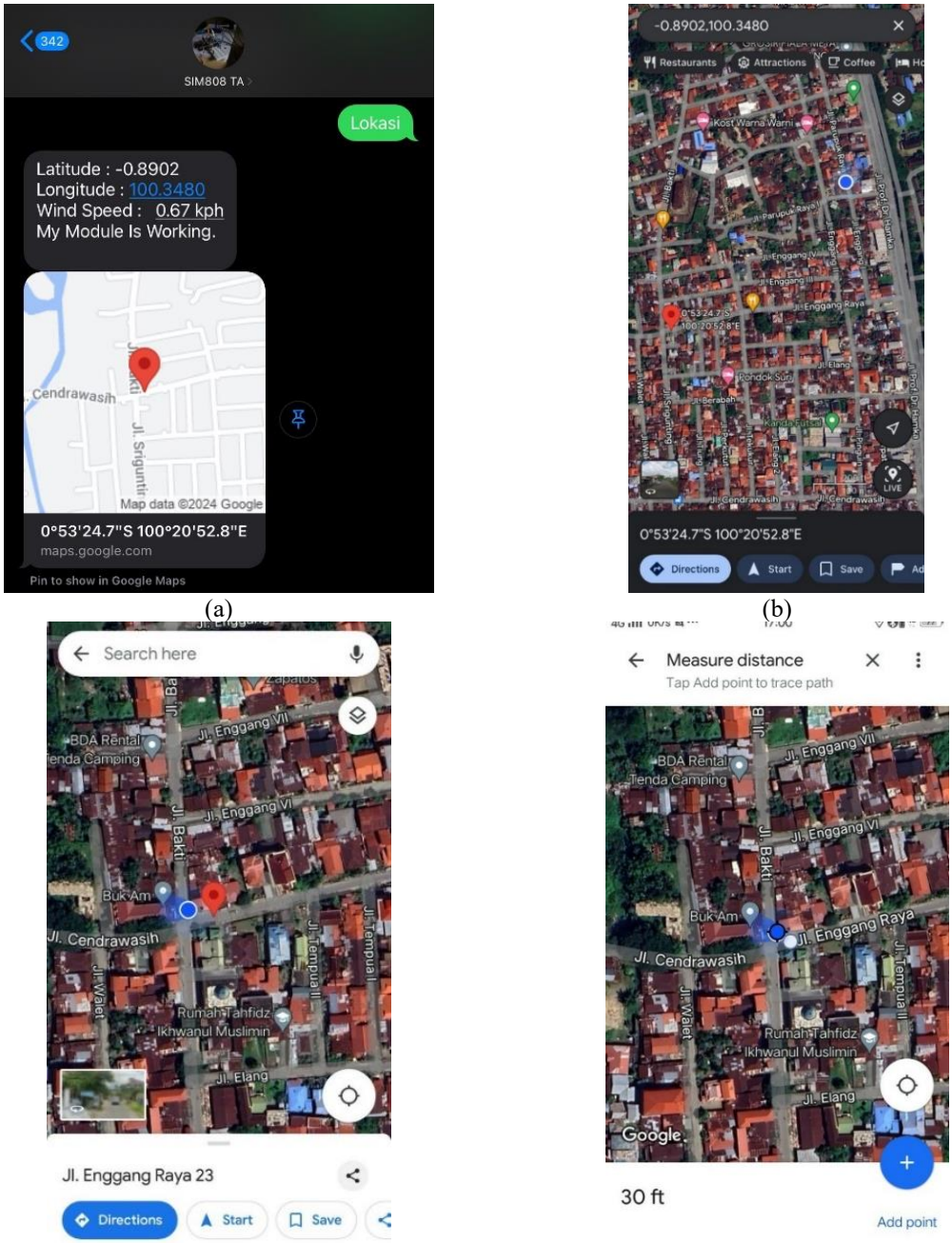

Figure 3. Display of location in application, (a) display when sending message “location”, (b) View on the Google Maps application as seen from where the user is located, (c) View on the Google Maps application seen from where the motorbike is located, and (d) Difference in Distance from the Actual Motorcycle Location with Location Provided by SIM808 GPS Module

Response time from testing using the Blynk app to turn it on and off feature *autolock* range between 1 second up to 2 seconds, and time reply message to SMS range between 6 seconds up to 8 seconds. And for test turn on feature autolock using Blynk application successfully as many as 5 out of 5 attempts and for turn off feature *autolock* use Blynk application successful as many as 5 out of 5 attempts, can seen in the experiments that have been is done based on Table 3. Testing to turn on and off feature *autolock* done using a smartphone with send “Auto Lock On” message to turn on the servo relay which functions as *a switch* for the servo motor and makes the servo motor rotate to 90º, and the message “Auto Lock Off” to turn off the servo relay which functions as a switch for the servo motor and makes the servo motor rotate. return to 0º. Figure 4 shows the servomotor position in motorbike.

Figure 4. Mounting the Servo Motor to the Motorcycle

Table 3. Testing Response Turning *Autolock* Feature On and Off Via Blynk

No	Keyword	Response Time System	Reply to Message	Reply Time Message	Results
1	Standby Mode On	2 seconds	Standby Mode Enabled	8 seconds	Turn on the vibration sensor and if mark vibration received more than 2500, it will turn on the buzzer relay and servo motor
	Standby Mode Off	2 seconds	Standby Mode Disabled	7 seconds	Turn off the vibration sensor, so that the vibration sensor No read mark vibration
2	Standby Mode On	2 seconds	Standby Mode Enabled	7 seconds	Turn on the vibration sensor and if mark vibration received more than 2500, it will turn on the buzzer relay and servo motor
	Standby Mode Off	1 second	Standby Mode Disabled	6 seconds	Turn off the vibration sensor, so that the vibration sensor No read mark vibration
3	Standby Mode On	1 second	Standby Mode Enabled	6 seconds	Turn on the vibration sensor and if mark vibration received more than 2500, it will turn on the buzzer relay and servo motor
	Standby Mode Off	1 second	Standby Mode Disabled	6 seconds	Turn off the vibration sensor, so that the vibration sensor No read mark vibration
4	Standby Mode On	1 second	Standby Mode Enabled	6 seconds	Turn on the vibration sensor and if mark vibration received more than 2500, it will turn on the buzzer relay and servo motor
	Standby Mode Off	1 second	Standby Mode Disabled	6 seconds	Turn off the vibration sensor, so that the vibration sensor No read mark vibration
5	Standby Mode On	1 second	Standby Mode Enabled	7 seconds	Turn on the vibration sensor and if mark vibration received more than 2500, it will turn on the buzzer relay and servo motor
	Standby Mode Off	1 second	Standby Mode Disabled	6 seconds	Turn off the vibration sensor, so that the vibration sensor No read mark vibration

Response time from testing using the Blynk app to turn it on and off *standby mode* range between 1 second up to 2 seconds, and time reply message to SMS range between 6 seconds up to 7 seconds. And for test turn on *standby mode* using Blynk application successfully as many as 5 out of 5 attempts and for turn off *standby mode* using Blynk application successfully as many as 5 out of 5 attempts, can seen in the experiments that have been was carried out. Testing to turn *standby mode on and off* was carried out using a smartphone with send "Standby Mode On" message for make a vibration sensor *high,* so that can accept mark vibration and will make the buzzer relay and the relay which becomes *a switch* for the servo motor in condition light up If mark vibration received more from 2500, and the message "Standby Mode Off" for make a vibration sensor *low,* so that No accept mark vibration . Figure 5 shows the vibration sensor position on the motorbike.

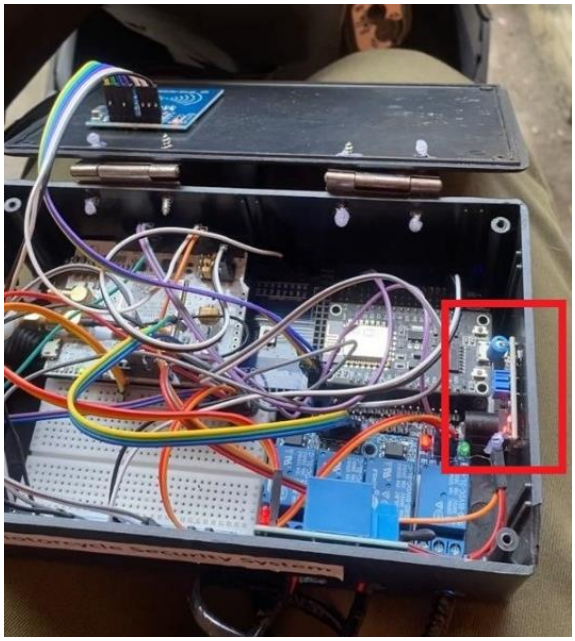

Figure 5. Vibration Sensor

4. CONCLUSION

After testing and analyzing the internet of things (IoT) based motorcycle security system, the following conclusions is The designed prototype can work according to the desired purpose, which is to be a motorcycle security system based on the internet of things (IoT). By utilizing the GPRS module, servo motor, vibration sensor, and Arduino Mega 2560 as its microcontroller. After testing and data collection, the effectiveness of the prototype that has been designed can be seen, for long distances it is more effective to use the Blynk application because the time needed to receive and process commands given by the user's smartphone is relatively fast, namely 1 second to 2 seconds.

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