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Design And Development of a Vehicle Security System Using Vibration Sensors and GPS Based on Arduino

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ABSTRACT

Incidents of theft and theft of motor vehicles have recently become more and more prevalent. This is suspected by the increase in the number of motorized vehicles every year. The most stolen or stolen types of motor vehicles are two-wheeled vehicles or motorcycles. So the researcher in this case conducted research in the form of designing motor vehicle safety using brittle sensors and GPS (Global Positioning System). The vibration sensor is functional to detect theft by forcibly moving the vehicle. Meanwhile, GPS functions to detect the location of the presence of the motor vehicle so that it can be monitored by the owner of the vehicle. This research focuses on measuring the accuracy and optimization of vibration sensors and GPS so that outputs in the form of simple patents and prototypes of motor vehicle safety devices can be obtained.

Keywords : Vibration Sensor, GPS, Arduino, Safety, Motor Vehicle

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1. INTRODUCTION

The rise of cases of theft and theft of motor vehicles in Indonesia is suspected by the number of notarized vehicles, both cars and motorcycles sold in Indonesia, which are not fully equipped with safety devices that are able to detect theft and at the same time can thwart theft(Rana et al., 2018).

The lack of a security system(Kaushal & Pathare, 2020) for motor vehicles is one of the causes of theft cases in Indonesia. The most stolen motorcycles are in parking lots and stolen on the highway. Usually motorcycles are only equipped with handlebar locks and double locks on the wheels which are easy for thieves to break into.

In this study, a motor vehicle safety has been designed and made equipped with a vibration sensor that functions to detect movement or shock from thieves who try to break into the handlebar lock or wheel lock on a motorcycle. So that if there is an attempted theft, the vibration sensor(Yoshida et al., 2021) will be activated and send a signal to the microcontroller(Mendoza, 2017), in this case using an Arduino(Pollo, 2019) that has been implanted with theft detection software. Then the Arduino will activate the alarm and disconnect the ignition to the engine system so that the engine cannot be started.

This safety device is also equipped with a GPS that functions to report the position of the vehicle based on the latitude and longitude location which shows the location or position of the vehicle that is likely to be stolen so that the owner can track the whereabouts of the vehicle(Adamowski & Rosiński, 2022).

This study also produced a design so that the safety system can disable the vehicle engine ignition system when there is an emergency, for example a case of beheading on the highway. So that the owner can simply avoid the begal and the tool will automatically turn off the engine and ignition system so that the begal cannot start the engine and cannot carry the vehicle(Astuti et al., 2020).

Vibration Sensor

A vibration sensor is a sensor that can detect vibrations(Gunawan et al., 2021) of a certain intensity. The vibration sensor used in this study is the SW420 vibration sensor(Pei et al., 2023). This sensor has a working principle as a piezoelectric which will change the electrical charge if there is a vibration in the form of pressure or impact around it.

This sensor has a sensitivity that can be adjusted from a scale of 10mV to 100mV(Yoshida et al., 2021) . The accuracy and sensitivity can be determined according to the results of the experiments and tests in this study in order to obtain good results and performance to be able to detect the occurrence of vehicle theft.

Figure 1 shows the physical shape of the SW420 vibration sensor(Al Afgan et al., 2021; Gunawan et al., 2021)

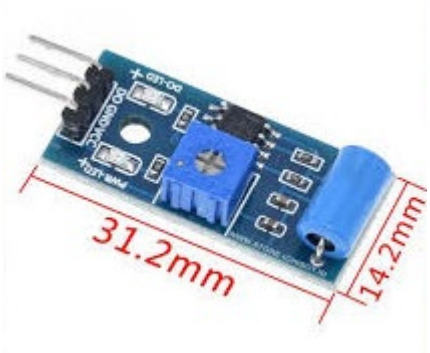

Fig 1. SW420 Vibration Sensor.

System Global Positioning System (GPS)

The Glogal positioning system(Fatoni & Adiananda, 2021) or often referred to as GPS(Kiruthiga et al., 2015) is a system that can provide location information based on the latitude and longitude of the globe or globe. This system or tool was first developed by the United States Armed Forces in 1973(PT. Otto Menara Globalindo, 2021).

GPS today has been widely used on every smartphone that has GPS or location designation facilities. Almost all smartphones with Android and IOS operating systems are equipped with GPS(Babalola & Olokun, 2021). On smartphones, the position shown by GPS can be immediately known with the Google Map(Strong, 2019) application.

In the research on the design and construction of this motor vehicle(Babalola & Olokun, 2021), it is equipped with GPS(U-Blox, 2022) so that the vehicle owner can find out the location of his vehicle in the event of theft or if the vehicle is used by other people. Information obtained by the owner through SMS media(Lubis & Aryza, 2017) or short messages via smartphones. By being equipped with GPS(Atunggal et al., 2018), it is hoped that this tool will be better and useful for tracking vehicles in the event of theft so that vehicles can be easily recovered. Figure 2 is the GPS (Koo et al., 2019)module used in this study.

Fig 2. GPS Module

2. RESEARCH METHOD

1) Formulation of Research Problems

The formulation of the problem in this study is to design a motor vehicle safety using vibration sensors and Arduino-based GPS to secure vehicles from theft and theft cases.**2) Development**

2) Scope of the Study

The limitations of the research are:

The system can only detect vibrations with strong intensity as a sign that theft has occurred.

The system can only provide location information in the form of short message service (SMS)

3) Method

The method in this study uses a qualitative method, namely conducting a literature review of previous studies that have the same topic and correcting the weaknesses of previous research. Then make improvements to previous research designs in order to get prototype results or tools that have better reliability. The next method is to design a block diagram and design a series of motor vehicle safety devices. Added a vibration sensor and improved GPS accuracy by optimizing the Arduino Uno programming. Then test the tool by simulating the theft of a motor vehicle and recording the results and analyzing the system. Furthermore, if the appropriate results have been obtained, the researcher writes a report on the results of the research and a draft for simple paten registration.

3. RESULTS

This research produced a prototype of motor vehicle safety using vibration sensors and GPS based on Arduino UNO. The researcher designed this motor vehicle safety block diagram as shown in figure 3. the following:

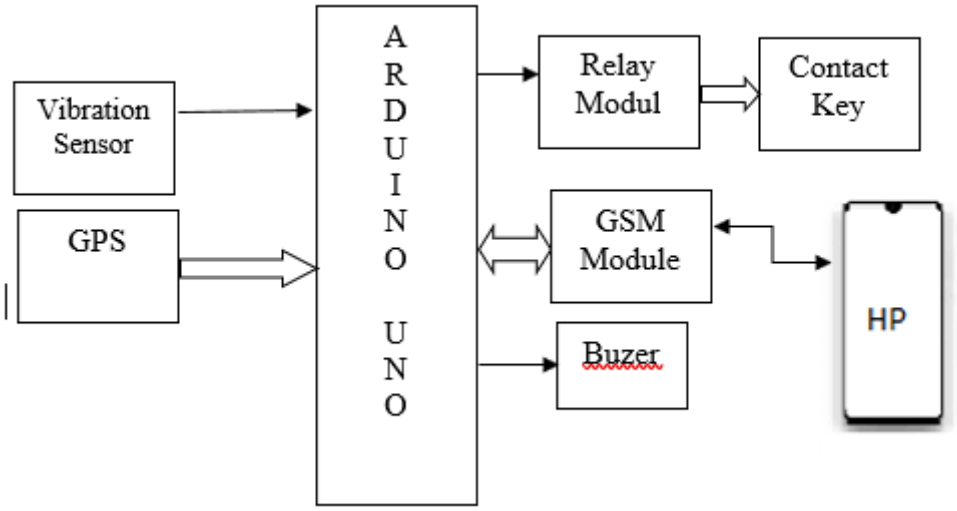

Fig 3. Block Diagram

Based on the block diagram in figure 3, this motor vehicle safety device has the following working principles:

The vibration sensor functions to detect vibration or shock if a thief forcibly dismantles the vehicle's ignition key or tries to open the safety lock of a parked motor vehicle. Then the vibration sensor sends a 1" logic signal to the Arduino Uno. The Arduino Uno reads the signal through the digital input and output pins, which in this study are attached to pin 5 of the Arduino Uno. Next, the Arduino Uno will activate the ignition disconnect relay to the ignition system of the motor so that the motor cannot be started. Next, the Arduino sends a logic digital signal "1" to activate the buzzer or alarm so that the vehicle owner hears that his vehicle is experiencing an attempted theft. In addition, the Arduino Uno also commands the GSM module through AT Command to make a phone call to the vehicle owner. The GPS module also provides input signals to the Arduino Uno with data containing the latitude and longitude location of the vehicle. The data is sent to the vehicle owner's cellphone using SMS.

In conditions where there is an attempted beheading, the vehicle owner is advised to leave the vehicle and avoid the begals. Furthermore, by sending an SMS with the code "505", the Arduino will read the code and activate the relay to disconnect the vehicle's ignition system so that the begal cannot drive the vehicle. GPS also immediately sends location data to Arduino and Arduino sends the data through the GSM module to the vehicle owner's mobile phone or other numbers that have been registered in the system.

In terms of software, this tool works according to the flow of the program diagram or flowchart in figure 4.

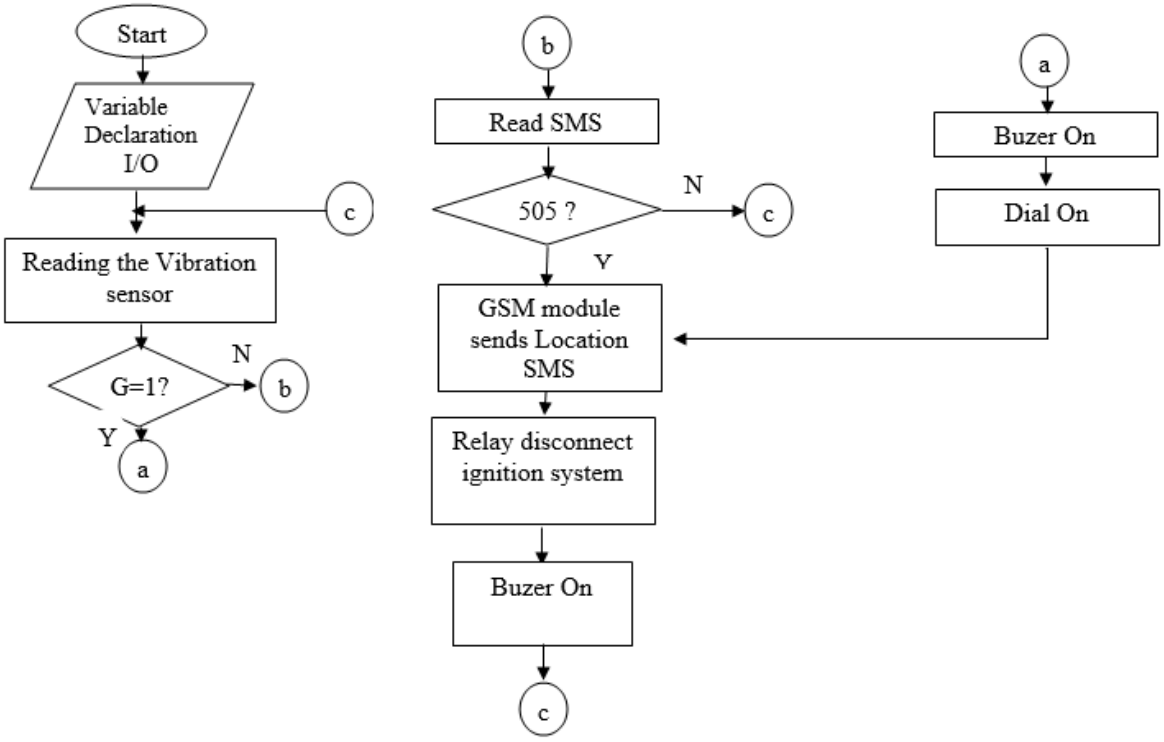

Fig 4.Flowchart of Vehicle Safety Program

Before programming the Arduino, the researcher designed a program flowchart or flowchart as shown in figure 4. First of all, the researcher prepares the variables for input and output. This vehicle safety system has 2 inputs, namely a vibration sensor and a GPS module. The vibration sensor functions to detect vibration or impact. If there is vibration, the vibration sensor gives a logical signal of "1" and if there is no vibration, it will be the opposite, which is logically "0".

The vibration sensor input is connected on pin 5 of the Arduino Uno. So the researcher declared G=5 which means that the vibration sensor is connected to pin 5 of the Arduino Uno as input. Then the researcher strings the Relay module on pin 12 as the output and declares the variable to Rly=12. The GSM module is a module that functions as both an output and an input because this module is a communication module between Arduino and mobile phones through a cellular network. For the GPS module it functions as a satellite signal receiver and sends its data to the Arduino uno via the Tx and Rx pins.

Then the program will read the data from the vibration sensor, if there is a logical signal LOW means that there is an attempted theft so the program will activate the GSM module to call the owner's cellphone and at the same time send SMS the location of the vehicle. Then the Arduino activates the relay to disconnect the ignition system and activates the buzzer or alarm so that the vehicle owner knows that there is an attempted theft. Then the program repeats the process of reading the vibration sensor.

Vibration Sensor Test Results

The researcher conducted a test on the vibration sensor by adjusting the variable resistor component contained in the vibration sensor module. The purpose of the

arrangement is to get the vibration strength so that the module only detects vibrations that indicate vibration or shock due to theft attempts, not vibrations because someone passes by or a touch that is not too hard.
In table 1. It shows the results of the vibration sensor test where if there is a weak and moderate vibration then the GSM module and buzzer are inactive and the Vout output is measured at pin 5 of the Arduino Uno 0.01 volts which means logical "0". If a strong vibration or shock is carried out then the vibration sensor sends a logic signal "1". From the observation results, the GSM module is active in sending SMS and making calls to the owner's cellphone number and buzr or active alarm.

Table 1. Vibration sensor test results

No	Vibration	Observation Results	Vout (volt)
1	Weak	Led Off	0,01 v
2	Strong	Led On	4,37 v

GPS and GSM Module Test Results

In the GPS test, the researcher conducted a test by programming a GPS module with a special library to be able to activate GPS, namely TyniGPS++. After connecting or assembling the Arduino and the GPS module and programming the Arduino then testing and producing the Arduino can send an SMS containing the location of the coordinate point, latitude and longitude. Table 2 shows the results of testing GPS and GSM modules at the same time.

Table 2. GPS and GSM module test results

No	SMS	GPS	SIM800
1	505	Send a location	Successful
2	halo	No Action	Successful

Test Results of Relay and Buzer Modules

In the relay module and buzer test, the researcher simultaneously tested the entire circuit. This vehicle safety device is equipped with a relay that functions to disconnect the ignition system so that the motorcycle cannot start because the connection between the spark plug wires is broken. The relay is in charge of disconnecting this connection. Then the buzer functions to produce an alarm sound so that the motorcycle owner or people around the motorcycle know that the vehicle is in trouble or experiencing security disturbances. The relay module is connected at pin 12 of the Arduino Uno while the buzer is connected at pin 11 of the Arduino Uno. Figure 5. shows the entire series of safety of this motor vehicle.

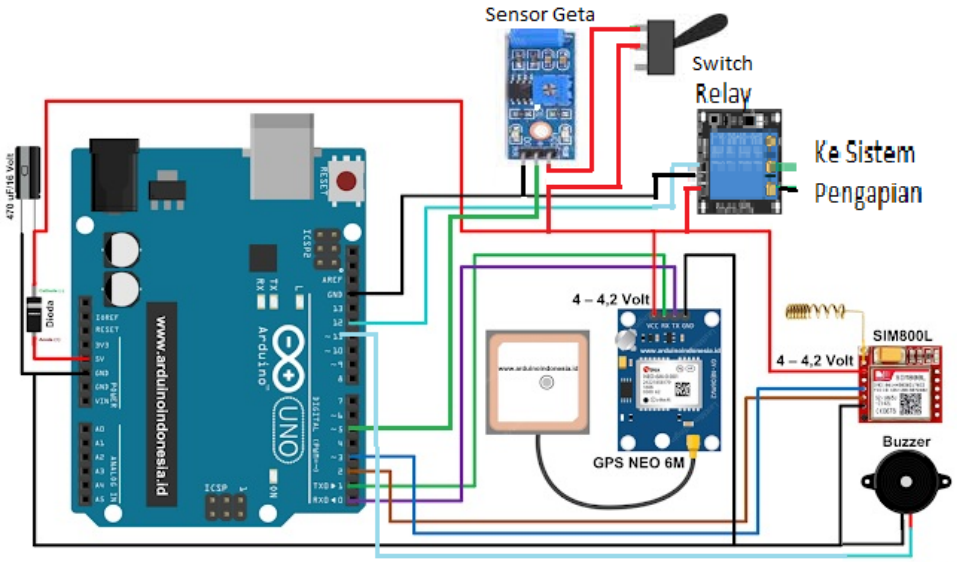

Fig 5. Circuit Diagram

In table 3. Showing the test results of the relay and buzer modules and Table 4. is the result of testing the whole series.

Table 3. Testing of relay and buzer modules

No	Vibration Conditions	Module Relay	Buzer
1	Weak Vibration	Off	Off
2	Strong Vibration	On	On
3	No vibration	Off	Off

Table 4. Overall Test Results

No	Condition	Vibration Sensor	GPS	GSM	Relay	Buzer
1	No vibration	Vout=0.01volt	Standby	Standby	Off	Off
2	Weak Vibration	Vout=0.01volt	Standby	Standby	off	Off
3	Strong Vibration	Vout=4.36volt	Active	Send SMS	On	On
4	Strong Vibration	Vout=4.36volt	Active	Fail	On	On
5	Strong Vibration	Vout=4.36volt	Active	Send SMS	On	On
6	Strong Vibration	Vout=4.36volt	Active	Send SMS	On	On
7	Strong	Vout=4.36volt	Active	Send	On	On

	Vibration			SMS		
8	Strong Vibration	Vout=4.36volt	Active	Send SMS	On	On
9	Strong Vibration	Vout=4.36volt	Active	Fail	On	On
10	Strong Vibration	Vout=4.36volt	Active	Send SMS	On	On

4. CONCLUSION

The safety of motor vehicles using vibration sensors and GPS based on Arduino Uno has functioned according to the design, but there are obstacles when the vehicle is started normally, the vibration sensor continuously sends a vibration signal. Therefore, the vibration sensor must be turned off manually using an additional switch connected to the Vcc vibration sensor module. The addition of a series of on-off switches for vibration sensors to be inactive when the vehicle is turned on normally by the vehicle owner. Vehicle owners must first turn off the vibration sensor before starting the vehicle's engine. Then activate the Restart switch "on" when it is about to leave the vehicle in the tempt parker to get the Resume vibration sensor to work.

In the test, the swith vibration sensor must be in the on position so that the vibration sensor gets a Vcc voltage of 5 volts from the Arduino Uno circuit. On the vibration sensor, there is a variable resistor or trimpot that can be rotated left and right to adjust the sensitivity of the sensor to the vibrations it receives. In this experiment, the setting of this variable resistor does not need to be done because during the test it has obtained the appropriate vibration to detect the occurrence of shock or vibration when the motorcycle is forcibly touched by a thief.

In the test, the GPS module has successfully detected the location of the vehicle's existence by marking it with an SMS coming from the SIM800 module. From software testing to programming GPS and GSM modules, the results have been obtained as shown in table 2.

In the test of the relay module and buzer also showed the appropriate results as shown in table 3. Where the relay is active if the vibration sensor gets a strong vibration and the buzer will also turn on. The overall test also showed good results, namely out of 10 tests there were 2 failed SMS sending. So that the ferporma of this tool can be calculated are:

Performance = number of successful tests : total number of tests x 100%

Performa = 8 : 10 x 100% = 80 %.

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