Designing and Building a Motorcycle Security System Based on the Internet of Things

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Abstract
Motorbikes are a means of transportation widely used in Indonesia and are easy to buy and sell. However, sometimes they are not equipped with valid vehicle documents with a selling price that is enough to use for one month. Perhaps it is based on the consideration that the perpetrators of the crime of motorbike theft never end, and what is added is that the work time only takes a matter of seconds. Much research has been carried out to help prevent the recurrence of the problem of motorbike theft, but based on the author's analysis, there are still shortcomings in the results of the research conducted. Therefore, the author tried combining a motorbike security system based on the Internet of Things (IoT) and GPS in this research. The research steps start from data collection, needs analysis, system design, system implementation, testing, and conclusion. From the results of the tests, a conclusion was drawn that the designed system could function well. Moreover, for future research, it is recommended that the system be equipped with a camera to detect faces.

Keywords: *Theft, Motorbike, Iot, Security, Arduino Uno*

Introduction

Motorcycles are one of the means of transportation that are widely used in Indonesia in general and North Sumatra in particular. This is because the price is affordable for all levels of society, fuel efficient, agile in dense traffic, easy, cheap maintenance costs and small vehicle tax costs that must be paid annually. Based on the above considerations, every household in North Sumatra can find 2-4 motorbikes with various brands of manufacturers, especially from Japan with a price of 1 unit ranging from 20,000,000 - 40,000,000. This price is quite high for Indonesian people with a lower middle economy, but ironically sometimes if you pay attention, motorbike owners are less careful in parking their vehicles, such as parking in random places, not locking the handlebars and double locks so that this invites and makes it easier for motorbike thieves to carry out their actions. This is reinforced by data obtained from the Central Statistics Agency (BPS) in 2023 which stated that there was an increase in criminal acts in cases of motor vehicle theft in North Sumatra as seen in Figure 1.

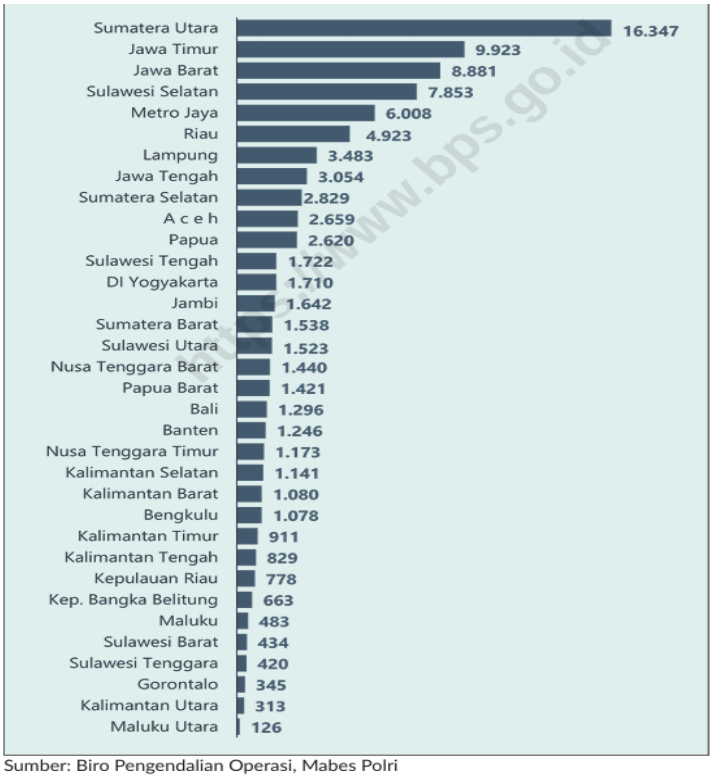

Figure 1. Increase in the number of thefts in North Sumatra 2022 [1]

To prevent motorcycle theft, several security measures have been taken on motorcycles, both those provided by the manufacturer, such as the presence of a handlebar lock. However, these security measures are still quite easy to anticipate by motorcycle thieves by damaging the main lock and breaking the handlebar lock, so that the motorcycle is automatically on as a sign that it can be operated. Seeing the shortcomings of the current motorcycle security system, several studies have been conducted, such as those carried out by [2]. In this study, [2] tried to add an on/off switch to the engine that was placed specifically on the motorcycle body and hidden but easily accessible to the owner of the motor vehicle and added a tilt sensor to identify whether the motorcycle was in a parked or operating position. Where the alarm will sound if the safety switch has not been activated when the side stand is returned to the operating position (run). The results of this study state that the designed system can be used as an alternative security for motorcycles. Then there is also other research related to motorcycle security conducted by [3] with adding bluetooth as a communication medium between a mobile phone and a motorcycle to turn on and off the engine on / off switch. The results of this study also stated that the designed system can function properly. Next, there is also research conducted by [4], [5], [6], [7], [8] which uses an Arduino Uno-based RFID card to turn on the motorcycle engine. The conclusion of this study states that the designed system is successful. Furthermore, research related to motorcycle security continues to develop with the use of E-KTP and RFID to be able to access the engine on / off switch, this study was conducted by [9] then there is also research that utilizes fingerprints, voice recognition and USB as a replacement for the ignition key as done by [10], [11], [12], [13], [14], [15]. The three studies state that the designed motorcycle security system functions properly.

From the eleven research results that have been completed above, the author analyzes that there are still shortcomings in the designed system, namely that it is not equipped with

remote control combined with GPS to turn on / off the motorcycle engine by utilizing the internet. And knowing the coordinates of the motorcycle. Based on this idea, the author tries in this study to design a motorcycle security system by adding control via IoT and GPS using Arduino ATMEGA 2560 for motorcycles.

Research Methodology

The research steps taken by the author to complete this research are as shown in Figure 2.

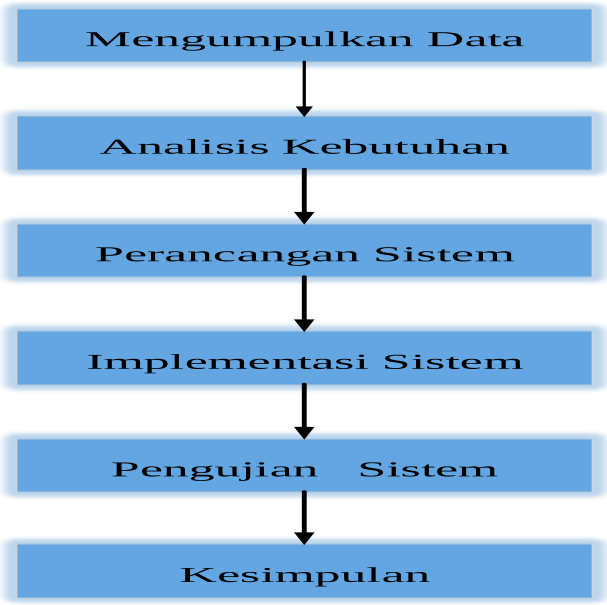

Figure 2. Research Stages [16]

A. Collecting Data

The initial step taken by the author so that this research can be completed properly is by reading and collecting as much data as possible related to the topic of motorcycle safety from various sources such as e-books, websites, proceedings, accredited national and international journals.

B. Needs Analysis

After it is felt that the collected data is sufficient, the work is continued at the stage of analyzing the needs of the hardware and software that will be used in the design of IoT-based motorcycle security such as the parts of the hardware architecture used such as power supply, sensors, Arduino ATMEGA 2560, Liquid Crystal Display (LCD), relay, Global Position System (GPS) and alarm. The software used includes Arduino IDE, proteus professional, eagle, blink [17], [18].

Table 1. List of Hardware Used

No	Name Hardware	Function	Amount
1	Diode 1 A	to change alternating current to direct current	5
2	Elco 1000 µF	to store electric charge	1
3	LED	as an indicator	1
4	Transformator 1A	reduce the voltage from 220VAC to 12VAC	1

5	Arduino ATMEGA2560	sebagai kontroler system keamanan sepeda motor	1
6	Sensor switch	to detect changes in the side standard angle	1
7	Module relay	as a switch to disconnect the electricity from the machine	1
8	LCD	to display characters	1
9	GPS	to send the motorcycle coordinate location	1
10	Alarm	as a sound generator	1

Table 2. List of software used

No	Name Software	Function
1	Proteus 8 profesional	for circuit simulation
2	Arduino IDE	for editing program syntax, compiling and uploading programs
3	Eagle	for circuit schematic design
4	Blink	to connect a cellphone to the Arduino ATMEGA 2560

C. System Design

At this stage the author does a schematic design on the SIM 900, controller, LCD, relay and GPS sections. For the schematic design here the author uses Eagle software. One form of the power supply schematic design designed in this study is as shown in Figure 3. After the hardware design is complete, it is continued with the flowchart design of the software that will be entered into the Arduino ATMEGA 2560 memory as shown in Figure 8.

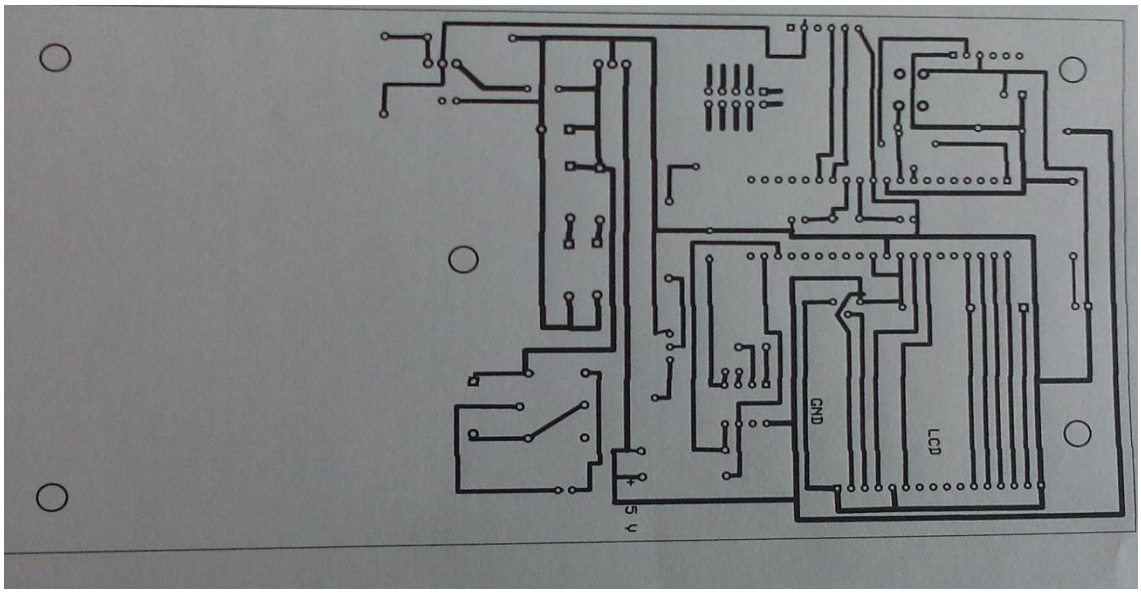

Figure 3. Printed Circuit Board (PCB) layout design

The schematic circuit design image is done using the eagle tool, then after it is finished it is printed using a laser jet printer that has powder ink while the paper used is also special, namely the duplex type. After printing is finished, the paper is placed on the PCB and rubbed with an iron with sufficient heat ± 2000C, then the results will look like Figure 4.[19], [20].

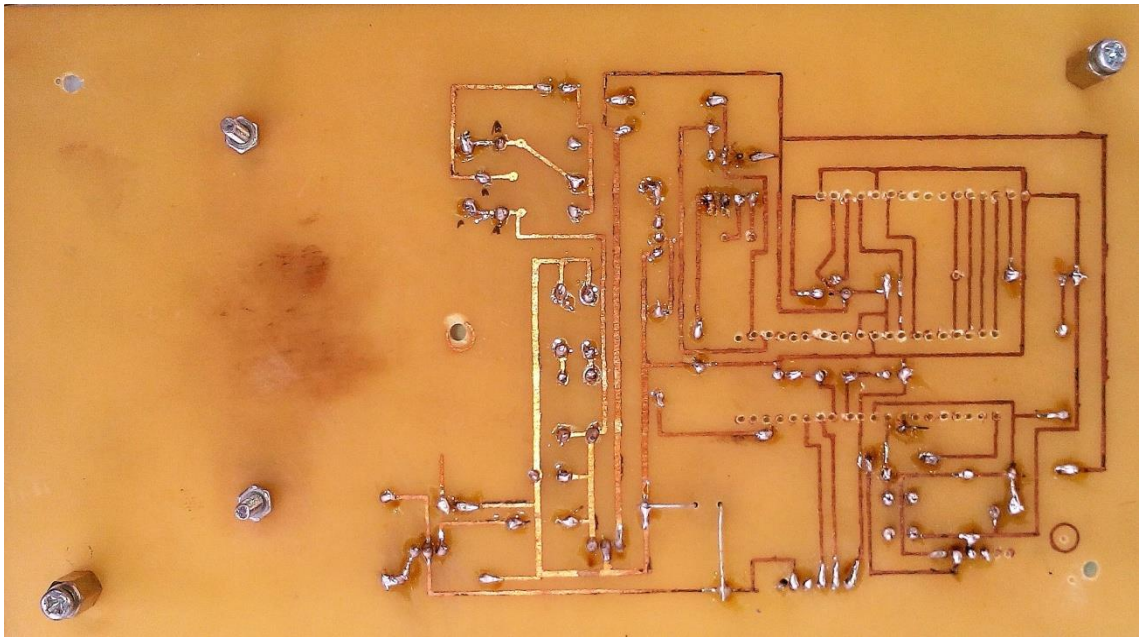

Figure 4. Result of transferring layout to PCB

D. System Implementation

While at this stage the schematic design that has been designed is realized by installing electronic components according to the initial design. After previously going through a dissolution process in ferrite chloride liquid in the formation of circuit paths.

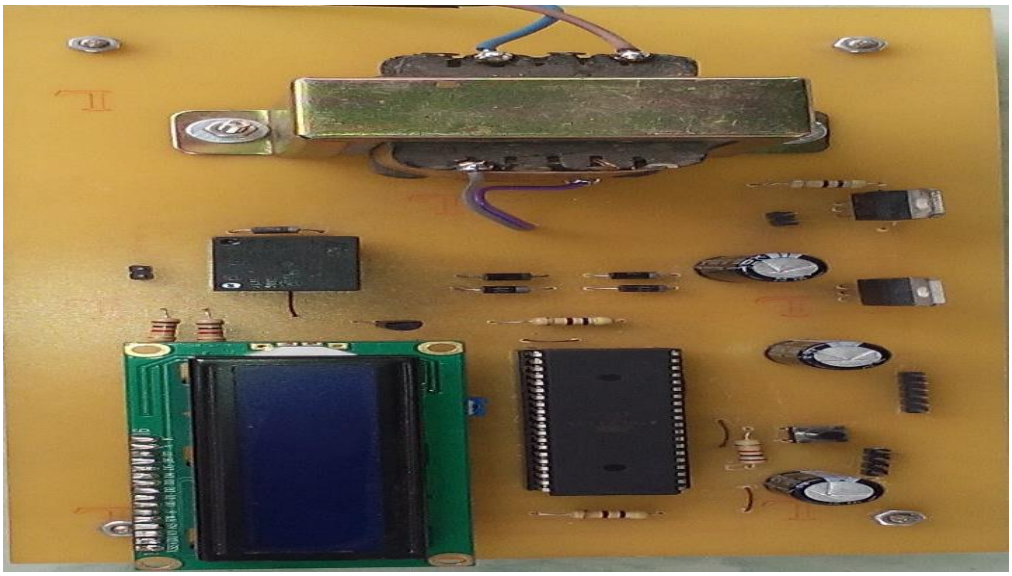

Figure 5. Form of system design implementation

E. System Testing

After the implementation stage is complete, the activity is continued with system testing and there are several tests carried out at this stage, including: power supply, relay, blink application.

F. Conclusion

After all testing is complete, the author can draw a conclusion regarding the completed design, whether it is successful in accordance with the research objectives.

Results

The results obtained from the research are two, namely hardware and software.

A. Hardware

The form of the motorcycle security system architectural design designed in the research is as shown in Figure 6.

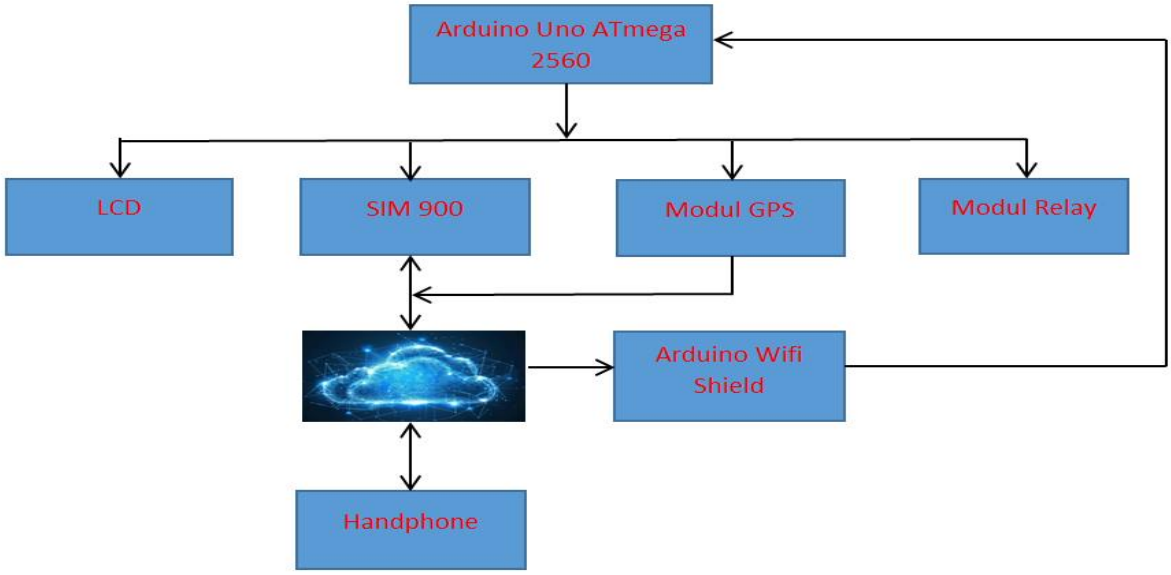

Figure 6. Architecture of motorcycle security system design

The function of each part of the motorcycle security system can be explained as follows:

1) Arduino Uno ATmega 2560

This part functions as a controller for all motorcycle security system activities such as reading input from a cellphone via Arduino wifi shield, SIM 800 to then display characters to the LCD, sending signals to GPS and relay modules.

2) LCD

This part functions like a monitor screen to display characters with 2 rows and 16 columns.

3) SIM 900

This part functions to receive commands from the Arduino Uno ATMEGA 2560 and send SMS containing the motorcycle coordinates to the specified cellphone number.

4) GPS Module

This part functions to determine the coordinates of the motorcycle.

5) Relay Module

This part functions to disconnect and connect the flow of electric current to the engine.

6) Arduino Uno Wifi Shield

This section is used so that the Arduino ATMEGA 2560 can connect to the internet to retrieve data from the blink server database.

7) Mobile Phone

This section is used as a medium that can give commands to turn on and off the flow of electric current to the machine through the blink application.

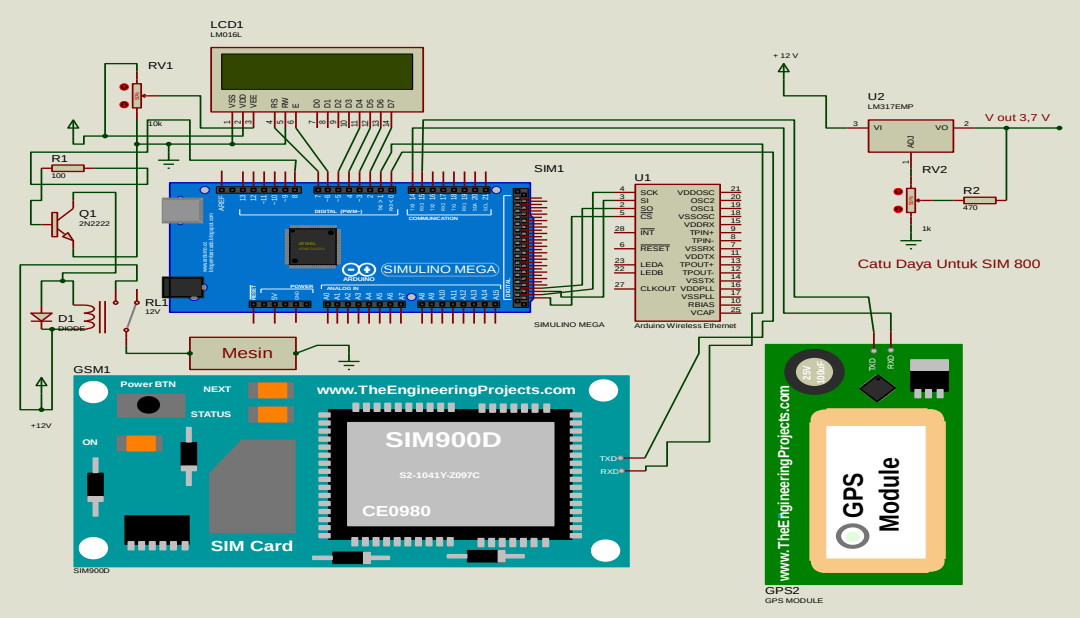

Figure 7. IoT based motorcycle security system series

In Figure 7. The SIM 900 used requires an electrical voltage of 3.7 VDC so that the power supply for the motorcycle security system that was designed was made separately because if it was taken from the existing source from the Arduino ATMEGA of only 3.3, it would not be sufficient.

B. Software

In order for all the hardware that has been assembled into one unit to function properly, the Arduino ATMEGA 2560, which functions as a controller, must be equipped with a program to later be able to control the motorcycle security system.

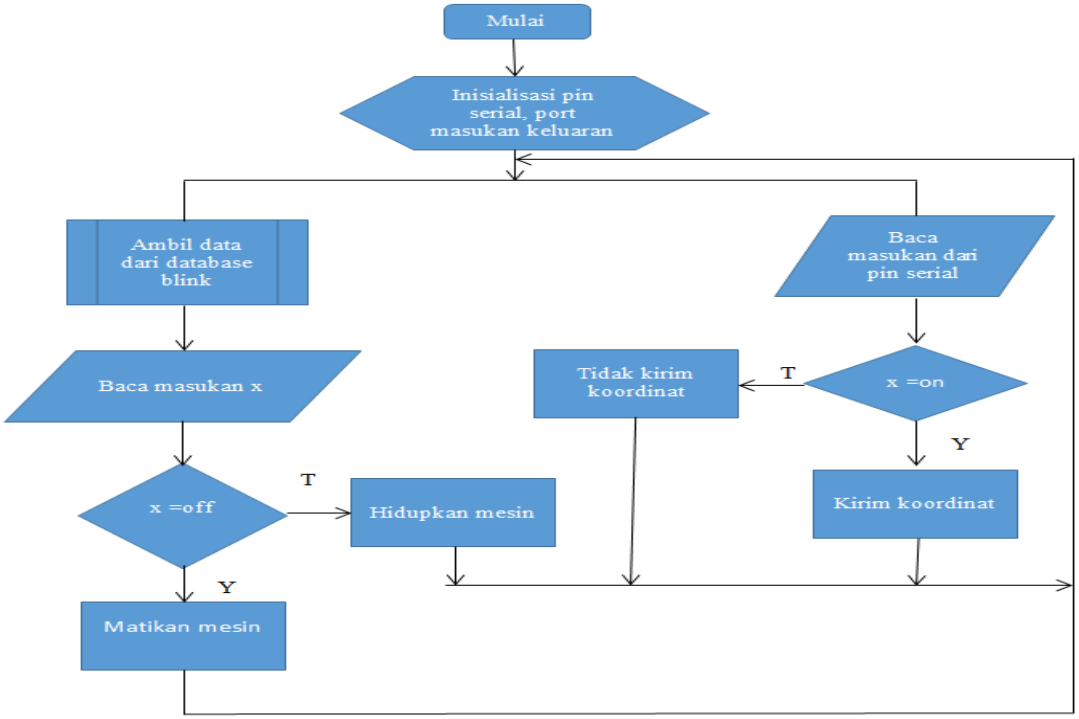

Figure 8. Flowchart of IoT-based motorcycle security system program

When first run then Arduino ATMEGA 2560 is to set the port/pin on Arduino which functions as input, output and serial. Furthermore, the program flow will read the temporary memory that holds data from the SIM 900 serial pin and GPS. If there is a change in data x = on then Arduino ATMEGA 2560 will send a command to GPS to send the coordinates of the motorcycle to the specified cellphone number in this case the owner of the motorcycle. And if not data x ≠ on then Arduino ATMEGA 2560 will not send a signal to GPS to send the coordinates of the motorcycle. At the same time Arduino ATMEGA 2560 also takes data from the blink database then checks whether there is a request to turn on and off the motorcycle engine with data x = off meaning there is a request to turn off the motorcycle and if x = on turns on the motorcycle. Furthermore, this program will repeat reading changes to the input pin, serial and take data from the blink server.

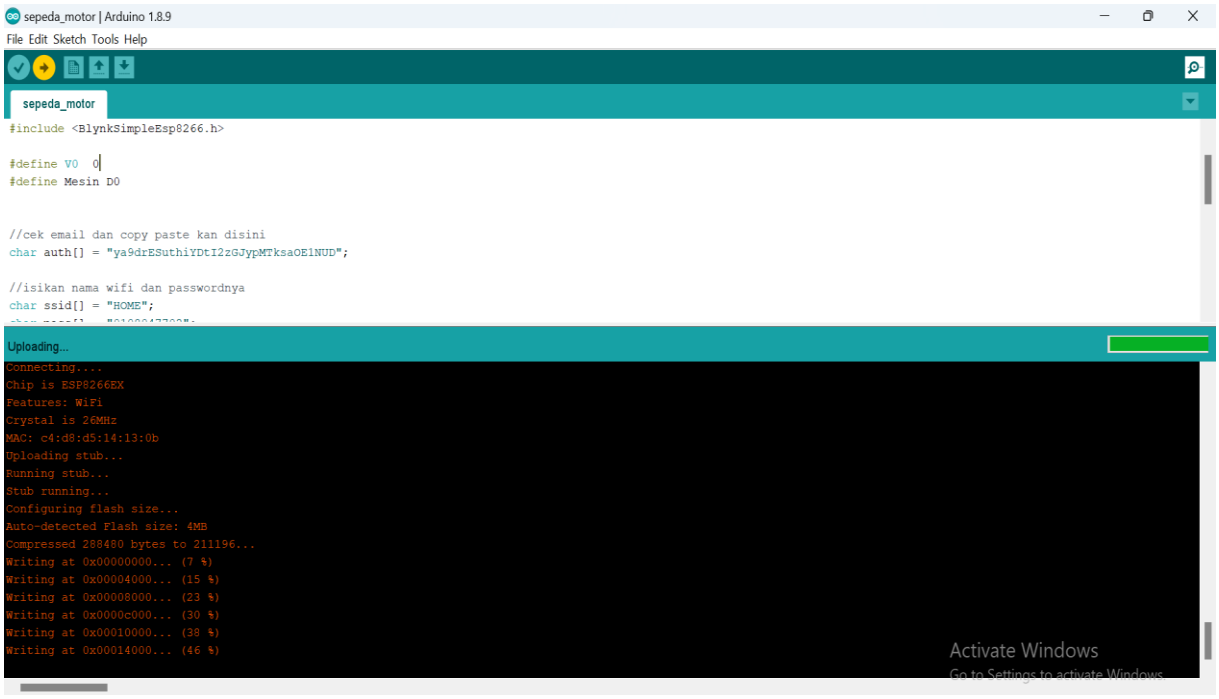

Figure 9. Loading the program into arduino atmega 2560 memory

Figure 9. Shows how the completed program is then compiled and if there are no errors in the program syntax then inserted into the Arduino ATMEGA 2560. The method is to first connect the Arduino ATMEGA 2560 that will be filled with the program to the computer via the USB port. Next, select the tool on the Arduino IDE menu, then the port will appear, then select the port address used. Next, select the board, still on the tool menu and set the type of board used in this study Arduino ATMEGA 2560 as in Figure 10. Then select sketch on the Arduino IDE menu and select upload, then the program will be entered into the Arduino memory as in Figure 9.

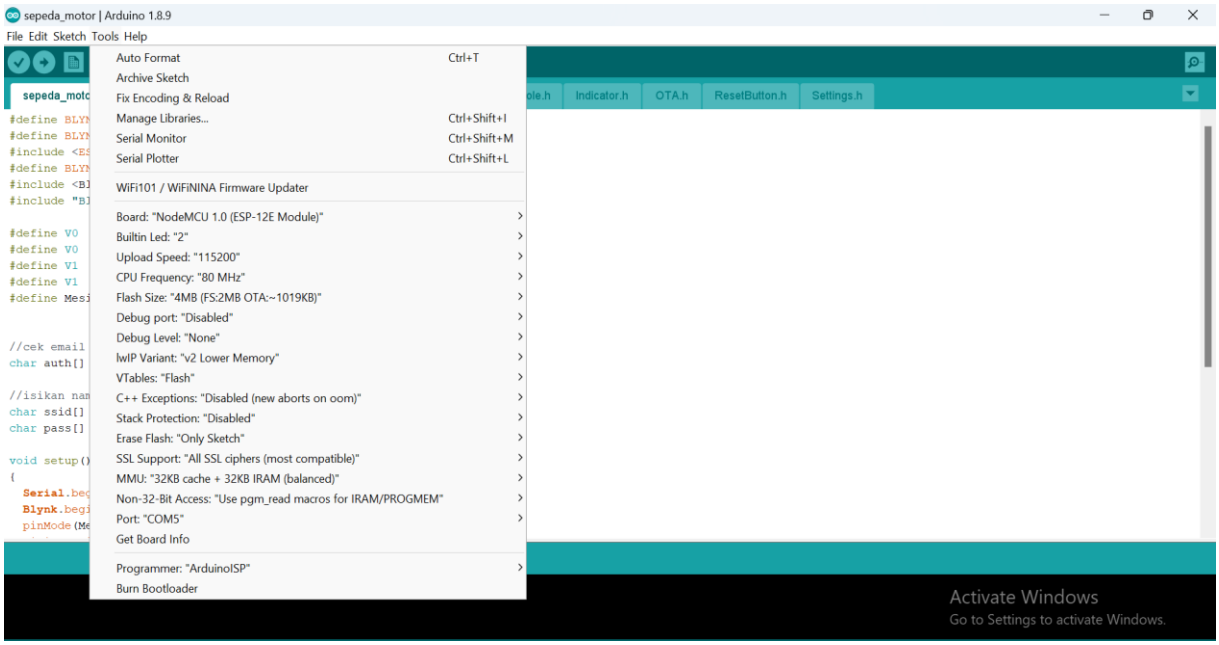

Figure 10. Tool menu on Arduino IDE to select Arduino port and board

C. Testing

There are several tests conducted in this research including power supply, GPS, blink and the overall security system.

Table 3. Power supply output voltage measurement testing

No	Power Supply Output Voltage (Volts)
1	3,75
2	3,81
3	3,82

Table 4. Testing GPS

No	Result
1	Send point coordinates
2	Send point coordinates
3	Send point coordinates

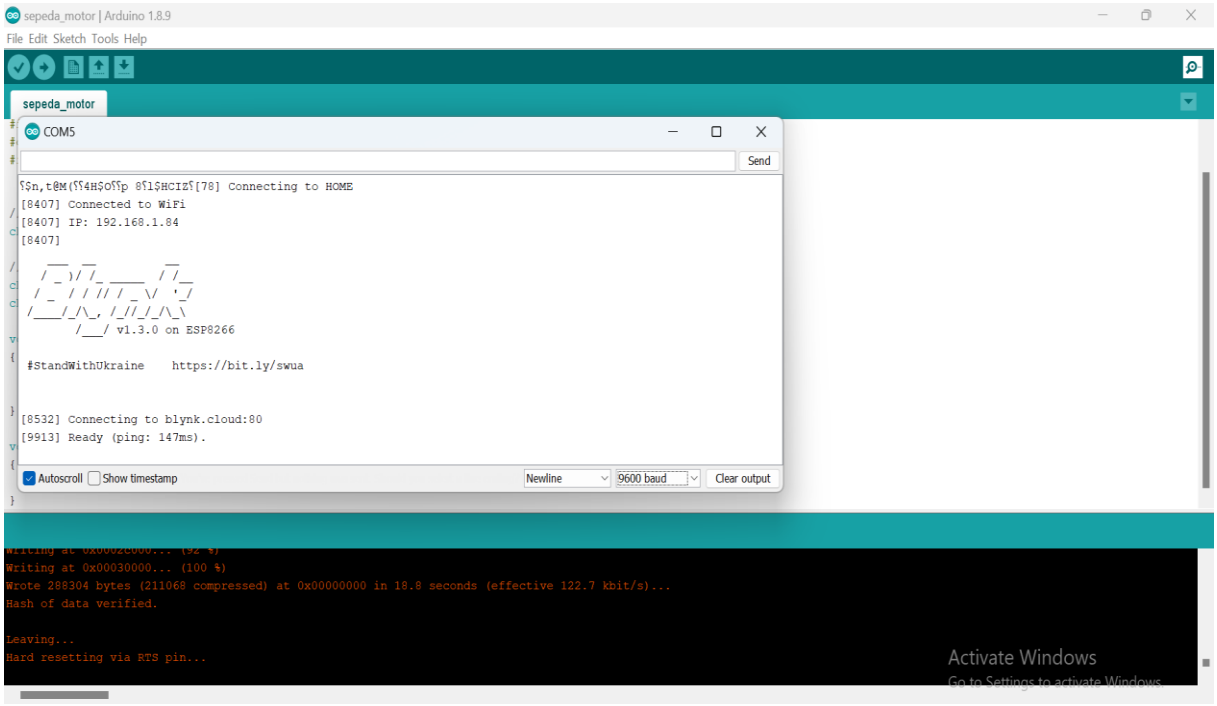

Figure 11. Testing blink

Figure 11 shows that the Arduino ATMEGA 2560 has been connected to the internet network so that it can retrieve data from the Blynk database. This can be seen by the appearance of the word Blynk on the monitor screen.

Table 5. Overall motorcycle security system testing

No	Result
1	Success
2	Success
3	Success

The form of testing the overall system is characterized by the functioning of the system as a whole, namely being able to send the motorcycle's coordinates and the engine can be turned off / on remotely via cellphone.

Conclusion

From the results of the tests that have been carried out, it is known that the security system designed in this study can function well in all parts of the system. In the future, it is recommended that the bicycle security system be equipped with several security combinations including fingerprints, GPS, voice recognition and IoT.

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