Design of Security System Device for Motorized Vehicles through the Telegram Messenger Application and Updating GPS Locations on Smartphones in Real Time with IoT-based Smart Vehicles

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Abstract – *Currently, the number of cases of motorized vehicle theft is increasing. Lack of double security, when left by the owner, is one of the factors that cause vehicles to be easily stolen. Based on these problems, we designed a motorized vehicle security system device that can monitor the condition and update the vehicle location with a smartphone through Global Positioning System (GPS). Furthermore, it can send an active alarm in the form of a buzzer alarm when there is an indication of the danger of vehicle theft. Furthermore, send notifications to the user so that the user immediately locks the vehicle by controlling it remotely in real-time through the Internet of Things (IoT)-based Smart Vehicle Security System using the Telegram Messenger Application and Google Maps (GMaps). The results of testing the response time show that the best performance is very responsive at 2.776 seconds in monitoring and controlling the vehicle. Moreover, the results of testing the vehicle distance position with GMaps and GPS obtained the best performance with a success rate percentage of 97.35% and an error rate percentage of 2.65%. It aims to make vehicle owners feel safe and comfortable and prevent motorized vehicle theft.*

Keywords: Security System, Motorized Vehicles, Telegram Messenger, GPS, Internet of Things

I.   Introduction

Nowadays, the phenomenon of motor vehicle theft is becoming more and more common. This is very disturbing to the community because motorized vehicles are valuable assets. Various ways are done to increase security, such as manually installing double lock padlocks on two-wheeled vehicles. But, this is not all vehicles are equipped with this feature because these features are usually only embedded in-vehicle products that are expensive [1]–[4].

Assistance from residents can also reduce the risk of motor vehicle theft. If residents immediately notice an attempted vehicle theft, they can help prevent it. Therefore, vehicle owners must be able to turn on their vehicle alarms remotely, so that they are monitored for suspicious actions against their vehicles, so that attempted thefts can be prevented as early as possible [1]–[4].

It would be very useful if Global Positioning System (GPS) technology could also be embedded in the vehicle so that wherever the vehicle is located, the owner can still monitor it [2], [3], [5].

Based on the problems above, we designed a smart security system device that can be applied to all types of motorized vehicles, car, and motorbike, where device can create a sense of security because they can always monitor and control the condition of their vehicles in real-time remotely via the Telegram Messenger application with Internet of Things (IoT) technology [6]–[10]. Therefore, making a smartphone as a vehicle key is a pretty good idea, especially today, the security system embedded in the smartphone is also very high, starting from the fingerprint sensor to the face

sensor being used as security to unlock the smartphone. So not everyone can operate a smartphone without permission from the owner [11]–[14]. In addition, utilizing the internet network as a medium of communication between vehicles and their owners can also eliminate distance as an obstacle in monitoring vehicles.

The contribution of this research resulted in a that is capable to monitor in real time the position or update the location of the vehicle with a smartphone through GPS. And capable to control remotely for the function of turning off the vehicle engine through IoT-based Smart Vehicle Security System using the Telegram Messenger Application and Google Maps (GMaps). With this research, hopefully device can be useful to help in preventing the theft of motorized vehicles, so as to create a sense of security for motorized vehicle owners.

II. Literature study

There are two studies related to the research conducted by the authors [3] and [20]. In [3], the researchers discuss the security system for two-wheeled vehicles using GPS. Furthermore, the vehicle can be tracked via a smartphone to provide information on the location of the motorbike. The analysis obtained is in the form of testing the distance difference on the GPS sensor to be able to provide information to users.

In [20], the researchers discuss the design of a car vehicle security system using RFID. Where the design of the car vehicle can be turned on using an RFID card. Furthermore, the results obtained in the form of a security system can work well, and the vehicle will be active if it can read the recognized card.

II.1. Internet of Things

Internet of Things allows users to control and monitor motorized vehicles via the internet. This is to prevent theft by monitoring vehicles with GPS sensors to provide vehicle location information and through a telegram application that is connected to GMaps [6]–[10], [15].

II.2. Telegram Messenger Application

Telegram is a cloud-based multi-platform instant messaging service application that is free. Telegram is available for Android, iOS, Windows Phone, Ubuntu Touch, and computer systems such as

Windows, OS X, and Linux. In this research, the telegram application was used by users in activating and deactivating the function of controlling motorized vehicles, so as to avoid vehicle theft. The system will send location notifications in case of theft through the GMaps application [16], [17].

II.3. Wemos D1 R1

Wemos D1 R1 is one of the board modules that can function with Arduino, especially for projects that carry the IoT concept. Wemos D1 R1 can run stand-alone without the need to be connected to a microcontroller, in contrast to other wifi modules that still require a microcontroller as the controller or the brain of the circuit. In this study, the microcontroller functions as a liaison between the sensor hardware and the internet network so that sensor data can be sent through the application to be able to give orders and information on motorized vehicles [4], [17]–[20].

II.4. Global Positioning System

GPS is a navigation and position monitoring satellite system owned and maintained by the United States. The system is designed to provide three-dimensional position and velocity and information about time, continuously around the world regardless of time and weather, for many people simultaneously. Currently, GPS has been widely used by people around the world in various fields of application that require precise information about position, speed, acceleration, or time. GPS can provide position information with accuracy varying from a few millimeters (zero order) to tens of meters [2], [8]–[10], [21]–[25].

II.5. Google Maps

Google Maps is a web mapping service developed by Google. This service provides satellite imagery, street maps, 360° panoramas, traffic conditions, and route planning for traveling by foot, car, bicycle, or public transport. In this study, the google maps application serves to determine the coordinates of the location if the vehicle is stolen. So that users can browse the location [5], [24].

III. Research Method

This system uses a smartphone as the user interface, the telegram application as a medium for sending and receiving messages, and the Google

Maps application as a medium to display the device's location. This device is connected to the internet network via Mobile Wi-Fi.

When the user sends a message via the telegram application, the message will be sent via the telegram server to Wemos which has been connected to the internet network using Mobile Wi-Fi. The message will be processed by Wemos D1 R1 to be executed according to the message content. If the message contains a command to activate the relay, the relay will be activated to activate or deactivate the alarm. After that Wemos will send a message in the form of a report that the order has been conducted. The message is sent back via the internet network to the telegram server and displayed via a smartphone on the telegram application.
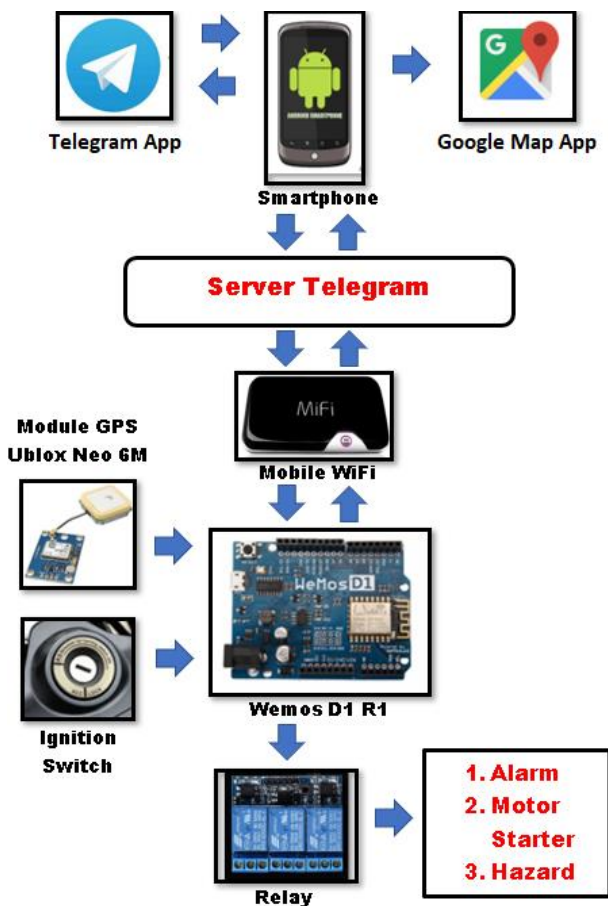

Fig. 1. Block diagram of security system device

If the message is a request for location coordinates, then Wemos will retrieve the coordinate data obtained from the GPS Module and send the coordinate data as a message via the internet to the telegram server and displayed via a

smartphone on the telegram application, after which the user can open the coordinates displayed on the telegram application, through the Google Map application by opening the coordinate link displayed in the Telegram message. If someone tries to start the vehicle without permission, by turning the ignition on the vehicle, then Wemos will send a danger warning to the user via the telegram application, and Wemos will also turn on the alarm. The following block diagram of the security system device can be shown in Figure 1.

When the security system was designed using Wemos D1 R1 where the microcontroller is to monitor internet of things-based vehicles. Where the device can be connected to the internet network connection. When the microcontroller is connected to the internet, the motor vehicle security system will be active. The system is designed using the telegram application to be able to monitor vehicles in real-time and can find out the condition of the user's vehicle location remotely. to activate a motor vehicle by sending a message in the form of a keyword that has been set in the programming so that the owner of the motor can know. Where the message for "Unlock" is to activate the motor engine, then the message "Status" is to find out whether the motor is active or not. If the vehicle is started without permission, it activates a buzzer and gives a message that the vehicle has been stolen. When theft is committed, the user sends a message to the system to be able to control so that the vehicle is locked so that the motorbike cannot be turned on, then the user can send a message to the system to be able to know the coordinates of the location of the motorbike using google maps. So that the expected results of the motor vehicle can be found with the location of the vehicle owner. The following flowchart of the security system device can be shown in Figure 2.

IV. Results and Discussion

The results and discussion in this study are to test the overall function of the device, both hardware testing (assembled devices) and software (uploaded with the program), in which the device is already installed on a Yamaha Vixion motorcycle. We conduct 4 (four) form of testing performances, i.e. testing of DC converter, testing of telegram application, testing of response time for motorized vehicle security systems, testing of GPS distance position and testing device power consumption.
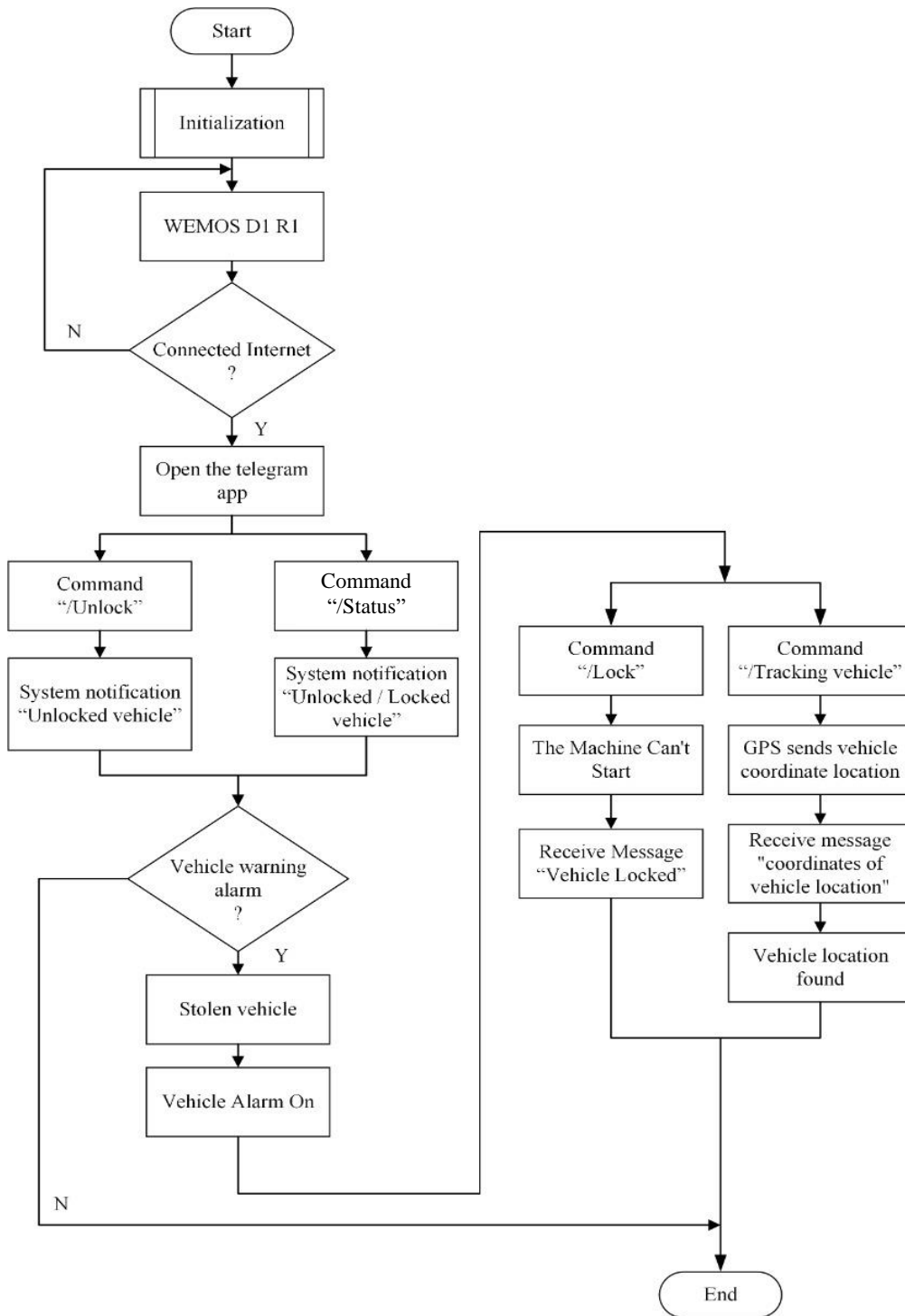
Fig. 2. Flowchart of security system device

IV.1 Testing of DC Converter

The first performance testing was conducted on the testing of DC converter on IC LM2596, to measure the output voltage value. The power supply of this device comes from a vehicle battery where the voltage is around 12 volts. While this device works requires a voltage of about 5 volts, so a DC converter is needed. The performance of the DC converter is expected to produce a voltage of 5 volts. For this reason, it is necessary to test the output voltage, so that a voltage of 5 volts can be obtained. The DC Converter test can be shown in Table I.

Table I shows the performance of the DC converter where a stable output voltage of 5 Volts is obtained.

TABLE I
TESTING OF DC CONVERTER

Testing	Measurement conditions	V_{in} (V)	V_{out} (V)
1	Engine Cranking	11.51	5
2	Stand by	12.38	5
3	Charging	14.01	5

IV.2 Testing of Telegram Messenger Application

This test aims to give orders to the sensor hardware to activate or deactivate motorized vehicles through the telegram application. This test is conducted using a smartphone by sending several commands via the telegram messenger application. The commands contained in the telegram messenger application include locking the vehicle, unlocking the vehicle, vehicle status, danger warning alarm, and vehicle position. From the results of this test, it is hoped that it will be useful for vehicle owners to find out information on the status and condition of the vehicle, so that this can prevent theft and improve the security system on motorized vehicles. The following is the implementation of a motorized security system with a telegram messenger application, which can be shown in Figure 3-9.

Fig. 3. Menu of system command

Figure 3 show a menu of system command on the telegram application that functions to lock the user's vehicle, unlock, vehicle status, activate an alarm in the event of theft, and provide position information to find out the location of the user's motor vehicle. In this application, the user only needs to enter the command. Where motor vehicles do not require manual keys such as locking the motor or opening the motor. Furthermore, if the user selects a key command, the vehicle will lock automatically following the results of the vehicle lock command
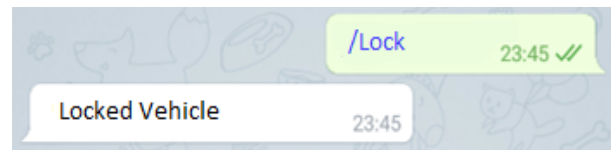
as shown in Figure 4.

Fig. 4. Command of vehicle lock

Figure 4 show vehicle information in a locked state. Where to lock the vehicle, the user can access via the telegram application. When the vehicle is locked, the hazard light will flash once, and activate the horn once. Furthermore, if the user unlocks the vehicle, the vehicle is unlocked. The following results of the vehicle unlock command can be shown in Figure 5.
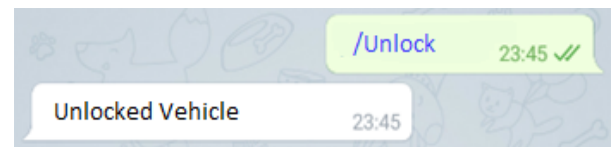

Fig. 5. Command of vehicle unlock

Figure 5 show vehicle information in an unlocked state. When the command is entered to open the lock, it is marked by activating the horn 2 times, and the hazard light 2 times. then testing the status of the motor vehicle where the user gets the information. Next, the results of the vehicle status command can be shown in Figure 6.
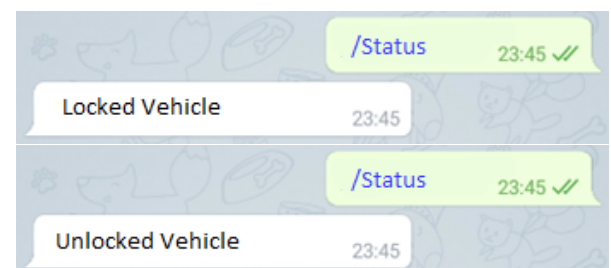

Fig. 6. Command of vehicle status

Figure 6 show vehicle status information. The information provided is in the form of the user's last usage. So, the system will provide information in the form of an open vehicle key or a locked vehicle. In this case, it can anticipate if the user forgets to lock the vehicle. Furthermore, testing the alarm for the motorcycle security system. The following vehicle warning alarm results can be shown in Figure 7.
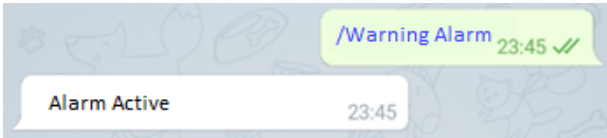
Fig. 7. Command of vehicle warning alarm

Figure 7 shows a vehicle warning alarm notification. The alarm will activate if there is an indication that the vehicle will be stolen. When the alarm is active, the vehicle will sound an alarm buzzer and the system will notify the user through the telegram application. So that the user can immediately lock the vehicle through remote control in real time, when the vehicle will be turned on without permission. So that the thief cannot start the motor vehicle. Furthermore, when the alarm is active, the system will provide information on the location of the motor vehicle to be traced via google maps. The results of the vehicle position command can be shown in Figure 8.
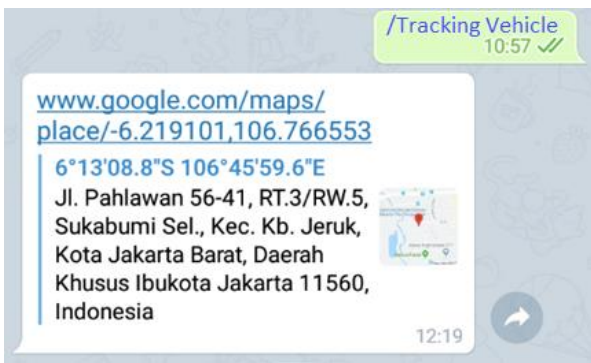

Fig. 8. Command of vehicle position tracking

Figure 8 show information on the position tracking of the motor vehicle. Where users can get information by entering position commands. The position can be sent automatically if the vehicle is theft by providing status information which simultaneously activates the alarm. When the position has been obtained the user can browse through the google maps application. The following vehicle position command results sent by the system can be shown in Figure 9.

IV.3 Testing of Response Time for motorized vehicle security systems

The test is conducted by calculating the response time, where the device is activated through commands made on the telegram application, whether the command is to activate or deactivate the device. The response time data is taken from commands carried out, including lock, unlock, status, warning alarm, and vehicle position tracking commands executed on motor vehicle security system devices. The following data response time for motorized vehicle security systems can be shown in Table II.

Fig. 9. Tracking of vehicle position
(*Source: Google Maps*)

TABLE II
TESTING OF RESPONSE TIME FOR MOTORIZED VEHICLE SECURITY SYSTEMS

Testing	Response Time (s)				
	Locked	Unlock	Status	Alarm	Tracking
1	2.85	2.84	2.81	2.87	2.81
2	2.76	2.80	2.80	2.81	2.75
3	2.81	2.80	2.80	2.79	2.75
4	2.82	2.78	2.77	2.80	2.76
5	2.79	2.76	2.77	2.79	2.76
6	2.79	2.69	2.76	2.78	2.76
7	2.74	2.71	2.75	2.78	2.78
8	2.77	2.72	2.75	2.78	2.77
9	2.77	2.72	2.76	2.79	2.77
10	2.71	2.75	2.76	2.79	2.76
Average	2.78	2.76	2.77	2.80	2.77
Overall Test Average :	2.776 s				

Table II shows the response time test of the motor vehicle security system, obtained by the test results, i.e., the average response times are 2.78 seconds for the vehicle lock command, 2.76 seconds for the vehicle unlock command, 2.77 seconds for the vehicle status command, 2.80 seconds for the activate vehicle warning alarms command, and 2.77 seconds for vehicle position tracking command. So, the overall test average was 2.776 seconds. From these tests, the results obtained are performance results with a very responsive response time of 2.776 seconds to activate or deactivate the device in controlling and monitoring the motorized vehicle security system. The results obtained by the response time of the motor vehicle security system can be shown in Figure 10.
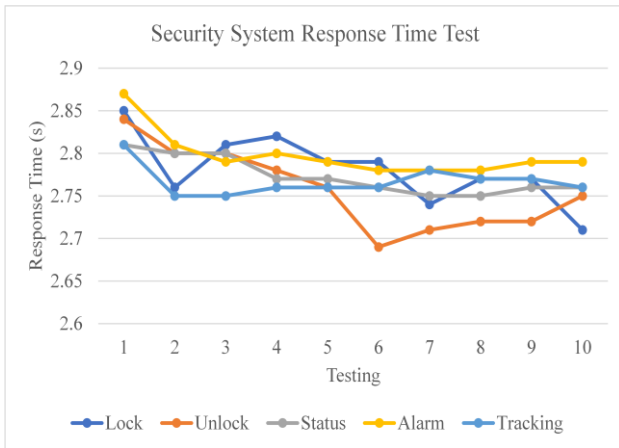

Fig. 10. Testing of response time for motorized vehicle security systems

IV.4 Testing of Vehicle Position Distance

This test is to measure the position distance of the motorized vehicle, where the vehicle is placed in a different location so that the system can provide updated information on the location of the vehicle. After getting the vehicle location information, the distance data of the vehicle position is taken from the starting point of the user's location. The starting point for the user's location starts from the FT UMJ campus by measuring the distance to the location of the vehicle that has been placed. So that it can be calculated the difference in location distance between using GPS sensors and GMaps. Table III shows the data on the results of testing the vehicle distance position by measuring the distance between GMaps and the distance of the GPS sensor.

TABLE III
TESTING OF VEHICLE POSITON DISTANCE

Location	Position Distance (m)				
	GMaps (m)	GPS Sensor (m)	Difference (m)	Error (%)	Success (%)
ITC Cempaka Mas	620	600	20	3.23	96.77
SMAN 21 Pulomas	3300	3200	100	3.03	96.97
Mall Artha Gading	5900	5800	100	1.69	98.31
Overall Average :				2.65	97.35

The results of testing the location distance data obtained can be used to calculate the percentage of error rates and the success rate of measuring distance data obtained between the distance of Google Maps and the distance of the GPS sensor sent via the telegram application. The following is a formula to calculate the percentage of errors and successes between the Google Maps distance and the GPS sensor distance, which can be shown in Equations (1) and (2).

$$Error\ (\%) = \frac{Distance\ Gmaps - Distance\ Sensor\ GPS}{Distance\ Gmaps} x100 \quad (1)$$

$$Success\ Rate\ (\%) = 100 - Error\ Rate \quad (2)$$

From the results of measuring the distance to locations at ITC mas, the percentage error rate is 3.23%, and the success rate is 96.77%. %, and the results of measuring the distance to the location at Mall Artha Gading obtained a percentage error rate of 1.69% and a success rate of 98.32%. then the overall average for the percentage error rate is 2.65%, and the percentage success rate is 97.35%. From the calculation results obtained, the percentage of the error rate is still within normal limits below 5%.

IV.5 Testing Device Power Consumption

This test is conducted to calculate the required power consumption of the device, so that the system can work continuously. Furthermore, the device that has been made can estimate the amount of battery energy needed to turn on the device so that the battery condition is always full, so as to prevent the battery from running low or empty. The following is the current measurement when the device is installed, it can be shown in Figure 11.

Fig. 11. Current measurement when the device installed

Figure 11 shows the results of measuring the amount of current needed by the tool is 0.12 Ampere, while the capacity of the battery installed in the vehicle is 6 Ah, then the power of the tool can be calculated by the following equation,

$$P = V \times I = 12\ V \times 0{,}12\ A = 1.44\ Watt$$

With a fully charged 6 AH battery capacity and a battery efficiency of 20%, the battery can survive with the following calculations:

$$\text{Usage time} = \left(\frac{\text{battery capacity}}{\text{Measuring Current}}\right) - \text{battery difference}$$
$$\text{Usage time} = \left(\frac{6\ AH}{0.12\ A}\right) - 20\%$$
$$\text{Usage time} = 50\ H - 10\ H$$
$$\text{Usage} = 40\ H$$

So, based on the calculation above, it shows that the battery lifetime can survive 40 hours, which the vehicle must be warmed up every day to keep the battery in maximum condition.

Conclusion

Based on the testing of DC converter, the results of the performance of a stable output voltage of 5 Volts are obtained. This is useful in preventing fluctuating output voltages. From testing the telegram messenger application, it was obtained that performance results have been successful in sending pop-up notifications appeared and command in monitoring and controlling motorized vehicle security system using smartphones through the telegram messenger application, i.e. locking the vehicle, unlocking the vehicle, vehicle status, hazard warning alarms, and vehicle position.

By testing the response time of the motor vehicle security system, the results obtained the best performance are very responsive 2.776 seconds to activate or deactivate the device in controlling and monitoring the motorized vehicle security system. From testing the vehicle distance position, the result obtained an overall average for the percentage of error rate is 2.65%, and the percentage of success rate is 97.35%. From the results of these calculations, the percentage of the error rate is still within normal limits below 5%.

Based on testing the power consumption needs of the device, the performance results show that the battery lifetime for power consumption on the device can last for 40 hours. This shows that the resulting time is long enough to be used in monitoring and controlling the motorized vehicle security system.

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