Buletin Ilmiah Sarjana Teknik Elektro
Vol. 3, No. 1, January 2021, pp. xx-xx
ISSN: 2685-9572, DOI: 10.12928/biste.v3i1.xxx

Motorized Vehicle Security System Using SMS with GPS Tracking Method Based on Arduino UNO

Andhika Dwi Prasetio [1], Wahyu Sapto Aji [2]
[1] Department of Electrical Engineering, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

ARTICLE INFORMATION

Article History:

Dikirimkan 01 Jun 2019
Direvisi 01 Juli 2019
Diterima 01 Agustus 2019

Keywords:

GPS Tracking;
Arduino UNO;
SMS;
Sepeda Motor;

Corresponding Author:

Name,
Institusi/Afiliasi,
Alamat, Negara.
Surel/*Email*:

ABSTRACT

Cases of motorcycle loss are increasingly common in the community. This situation is caused by the lack of security systems installed on motorcycles, which are generally limited to the vehicle's ignition key. In fact, only a few medium-sized motorcycles are equipped with alarms as an additional form of security. A solution is needed to reduce theft or robbery on motorized vehicles, which is realized through a study entitled "Motorized vehicle security system using SMS with GPS Tracking method based on Arduino UNO A system that uses GPS and SMS that can be found on smartphones. This system is able to control the connection and disconnection of electric current in motorized vehicles using SMS, then it will be forwarded to the relay. The motorized vehicle security system using SMS with the Arduino UNO-based GPS Tracking method that has been made can function properly and can detect the position of the motorcycle accurately according to the motorcycle coordinate point. Tests to detect the position of the vehicle were carried out as many as 20 locations and the results were in accordance with the coordinate points of the vehicle. In testing to turn off the motorcycle engine, the results show that the motorcycle can be turned off remotely with an average delay of 6.97 seconds. In testing to turn on and turn off the alarm, the results show that the motorcycle alarm can be turned off remotely with an average delay of 7 seconds. this shows that the motorized vehicle security system using SMS with the Arduino UNO-based GPS Tracking method that has been made can function properly and as it should.

Citation Document:

Author 1 and Author 2, “Title,” *Buletin Ilmiah Sarjana Teknik Elektro*, vol. 3, no. 1, pp. xx-xx, 2021. DOI: 10.12928/biste.v3i1.xxx

1. INTRODUCTION

Nowadays, cases of motorcycle loss are increasingly common in the community. This situation is caused by the lack of security systems installed on motorcycles, which are generally limited to the vehicle's ignition key. In fact, only a few medium-sized motorcycles are equipped with alarms as an additional form of security [1]-[4].

In line with the changing times, the demand for personal vehicles is increasing from time to time, especially in the context of motorcycles which have high consumptive potential due to their affordable price and ease of use. This is due to Indonesians' need for motorized vehicles to fulfill their daily routines [5]-[7].

In Indonesia, the unemployment rate grows significantly every year, causing economic instability that impacts people's welfare. For this reason, this condition has a significant impact on the increase in motorcycle theft or violent taking (begal) which is increasingly rampant. Not only that, in the incidents that occur, the perpetrators of theft can violently involve acts of violence. [8]

Referring to the previous explanation, a solution is needed to reduce theft or robbery on motorized vehicles, which is realized through a research entitled. "Motor vehicle security system using SMS with GPS Tracking method based on Arduino UNO A system that uses GPS and SMS that can be found on smartphones. This system is able to control the connection and disconnection of electric current in motorized vehicles using SMS, then it will be forwarded to the Relay. [9]

In addition, this system is able to detect the location point that can be identified directly through a smartphone device when the vehicle is stolen or lost. After obtaining information about the location of the motor, the vehicle owner can request assistance from the authorities to retrieve the vehicle that has been stolen or robbed. [10]

In the implementation of this observation, the focus of this research is to design a motor vehicle security device that utilizes SMS, Ublox Neo-6M GPS for motor position tracking, and GSM / GPRS SIM800L V2 in the role of sending short messages containing links to web pages that can be displayed directly on Google Maps on smartphones. with GPS Tracking method. The way this tool works is to set the location of the area if the motor passes through the location of the area that has been set and automatically the motor will be off Relay by disconnecting. The engine CDI and alarm will be active by sending a notification to the smartphone of the vehicle owner who has been given the tool [11]-[15].

Thus, SMS plays a key role in strengthening the security system of motorized vehicles with Arduino-based GPS tracking method. Through the use of SMS, vehicle owners can remotely monitor and control their vehicles, provide additional protection against theft and unauthorized use, and provide peace of mind. In addition, SMS can also be used to give commands or instructions to the security system. For example, a vehicle owner can send a special text message to remotely turn off the vehicle's engine if the vehicle is stolen or used unauthorized. The system will then receive the message and take appropriate action, such as disconnecting the vehicle's electrical system using a relay connected to an Arduino [16].

2. METHODS

2.1. Motorcycle

A motor vehicle is a means of transportation that is powered by an engine. These vehicles include various types, such as cars, motorcycles, trucks, and the like. Motor vehicles typically use fuel to generate the power necessary to move. The definition and scope of a motor vehicle may vary by jurisdiction and traffic rules within the land transportation system. In general, motor vehicles may use various types of engines, including internal combustion engines, electric engines, or other engine technologies. These motor vehicles are equipped with wheels and are generally designed to operate on a road surface [17].

2.2 GPS

Global Positioning System (GPS) is a navigation system that utilizes signals from satellites to determine the position of an object on the Earth's surface. and is designed to provide instant information regarding position, speed, and time in all regions of planet Earth, without being affected by atmospheric conditions.

GPS receives signals from satellites that are commonly known as GPS Tracking. By utilizing this device, the user has the ability to track the position of the vehicle in real time. The most crucial component within the framework of the GPS navigation system consists of a number of satellites orbiting around the Earth, often referred to as space. The total number of GPS satellites is currently 24 units that have the capability to send signals to the Earth's surface which can later be received by the signal receiving device or GPS Tracker. In addition to the presence of satellites, there are two additional systems that are interrelated, forming three important components in the GPS system. The three parts include: GPS Control Segment, GPS Space Segment, and GPS User Segment [18].

2.3 SMS

SMS Gateway is a system or platform that facilitates sending and receiving short messages (SMS) through mobile devices, such as cell phones and smartphones, using certain keywords or methods. This platform enables two-way interaction in communication through text messages. SMS Gateway is a further development of the basic functionality of SMS, which provides the ability to automate the process of sending messages and receiving responses in various usage scenarios, including mass delivery, notification, and integration with other systems [19].

2.4 Arduino UNO

On the Arduino UNO R3 microcontroller board, there are 14 digital input/output pins also known as I/O pins. Of these, 6 pins can function as PWM output pins, while the other 6 pins act as analog outputs. This microcontroller uses a crystal with a frequency of 16 MHz to run its operations. In addition, there is a USB connection, power jack, ICSP header, and restart button around the USB connector [20].

2.5 Arduino IDE

The development software known as Arduino IDE plays a significant role in programming Arduino microcontrollers. In the Arduino IDE environment, users are given the ability to create programs using a programming language that has been equipped with C/C++ libraries. The existence of these libraries is very useful because it can simplify input/output operations on microcontroller devices. The Arduino IDE offers a very useful tool for electronics developers and hobbyists. By using a programming language equipped with C/C++ libraries, users can design and implement programs to control various input and output functions on Arduino microcontrollers. Thus, the Arduino IDE provides an efficient and effective platform for developing electronics projects. The main advantage of the Arduino IDE is its ability to simplify the Arduino microcontroller programming process. The facilities provided by the Arduino IDE, such as the integrated C/C++ library, allow users to easily create and manage programs that involve input/output operations on the microcontroller. Thus, the Arduino IDE is a very useful tool in developing various electronic applications.

2.6 GPS Ublox Neo-6M

The Ublox Neo-6M GPS is designed to provide accurate position data to Arduino devices. The information provided includes time, latitude, longitude, altitude, and speed. With this data, this module can be used as a tracking device. The module's ability to have small dimensions of about 16x12.2x2.4 mm allows it to be applied in various electronic projects. To use the Ublox NEO-6M GPS module, connecting with microcontrollers such as Arduino and Raspberry Pi is required.

2.7 SIM800L V2

SIM800L v2 is a GSM/GPRS module used in mobile communication applications. This SIM800L V2 can communicate over the GSM network to transmit data and messages. It allows for data connection and SMS sending. It supports connection across four GSM frequency bands (850/900/1800/1900 MHz). This makes it compatible with most cellular networks around the world. Despite having a very wide coverage, the SIM 800l V2 is designed with a fairly low power consumption. The SIM800L V2 module is commonly used in various IoT applications, tracking systems, remote surveillance systems, or communication systems that require cellular connectivity. Due to its diverse capabilities, this module can be adapted for many purposes, including Arduino-based motor vehicle security systems with GPS integration and SMS communication.

2.8 Kalkulator Haversine Distance

Haversine calculator is used to calculate the distance between two points on the earth's surface with a high degree of precision, especially when the points have different latitudes and longitudes. By considering the curvature of the earth's surface, the Haversine method provides more accurate results compared to distance calculation methods that use flat assumptions. This calculator can be applied with various units of measurement, such as kilometers, miles, or even angular degrees, depending on the user's preference or needs. The speed in providing calculation results makes the Haversine calculator suitable for applications that require direct distance calculations, such as in GPS navigation systems or online travel applications.

2.9 System Design

In designing this software using its own software provided on the official arduino website. The language used in this software is the C / C ++ language with additional other libraries for additional motorized vehicle security systems using arduino-based GPS Tracking method sms such as the newping library.

To explain the system design carried out in realizing the research of a motorized vehicle security system using SMS with the Arduino-based GPS Tracking method. First in general described by the block diagram of

the working system shown power suplay as a power source of all components of the tool. Arduino UNO R3 as input/output that will process data. Then from GPRS Shield and GPS Shield to send and receive data then the data is processed by Arduino UNO R3 so that the data is forwarded to the smartphone. The relay function in this block diagram can disconnect and connect the current from the socket on the motor vehicle. Wiring diagram shown in Figure 1.

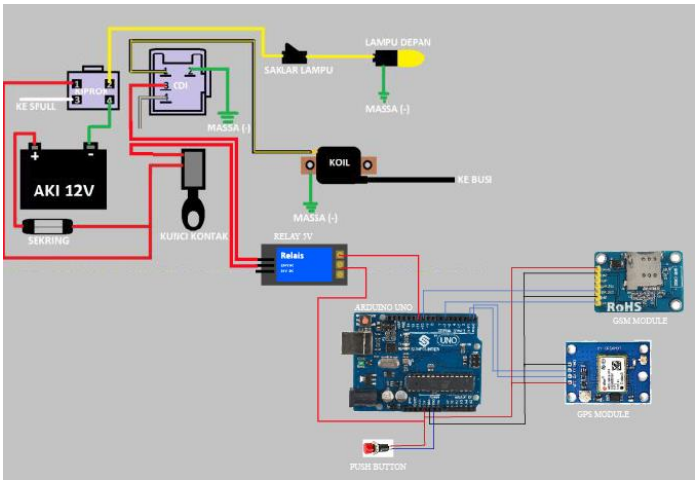

Figure 1. Wiring diagram

Block Diagram of Motorized Vehicle Security System Using SMS with Arduino-based GPS Tracking Method consists of several inputs and outputs. The main power source used is a power supply / adapter. The microcontroller used is Arduino UNO R3. This Arduino UNO R3 will process input data and provide output. The GPRS shield as input and output is processed by Arduino Mega which can send information and receive if the motor vehicle user requests data via a smartphone and GPS shield as input to find out the location where the motor vehicle is in real-time. The relay function in this system is to disconnect and connect the current to the motor vehicle.

The block diagram design of a motorized vehicle security system using SMS with Arduino-based GPS Tracking method. When the system is first turned on, it first performs the initialization process of the parts in the vehicle security system such as, the microcontroller as the control center to connect several parts of the tool to function properly. The microcontroller recognizes several devices, namely the GPRS shield and GPS shield, when the microcontroller is connected to the two components, the GPRS shield will first look for a signal, after the GPRS shield gets a signal. The system flow chart can be seen in Figure 2.

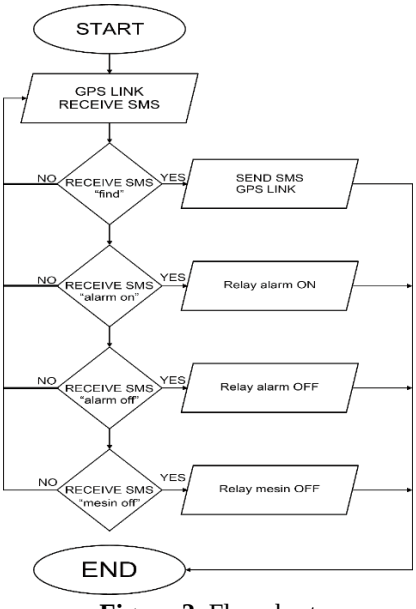

Figure 2. Flowchart

3. RESULT AND DISCUSSION

To get the location of the vehicle, the vehicle user must send an SMS to the device installed on the motor vehicle. And when the device gets an SMS according to the vehicle user's request (location), the device will automatically send an SMS back to the vehicle user to find out the location information or coordinates and time received. The google maps address and some numbers sent from the device to the motorcycle user are the coordinates of the vehicle position that we can see from google maps. Flowchart shown in Figure 3.

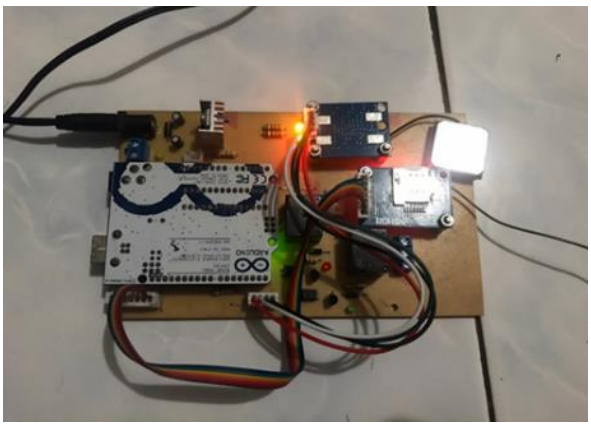

Figure 3. Flowchart

3.1 Location Point Retrieval Testing

Vehicle location point retrieval testing is a test that serves to get the actual location of the vehicle. Location data obtained in the form of a GPS link that can be accessed through the google maps application.

Testing is done by placing the vehicle in certain locations, then the smartphone is entered the find command. The number of locations for taking vehicle location points is 20 locations. The first test was carried out by placing the vehicle in a boarding house located on Jalan Pakel Baru. Then the find command is entered on the smartphone so that the vehicle location point is obtained in the form of a GPS link which can be seen in Figure 4.

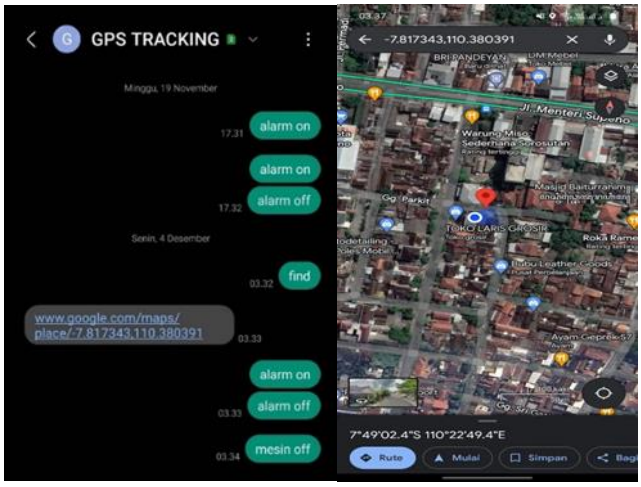

Figure 4. Google maps

The first vehicle location point retrieval test produces a location point that is quite accurate according to the location of the vehicle. However, the location point obtained through GPS is slightly different from the location where the vehicle is placed. The difference in distance obtained as far as 2m with GPS-generated coordinates is -7.817343,110.380391. While the actual vehicle coordinate point is -7.817350,110.380369. The GPS-generated coordinate point and the actual vehicle point can be seen in Figure 5.

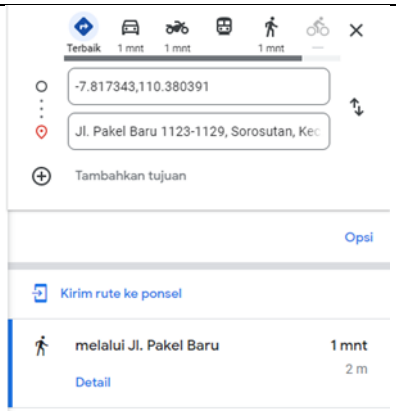

Figure 5. GPS Tracking

3.2 Alarm and Engine Testing

Alarm and engine testing is a test carried out on research tools that have been made with the aim of observing the tool's response to commands entered on SMS. This test is carried out by entering the alarm on command to turn on the alarm in the form of a horn and entering the alarm off to turn off the alarm. In addition, the command entered is engine off which functions to turn off the engine. This test is carried out remotely at 20 location points. Alarm and engine test results can be seen in Table 1.

Table 1. Alarm and engine test results

No	Vehicle Location	Smarphone Location	Alarm	Delay Alarm On (Second)	Alarm	Delay Alarm Off (Second)	Machine Off	Delay Mesin Off (Second)
1	Kost Tinus jalan pakel baru	Jl. Menteri Supeno No.65	On	7	Off	6	Off	7
2	bank BRI Jl. Menteri Supeno No.65	Jl. Pakel Baru Utara No.14-2	On	7	Off	8	Off	7
3	lapangan sidokabul Jl. Pakel Baru Selatan 41	Kost Tinus jalan pakel baru	On	6	Off	6	Off	7
4	Rumah makan masakan padang Jl. Sidokabul	Kost Tinus jalan pakel baru	On	8	Off	7	Off	7
5	Rumah makan BongObong Jl. Sorosutan 2	Jl. Menteri Supeno No.65	On	8	Off	7	Off	8
6	ATM BRI XT Square Jl. Veteran, Pandeyan.	Jl. Veteran No.184	On	8	Off	7	Off	7
7	Tini laundry Jl. Ki Ageng Pemanahan No.14	Jl. Ki Ageng Pemanahan, Kragilan,	On	7	Off	8	Off	6
8	Indomaret Jl. Ki Ageng Pemanahan 1-122.	Indomaret Jl. Ki Ageng Pemanahan 1-122.	On	5	Off	7	Off	6
9	RS Hidayatullah Jl. Veteran No.184	Gg. Teratai 565-567, Pandeyan	On	6	Off	6	Off	7
10	lapangan karang Jl. Raden Ronggo I.	Jl. Raden Ronggo II	On	8	Off	6	Off	6
11	Jl. Raden Ronggo II. Prenggan	Jl. Raden Ronggo KG II	On	7	Off	6	Off	7

No	Vehicle Location	Smarphone Location	Alarm	Delay Alarm On (Second)	Alarm	Delay Alarm Off (Second)	Machine Off	Delay Mesin Off (Second)
12	Alun Alun kidul Jl. Alun Alun kidul, Patehan	Jl. Alun Alun Kidul	On	7	Off	6	Off	7
13	Jl. Ngadisuryan KT 1 No.168.	Gg. Abdul Hadi, Patehan.	On	8	Off	8	Off	6
14	Bengkel Mobil Listrik UAD 4 Jl. Nasional III, Tamanan	Jl. Nasional III, Tamanan.	On	6	Off	7	Off	7
15	Jl. Nogodewo, Ambarukmo, Caturtunggal	Jl. Nogodewo, Ambarukmo, Caturtunggal	On	8	Off	7	Off	7
16	Gg. Glagahwangi 158, Warungboto	Gg. Glagahwangi 152, Warungboto	On	8	Off	7	Off	7
17	Gg. Teratai 565, Pandeyan.	Kost Tinus jalan pakel baru	On	6	Off	8	Off	8
18	lapang Futsal 4R Jl. Parangtritis, Brontokusuman.	Jl. Jogokaryan, Mantrijeron.	On	6	Off	8	Off	8
19	Parkiran kampus UAD 4 Jl. Islamic Center UAD, Tamanan.	Parkir Selatan UAD Kampus 4, Tamanan	On	6	Off	8	Off	7
20	Jl. Margomulyo 101-107, Gowongan	Gowongan, Kec. Jetis	On	8	Off	7	Off	7
	Delay Average			7		7		6.95

From the research that has been done, the results are in the form of a good alarm and engine response. At 20 points of data collection location the alarm can be turned on accurately. The alarm *on* command can turn on the alarm found on the motor with a *delay* time that varies between 5 - 8 seconds, the average *delay* obtained is 7 seconds. On the command to turn off the alarm, namely the alarm *off*, the time *delay* is obtained between 6 - 8 seconds, the average *delay* obtained is 7 seconds. While on the command to turn off the machine, namely the engine *off*, the *delay* is obtained between 6 - 8 seconds, the average *delay* obtained is 7 seconds. This shows that the experiments carried out get good results. *Delays* occur due to the process of sending data from the *smartphone* to the research tool but this is still in the normal stage.

3.3 Vehicle Coordinate Point Testing

Testing between two coordinate points is used to determine the difference between the coordinate points of the GPS module and the vehicle location point. The test sample was carried out as many as 20 locations at certain coordinate points. To determine the coordinate point, latitude and longitude data is used. Then this data is calculated using a distance calculator using the haversine formula. The data obtained in the coordinate point test can be seen in Table 2.

Table 2. Vehicle coordinate point test results

No	Koordinat				Distance difference (m)
	Modul GPS Ublox Neo-6M		Vehicle Location		
	Latitude 1	Longtitude 1	Latitude 2	Longtitude 2	
1	-7.817343	110.380391	-7.817350	110.380369	2.55
2	-7.816219	110.380413	-7.816293	110.380433	8.52
3	-7.820297	110.379376	-7.820257	110.379377	4.45
4	-7.816680	110.381679	-7.816650	110.381617	7.60
5	-7.816133	110.378346	-7.816089	110.378370	5.56
6	-7.815957	110.387291	-7.815891	110.387280	7.44
7	-7.834648	110.381450	-7.834624	110.381428	3.60
8	-7.829740	110.380040	-7.829723	110.380102	7.09

9	-7.815340	110.387762	-7.815422	110.387780	9.33
10	-7.822702	110.396210	-7.822715	110.396199	1.89
11	-7.824906	110.397314	-7.824999	110.397311	10.35
12	-7.811348	110.362679	-7.811363	110.362663	2.43
13	-7.810500	110.361532	-7.810518	110.361500	4.05
14	-7.834961	110.382962	-7.834915	110.382968.	5.16
15	-7.783379	110.402445	-7.783340	110.402363	10.02
16	-7.802708	110.387884	-7.802677	110.387881	3.46
17	-7.817479	110.383404	-7.817450	110.383395	3.37
18	-7.825864	110.367682	-7.825874	110.367611	7.90
19	-7.833876	110.382241	-7.833837	110.382243	4.34
20	-7.784139	110.367007	-7.784155	110.366992	2.43

The results obtained in the coordinate point test produce varying differences with the closest distance of 2.43 M and the farthest distance obtained is 10.35 M. This shows that the test can detect the position of the vehicle accurately with minimal differences. This shows that the tests carried out can detect the position of the vehicle accurately with a minimal difference. The average difference between the position of the vehicle and the GPS coordinate point is 5.577 m. The display of the distance calculator used can be seen in Figure 6.

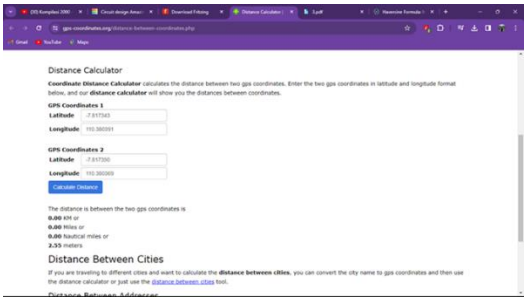

Figure 6. Distance calculator

3.4 Indoor System Condition Testing

Indoor System Condition Testing, Testing between two coordinate points is used to determine the difference in GPS module coordinate points and vehicle location points. Indoor location point testing samples are carried out as many as 10 locations at certain coordinate points. To determine the coordinate point, latitude and longitude data is used. Then this data is calculated using a distance calculator using the haversine formula. The data obtained in the coordinate point test can be seen in Table 3.

Table 3. Pengujian Kondisi Sistem Dalam Ruangan

No	Coordinate				Error (meter)
	Modul GPS Ublox Neo-6M		Vehicle Location		
	Latitude 1	Longtitude 1	Latitude 2	Longtitude 2	
1	-7.817460	110.380127	-7.817479	110.380383	28.28
2	-7.790107	110.366975	-7.789968	110.367194	28.65
3	-7.824827	110.381521	-7.824828	110.381300	24.35
4	-7.810475	110.362191	-7.810438	110.362425	26.10
5	-7.816258	110.379443	-7.816481	110.379487	25.27
6	-7.817461	110.383101	-7.817487	110.383226	14.07
7	-7.810993	110.382208	-7.810943	110.382100	13.13
8	-7.834987	110.382906	-7.834918	110.382861	9.13
9	-7.833763	110.381829	-7.833722	110.381700	14.92
10	-7.817377	110.380509	-7.817377	110.380685	19.39

The results obtained in indoor system testing, the coordinate points produce varying differences with the closest distance being 9.13 meters and the farthest distance obtained being 28.65 meters. Indicating that the indoor system tests carried out detect the position of the vehicle is not accurate. The average difference between the position of the vehicle and the GPS coordinate point is 20.329 meters.

In this section, the results of the study are explained and at the same time a comprehensive discussion is given. Results can be presented in figures, graphs, tables, and others that make the reader understand easily [2] [5]. The discussion can be done in several sub-chapters.

4. CONCLUSIONS

Based on the research that has been carried out, it can be concluded as follows: This research successfully obtained vehicle location data, based on the actual location of the vehicle accurately with an average distance of 5,577 meters. This research did not succeed in obtaining accurate location data when carried out on indoor testing, with an average inaccurate result of 20,329 meters. This research was successful in testing the alarm function, and motorized vehicle engine control with an average delay of alarm on 7 seconds, alarm off 7 seconds and engine off 6.97 seconds. This research has succeeded in obtaining GPS Ublox Neo 6-M comparison data with Google Maps, using a distance calculator.

REFERENCES

[1] F. Lyu et al., "Characterizing Urban Vehicle-to-Vehicle Communications for Reliable Safety Applications," in IEEE Transactions on Intelligent Transportation Systems, vol. 21, no. 6, pp. 2586-2602, June 2020, doi: 10.1109/TITS.2019.2920813.

[2] G. Xie, Y. Li, Y. Han, Y. Xie, G. Zeng and R. Li, "Recent Advances and Future Trends for Automotive Functional Safety Design Methodologies," in IEEE Transactions on Industrial Informatics, vol. 16, no. 9, pp. 5629-5642, Sept. 2020, doi: 10.1109/TII.2020.2978889.

[3] Q. Shi and H. Zhang, "Fault Diagnosis of an Autonomous Vehicle With an Improved SVM Algorithm Subject to Unbalanced Datasets," in IEEE Transactions on Industrial Electronics, vol. 68, no. 7, pp. 6248-6256, July 2021, doi: 10.1109/TIE.2020.2994868.

[4] M. Saleem, A. Khadim, M. Fatima, M. A. Khan, H. K. G Nair and M. Asif, "ASSMA-SLM: Autonomous System for Smart Motor-Vehicles integrating Artificial and Soft Learning Mechanisms," 2022 International Conference on Cyber Resilience (ICCR), Dubai, United Arab Emirates, 2022, pp. 1-6, doi: 10.1109/ICCR56254.2022.9995824.

[5] J. Solano, S. Jemei, L. Boulon, L. Silva, D. Hissel and M. . -C. Pera, "IEEE VTS Motor Vehicles Challenge 2020 - Energy Management of a Fuel Cell/Ultracapacitor/Lead-Acid Battery Hybrid Electric Vehicle," 2019 IEEE Vehicle Power and Propulsion Conference (VPPC), Hanoi, Vietnam, 2019, pp. 1-6, doi: 10.1109/VPPC46532.2019.8952246.

[6] H. Li, G. Zhao, L. Qin, H. Aizeke, X. Zhao and Y. Yang, "A Survey of Safety Warnings Under Connected Vehicle Environments," in IEEE Transactions on Intelligent Transportation Systems, vol. 22, no. 5, pp. 2572-2588, May 2021, doi: 10.1109/TITS.2020.3026309.

[7] H. Peng, W. Wang, C. Xiang, L. Li and X. Wang, "Torque Coordinated Control of Four In-Wheel Motor Independent-Drive Vehicles With Consideration of the Safety and Economy," in IEEE Transactions on Vehicular Technology, vol. 68, no. 10, pp. 9604-9618, Oct. 2019, doi: 10.1109/TVT.2019.2935617.

[8] S. Narain, A. Ranganathan and G. Noubir, "Security of GPS/INS Based On-road Location Tracking Systems," 2019 IEEE Symposium on Security and Privacy (SP), San Francisco, CA, USA, 2019, pp. 587-601, doi: 10.1109/SP.2019.00068.

[9] R. Yang, D. Xu and Y. T. Morton, "Generalized Multifrequency GPS Carrier Tracking Architecture: Design and Performance Analysis," in IEEE Transactions on Aerospace and Electronic Systems, vol. 56, no. 4, pp. 2548-2563, Aug. 2020, doi: 10.1109/TAES.2019.2948535.

[10] N. Aktar, I. Jaharr and B. Lala, "Voice Recognition based intelligent Wheelchair and GPS Tracking System," 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE), Cox'sBazar, Bangladesh, 2019, pp. 1-6, doi: 10.1109/ECACE.2019.8679163.

[11] O. D. Jimoh, L. A. Ajao, O. O. Adeleke and S. S. Kolo, "A Vehicle Tracking System Using Greedy Forwarding Algorithms for Public Transportation in Urban Arterial," in IEEE Access, vol. 8, pp. 191706-191725, 2020, doi: 10.1109/ACCESS.2020.3031488.

[12] P. Kanani and M. Padole, "Real-time Location Tracker for Critical Health Patient using Arduino, GPS Neo6m and GSM Sim800L in Health Care," 2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2020, pp. 242-249, doi: 10.1109/ICICCS48265.2020.9121128.

[13] X. -B. Jin, J. -Y. Xie, J. -L. Kong, J. -S. Zhang, W. -W. Cai and M. Zuo, "End-to-End GPS Tracker Based on Switchable Fuzzy Normalization Codec for Assistive Drone Application," in IEEE Transactions on Consumer Electronics, doi: 10.1109/TCE.2023.3331770.

[14] P. Kanani and M. Padole, "Real-time Location Tracker for Critical Health Patient using Arduino, GPS Neo6m and GSM Sim800L in Health Care," 2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2020, pp. 242-249, doi: 10.1109/ICICCS48265.2020.9121128.

[15] B. Pardhasaradhi and L. R. Cenkeramaddi, "GPS Spoofing Detection and Mitigation for Drones Using Distributed Radar Tracking and Fusion," in IEEE Sensors Journal, vol. 22, no. 11, pp. 11122-11134, 1 June1, 2022, doi: 10.1109/JSEN.2022.3168940.

[16] X. -B. Jin, J. -Y. Xie, J. -L. Kong, J. -S. Zhang, W. -W. Cai and M. Zuo, "End-to-End GPS Tracker Based on Switchable Fuzzy Normalization Codec for Assistive Drone Application," in IEEE Transactions on Consumer Electronics, doi: 10.1109/TCE.2023.3331770.

[17] H. K. Patel, T. Mody and A. Goyal, "Arduino Based Smart Energy Meter using GSM," 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU), Ghaziabad, India, 2019, pp. 1-6, doi: 10.1109/IoT-SIU.2019.8777490.

[18] Q. I. Sarhan, "Systematic Survey on Smart Home Safety and Security Systems Using the Arduino Platform," in IEEE Access, vol. 8, pp. 128362-128384, 2020, doi: 10.1109/ACCESS.2020.3008610.

[19] Q. I. Sarhan, "Arduino Based Smart Home Warning System," 2020 IEEE 6th International Conference on Control Science and Systems Engineering (ICCSSE), Beijing, China, 2020, pp. 201-206, doi: 10.1109/ICCSSE50399.2020.9171939.

[20] W. A. Jabbar, M. A. B. Yuzaidi, K. Q. Yan, U. S. B. M. Bustaman, Y. Hashim and H. T. AlAriqi, "Smart and Green Street Lighting System Based on Arduino and RF Wireless Module," 2019 8th International Conference on Modeling Simulation and Applied Optimization (ICMSAO), Manama, Bahrain, 2019, pp. 1-6, doi: 10.1109/ICMSAO.2019.8880451.

AUTHOR BIOGRAPHY

Penulis 1 Pas Foto (3x4cm)	**Andhika Dwi Prasetio** lahir di Karawang 11 Maret 2000. Menempuh pendidikan di Universitas Ahmad Dahlan Program Studi S1 Teknik Elektro, Email: prasetioandhikadwi@gmail.com.
Penulis 2 Pas Foto (3x4cm)	**Nama Penulis 2 (9 pt)** Penulis 2 menyelesaikan pendidikan sarjana di program studi teknik elektro universitas ahmad dahlan pada tahun 2020. Saat ini penulis 2 adalah dosen tetap di program studi teknik elektro universitas ahmad dahlan. Bidang penelitiannya adalah sistem kendali dan robotika.