Journal of Computer Science, Information Technology and Telecommunication Engineering (JCoSITTE)
Vol. 5, No. 2, September 2024, pp. 712~721
ISSN: 2721-3838, DOI: 10.30596/jcositte.v5i2.21032

Motorcycle Safety System Using RFID and GPS Based on ESP32 Internet of Things

Indra Maulana[1], Misbah[2]
[1,2] Electrical Engineering, University of Muhammadiyah Gresik, Indonesia

ABSTRACT

Motorbikes are an alternative transportation for the majority of lower middle class Indonesians, because motorbikes have affordable prices, low maintenance costs, and are fuel efficient. The increasingly rapid use of motorbikes also increases the speed of criminal acts, namely motorbike theft, because apart from user error, the built-in security system of motorbikes can still be hacked, which can trigger theft. To overcome this, a security system was added with tools that can monitor and control remotely. This system utilizes RFID to recognize registered IDs. To turn it on, you can only use the ID that has been registered. Then the ESP 32 which is connected to Mifi is the brain that processes the motorbike and will send notifications and locations using the GPS module to the user via telegram. If the ID used is not registered and you tap 3 times/the motorbike is indicated to be stolen, a danger notification will be sent to the user via telegram. Users can also send commands back to the motorbike remotely via telegram. The results of this research show that the efficient RFID distance is 1-3 cm because there is no error (0%), and GPS accuracy has an average error of 3.3 meters, as well as suitability for use of the Telegram application.

Keyword : Motorcycle safety systems, RFID, GPS, Internet of Things (IoT)

Corresponding Author:
Indra Maulana
Electrical engineering
Universitas Muhammadiyah Gresik
Jl. Sumatera No.101, Gn. Malang, Randuagung, Gresik, East Java, Indonesia.
Email : indramaulanajoe875@gmail.com

Article history:
Received Aug 20, 2024
Revised Aug 23, 2024
Accepted Aug 29, 2024

1. INTRODUCTION

Humans need to move from one place to another to carry out activities that support their living needs. To make this moving process easier, humans need tools that can help them on this journey (Asti, 2017). Motorbikes are an alternative means of transportation that is most widely used by Indonesian people, not least because they are relatively affordable both in terms of price, maintenance and fuel (Auwali et al., 2023). In 2021, the use of motorbikes in Indonesia is very high compared to other transportation models, with a total of 114.54 million units (Ferdian et al., 2023).

With the increase in the number of motorbike users, criminal acts such as motorbike theft (curanmor), also tend to increase rapidly (Putra, 2021). According to East Java Province crime data, motorbike theft cases are in second place after fraud in the list of crimes. With 1,172 cases of motorbike theft (Insiyah et al., 2023). Several factors that influence the occurrence of motorbike theft include economic factors, which play an important role in daily life and need to be met regularly (Zahra & Lampung, 2024). Theft cases often occur due to factors such as lack of environmental security, negligence of residents, and the ease for perpetrators to hack motorbike security systems. Even though the motorbike wheels have been chained or locked, even using a letter T lock, the motorbike can still be easily stolen by a group of thieves. In reality, these security systems can often still be penetrated relatively easily (Surahman et al., 2022). The existence of CCTV is considered efficient by most people, even though it functions as a recording device that uses one or more cameras to produce data files in the form of video or audio, and not as an alarm system that can notify motorbike users directly (Muid, 2022)

After seeing cases of motorbike theft, motorbike owners must pay serious attention to the security of their motorbikes. Effective and efficient additional safety is very necessary to protect motorbikes (Manalu et al., 2023). The use of RFID sensors on motorbikes is a modern method that is quite effective and efficient for protecting motorbikes. This system works by preventing the motorbike engine from starting if the RFID sensor does not recognize the ID, even though the ignition key is in the on position (Julianthi et al., 2023). Apart from that, adding a GPS module is also very important for monitoring the position of the motorbike. If the RFID tag is likely to be misused by friends or relatives,

the GPS module can help in manual search, because GPS coordinates are very useful in the investigation process (Suwardoyo et al., 2023). Use of ESP32 which is integrated with Mifi so you can monitor and control all components. To be able to monitor and control the device so that it can process data received from the ESP32 which is integrated with Mifi for processing, the Telegram application as the Internet of Things is needed (Sanaris & Suharjo, 2020). This process involves processing data for monitoring and granting permission to use motorbikes. If the RFID detects the registered ID, the motor will start and send the location coordinates to the user. Conversely, if RFID is not detected, the motor will not turn on even though the contact is in the ON position. If the tag is tapped three times but is still not detected, the system will send a danger notification to the user and the motorbike will not start.

This research takes reference sources from previous research, namely, 1. "Motorcycle Control and Security Devices Using ESP 32 Cam Based on Telegram to Minimize Theft (2023)" This research uses facial recognition with ESP32-Cam to activate the motorbike electrical system and send notifications via Telegram (Auwali et al., 2023). 2. "Physical Touch Code Motorcycle Safety System Using GPS (2023)" This research applies a secret touch code in less than 9 seconds to activate a motorbike, and sends notifications and location to the user via Telegram (Ferdhiansyah et al., 2023). 3. "Design and Build a Motorcycle Security System Using Fingerprints Using an Android Device Based on the Internet of Things (2023)" This research utilizes an Arduino Uno with an ATMEGA 2560 microcontroller chip as a controller, a NodeMCU ESP8266 Wi-Fi module for communication with a smartphone, and GPS for Location tracking (Yusman et al., 2023). 4. "Designing a Motorcycle Security System Based on RFID Microcontroller Esp8266 (2023)" This research uses RFID to identify ID and combines it with ESP8266 to communicate with smartphones (Sri et al., 2023). 5. "Design of a Motor Vehicle Safety and Monitoring System (2023)" This research uses Arduino Uno as a controller which is connected to a GPS module and combined with a GSM module to send data and location to users via SMS. Users can also send a reply SMS to instruct the motorbike to be turned off remotely if it is detected stolen (Atabia et al., 2023).

2. 2. RESEARCH METHOD

This research procedure adopts the research and development (R&D) method, where the research method is used to collect information about the initial conditions of the research. After that, the Development method is applied to ignite and develop the product based on the data that has been collected. Creating block diagrams, flow diagrams and wiring diagrams are 3 steps to achieve the final goal. Although each process has a different goal, the third step collaborates to achieve the final goal (Prayoga et al., 2024).

2.1 System Design

After understanding several stages and collecting some data and information from the references obtained, the next step is to identify the required components. Then, develop plans and designs that will be used in research. At this stage, a comprehensive description of the entire system is given.

2.2 System Block Diagram

Block Diagrams Systems are represented by blocks and display the main parts or functions connected by lines that show the relationships between blocks. The following is a block diagram design for a motorbike safety system, which can be seen in Figure 1.

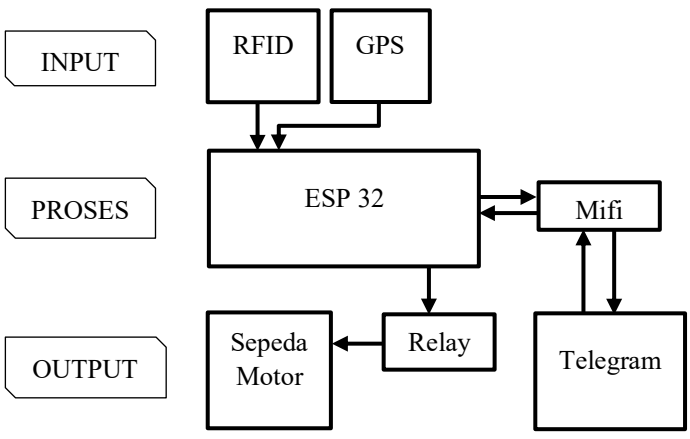


Figure 1 Block diagram system

There is a system block diagram, for the workflow, namely RFID RC522 is a device used to identify motorbike vehicle users by placing an e-KTP or RFID tag on the RFID module. GPS is a device used to determine the coordinates attached to the motorbike body. The ESP32 microcontroller is the core of this motorbike safety system, controlling all components integrated in the system. The MIFI module is connected directly to the microcontroller, allowing system control via commands from the Telegram application. MIFI is a helpful component for connecting the ESP32 to Telegram. The Telegram application is a tool that can monitor and control motors remotely which can communicate with the ESP32 microcontroller. The relay is an important part of the system, responsible for regulating the connection and disconnection of electrical current at the motorbike contacts. The relay will activate when receiving instructions from the ESP32 microcontroller once the appropriate RFID Tag card has been registered.

2.3 Wiring diagram

The Wiring Diagram is a series of cables used in this research, connecting all input and output components to the microcontroller. The microcontroller used is ESP32, which is responsible for connecting the input and output components. For a device to function properly, all components must be connected properly.

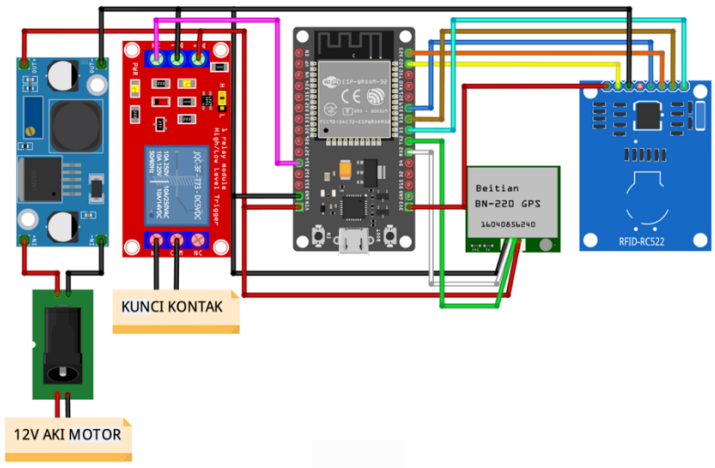


Figure 2 Wiring diagram system

Table 1 Port usage

No	Component name	Pin ESP 32	Component pin
1	RFID	3.3 V	3.3 V
		IO 22	RST
		GND	GND
		IO 19	MISO
		IO 23	MOSI
		IO 18	SCK
		IO 5	SDA
2	GPS BN-220	GND	GND
		IO 16	TX

		IO 17	RX
		5 V	VCC
		5 V	DC +
3	RELAY 1 CH	GND	DC -
		IO 14	IN

2.4 Flowchart

At this stage, the system explains how it works by illustrating two flowcharts, namely the first is a flowchart for the safety system on the motorbike and the second is a flowchart for processing commands by the user. In the flowchart, the working principles of the system that have been designed are explained in detail.

1. Motorcycle safety system flowchart
   At this stage of the security system work process on a motorbike, starting with Initializing the Security System Device first, then contact ON is the process of connecting electricity, connecting to Wi-Fi is the stage where the device is connected to the internet network, continue to the process of identifying an ID if is successful, it will send a notification in the form of ID data and coordinate points to the user via Telegram, and the relay will connect the electrical system, if the ID identification process is not successful then it cannot start the motorbike, and if identification for 3x still fails, it will send a danger notification.

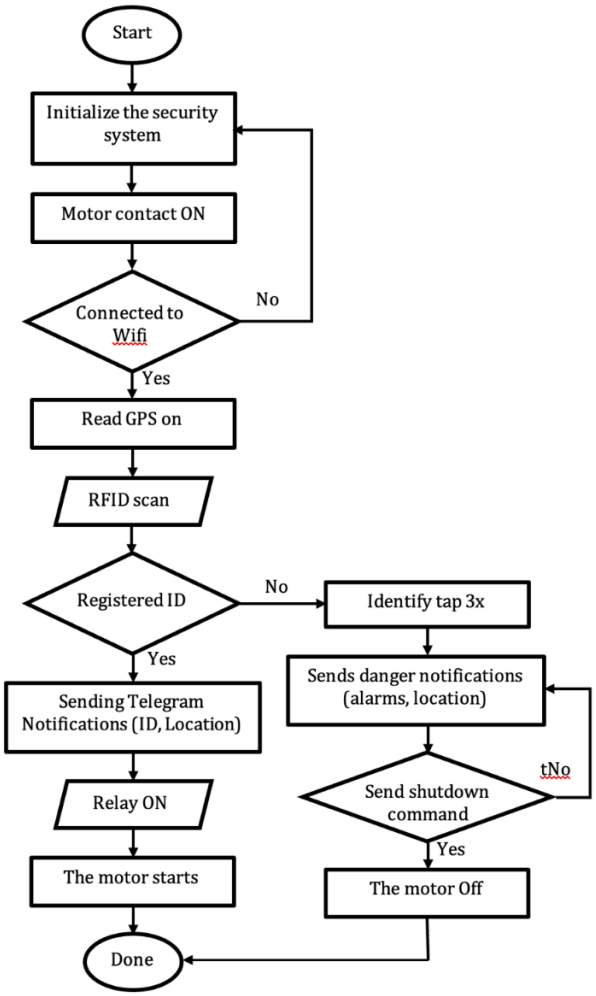


Figure 3 Safety system Flowchart

2. Flowchart of command by user
   At this stage of the command system work process by the user, it begins with Initializing the Security System Device first, then contact ON is the process of connecting electricity, connecting to Wi-Fi is the stage where the device is connected to the internet network, a process where the user will ask for the status of the motor. When the motorbike is indicated to be suspected, the user can send a command to turn off the motorbike, and the relay will be off and the motorbike cannot be turned on/off. If the motorbike is not indicated as stolen, the user can also not send a command back to the motorbike via telegram.

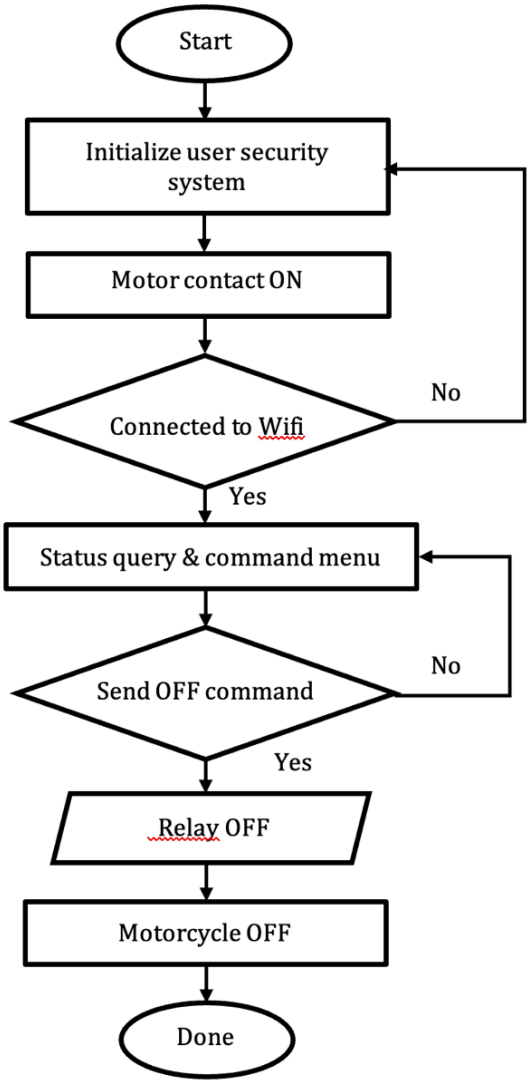


Figure 4 User flowchart

3. Result

Initial testing is the evaluation stage of the program design which aims to determine whether the tool is functioning properly, especially in terms of adding to the motorbike safety system. In this test, the main focus includes RFID responsiveness, the accuracy of the GPS module in sending coordinates, and communication between the device and the user. The purpose of this testing is to ensure that the additional tools function efficiently and effectively.

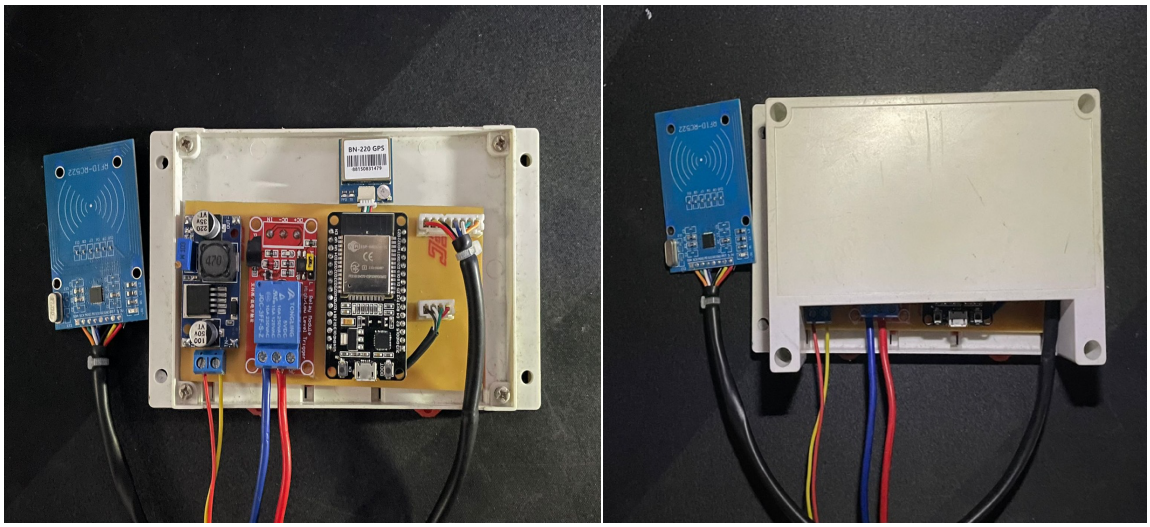


Figure 5 Tool realization results

3.1 Telegram display testing

At this stage, 2 telegram display tests will be taken, where the telegram will give commands, namely turning on the relay and turning off the relay. This test is used to determine the compatibility between the telegram display and the relay hardware, whether the relay responds according to the command sent by the telegram or not.

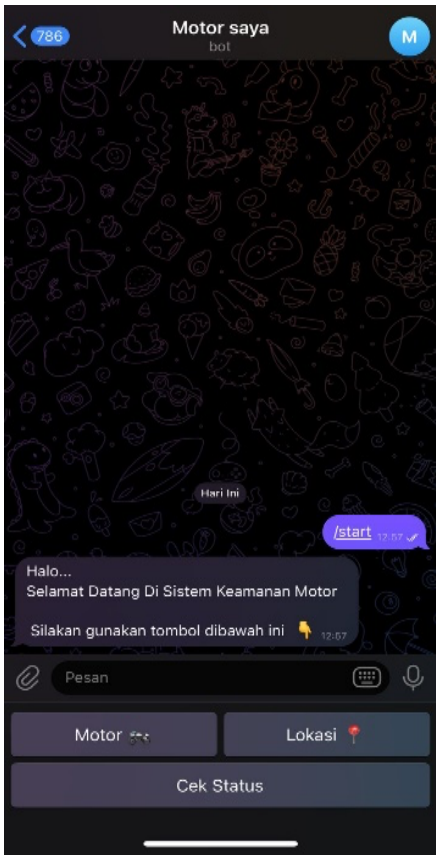
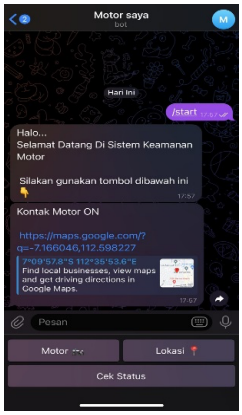
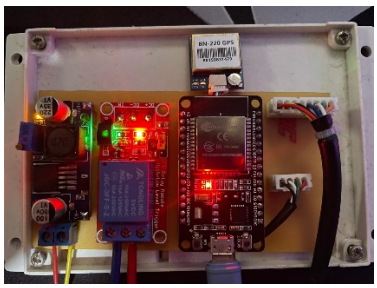
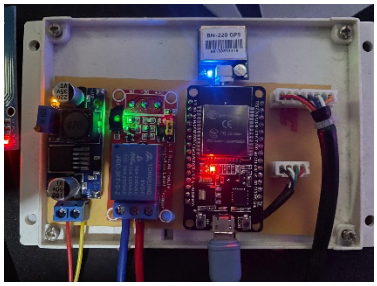


Figure 6 Telegram display

Table 2 Telegram display testing

Telegram display	Relay condition	Suitability	
		Yes	No
 Turn ON Relay	 Relay ON	✓	
 Turn OFF Relay	 Relay OFF	✓	

3.2 RFID Module testing

Testing the reading distance of the RFID sensor with the Tag Card was carried out using the RFID RC522. This distance measurement aims to determine the maximum distance at which the RFID RC522 can read the ID on a Tag Card or e-KTP.

Table 3 RFID reading distance testing

No	Distance	Read	Can not be read	Eror (%)
1.	1 cm	5	0	0%
2.	2 cm	5	0	0%
3.	3 cm	5	0	0%
4.	4 cm	3	2	40%
5.	5 cm	1	4	80%

From the results of tests carried out five times by comparing the distance values on the RFID module, it was found that at a distance of 1 - 3 cm there was no error (0% error). However, at a distance of 4 cm, the error rate reaches 40%, and at a distance of 5 cm, the error rate increases to 80%.

3.3 GPS Module testing

Then, testing was carried out on a series of GPS modules. This test aims to verify whether the GPS module can track position coordinates and the accuracy of sending coordinate point information.

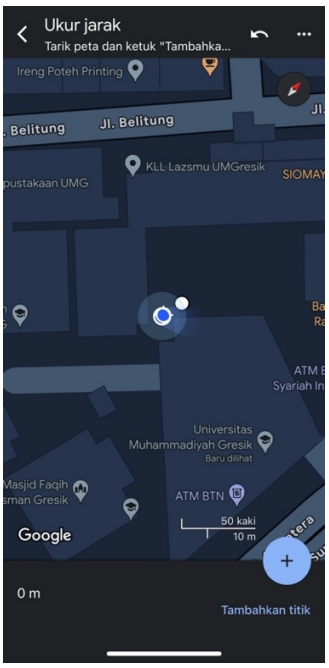


Figure 7 GPS module accuracy

Table 4 Testing the accuracy of coordinate points

NO.	Location	Reference Location		Measureable Location		Error distance (Meter)
		lattitude	longitude	lattitude	longitude	
1	UMG	-7.161101	112.6154807	-7,161019	112,6155651	0
2	Icon Mall	-7,167243	112,601762	-7,1672222	112,6018333	8,2
3	RS Denisa	-7,167677	112,597901	-7,1676511	112,597902	3
4	GKB Convex	-7,148774	112,613243	-7,148786	112,613241	1,4
5	SMA Muhammadiyah 1 Gresik	-7,160574	112,617749	-7,160608	112,617726	4

Table 4 shows the results of calculating distance error using GPS. Latitude A is a reference latitude determined from a location on Google Maps. Latitude B is the latitude measured using GPS measurements on the device used to locate the motorbike. Longitude C is a longitude reference which is also obtained from Google Maps, while longitude D is the measured longitude determined from GPS measurements on the device.

Based on the calculation results, the lowest error distance is 0 meters, while the highest error distance reaches 8.2 meters at certain locations. The average error distance is 3.3 meters. The standard position

accuracy provided by GPS surveys for absolute position is between 8 and 10 meters. The difference in results obtained is influenced by the strength of the GPS antenna in receiving signals.

3.4 Relay suitability testing

Testing of the relay, this test is carried out to ensure that the output of the system can work according to the input entered, for example, if the RFID that is tapped is identified, will the relay be ON and vice versa, if the RFID is not identified then the relay will be OFF.

Table 5 Testing the suitability of input to output

No	Card type	Information	Suitability	
			Yes	No
1	KTP (Registered)	Relay ON	✓	
2	SIM (Registered)	Relay ON	✓	
3	E-TOLL (Not registered)	Relay OFF		✓
4	RFID TAG (Not registered)	Relay OFF		✓

3.5 Testing notification alarm system

Testing the Telegram alarm and notification system aims to verify whether the motorbike security system is operating properly. When the ignition is in the ON position and the RFID does not recognize the registered ID, the motor cannot be started. If the wrong ID is scanned three times, the system will send a notification to the Telegram application and the motorbike will still not start. The following is an example of a Telegram notification image displayed in the application.

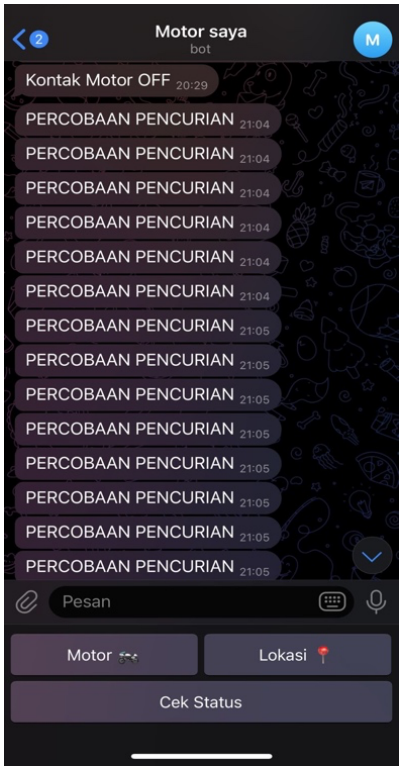


Figure 8 Notification alarm

4. CONCLUSION

Based on the results of testing and analysis in the design and manufacture of the tool with the title "Motorcycle Safety System Using RFID and GPS Based on ESP32 Internet of Things," the conclusions that can be drawn are as follows:

1. If the layer distance exceeds the limit, the RFID will not respond because it is blocked by the plastic of the motor body. RFID operates at a frequency of 13.56 MHz, which has an effective detection distance of approximately ±4 cm.
2. Obstacles/indoors affect GPS in getting coordinates.
3. The Telegram application runs according to the program and can communicate with the microcontroller
4. The speed or delay in the system's response to commands given will depend on the internet network

REFERENCES

Asti, M. (2017). ANALISA PENGGUNAAN SEPEDA MOTOR LISTRIK BAGI TRANSPORTASI ONLINE TERHADAP KETAHANAN ENERGI (STUDI PADA GOJEK). *Jurnal Ketahanan Energi*, *110*, 51–61. https://doi.org/10.1016/j.enpol.2017.08.015

Atabia, H., Ch, S., & Darmawan, B. (2023). *Rancang Bangun Sistem Pengaman dan Monitoring Kendaraan Bermotor ARTICLE INFO ABSTRACT*. *1*(1), 28–35.

Auwali, G. R., Ahfas, A., & Ayuni, S. D. (2023). Alat Kontrol dan Pengaman Sepeda Motor Menggunakan ESP 32 Cam Berbasis Telegram untuk Meminimalisasi Pencurian. *MALCOM: Indonesian Journal of Machine Learning and Computer Science*, *3*(2), 219–229. https://doi.org/10.57152/malcom.v3i2.923

Ferdhiansyah, M. F., Setyaningsih, N. Y. D., & Dahlan, M. (2023). Physical Touch Code Sistem Pengaman Sepeda Motor Menggunakan GPS. *Pseudocode*, *10*(2), 97–105. https://doi.org/10.33369/pseudocode.10.2.97-105

Ferdian, *, Delasta, G., & Ismail, R. (2023). Pengujian Konversi Sepeda Motor Berbahan Bakar Bensin Dengan Transmisi Cvt Menjadi Bertenaga Listrik. *Jurnal Teknik Mesin S-1*, *11*(3), 219–222.

Insiyah, I., Khasanah, M., & Hendarsyah, T. P. (2023). Penerapan Metode Ward Clustering Untuk Pengelompokkan Daerah Rawan Kriminalitas Di Jawa Timur Tahun 2021. *Jurnal Statistika Dan Komputasi*, *2*(1), 44–54. https://doi.org/10.32665/statkom.v2i1.1664

Julianthi, P., Husen, A., Tjahjono, G., & Tamal, C. P. (2023). Rancang Bangun Sistem Pengaman Sepeda Motor Dengan Menggunakan Sensor Sentuh TTP223. *Jurnal Spektro / Vol. 6 /No. 2 P-ISSN: 2655-577*, *6*(2), 56–63.

Manalu, W. C., Sitorus Pane, U. F. S., & Ramadhan, M. (2023). Rancang Bangun Sistem Keamanan Sepeda Motor Menggunakan Modul GSM Berbasis Arduino. *Jurnal Sistem Komputer Triguna Dharma (JURSIK TGD)*, *2*(6), 286–297. https://doi.org/10.53513/jursik.v2i6.8575

Muid, F. R. (2022). Rancang Bangun Sistem CCTV Dengan Sensor Gerak Mengunakan Arduino Dan Telegram. *Seminar Nasional Teknologi Informasi Dan Komunikasi - Be Smart with Metaverse Technology*, 389–400. http://prosiding.unipma.ac.id/index.php/SENATIK/article/view/2864

Prayoga, D. D., Anshory, I., Wicaksono, A., & Syahrorini, S. (2024). *Automatic Satay Grill Using 5 Volt Stepper Motor for Home Business*. *6*(2), 155–163. https://doi.org/10.12928/biste.v6i2.10519

Putra, A. P. (2021). Sistem Keamanan Sepeda Motor Berbasis Iot (Internet of Things) Dengan Smartphone Menggunakan Nodemcu. *JTT (Jurnal Teknologi Terpadu)*, *9*(1), 77–87. https://doi.org/10.32487/jtt.v9i1.1112

Sanaris, A., & Suharjo, I. (2020). Prototype Alat Kendali Otomatis Penjemur Pakaian Menggunakan NodeMCU ESP32 Dan Telegram Bot Berbasis Internet of Things (IOT). *Jurnal Prodi Sistem Informasi*, *84*, 17–24.

Sri, P. A., Hartini, & Dimas, Adi, N. (2023). Perancangan Sistem Keamanan Sepeda Motor Berbasis Rfid Mikrokontroler Esp8266. *Jusikom : Jurnal Sistem Komputer Musi Rawas*, *8*(1), 19–29.

Surahman, A., Prastowo, A. T., & Aziz, L. A. (2022). Rancang Alat Keamanan Sepeda Motor Honda Beat Berbasis Sim Gsm Menggunakan Metode Rancang Bangun. *Jurnal Teknologi Dan Sistem Tertanam*, *3*(1). https://doi.org/10.33365/jtst.v3i1.1918

Suwardoyo, U., Yunus, M., & Tadjo, S. (2023). Sistem Keamanan Mobil Menggunakan GPS dan Penyadap Suara. *Prosiding Seminar Nasional Teknik Elektro Dan Informatika (SNTEI)*, *9*(1), 104–108.

Yusman, Y., Mellyssa, W., & Adil, T. M. (2023). Rancang Bangun Sistem Pengaman Sepeda Motor dengan Sidik Jari melalui Perangkat Android Berbasis Internet of Things. *Jurnal Litek : Jurnal Listrik Telekomunikasi Elektronika*, *20*(1), 33–39. https://doi.org/10.30811/litek.v20i1.8

Zahra, F. Al, & Lampung, B. (2024). Pidana Pencurian Sepeda Motor Dengan Kekerasan (Studi Di Polresta. *Jurnal Review Pendidikan Dan Pengajaran (JRPP)*, *7*, 4642–4649.