EasyChair Preprint

№ 7512

Arduino-Uno Motorcycle Security Prototype with RFID and SMS Notification

Muhammad Zidni Tsawab, Agung Pangestu,
Rosyid Ridlo Al Hakim, Joko Purnomo, Alona Situmeang and
Aditia Putra Hamid

February 26, 2022

Arduino-Uno motorcycle security prototype with RFID and SMS notification

Muhammad Zidni Tsawab[1], Agung Pangestu[2,*], Rosyid Ridlo Al Hakim[2], Joko Purnomo[1], Alona Situmeang[1], Aditia Putra Hamid[2]

[1] Department of Electrical Engineering, Faculty of Industrial Technology, Gunadarma University, Depok 16424, Indonesia
[2] Department of Electrical Engineering, Faculty of Engineering and Information System, Jakarta Global University, Depok 16412, Indonesia

email: agungp@jgu.ac.id[2,*]

Abstract. This study is designing a motorcycle security prototype based on Arduino-Uno to provide security for motorized vehicles using RFID and SMS notification. This prototype consists of RFID, vibrating sensor as input, Arduino-Uno as a microcontroller, LED, LCD, relay, DC Motor, and *SIM800L* module as output. The research method used the prototype design. The results are when the RFID reader detects a tag that is brought closer in the motor contact position ON, the motor and LCD will be active. When the RFID reader detects unregistered tags, it will turn on the buzzer as an alarm and the red LED as an indicator and send information through the *SIM800L* module. When the RFID reader detects that a tag is registered for the second time it will cause the LCD and the motor to turn off and activate the vibration sensor as a safety in case of vibration. When the vibration sensor detects a vibration causes the buzzer as an alarm and a red LED that functions as an active indicator and sends information through the *SIM800L* module. This prototype can increase motorcycle safety.

1. Introduction

Along with the advancement of science and technology from various aspects of life, equipment that supports its development is also needed. These advances and technology have encouraged people to try to overcome all the problems that arise around them, including motorcycle safety [1], [2]. Some owners of motorized vehicles simply by locking the handlebars already feel quite safe, even though the techniques of breaking keys are now increasingly diverse. The security system of the motorcycle's default keyhole cover can be opened with a box-shaped key that has four small holes. In addition to locking the handlebars, another security that is still relatively used today is to use a padlock that is mounted on the disc so that the wheels cannot run, but even with a padlock, thieves can still break into it [1]–[3].

Therefore, a tool is needed that functions to activate the motor so that it will move using RFID, vibration sensors, and SIM modules. RFID module has a unique passcode [1], [4]–[9]. Vibration sensors are used to detect vibrations that are not from the owner of the motor [10], [11]. The SIM module is used to provide information [2].

The RFID system has a unique passcode in each tag so it is impossible to have the same passcode. The vibration sensor itself is used for additional safety in the event of a vibration that is not from the vehicle owner and can be deactivated by RFID [1], [4]–[9]. This study is to design a prototype based on Arduino-Uno for motorcycle safety with RFID and SMS notification. The tool can start the motor with RFID that has been registered in the Arduino database and secure the motor with a vibration sensor and SIM800L module. It is hoped that the tool can increase the security of motorized vehicles.

2. Methodology

First, the prototype designed based on circuit schematic diagram. The following circuit schematic diagram can be seen in Figure 1.

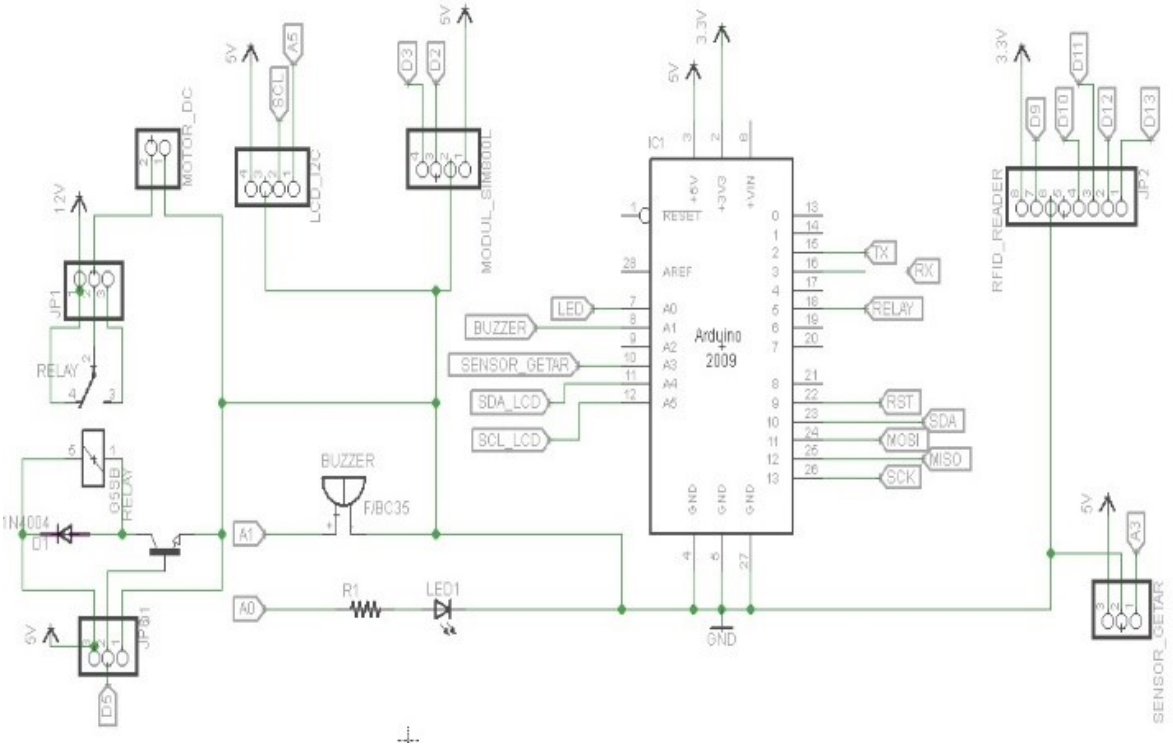


Figure 1. Circuit schematic diagram of this prototype.

Figure 1 is the design of circuit schematic diagram of motorcycle safety prototypes with RFID and SMS notifications based on Arduino-Uno that consists of RFID *Mifare RC522*, vibration sensor, LED, buzzer, relay, DC motor, *SIM800L* module, and LCD. In more detail, how the flow of the system runs when it is running, can be seen in the system flowchart diagram in Figure 2.

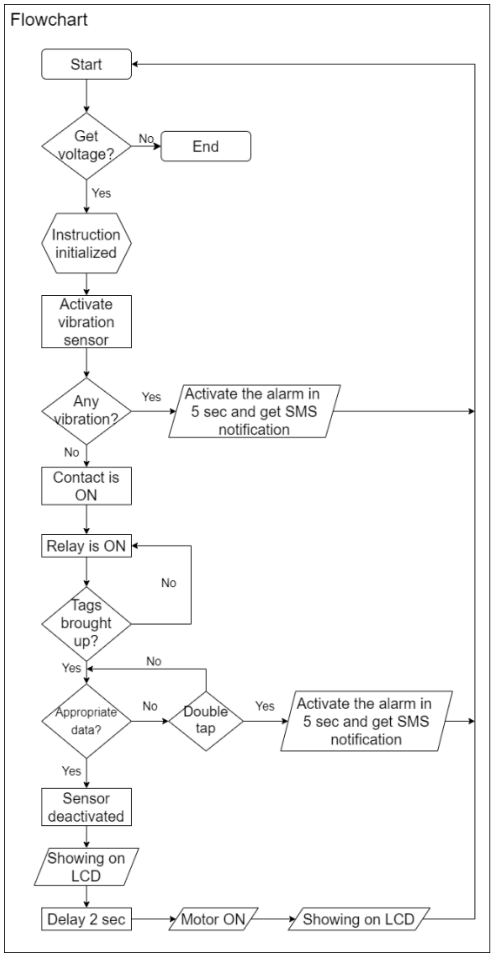


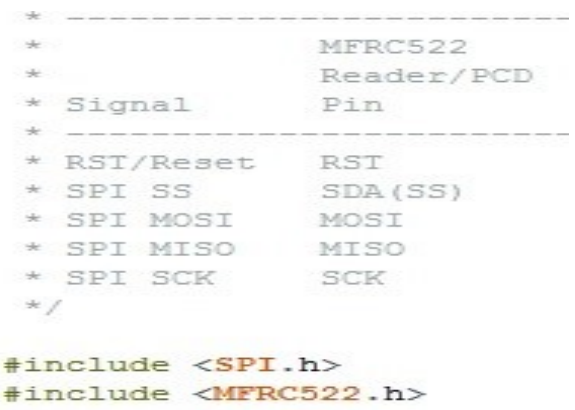
Figure 2. System flowchart diagram.

Based on Figure 2, it can be explained that system starts from the *start* instruction which indicates that the program will start, then there is a decision box that explains whether the power supply gets a voltage or not, if it is not activated then the tool will turn off, but if it is activated, the Arduino-Uno will be active and carry out a functioning data initialization process declares the pins to be used. After that, there is an output box that will activate the vibration sensor. Next, there is a decision box where whether the vibration sensor detects vibration, if there is no vibration, then the alarm is not active, if there is a vibration the alarm will be active and send information. Furthermore, there is an input condition, namely, the ignition key is on, the relay will receive voltage. When the relay is on, there is a decision box where if the tag is read by the RFID reader it will go to the next decision box, otherwise, the RFID reader will not send any signal to Arduino-Uno. In the next decision box, if the tag attached is listed, it will disable the vibration sensor, activate the LCD, and drive the DC motor, if the tag attached is not registered and is approached more than twice, it will set off an alarm and send information.

3. Result and Discussion

3.1. Mifare RC522 Testing and Analysis

Mifare RC522 is used as an RFID reader that functions to read registered or unregistered tags. In this prototype, there are several tests carried out on the RFID reader. This is done to find out how it works and the results of observations obtained from the use of an RFID reader. In Arduino programming, the connecting point between the RFID reader pin and Arduino-Uno is as shown in Figure 3.



```
* ------------------------
*              MFRC522
*              Reader/PCD
* Signal       Pin
* ------------------------
* RST/Reset    RST
* SPI SS       SDA(SS)
* SPI MOSI     MOSI
* SPI MISO     MISO
* SPI SCK      SCK
*/

#include <SPI.h>
#include <MFRC522.h>
```

Figure 3. Arduino program for connecting the RFID reader.

Based on Figure 3 can be seen the pin of the RFID reader that is connected to the Arduino-Uno along with the initialization of the RFID reader.

3.2. RFID Tag Testing

In this test, to find out the registered and unregistered tags on the system, the results are as shown in Table 1.

Table 1. RFID tag testing

No	Distance	Sensor Reading Data		
		Trial 1	Trial 2	Trial 3
1	1 cm	Detected	Detected	Detected
2	2 cm	Detected	Detected	Detected
3	3 cm	Detected	Detected	Detected
4	4 cm	Detected	Detected	Detected
5	5 cm	Not detected	Not detected	Not detected
6	6 cm	Not detected	Not detected	Not detected
7	7 cm	Not detected	Not detected	Not detected
8	8 cm	Not detected	Not detected	Not detected
9	9 cm	Not detected	Not detected	Not detected
10	10 cm	Not detected	Not detected	Not detected

Based on Table 1, it can be explained that if the registered RFID tag is brought closer to the reader, the LCD and relay will be active. If the tag attached to the reader is not registered, it will activate the LED and buzzer.

3.3. Mifare RC522 Distance Testing

To test the tool that has been made, a distance test for the reading of the *Mifare RC522* reader module was carried out by conducting several experiments in the reading of the *Mifare RC522* reader module and giving a distance of 1 cm to 8 cm. The distance range used to measure the distance to the *Mifare RC522* reader requires a ruler measuring instrument that has an accuracy of 1 (one) mm, so the results are as shown in Table 2.

Table 2. Reader module reading distance.

Pin	Not Receiving Input Signal (V)	Information
VCC	3.3	Stand by
RST	4.5	Stand by
SDA	0.23	Stand by
MOSI	1	Stand by
MISO	0.420	Stand by
SCK	1.96	Stand by
GND	0	Stand by

Based on Table 2., the reading distance of the *Mifare RC522* reader to the tag obtained a maximum result of 10 cm. This result was obtained after experimenting on reading the tag that was brought closer. This reader reading is because it uses a passive reader module that can only read tags from a close distance with a maximum detected range of 4 cm.

3.4. Mifare RC522 Voltage Testing

To determine the voltage on the *Mifare RC522* reader during stand by conditions or when the reader does not detect the tag, we measure the voltage on the pins contained in the *Mifare RC522* reader module, the results are shown in Table 3.

Table 3. Pin reader voltage while stand by.

Address Tags	Status of relay and LCD	Status of LED and buzzer
70:33:00:74	Active	Not active
75:8D:FE:45	Not active	Active
00:49:E4:EC	Not active	Active

Based on Table 3, it can be analyzed that when the reader does not detect the tag on pins D.9, D.10, D.11, D.12, and pin D.13, the *Mifare RC522* is in stand by mode where the tag is not brought near to an RFID reader. To determine the voltage on the reader when the active condition or when the reader detects the tag that is brought near it will move the DC motor and turn on the LCD and get the results as shown in Table 4.

Table 4. Pin reader voltage in the active position.

Pin	Not Receiving Input Signal (V)	Information
VCC	3.3	Active
RST	4.4	Active
SDA	4.43	Active
MOSI	4.42	Active
MISO	0.06	Active
SCK	0	Active
GND	0	Active

Based on Table 4, it can be seen that the reader is active or in a state of detecting the tag pins on the reader.

3.5. SW420 Vibration Sensor Testing and Analysis

To determine the voltage on the *SW420* vibration sensor during stand by conditions or when the sensor does not detect a vibration, we measure the voltage on the pins contained in the vibration sensor module, the results were obtained as shown in Table 5.

Table 5. Vibrating sensor pin voltage at stand by position.

Pin	Not Receiving Input Signal (V)	Information
VCC	4.5	Stand by
DO	0.25	Stand by
GND	0	Stand by

Based on Table 5, it can be seen that the vibration sensor does not detect any vibration so that the sensor is in a stand by state at pin D0. To determine the voltage on the vibration sensor when the active condition or when the sensor detects a vibration, the results are shown in Table 6.

Table 6. Vibrating sensor pin voltage in active position.

Pin	Not Receiving Input Signal (V)	Information
VCC	4.5	Active
DO	3.9	Active
GND	0	Active

Based on Table 6, it can be seen that the vibration sensor is active or in a state of detecting voltage on the pins on the sensor.

3.6. LED and Buzzer Circuit Testing

The testing and analysis of the LED and buzzer circuit are done by measuring the voltage at several points on the LED and buzzer circuit with two conditions. First, by measuring the voltage at several points on the LED circuit and the buzzer in a tag state is not registered in the database. Second, by measuring the voltage at several points on the LED circuit and the buzzer is in a state of vibration sensor receiving vibration.

3.7. Testing the LED Circuit and Buzzer when the Tag is Not Registered

To test the LED and buzzer circuit when the tag is not registered, measurements are made at several points as shown in Figure 4.

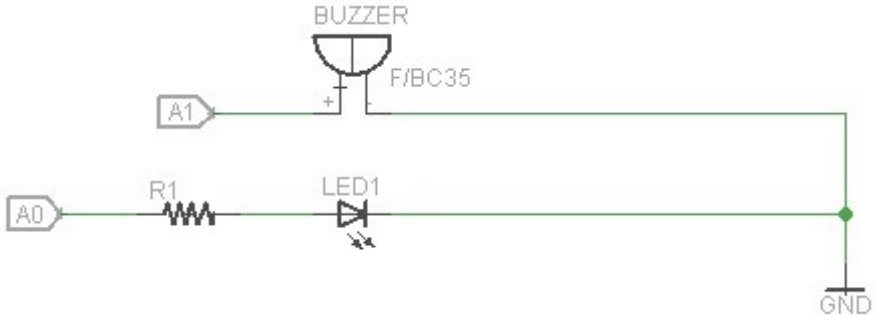


Figure 4. Schematic of testing the LED circuit and buzzer when the tag is not registered.

The measurement points are carried out at two points in Figure 4. Point A0 is used to measure the voltage value on the red LED, Point A1 is used to measure the voltage value on the buzzer. After measuring at several points as shown in Figure 4, the results are as in Table 7.

Table 7. Rated voltage of LED and buzzer.

Measuring Point	Voltage (V)	Information
Red LED (A0)	2.8	On
Buzzer (A1)	0	Off

Based on Table 7 it can be seen that the value of the voltage that comes out of the LED and buzzer in the unregistered tag is brought closer to the RFID reader and will send a high signal on pin A0 which is the red LED measurement point and after measuring the voltage value is 2.8 Volt, for unregistered tags to be brought together for the second time, the results will be obtained as in Table 8.

Table 8. Rated voltage of LED and buzzer for unregistered tags.

Measuring Point	Voltage (V)	Information
Red LED (A0)	2.78	On
Buzzer (A1)	4.56	On

Based on Table 8 it can be seen that the voltage value that comes out of the LED circuit and the buzzer in the unregistered tag is brought close to the RFID reader a second time, it will send a high signal on pins A0 and A1 which is the measurement point of the red LED and buzzer, after measuring the voltage value is 2.78 Volt and 4.56 Volt.

3.8. Testing the LED Circuit and Buzzer when Available of Vibration

For testing the LED and buzzer circuit when there is a vibration, measurements are taken as shown in Figure 4. After taking measurements at several points as shown in Figure 4, the results are shown in Table 9.

Table 9. Rated voltage of LED and buzzer while vibration is available.

Measuring Point	Voltage (V)	Information
Red LED (A0)	2.78	On
Buzzer (A1)	4.56	On

Based on Table 9 it can be seen that the voltage value that comes out of the LED and buzzer circuit when there is a vibration will send a high signal on pins A0 and A1 which is the measurement point of the red LED and buzzer, after measuring the voltage value is 2.78 Volt and 4.56 Volt.

3.9. LCD and Relay Tests

The testing and analysis of the LCD and relay circuits are done by measuring the voltage at several points on the LCD and relay circuit with one condition when the registered tag is brought close to the RFID reader. For testing the LCD and relay circuits when the tag is registered, measurements are made at several points as shown in Figure 5.

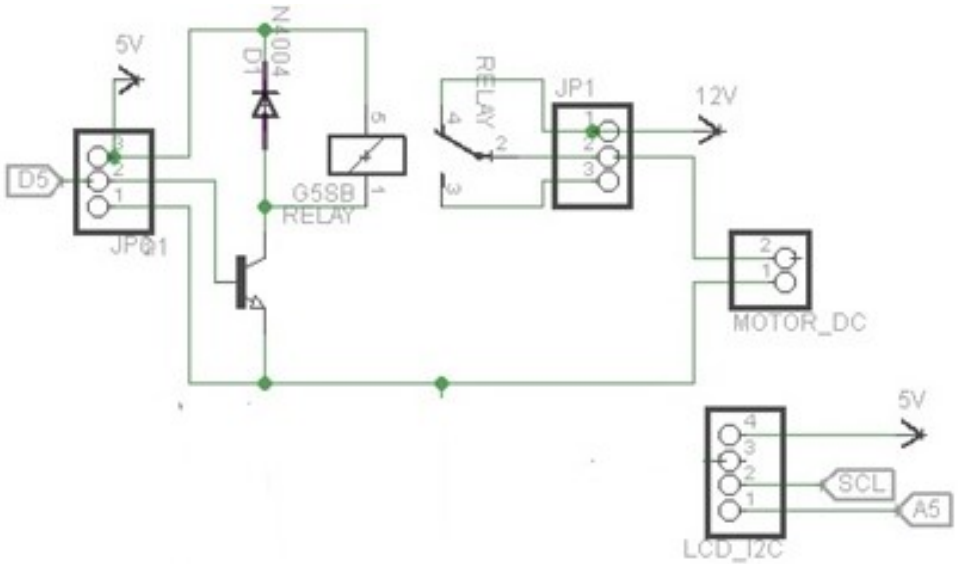


Figure 5. LCD and relay observation point circuit.

The measurement points are carried out at three points in Figure 5. Points A4 and A5 are used to measure the voltage value on the LCD, point D5 is used to measure the voltage value on the relay. After measuring at several points as shown in Figure 5, the results are shown in Table 10.

Table 10. Rated voltage of LCD and relay circuit.

Measuring Point	Voltage (V)	Information
SDA LCD (A4)	4.56	Active
SCL LCD (A5)	4.36	Active
Relay (D5)	4.62	Active

Based on Table 10 it can be seen that the voltage value that comes out of the LCD circuit when the tag is brought close to the RFID reader will send a high signal on pins A4 and A5, namely the LCD measurement point, while for the Arduino relay it will send a low signal on pin D5. After measuring the voltage values for the LCD 4.56 Volt and 4.36 Volt, while the relay is 4.62 Volt.

3.10. SIM800L Module Testing and Analysis

The *SIM800L* module on the prototype of the motorcycle safety with RFID and SMS notification based on Arduino-Uno is used to send information in the form of short messages in SMS. In the event of vibration and attempted theft using an unregistered tag, the system via the *SIM800L* module will send information to user's cellphone. The test is carried out by vibrating the vibration sensor and bringing the unregistered tags closer together twice. After testing, the results were obtained as in Table 11.

Table 11. SMS delivery testing by *SIM800L* module.

Testing to-	Vibration test	Unregistered tag test
1	Sent	Sent
2	Sent	Sent

Based on Table 11 it can be seen that if there is a vibration or an attempt to steal using another tag, the *SIM800L* module will send information to user. The following is a short message that comes from the tests that have been carried out in Figure 6.

Figure 6. SMS notification with text message (in Indonesian language).

In Figure 6 it can be explained that when the sensor gets a vibration or an RFID reader, the *SIM800L* module will send the short message (SMS) to the motorcycle owner.

4. Conclusion

The vibration sensor will detect a vibration if the motor is in the OFF condition when the DC motor and LCD are not in an active condition. When the sensor receives a vibration, it will activate the buzzer and red LED and send information through the *SIM800L* module. This prototype can increase the safety of the motorcycle.

5. References

[1] R. Hamdani, H. Puspita, and D. R. Wildan, "PEMBUATAN SISTEM PENGAMANAN KENDARAAN BERMOTOR BERBASIS RADIO FREQUENCY IDENTIFICATION (RFID)," *J. Ind. Elektro dan Penerbangan*, vol. 8, no. 2, 2019, Accessed: Jul. 09, 2021. [Online]. Available: https://jurnal.unnur.ac.id/index.php/indept/article/view/290.

[2] F. A. Pratama and F. A. Rakhmadi, "Design of Motorcycle Security System Using Fsr (Force Sensitive Resistor) Sensor, Arduino Uno Microcontroller and Sim800L Module," *Proceeding Int. Conf. Sci. Eng.*, vol. 2, pp. 185–187, Mar. 2019, doi: 10.14421/icse.v2.82.

[3] N. P. Astuti, R. Ritzkal, A. H. Hendrawan, and B. A. Prakosa, "Vehicle Security System using Short Message Service (SMS) as a Danger Warning in Motorcycle Vehicles," *J. Robot. Control*, vol. 1, no. 6, pp. 224–228, Jun. 2020, doi: 10.18196/jrc.1642.

[4] I. Komang, "RANCANG BANGUN SISTEM PENGUNCI LOKER OTOMATIS DENGAN KENDALI AKSES MENGGUNAKAN RFID DAN SIM 800L," *J. Ilm. Mhs. Kendali dan List.*, vol. 1, no. 1, pp. 33–41, Jul. 2020, doi: 10.33365/jimel.v1i1.187.

[5] Chandrawati, B. T., Christanti, F. R., Sanjaya, and Ridwan, "Deteksi Buku Perpustakaan Fakultas dengan Aplikasi RFID Berbasis WEB." 2011.

[6] S. A. Dewanto, M. Munir, B. Wulandari, and K. Alfian, "MFRC522 RFID Technology Implementation for Conventional Merchant with Cashless Payment System," in *Journal of Physics: Conference Series*, Jan. 2021, vol. 1737, no. 1, p. 12012, doi: 10.1088/1742-6596/1737/1/012012.

[7] F. Hamdani, "Penerapan RFID (Radio Frequency Identification) di Perpustakaan: Kelebihan dan Kekurangannya," Jun. 2014. Accessed: Jul. 09, 2021. [Online]. Available: http://journal.uin-alauddin.ac.id/index.php/khizanah-al-hikmah/article/view/142.

[8] M. S. Novelan, "Application of Attendance Monitoring System Using RFID (Radio Frequency Identification) and Interface," *J. Mantik*, vol. 4, no. 3, pp. 1837–1842, 2020, Accessed: Jul. 09, 2021. [Online]. Available: http://iocscience.org/ejournal/index.php/mantik/article/view/1025.

[9] R. A. Mahmood and W. A. Al-Hamdani, "Is RFID technology secure and private?," in *Proceedings of the 2011 Information Security Curriculum Development Conference, InfoSecCD'11*, 2011, pp. 42–49, doi: 10.1145/2047456.2047462.

[10] A. Pangestu, M. N. Mohammed, S. Al-Zubaidi, S. H. K. Bahrain, and A. Jaenul, "An internet of things toward a novel smart helmet for motorcycle: Review," in *AIP Conference Proceedings*, Mar. 2021, vol. 2320, no. 1, p. 050026, doi: 10.1063/5.0037483.

[11] A. Pangestu, M. Yusro, W. Djatmiko, and A. Jaenul, "The Monitoring System of Indoor Air Quality Based on Internet of Things," *Spektra J. Fis. dan Apl.*, vol. 5, no. 2, pp. 141–152, 2020, doi: 10.21009/spektra.052.06.