Design And Build Of Motorcycle Safety Using Arduino-Based RFID

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ABSTRACT

The rise in the number of thefts that occur, especially on motorcycles, has prompted many people to improve motorcycle security systems by adding security devices and using security services such as security guards or parking attendants. Despite the tight security, sometimes thieves can get in. This can happen because of negligent security officers. This research aims to create a motorcycle security system based on Radio Frequency Identification (RFID). Where this security system is equipped with an alarm, so that if the Tag ID card used does not match the Tag ID code stored on the Arduino, it will automatically turn on the alarm. The making of this Radio Frequency Identification (RFID) Based Motor Vehicle Security System uses 1 sensor, namely the RFID sensor as input which will be forwarded to Arduino to turn on the motorized vehicle. Based on the observations and tests carried out, the authors can conclude that the performance of this Motor Vehicle Security System works quite well. When the RFID Reader receives input from the ID Tag and is forwarded by Ardiuno so that the Arduino will provide its output to the Relay to turn on the Electricity and starter so that the motorized vehicle will turn on.

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1. INTRODUCTION

Increasing human needs and technological advances influence each other [1]. Due to a lot of competition in the computerized world, people are switching from manual equipment to more sophisticated equipment programmed by computers [2]. This is due to its high level of accuracy and the convenience it offers for human work. Increasing needs will lead to technological development, which will also have a negative impact on humans [3].

Motorcycles are one type of technology that is increasingly popular and always in use. Motorcycles are easy to use, practical, flexible, save money, and reduce congestion [4]. Directly proportional to the increase in motorcycle use, the crime rate has also increased. The number of motorcycle thefts continues to increase due to weak vehicle security systems, which rely on handlebar locks and lock caps that are easily tampered with [5].

In Indonesia, the unemployment rate grows significantly every year, causing economic instability that impacts on 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 events that occur, the perpetrators of theft can cruelly involve acts of violence [6].

Motorcycle theft cases are not new to society and the police world [7], [8]. Theft can occur at any time, with many opportunities utilized by thieves [9], [10]. Factors causing theft include unsafe neighborhood security [11]-[14], vehicle owners leaving vehicles in quiet neighborhoods, lack of security around, lack of security systems on vehicles, and negligence of the owner [15], [16]. Motorcycle security systems that generally still use manual ignition keys make motorbikes the target of thieves because this system is easily tampered with [17], [18]. Therefore, a system that is able to maintain vehicle security using Arduino-based RFID is needed to prevent and reduce motorcycle losses.

Motor vehicle security using Radio Frequency Identification (RFID) is installed on the vehicle and uses an ID tag card as an identity when starting the vehicle. The advantage of RFID security is that it is better than manual keys because it is difficult to know how to use it. This key is also connected to the vehicle's electrical system which allows the engine to start. In addition, the RFID safety is equipped with an alarm system that will activate if the ID tag card does not match the code stored on the Arduino microcontroller. The author designed this system to be applied to motorized vehicles by automotive companies and hopes that it can be further developed with better technology. The purpose of this design is to implement motorcycle security using Arduino-based RFID as a double security to overcome the increase in motorcycle theft, with a buzzer as an alarm if the input card is invalid.

2. METHODS

2.1. Safety

Security is a condition expected by everyone to avoid all forms of threats, be it in the form of intentional crime or unexpected accidents. Gaining that sense of security requires effective protective measures to fend off potential dangers. In an increasingly modern context, where technological advancements are moving at a rapid pace, there is a worrying paradox: innovations that bring everyday conveniences often also open up loopholes for the creation of new methods of committing crimes. Along with that, the demand for more sophisticated and difficult-to-penetrate security systems is becoming increasingly crucial. A capable access control system has become not only desirable but a fundamental necessity to ensure that everyone can maintain their privacy and protect themselves from unwanted threats. Therefore, every individual and entity needs to be equipped with a reliable security system, where access is restricted and can only be run by those who have proper authorization, thus making security not just a concept, but a reality that can be felt by every layer of society [19].

2.2. Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a technology that enables automatic identification of objects using electromagnetic fields to transfer data without the need for direct physical contact [20], [21]. This technology consists of two main components: RFID Reader and RFID Tag or Transponder. The RFID Reader functions as a radio signal transmitter and receiver, which communicates with the Tag containing digital information in the form of a chip embedded in a card or label. The key to communication between the Reader and Tag lies in the operating frequencies that must match between the two components for the information exchange to take place effectively.

RFID technology consists of two main components: RFID Reader and RFID Tag or Transponder. The RFID Reader functions as a transmitter and receiver of radio signals, communicating with Tags that contain digital information in the form of chips embedded in cards or labels. The RFID reader sends requests and receives data from RFID tags through electromagnetic fields. An RFID Tag on the other hand, is a device that contains digital information that can be read by an RFID Reader with this information stored in a chip embedded in the tag. When the tag is within range of an RFID reader and is exposed to the electromagnetic field generated by the reader the tag will respond by sending data identifying the tag to the reader.

The ISO 18000 standard defines a set of frequencies used for RFID communication allowing interoperability between different devices [22], [23]. The frequency spectrum given by this standard includes

Low Frequency (LF) at 135 kHz, High Frequency (HF) at 13.56 MHz, Ultra High Frequency (UHF) ranging from 433 MHz to 960 MHz, and Super High Frequency (SHF) at 2.45 GHz. For the purposes of this research, an RC522 type RFID was selected that works at a frequency of 13.56 MHz in the HF category. This frequency was chosen based on its wide availability in various microcontrollers and its compatibility with embedded systems operating at lower clock speeds, making it an efficient and practical choice for room security applications [24].

In Table 1, the technical specifications of the RC522 RFID module are outlined in detail, exposing characteristics relevant to the implementation of the security system designed in this study. This module is not only capable of operating at an optimal frequency for short-range communication but also offers sufficient data transmission speed for a fast and secure identification process.

Table 1. RFID RC522 Specification

Specification	Specification Value
Voltange Input	3,3 V DC
Current	13-26 mA
Current *Idle*	10-13 mA @3,3 V DC
Current *Sleep*	< 80 uA
Peak Current	< 30 mA
Frequence	13,56 MHz
Module Interface	SPI
Data Transfer	Maximum 10Mbit/s
Reading Distance	>= 50mm
Dimension	40 mm * 60 mm

Table 1 reveals that the RC522 RFID module operates at low current and voltage, which indicates high energy efficiency making the RC522 RFID ideal for applications that require long periods of battery life. Figure 1. displays the RFID Reader, and Tag.Fuzzyfication

Figure 1. RFID RC522 Reader dan Tag

2.3. Motorcycle Lock

A motorcycle lock is one of the most important parts of a motorcycle. The main purpose of the ignition lock is to start and stop the engine on the motorcycle, lock the steering wheel when parking, and operate as a disconnect switch for electrical components on the motorcycle. The function of the switch in the motorcycle lock is to connect the electric current from the battery or power supply to the equipment that requires electric current. The center of the main switch is connected to the motorcycle ignition or the main lock terminal of the main power line, and terminal B, the main ignition terminal, is connected to the battery; the IG/ON terminal is connected to Coil+ and additional loads; and the ST terminal is connected to the starter solenoid [25].

When the ignition key on the motorcycle is on, the ignition key will be connected to supply electricity, meaning that the motorcycle ignition system is active and can be used. When the ignition switch on the motorcycle is off, the electric current will not be connected, meaning that the current in the motorcycle electricity does not work either for lights, horn stater or other electrical components on the motorcycle.

2.4. Design System

In this research includes system design, researchers compiled a technical and functional design of an RFID-based motorcycle safety design system. This design started with the selection of Arduino Uno as the main microcontroller due to its high capability of efficient data processing. The research involved the use of an RFID reader module operating at a frequency of 13.56 MHz, compatible with ID cards, as an access identifier. The security system is designed with a relay-controlled mechanism, activated by a signal generated when a registered e-KTP is detected. The overall design is documented in the block diagram in Figure 2 and the flow chart in Figure 3.

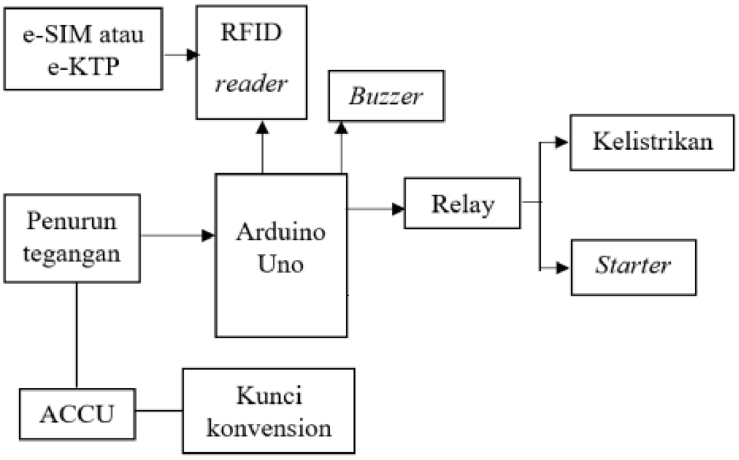

Figure 2. Diagram Blok Sistem

Based on Figure 2, the system input to access the motorcycle is the e-SIM or e-KTP which will be read by the RFID that has stored e-SIM and/or e-KTP data that is recognized or given the will to access this system. If appropriate, it will activate the relay to turn on the electricity and can access the motorcycle starter, if the e-SIM and/or e-KTP is not recognized, the buzzer will activate as an indicator if it cannot access the motorcycle.

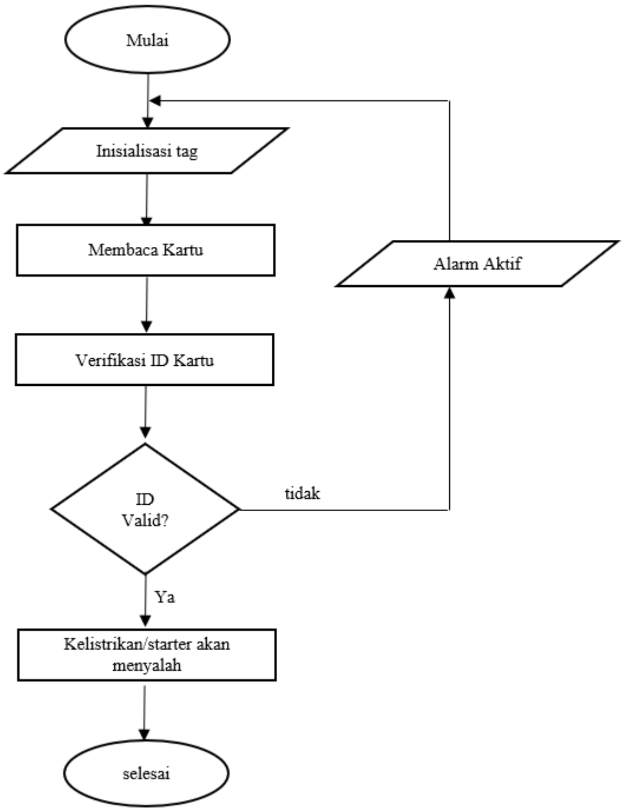

Figure 3. Flowchart Sistem

Based on Figure 3, the flow chart of the system in the study begins with the start then the contact will be On to activate the arduino as a data processing step, then enter into the processing of RFID scan data using electromagnetic waves the data will be read through the tag attached and sent to the arduino Uno to validate the data, if the data received by Arduino Uno is valid or in accordance with the instructions, Arduino will tell 1,2 if the data is valid then the relay will be connected so that the vehicle engine can be dihidupakan namu if the data is not valid then or does not match then Arduino Uno will tell the relay to turn on as a warning of a break-in.

2.5. Diagram Pengabelan

The phases listed in the System Design are connected to each other. Using ID cards and driver's licenses as Arduino Uno-based tags, the RFID-based motorcycle lock security system is built following the wiring diagram of the research flow can be seen in Figure 4.

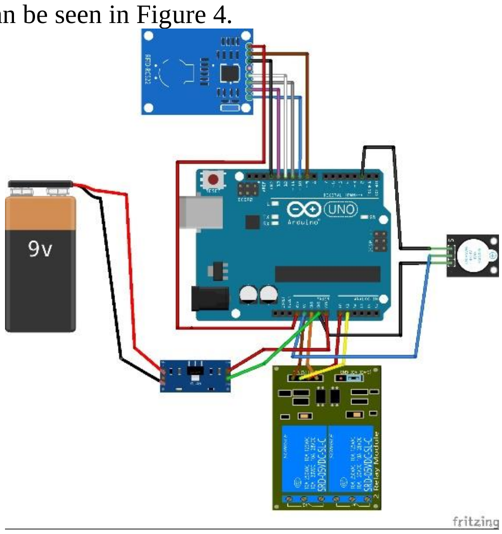

Figure 4. Wiring Diagram System

Based on Figure 4, it can be seen that the role of Arduino Uno as the brain in the system functions as a command or control of other components. This system consists of input, process, and output. The output circuit is a relay that functions as a digital switch that converts analog signals into digital signals. Buzzer serves as a notification in the form of sound when the card or tag attached to the RFID reader is not suitable. The input circuit in the form of RFID which functions to forward the vehicle starter system ignition command by Arduino, Table 2, displays the relationship between Arduino, with the components used.

Table 2. Arduino relationship with the components used

RFID Reader	Relay	Buzzer	Step Down	Arduino Uno
SDA				10
SCK				13
MOSI				11
MISO				12
GND	GND	GND	GND	GND
RST				9
3.3 V				+ 3.3 V
	VCC	VCC		+ 5 V
	In 1			A0
	In 2			A1
		I/O		D2
			OUT +	VIN

2.6. Device Design

Based on the components and wiring diagram, a tool design is needed, to store all the components used in this research, Figure 5 shows the design of the component box made of black acrylic.

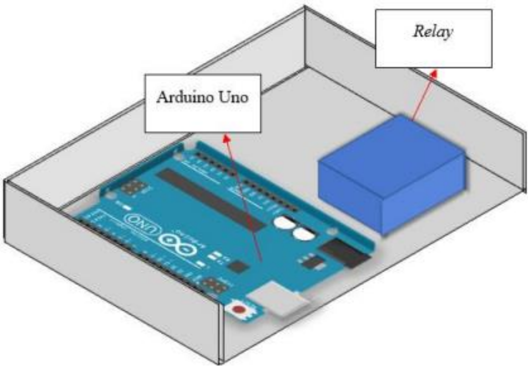

Figure 5. Component Box Design

Based on Figure 5, this stage is the manufacture of a container for the module made of acrylic where the Arduino Uno module components and 2 Channel relays. Using acrylic material has the benefit of protecting from water when it rains so that the components in the module remain safe. Figure 6 displays the position of the device on the motorcycle.

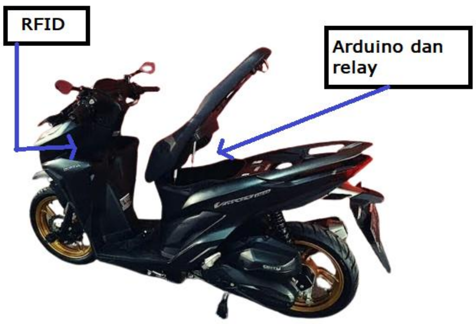

Figure 6. Placement of the Device on the Motorcycle

Based on Figure 6, the location of the mapping of tools and components in the motorcycle safety design using Arduino-based RFID. In the picture using a researcher motorcycle with an Arduino module located in the seat storage where the room inside is quite spacious and easy to reach so that if an error occurs in the module can be repaired immediately and this can also protect components or modules from water when it rains. As for the placement of the RFID Reader, it is located on the left side of the motorcycle so that this can make it easier for users to scan tags such as driver's licenses or ID cards and so on.

3. Results and Discussion

3.1. Device Testing and Checking

This research is design-oriented, namely developing a safety system on a motorcycle based on RFID. Figure 7 shows the circuit of the safety system on the motorcycle.

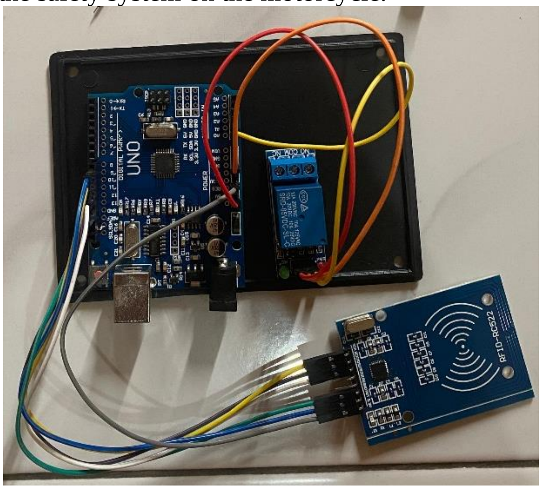

Figure 7. Motorcycle Safety System Device Set

Based on Figure 7, the construction of a motorcycle security using Arduino-based RFID has been successfully made. The RFID reader can be used to unlock the ignition of a motorcycle by acting as a driver's license or ID card reader. The motorcycle will not start, the turn signal will turn on, the siren and bell will sound, and the SIM or KTP does not match. Figure 4.1 The RFID reader is installed on the inside of the front left side of the motorcycle, chosen because of its convenient location to help scan the card card. At the ID registration stage, namely by inputting the RFID program code in the Arduino, after the program code has been entered, press Complate, then Done, then the program that has been coded is correct. Then select Upload, if Done Uploading appears, the codingan program has been input into Arduino. After that, open the Serial Monitor and bring the RFIG Card / Tag close to the RFID Reader. Then the data from the RFID Card / Tag will appear.

3.2. Testing Tool Effectiveness

The results of the experiment were carried out to ensure the efficacy of the design of an RFID-based motorcycle key security system that uses a driver's license and ID card as Arduino-based tags with metrics:

3.2.1. Step Down Testing

The results of the step down output voltage test were measured using a multimeter, the results of this test can be seen in Table 3.

Table 3. Step Down Test Measurement Results

Testing	Voltage ACCU (volt)	Voltage Output (volt)	Reference (volt)	Difference (volt)
1	13.24	5.07	5	0.07
2	13.06	5.08	5	0.08
3	13.00	5.08	5	0.08
4	13.02	5.08	5	0.08
5	13.02	5.07	5	0.07
6	13.02	5.07	5	0.07
7	12.93	5.07	5	0.07
8	13.05	5.07	5	0.07

Testing	Voltage ACCU (volt)	Voltage Output (volt)	Reference (volt)	Difference (volt)
9	12.11	5.07	5	0.07
10	10.06	5.07	5	0.07
Average	12.651	5.073	5	0.073

Based on Table 3, the input voltage from the ACCU varies from 10.06 Volts to 13.24 Volts although there are fluctuations in the input voltage, the output voltage still remains stable at around 5.07 Volts. This shows that Steapdwon has good regulation capabilities, able to keep the output voltage stable despite variations in the input voltage. Voltage output generated by Stepdown shows a very good consistent value. From all experiments, the output voltage is around 5.07 Volts to 5.08 Volts, with very small variations. While the expected or reference output voltage is 5 volts. The actual output voltage is only slightly higher than the reference value with an average data difference of 5.07 volts to 5.08 volts with a very small variance.

3.2.2. Arduino Uno Voltage Testing

The results of this test are to ensure that the Arduino Uno output voltage to other components is as needed, Table 4 shows the test results.

Table 4. Arduino Voltage Test Measurement Results

Testing-	Voltage Input (volt)	Voltage Output (volt)
1	5.07	4.93
2	5.08	4.93
3	5.08	4.93
4	5.08	4.93
5	5.07	4.93
6	5.07	4.93
7	5.07	4.93
8	5.07	4.93
9	5.07	4.93
10	5.07	4.93
Average	5.073	4.93

Based on Table 4, the input voltage in each experiment is very consistent, between 5.07 Volts and 5.08 Volts. The average input voltage is 5.073 Volts. While the Output voltage also shows good consistency, between 4.93 Volts with an average of 4.93 Volts. As for the difference between Input and Output voltage, there is a slight decrease in voltage from input to output. The difference between the average input and output voltage is about 0.141 volts. Overall, the test results show that the Arduino Uno can maintain a very stable output voltage around 4.93 Volts from an input that is slightly higher than 5 Volts.

3.2.3. Electrical and Starter Function Test

In this metric, ten trials were conducted to test the electrical and starter functions. Table 5 shows the results of testing the starter and alarm functions.

Table 5. Electrical and Starter Function Test Results

No.	Testing	Success (%)
1	Electrical Function	100
2	Starter	100

Based on Table 5, the results of the electrical and starter function tests on the motorcycle show 100% success. This analysis shows that both tests work perfectly in all tests carried out. The function of electricity in this study includes all systems and components that depend on electricity to operate, such as front and rear lights, turn signals, clocks, dashboard indicators and so on. The test results show that all electrical components function properly without any failures. As for the starter test in this study, it also got a test result of 100%. The starter system on the motorcycle is responsible for starting the engine. 100% success in starter testing means that the starter system successfully starts the engine in each test performed.

3.2.4. Tag Testing on Distance and Time

In this test metric, 2 tests were carried out, namely testing registered tags 10 times, and testing on unregistered tags 10 times as well. To test the range of the RFID sensor, four types of tags registered on the Arduino were read at distances ranging from 0 to 4.5 cm. In addition, the activation speed of the device was tested ten times. Table 6 displays the test results on registered tags.

Table 6. Registered Tag Distance Measurement Results

Distance (cm)	e-SIM		e-KTP		RFID *card*		RFID *Keychain*	
	Readability	Time (s)	Readability	Time (s)	Readability	Time (s)	Readability	Time (s)
0	√	1.622s	√	1.621s	√	1.608s	√	1.614s
0.5	√	1.629s	√	1.622s	√	1.616s	√	1.614s
1	√	1.605s	√	1.611s	√	1.616s	√	1.625s
1.5	√	1.615s	√	1.620s	√	1.621s	√	1.625s
2	√	1.619s	√	1.620s	√	1.610s	√	1.616s
2.5	√	1.620s	-	-	√	1.613s	-	-
3	√	1.626s	-	-	√	1.631s	-	-
3.5	-	-	-	-	√	1.635s	-	-
4	-	-	-	-	√	1.626s	-	-
4.5	-	-	-	-	-	-	-	-
Average		1.619s		1.618s		1.619s		1.618s

Based on Table 6, it can be seen in the results of reading SIM and KTP tags, both types of tags can be read well up to a distance of 2 cm. at a distance of more than 2 cm, these two tags can no longer be read by the RFID sensor, while for the RFID Card has the best reading range, remaining readable up to a distance of 4 cm. This can be a better choice for applications that require a wider reading range. As for the RFID Keychain, its performance is similar to a driver's license and ID card, effective at a distance of up to 2 cm. The responsiveness of the RFID sensor is relatively uniform and fast at around 1.619 seconds, indicating that the RFID sensor is able to process and identify tags quickly and efficiently with small variations in reading time. This shows that this sensor is quite stable in performance, providing a consistent response at various distances and tag types.

Testing on unregistered cards is to test the feasibility of the alarm system in the event of a break-in or attempted scanning of an unregistered card on the system so that the system will respond and turn on the alarm on the following motor is the result of measuring the distance of unregistered tags can be seen in Table 7.

Table 7. Unregistered Tag Distance Testing Results

Distance (cm)	e-SIM		e-KTP		Kartu RFID		RFID *Keychain*	
	Readability	Time (s)	Readability	Time (s)	Readability	Time (s)	Readability	Time (s)
0	√	0.617s	√	0.625s	√	0.617s	√	0.622s
0.5	√	0.623s	√	0.626s	√	0.619s	√	0.632s
1	√	0.628s	√	0.612s	√	0.617s	√	0.629s
1.5	√	0.625s	√	0.635s	√	0.624s	√	0.621s
2	√	0.626s	√	0.633s	√	0.619s	√	0.623s
2.5	√	0.625s	-	-	√	0.627s	-	-
3	√	0.625s	-	-	√	0.626s	-	-
3.5	-	-	-	-	√	0.619s	-	-
4	-	-	-	-	√	0.623s	-	-
4.5	-	-	-	-	-	-	-	-
Average		0.624s		0.626s		0.621s		0.625s

Based on Table 7, it can be seen that the SIM measurement results can be read by the RFID sensor up to a distance of 2.5 cm. after this distance the SIM tag can no longer be read, while for the KTP tag it is read up to a distance of 2 cm, but is not read at a distance greater than that. And for the RFID card shows the best readability, it remains readable up to a distance of 4 cm. this shows that the RFID Card has a better antenna or one that matches the sensor used and the last RFID Keychain is read up to a distance of 2 cm, after which it is no longer read by the sensor. The average reading time for all tag types was around 0.624 seconds and there was no significant difference in reading time between the various tag types and distances, indicating that the

RFID sensor processed tags efficiently and fairly uniformly under the conditions tested. Overall, these results indicate that the RFID sensor has a good ability to detect and respond to unregistered tags, with a fast response time.

3.2.5. Tag Testing

In this test metric, 2 tests were carried out, namely testing registered tags 10 times, and testing on unregistered tags 10 times as well. Table 8 displays the results of testing registered tags with 10 trials.

Table 8. Experiment Results using Registered Tags

No	Tag variation	Succes (%)
1	SIM	100
2	KTP	100
3	Kartu RFID	100
4	RFID *Keychain*	100

gBased on Table 8, all types of tags tested namely SIM, KTP, RFID Card, and RFID Keychain have a 100% success rate. It can be stated that the RFID sensor successfully detected and identified all the registered tags perfectly in every experiment conducted and also the RFID sensor successfully recognized and distinguished between the different types of registered tags. This confirms that RFID sensors are reliable in applications that require the recognition of registered tags, providing a solid foundation for security, identification, and efficient management in a variety of contexts.

Testing on unregistered cards is to test the feasibility of the alarm system in the event of a break-in or attempted scanning of an unregistered card on the system so that the system will respond and turn on the alarm on the motor, the following are the results of the unregistered tag experiment can be seen in Table 9.

Table 9. Experiment Results using Unregistered Tags

No	Tag variation	Succes (%)
1	SIM	100
2	KTP	100
3	Kartu RFID	100
4	RFID *Keychain*	100

Based on Table 9, the measurement results of unregistered tags show that the RFID sensor is successful in detecting and identifying unregistered tags with a 100% success rate. The RFID sensor successfully recognizes and distinguishes between different types of unregistered tags, showing good ability to process signals from each tag. The 100% success confirms that the RFID sensor gives consistent and reliable responses in detecting unregistered tags. These results confirm that RFID sensors can be used to detect unregistered tags in security applications.

3.2.6. Testing RFID with Barriers

In this test metric, 3 tests were carried out, namely testing with HVS paper, acrylic, and plywood barriers. In this test, the number of barriers was increased, on HVS paper, 20 sheets were added to each test, on acrylic and plywood, 1 sheet was added to each test, each barrier was tested 5 times with an increasing number. Table 10 shows the results of the Tag with HVS Paper Stack test.

Table 10. Tag Testing Results with HVS Paper Stacks

Number of sheets	SIM	KTP	RFID tag	RFID *Keychain*
20	√	√	√	√
40	√	√	√	√
60	√	√	√	√
80	√	√	√	√
100	√	√	√	√

Based on Table 10, the results of tag measurements with stacks of HVS paper. The first experiment was carried out by stacking 20 sheets of HVS paper and the identification results of all tags could be read by the RFID Reader, then again the addition of stacking on HVS paper as many as 40 sheets and the identification results of all tags could be read by the RFID Reader, and added another stack of HVS paper as many as 60 sheets RFID Reader is still able to detect all tags until the stack of HVS as many as 100 sheets RFID Reader barrier is still able to read all types of tags. Table 11 displays the results of testing the barrier with acrylic stacks.

Table 11. Tag Testing Results with Acrylic Stacks

Number of stacks	Thickness (mm)	SIM	KTP	RFID *Card*	RFID *Keychain*
1	0.37	√	√	√	√
2	0.75	√	√	√	√
3	1.50	√	-	√	√
4	1.87	-	-	√	-
5	2.24	-	-	-	-

Based on Table 11, the results obtained state that for SIM reading it can be read with 3 stacks of acrylic with a thickness of 1.5 mm. while for ID card tag reading it only reaches 2 stacks with a thickness of 0.75 mm. and for reading on RFID cards read up to 4 stacks with a thickness of 1.87 mm and the last is on RFID Keychain able to be read with 3 stacks of acrylic with a thickness of 1.5 cm. Table 12 displays barrier testing with plywood stacks.

Table 12. Tag Testing Results with Plywood Stack

Number of stacks	Thickness (mm)	SIM	KTP	RFID *Card*	RFID *Keychain*
1	0.59	√	√	√	√
2	1.18	√	√	√	√
3	1.77	√	-	√	√
4	2.36	-	-	√	-
5	2.95	-	-	-	-

Based on Table 12, the reading on the SIM tag can be read as many as 4 stacks with a thickness of 2.36 mm. and for the KTP tag, it can be read with 3 plywood stacks with a thickness of 1.77 mm. As for the RFID Card tag and RFID keychain can be read up to 4 stacks with a thickness of 2.36 mm.

4. CONCLUSIONS

The conclusion obtained from this research shows that the RFID-based motorcycle safety device designed using Arduino works well. This security system that utilizes RFID cards and Arduino Uno has proven effective in preventing motorcycle theft. From a series of tests that have been carried out, it is known that RFID cards have a high reading success rate, both in terms of distance and when there are barrier attributes such as HVS paper, acrylic, and plywood. This research managed to achieve a 100% success rate in reading experiments against all types of tags that have been registered and unregistered.

For suggestions, this research suggests further development on motor vehicle starter systems that use RFID cards and microcontrollers. This development especially needs to focus on integration with other security systems, such as surveillance cameras or GPS. In addition, it is also recommended to test this system on a larger scale by involving more vehicles and different locations to get more comprehensive results.

REFERENCES

[1] Tangkowit, . A. E., Palilingan, V. R., & Liando, O. E. S. (2021). ANALISIS DAN PERANCANGAN JARINGAN KOMPUTER DI SEKOLAH MENENGAH PERTAMA. Edutik : Jurnal Pendidikan Teknologi Informasi Dan Komunikasi, 1(1), 69-82. https://doi.org/10.53682/edutik.v1i1.1044.

[2] Fikri, R. (2023). Optimalisasi Keamanan Rumah dengan Implementasi Sistem Notifikasi Gerbang Cerdas Berbasis Internet of Things (IoT). Journal of Computer System and Informatics (JoSYC), 4(4), 816-829. https://doi.org/10.47065/josyc.v4i4.4004.

[3] Hamdani, R., Puspita, H., & Wildan, D. R. (2019). Pembuatan Sistem Pengamanan Kendaraan Bermotor Berbasis Radio Frequency Identification (Rfid). Jurnal: Industri Elektro dan Penerbangan, 8(2).

[4] Romdoni, M. Y., & Fuad, F. (2019). Rancangan Bangun Sistem Keamanan Sepeda Motor Menggunakan RFID dan Arduino. Jurnal Ilmiah Sains dan Teknologi, 3(1), 48-58.

[5] Lidinnasa, A. A. N. (2022). Penanggulangan Tindak Pidana Pencurian Di Mobil Angkutan Umum Di Wilayah Hukum Polresta Pekanbaru (Doctoral dissertation, Universitas Islam Riau). https://repository.uir.ac.id/11858/.

[6] Hisyam, C. J., Rodja, Z., Salsabila, N., Aisyah, K. P., Aldrian, N., & Augea, S. M. (2023). KEKERASAN BADAN DAN NYAWA: ANALISIS KASUS PEMBEGALAN BERDASARKAN TEORI ANOMIE DURKHEIM. Jurnal Ilmiah Research Student, 1(2), 492-500. https://doi.org/10.61722/jirs.v1i2.349.

[7] Faqih, M. N., Budiyono, B., & Prasetyo, I. (2022). Rancang Bangun Prototype Sistem Keamanan Sepeda Motor Berbasis E-SIM Menggunakan RFID. Surya Teknika, 32-37.

[8] Musyafa, F. F., Pamuji, S., & Nasrullah, H. (2021). Sistem Keamanan Sepeda Motor Mio Gt Berbasis Arduino Uno Dan Rfid. Auto Tech: Jurnal Pendidikan Teknik Otomotif Universitas Muhammadiyah Purworejo, 16(2), 174-186.
[9] Indriastuti, M. T., Arifin, S., Fadhilah, N., & Aprilianto, T. (2020). Rancang bangun sistem keamanan sepeda motor menggunakan arduino nano dan android via bluetooth. Jurnal Ilmiah Teknologi Informasi Asia, 14(1), 19-30.
[10] Novianti, N., Amin, M., & Kifti, W. M. (2021). Metode Exponential Smoothing Pada Peramalan Tingkat Kriminalitas Pencurian Sepeda Motor. J-Com (Journal of Computer), 1(1), 15-20.
[11] Syahra, M. N., Soesanto, E., Azahra, Y. P., & Diana, N. H. (2024). PERAN MAHASISWA SEBAGAI AGEN PERUBAHAN DALAM MENJAGA KEAMANAN TINDAK KEJAHATAN PENCURIAN DI LINGKUNGAN KAMPUS. HUMANITIS: Jurnal Homaniora, Sosial dan Bisnis, 2(1), 94-101.
[12] 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).
[13] Brahmantara, I. G. N. A., Dewi, A. A. S. L., & Sukaryati, N. M. (2020). Peranan Reserse Kriminal dalam Mengungkap Tindak Pidana Pencurian Kendaraan Bermotor di Wilayah Hukum Polsek Ubud. Jurnal Preference Hukum, 1(1), 14-20.
[14] Hadynata[1], B., & Aprilia, T. PENGALAMAN MASYARAKAT YANG MENGALAMI AKSI PENCURIAN DI KOTA LUBUKLINGGAU.
[15] 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).
[16] Ali, I. (2024). Tinjauan Hukum Terhadap Peran Kepolisian Dalam Penanggulangan Tindak Pidana Pencurian Hewan Ternak di Polsek Penrang. Legal Journal of Law, 3(1), 30-42.
[17] Wildan, M., Hesti, A., Anan, S., & Rofiq, M. (2023). Sistem Keamanan Sepeda Motor Menggunakan Voice Recognition Yang Terintegrasi Dengan Helm. JATISI (Jurnal Teknik Informatika dan Sistem Informasi), 10(2).
[18] Wildan, M., Hesti, A., Anan, S., & Rofiq, M. (2023). Sistem Keamanan Sepeda Motor Menggunakan Voice Recognition Yang Terintegrasi Dengan Helm. JATISI (Jurnal Teknik Informatika dan Sistem Informasi), 10(2).
[19] Almuzani, N., & Purnomo, T. (2022). THE EDUCATION TO INCREASE AWARENESS OF FISHERMEN'S SAFETY AND SECURITY THROUGH CERTIFICATION IN ORDER TO INCREASE HUMAN DEVELOPMENT INDEX IN CENTRAL JAVA: LITERATURE STUDY. Asian Journal of Aquatic Sciences, 5(1), 42-54.
[20] Hayati, R. N., Saputra, S., & Anggraini, R. (2023). Digitalisasi Manajemen Sistem Dokumen Pengelolaan Perpustakaan Universitas Bumigora Menggunakan Teknologi Radio Frequency Identification (RFID). Digital Business Journal, 1(1), 45-58.
[21] ARI, S. (2022). Rancang Bangun Keamanan Portal Parkir Otomatis Menggunakan Teknologi Radio Frequency Identification (Rfid) Dengan Sistem Counting Berbasis Arduino Uno.
[22] AL HABSYI, Y. E. S. A. OTOMATISASI PELAYANAN BINATU BERBASIS RASPBERRY PI UNTUK MENINGKATKAN EFEKTIVITAS DAN EFISIENSI KEGIATAN OPERASIONAL DAN PELAYANAN BINATU.
[23] Sensussiana, T., & Ns, M. K. (2020). Modul Pembelajaran Teknologi Informasi dan Komunikasi.
[24] Fajar, R., Handayani, H., & Juwita, A. (2022). Perancangan Kunci Pintu Digital dengan Elektronik Kartu Tanda Penduduk Berbasis Internet of Things. Scientific Student Journal for Information, Technology and Science, 3(2), 260-267.
[25] Soedarmo, H. (2008). Panduan Praktis Merawat & Memperbaiki Sepeda Motor. (No Title).