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PROTOTYPE DOORSTOP WITH RFID SENSORS ARDUINO-BASED AS A VEHICLE SECURITY SYSTEM AT UNIVERSITIES

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ABSTRAK

Pesatnya perkembangan teknologi ditandai dengan kemajuan dalam penciptaan alat yang dapat membantu pekerjaan manusia, seperti salah satu teknologi yang sedang dikembangkan oleh penulis, yaitu teknologi Smart Parking menggunakan RFID (Frequency Radio Identification). RFID adalah teknologi nirkabel untuk transfer data jarak pendek. Ini adalah sifat RFID yang memungkinkan teknologi ini menjadi sistem keselamatan kendaraan yang efektif. Teknologi RFID dapat merekam data yang masuk dan keluar menggunakan kartu terdaftar. Penulis mencoba menerapkan dan mengembangkan RFID ini menjadi perangkat keamanan yang sederhana dan mudah digunakan. Dalam percobaan, alat ini akan dicoba dengan 2 kartu terdaftar dan 1 kartu yang tidak terdaftar masing-masing 10 kali. Para penulis mencoba menguji seberapa akurat pembaca RFID dalam membaca kartu terdaftar. Selain RFID, penulis juga menggunakan sensor ultrasonik untuk mendeteksi kendaraan yang lewat. Hasil tes menunjukkan bahwa pembaca RFID dapat berfungsi dengan baik dan dapat membaca dengan tingkat akurasi yang tepat dan waktu rata-rata 0,6 detik. Selain itu, penulis juga memasukkan uji coba menggunakan penghalang dalam RFID yang bertujuan untuk mengidentifikasi sejauh mana frekuensi dalam RFID dapat bekerja bahkan jika mereka masih diblokir oleh objek lain, hasilnya adalah bahwa pembaca RFID masih dapat membaca kartu yang terdaftar pada jarak 1,5cm dan ketebalan penghalang hingga 2,0mm. Dalam masa percobaan, penulis merasa cukup puas dengan hasil kinerja perangkat, tetapi penulis merasa bahwa perangkat masih dapat dikembangkan.

Kata kunci: *Palang Pintu, Sensor, RFID, Parkir Pintar*

ABSTRACT

The rapid development of technology marks an advance in creating tools that can help people work, such as one of the technologies being developed by the author, namely Smart Parking technology using RFID (Frequency Radio Identification). RFID is a wireless technology for short-distance data transfer. The nature of RFID allows this technology to become an effective vehicle safety system. RFID technology can record incoming and outgoing data using a registered card. The author tried to implement and develop this RFID into a simple and easy-to-use security device. The tool will be tried in the experiment with two registered cards and one unregistered card 10 times each. The authors tried to test how accurate RFID readers were at reading registered cards. In addition to RFID, the authors also use ultrasonic sensors to detect passing vehicles. The test results showed that the RFID reader could function adequately and read with the right degree of accuracy and an average time of 0.6 seconds. In addition, the authors also included trials using barriers in RFID aimed at identifying the extent to which frequencies in RFID can work even if other objects still block them, the result being that RFID readers can still read cards registered at a distance of 1.5cm and barrier thicknesses of up to 2.0mm. In the trial period, the author felt quite satisfied with the results of the device's performance, but the author thought that the device could still be developed.

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***Keywords**: Doorstops, Sensor, RFID, Smart Parking*

INTRODUCTION

The modern world is rapidly evolving, driven by scientific inventions and technological discoveries that facilitate the creation of a wide range of smart devices, equipment, and systems. These intelligent devices, equipment, and methods include robots, smart vehicles, smart transportation systems, automation, smart sensors, communication systems, and various other gadgets. Through the development of this technology, human life has become more accessible, flexible, and comfortable. Today, multiple aspects of human life are fully or partially influenced by modern technology and its blessings. Along with the development of technology that is present around us, technology must be able to help and facilitate our daily work. Likewise, parking systems continue to grow and evolve, starting with manual data collection, then changing into barcodes, and eventually, barcode systems will be replaced by RFID systems.

t is not uncommon for us to find doorstops in public places or industrial areas, which help maintain the safety of vehicles parked in the environment and have been considered an effective form of protection to limit the movement of vehicles in an area; therefore, these doorstops are widely used as vehicle parking barriers. As mentioned in the title of this article, the author uses doorstops as models for prototypes.

Based on the type, the parking system is divided into 2. First, conventional parking systems, which still use parking tickets as proof of parking, and computerized parking systems, which use the help of computers to automate the parking process. Both types of parking systems have their advantages and disadvantages. For conventional parking systems, the advantage is that their use is familiar, considered manageable, and does not require technological investment. On the other hand, this system has a weakness: frequent errors in writing tickets by parking attendants, thus impacting the long service time due to the duplication process. Rewrite the ticket. Another drawback is the waste of packaging paper and unrecorded transaction data. Then for computerized parking system also has advantages and disadvantages. The benefits include management problems with conventional parking systems that can be eliminated. Computerized parking systems generally use barcode technology, but President University has not used Radio Frequency Identification (RFID) technology as an authentication medium. Barcode technology has advantages such as automation of data realization by using barcode scanners, the accuracy of data reading, and is easy to use so that information and data processing will be more accurate. (Setiadi, Priyandari and Cahyono 2017)

RFID (Radio-Frequency Identification) technology has many uses, one of which is for security systems in parking. RFID security like this is commonly called Smart Parking. RFID is a technology that can replace optical barcodes in the future, today's technology is increasingly advanced, especially in electronics and telecommunications, and many developers are developing RFID technology (Prasetyo and Kartadie 2019). This technology will be combined with doorstops which is one of the smart campus concepts. The development of the smart campus concept is needed by universities in Indonesia to increase lecture activities both inside and outside the classroom and is also useful as an assessment to improve accreditation (Noprianto and Rijayanti 2008).

Many campuses still use manual parking systems and have not used computerized technology that helps with parking guard work. As already mentioned in the previous paragraph that RFID is commonly used in parking security. The system encourages the authors of this paper to implement smart parking generally on all campuses so that students are easier and faster to do activities on campus. The system enables the authors of this paper to implement smart parking generally on all campuses so that students are easier and quicker to do activities on campus.

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RESEARCH METHODS

First, the author conducts the Observation Method, a data collection technique, by conducting research and direct review of the problems. The problem that the author found on campus is a manual paid parking tool that is quite time-consuming to produce, and the tickets are often potentially lost.

Furthermore, the author also conducts Literature Studies, namely data collection techniques, by collecting data through literature, journals, papers, and readings that have something to do with the research title. This process is carried out to find and collect all information to construct parking systems using RFID technology and a database. (Kurniawan, Budisetiawan And Hartono 2014).

Table 1. Matrix Data Literature Review

Previous Research	Journal Name	Components used	Implementation	Project Conclusion
Parking tools are still semi-conventional using human operators	"Sistem Keamanan Area Parkir Stkip Pgri Tulungagung Berbasis Radio Frequency Identification (Rfid)" (Prasetyo and Kartadie 2019)	RFID Reader, RFID Tag, IC L293D, Stepper Motor, MP3, AVR ATmega 8535 Microcontroller, InfraRed Transmitter, InfraRed Receiver, Power Supply, and LCD.	Prototype	related to the author's but has differences in the infrared sensor used
There are no related devices yet	"Pengelolaan Sistem Parkir Dengan Rfid Berbasis Arduino Uno" (Prasetyo, Argoteo and Supriyono 2017)	RFID Reader, RFID Tag, L293D IC, Servo Motor, Arduino uno and LCD.	Prototype	related to the author's property but has the difference of not using Ultrasonic sensors
Parking facilities are still manual with written as an entry sign	"Aplikasi Sistem Parkir Kendaraan Bermotor Berbasis Kartu Rfid"(Yusuf and Srisulistiowati 2020)	RFID Reader, RFID Tag, UML Diagram, MySQL Data Web Application	Software, Simulation	Use different components and use the software as an IoT medium
Conventional parking system	"Implementation Of Parking System Based On Radio Frequency Identification (Rfid) At The Faculty Of Engineering Sebelas Maret University"	Transponder, RFID Reader ultra-high frequency (UHF), RFID tag, Parking bar, computer database, MySQL	Real Device	Using the same way tools work but with different components and equipped with an IoT database

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(Setiadi, Priyandari, and Cahyono 2017)

From the 5 data matrices collected by the author, there are some differences in each device created. In journals 1 and 2, the authors of the journal made a similar mini prototype, but there are differences in the sensors used. While in journal 3, the authors the journal focus more on IoT software creation. Then in journal 4, the author creates a device of actual size and directly tested in the field, not forgetting that the author of journal 4 pinned IoT technology, but the author did not Arduino is used as a microcontroller. While in the journal, five authors use Arduino on the device, and IoT technology uses ESP8266, the shortcomings of this journal is that there is no actual image of the device used.

The author conducted a study using the Analysis Experimental method to create the device, which aims to develop and test prototype doorstops with RFID sensors to make the vehicle's security system safer. This research will produce a prototype, and the authors will directly try it in the field. The results of this method can change to maximize the potential of this prototype again if the authors find things that are not suitable during the experiment.

The author used the HC-sr04 ultrasonic sensor and tested whether the ultrasonic sensor was correct by manually measuring it using a ruler while monitoring the ultrasonic sensor using Arduino ide software the results of the trial will be displayed in the Result and Discussion chapter

In addition, the quantitative method used to measure smart doorstops is to use RFID tags, student cards, and unregistered ATM cards. The testing focused on distance tests, how the system identified the card, and checking whether the unregistered cards could access the door. On the other hand, it was also tested if there were any chance on the registered card or the card data, how is the system would reject it? The experiment was tested using three cards, and each card was tested ten times.

RFID (Radio Frequency Identification) is a method of identification using a means called an RFID label or transponder to store and retrieve data on an object. This technology is used to identify the entry and exit of vehicles in an environment. The working system of this tool is an RFID reader that will read or scan the address on the RFID card owned by the team member or customer of the agency. When the necessary data and the data entered are appropriate, the microcontroller device will give the machine the command to open and close the doorstops without third-party intervention.

In another implementation area, RFID can manage doorstop security access control systems. It also can be used to store data entering or exiting vehicles. In this work, The RFID was used to support a smart parking prototype integrated with automatic doorstops and arduino as a basic microcontroller.

Project Components:

1. Arduino Uno

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Figure 1. Arduino Uno

Arduino Uno is a microcontroller board based on ATmega328 (datasheet). It has 14 input pins from the digital output of which 6 input pins can be used as PWM output and 6 analog input pins, a 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. (Banzi and M. Shiloh 2022) To support microcontrollers for use, it is enough to connect the Arduino Uno board to the computer using a USB or power cable with an AC-to-DC adapter or battery to run it. Arduino is a simple open-source microcontroller system that is widely used to build basic electronic projects.

2. RFID-RC522

Figure 2. RFID-RC522 (hitechchain 2022)

RFID (Radio Frequency Identification) is a radio frequency identification system using tags or labels attached to the object to be identified. A two-way radio transmitter-receiver, called a checker or reader, sends a signal to the tag and then reads the response. Generally, readers send observations to computer systems running RFID software or intermediate software. Barcodes are binary codes consisting of bars and slots arranged in parallel configurations. RFID Uses Barcodes as a Way to Identify Something. (Finkenzler 2010)

3. Servo Motor

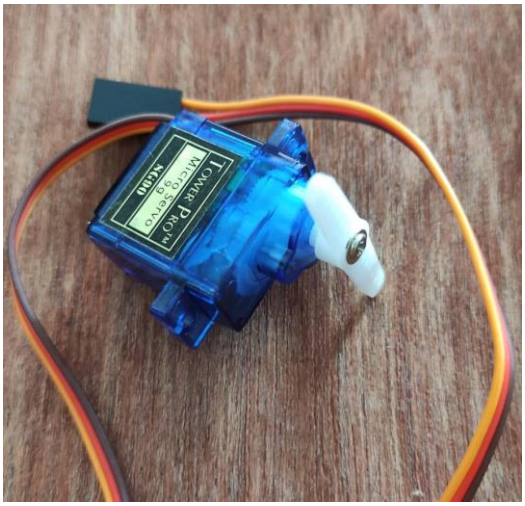

Figure 3. Servo Motor

Servo motors are electronic devices designed to use a closed-loop type (servo) control system as a drive in a circuit that produces torque and speed based on a particular electric current and voltage. Servo motors serve to push or rotate objects with high-precision control in terms of angular position, acceleration, and speed, capabilities that ordinary motors do not have.

4. HC-SR04 Ultrasonic Sensor

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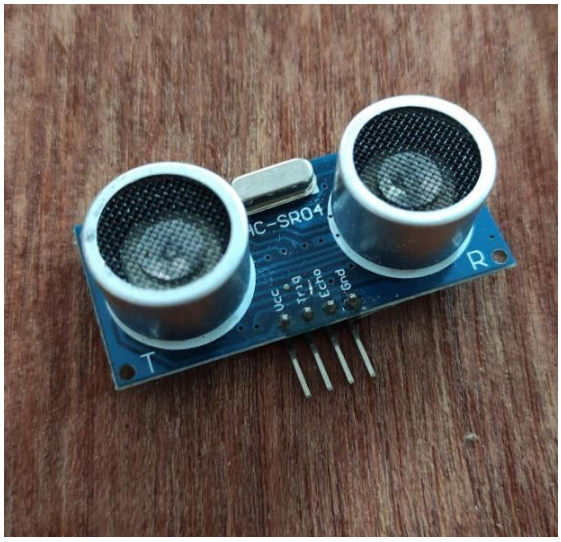

Figure 4. HC-SR04 Ultrasonic Sensor

An ultrasonic sensor is a sensor that works on the principle of reflection of sound waves and is used to detect the presence of a particular object in front of it, its working frequency being in the area above the sound waves from 40 kHz to 400 kHz.(Carullo and Marco Parvis 2001)

5. RFID Tag Card

Figure 5. RFID Chip Card

An RFID label or card is an object that can be installed or inserted in a product in the form of a card or other form for identification using radio waves. Each tag has a unique ID of 10 digits each, allowing tracking of tags through radio waves(Yusuf and D. B. Srisulistiowati 2020). Cards that have been implanted with Passive RFID technology and have been registered on the device can be used to access Devices that have Active RFID. Passive RFID has no resources of its own and will only activate when tapped or carried to the reader (RFID chip reader). Our Indonesian ID card also has passive RFID technology. ID cards are designed to embed chips on cards that have high-security authentication, encryption, and digital signature capabilities so that they can be registered on an RFID chip reader. In addition to ID cards, ATM cards and E-toll cards also have chips for payment.

6. LCD I2C

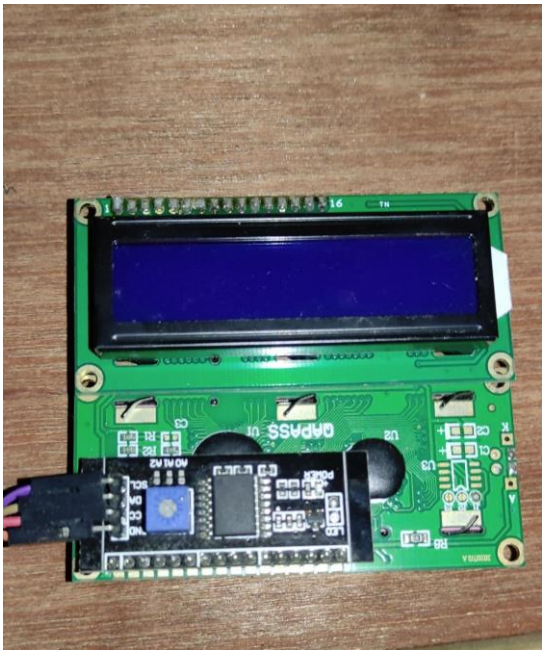

Figure 6. LCD and I2C

I2C LCD is a serially controlled LCD module in sync with the I2C/IIC (Inter-Integrated Circuit) protocol I2C LCD is a serially controlled LCD module in sync with the I2C/IIC (Inter-Integrated Circuit) protocol

A. Modeling

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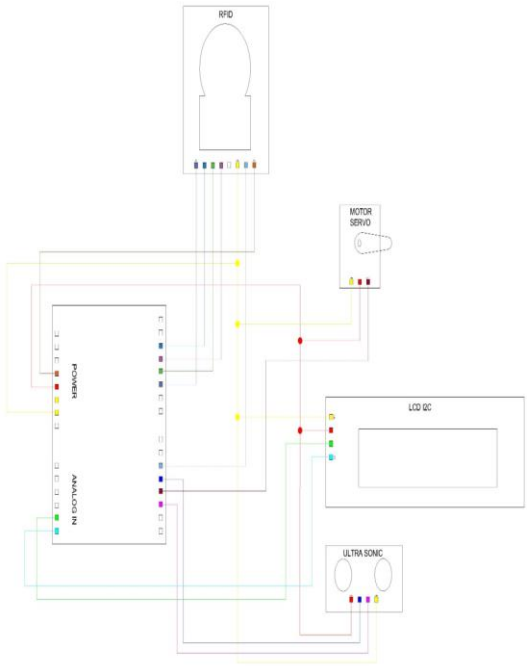

Figure 7. Wiring Device

As for the wiring prototype that the author made such as Figure 1.7

B. FlowChart

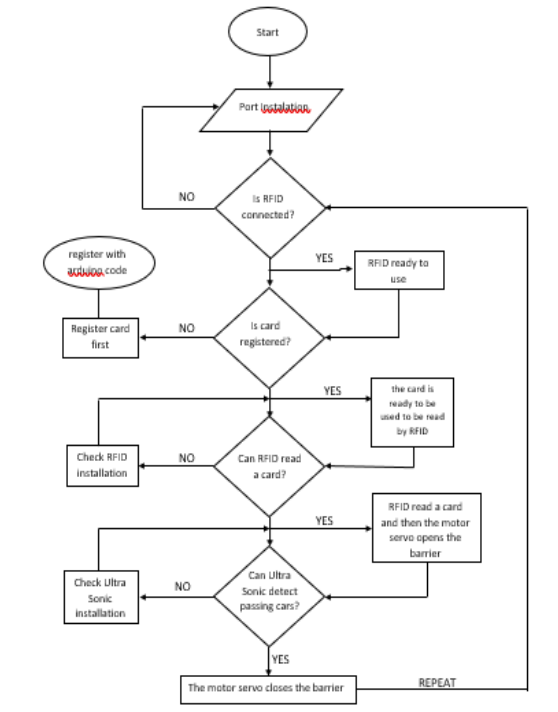

Figure 8. Flowchart

We used an experimental method that aims to create and test smart parking prototypes that use Automatic doorstops. By creating this prototype we can look at the performance of the tool and evaluate its shortcomings of the prototype before it is implemented into an actual tool in the field.

The prototype uses Arduino as the main microcontroller as a place to accommodate component system commands. The RFID sensor is the main sensor in this tool because it has an important role as an RFID reader that serves to read the RFID chip emitting card. We use RFID chip cards as a medium to provide access to the staff and students concerned. Not all RFID chip cards can receive access and open doorstop RFID readers. Previously, we had to register an RFID chip card to have legal access. Only registered cards have acceptable access and can open doorstops.

This prototype will be made as shown in the schematic image [Figure 1.7]. If all components have been installed and the coding has entered the microcontroller, the prototype is ready to be tested. The trial will begin when the doorstop is closed. When the user's vehicle wants to enter the parking area, the user must use a card that has been registered with the RFID reader. When the card is pasted and the doorstop opens then access is accepted. However, if the affixed card does not open the doorstop, it means that access is denied, then the user must register the card on the RFID reader. Once access is received and the user passes through the doorstop, the user will continue to walk until he is in front of the ultrasonic sensor.

RESULTS AND DISCUSSIONS

To produce an accurate device the author conducts a test on the sensor used before being assembled on the prototype. First, the author tested the Ultrasonic sensor (HC-04SR). The author conducted a test by placing the object on the ruler exactly at 10cm and the Ultrasonic sensor at 0cm. The result is that is seen in the table there are 37 data and there are still more afterward with an Accuracy Rate of 98%. Further testing is carried out on the RFID reader sensor by inserting coding into the Arduino that is deprogrammed to read the RFID Tag. The results of the experiment showed that the RFID reader can read 2 different RFID tags.

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This indicates that the RFID reader is working properly.Results from Ultrasonic and RFID sensor experiments before the raft became a prototype:

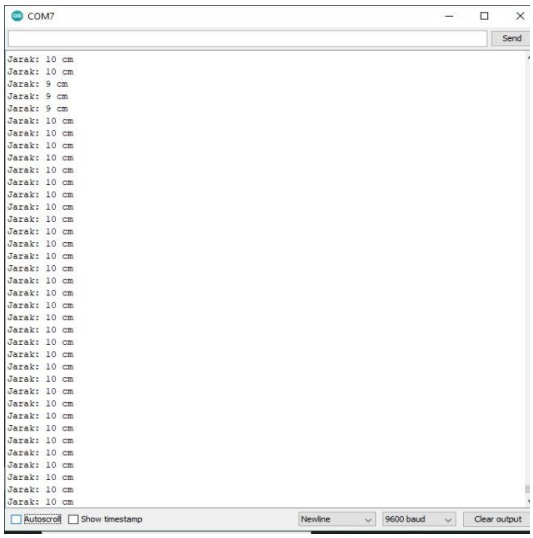

Figure 9. Result for Ultrasonic Test

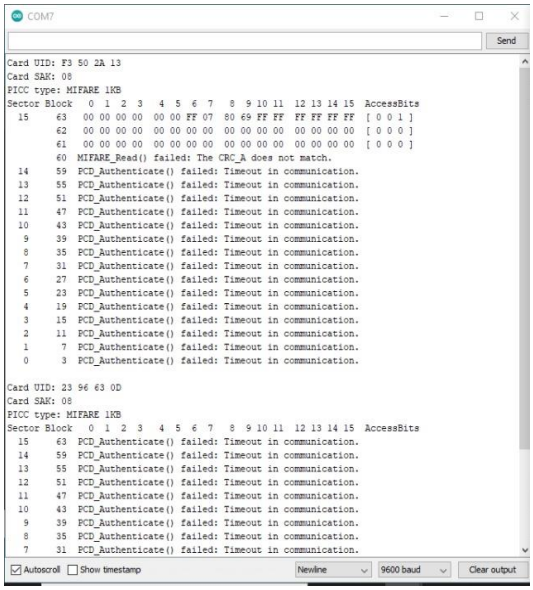

Figure 10. Result for RFID reader Test

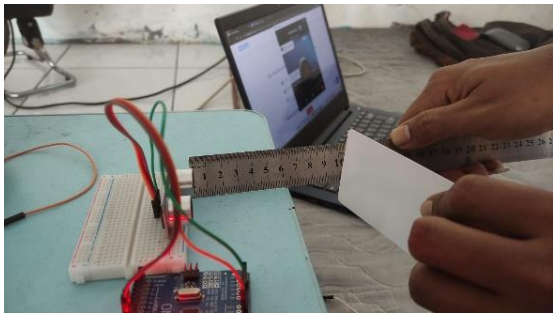

Figure 11. Ultrasonic sensor test

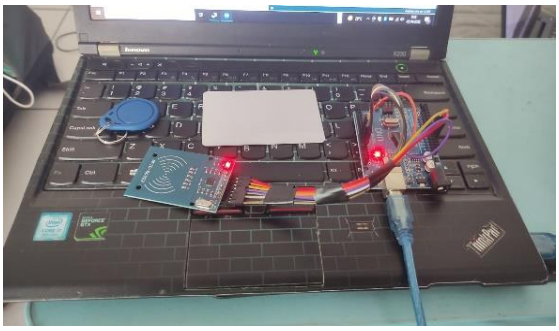

Figure 12. RFID reader Test

Based on these results it was concluded that the sensor used was in good condition and accurate.

In addition, the author also applied the test on the RFID reader to be used for the prototype by providing a program to read several RFID card tags and the result can read 2 cards well as much as 10 times with a maximum distance of 3cm. After making sure both sensors are working properly then set the device to fit the plan. In short, the device is ready and ready to be tested as in the following image.

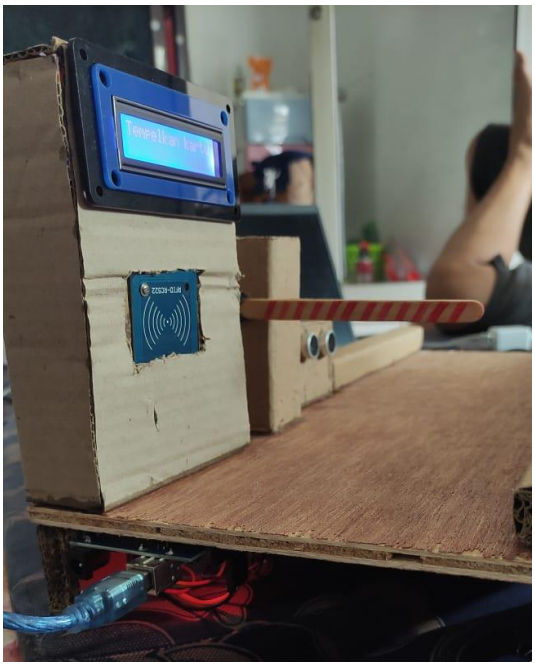

Figure 13. Prototype Smart Doorstops

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Because the device is ready, the author will start testing the prototype. First, the author connected the prototype with 5V voltage electricity, then the trial was conducted when the doorstops were closed. The author brings the object closer to the doorstops, then attaches the RFID tag to the RFID reader then the RFID reader will send data and process the data in Arduino.

Figure 14. Scanning RFID tags on RFID reader

When the RFID reader reads the RFID tag with the number that has been registered, then the data will be verified correctly and Arduino will send an order to the doorstop to open, then after the object enters and passes through the ultrasonic sensor, the door will be stutedup again like Figure 15 below.

Figure 15. Object has passed doorstops

The author experimented 10 times on 3 different RFID card tags, The author used 2 registered RFID tags and 1 unregistered RFID tag. The author conducted a trial with distance parameters to get the remotest data that the RFID reader could read. In addition, the author also tested the RFID reader using other parameters, namely the barrier 0.5mm – 2.0mm thick so that it gets the following results.

Card 1 (ID Tag : F3 50 2A 13)			
Distance (cm)	Responsive (sec)	Barrier (mm)	Result
5	-	No	No
4,5	-	No	No
4	-	No	No
3,5	-	No	No
3	-	No	No
2,5	0,7	No	Read
2	0,57	No	Read
1,5	0,95	0,5	Read
1,5	1,21	1	Read
1,5	1,34	2	Read

Table 1.1

Card 2 (ID Tag : 23 96 63 0D)			
Distance (cm)	Responsive (sec)	Barrier (mm)	Result
5	-	No	No

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4,5	-	No	No
4	-	No	No
3,5	-	No	No
3	-	No	No
2,5	0,65	No	Read
2	0,51	No	Read
1,5	1,12	0,5	Read
1,5	1,19	1	Read
1,5	1,32	2	Read

Table 1.2

Card 3 (ID Tag : 14 34 99 7A) (No register)

Distance (cm)	Responsive (sec)	Barrier (mm)	Result
5	-	No	No
4,5	-	No	No
4	-	No	No
3,5	-	No	No
3	-	No	No
2,5	-	No	No
2	-	No	No
1,5	-	0,5	No
1,5	-	1	No
1,5	-	2	No

Table 1.3

The first test is carried out on 2 registered cards. As stated in Table 0.1 and Table 0.2, it can be concluded that the prototype can read all the cards listed well but has different time delays. In addition, the authors also included trials using barriers in RFID aimed at identifying the extent to which frequencies in RFID can work even if they are still blocked by other objects, the result being that RFID readers can still read cards registered at a distance of 1.5cm and barrier thicknesses of up to 2.0mm. Then the second test is done on one card that is not registered 10 times as well and the result is that the RFID reader reads accurately so that unregistered cards cannot access doorstops and doorstops do not open.

As for after the experiment 10 times it can be concluded that the prototype went well. When tested with registered cards all work well only sometimes it has a slight delay of about 0.3 seconds. The farthest distance of the reader frequency is 3cm.

CONCLUSION

From the results of the trials conducted, the authors concluded that this Prototype was successful and accurate. From the data that has been compiled the author uses 2 RFID tags that have been registered can open the doorstop up to each card 10 times during the experiment without any errors that make the doorstop can not open. Likewise, trials with 1 unregistered RFID tag up to 10 attempts never once opened doorstops. In addition, the author also uses the barrier as a test medium whether with RFID reader barrier can still read RFID tags? It turned out that by the expectations of the author who brought the RFID reader could still read RFID tags but the range of RFID reader transmitters was reduced which was able to read up to a distance of 3cm to be reduced to 1.5 cm. Another drawback of this device may lie in the erratic reading time of the RFID reader, but the time difference is only very short.

In this modern era, it should use sophisticated and efficient security. Smart doorstops with RFID sensor systems have been successfully made by the author can be applied in real life after passing a thorough trial. We hope that this system can make it easier for students at each university to enter or leave campus more easily and practically. In addition to providing easy access, RFID also makes security systems more sophisticated and secure. In the future, improvements can be made by adding IoT features to this system to add a safer and easier-to-use cashless feature, and installing all the cables on the PCB will make all components simpler.

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