

SMART DOOR LOCK SYSTEM DEVELOPMENT PROTOTYPE USING RFID TECHNOLOGY ID-12

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Abstract

This smart door lock system is intended to make it easier to control security in specific homes or rooms, such as government offices or factories, to prevent unauthorized entry into a small space. This automatic door lock system includes an ID-12 RFID reader, tag/transponder, Arduino UNO R3, 5v buzzer, drop bolt lock, relay module, and LCD. This ID-12 RFID reader functions as both a receiver and a transmitter. RFID improves system performance by enhancing information acquisition and remote digital archiving. This research aims to develop RFID-based technology by combining it with current information technology development. Contribute to the advancement of scientifically based digital technology.

Keywords: RFID; Reader; Arduino; Smart Lock Door

Abstrak

Sistem kunci pintu pintar ini di desain untuk mempermudah pengontrolan keamanan pada rumah atau ruangan tertentu seperti pada kantor pemerintahan maupun pabrik untuk membatasi seseorang masuk ke dalam ruangan terbatas. Dalam sistem pada kunci pintu otomatis ini menggunakan RFID reader tipe ID-12, tag/transponder, arduino UNO R3, buzzer 5v, drop bolt lock, modul relay, dan LCD. Dimana RFID reader ID-12 ini digunakan sebagai receiver dan tag/transponder sebagai transmitter. RFID meningkatkan kinerja sistem dengan meningkatkan perolehan informasi dan pengarsipan jarak jauh dalam bentuk digital. Tujuan penelitian ini mengembangkan teknologi berbasis RFID dengan menggabungkannya dengan perkembangan teknologi informasi saat ini. Sehingga memberikan kontribusi bagi pengembangan ilmu pengetahuan berbasis teknologi digital.

Kata kunci: RFID; Reader; Arduino; Kunci Pintu Pintar.

INTRODUCTION

Modernization conditions are present, especially in Indonesia, which has entered industrial development 4.0. In this case, it impacts the phenomenon that is a combination of computer telecommunications and automation, so technology is growing more rapidly and more advanced. Automation and data turnover have been widely used in a company's infrastructure. In the era of

increasing industry 4.0, the industry has started to touch the online situation, which creates integration with users, devices, and data, or can be said as IoT, AI, big data, machine learning, and cloud computing (Hermawan, 2021). The Internet of Things (IoT) is a system where computing devices, digital machines, and mechanical devices have an interrelated connection wherein carrying out data communication functions on the internet network does not require human interaction with computers or interactions between humans. This IoT system

combines four components: data processing, sensor devices, connectivity, and user interfaces. Examples of IoT applications in Indonesia include e-Fishery (IoT for automatic fish feeders), Hara (IoT for food and agriculture), Gowes (IoT for bike sharing), Qlue (IoT for smart cities), and RFID (IoT for smart lock doors) (Abir, Islam, Anwar, Mahmood, & Oo, 2020; Oktian, Witanto, & Lee, 2021)

The background of making a smart door lock system using Arduino-based RFID technology, in general, is that the company wants the activities of its employees to be easy or flexible in terms of room security in each division or department. Security is the most important and beneficial thing in life. Security can recommend issues of peace and satisfaction to individuals so that they can carry out their activities or activities every day to be smooth. Security is carried out from anywhere, from homes, buildings, rooms, safes, vehicles, electronic goods, and everything that can be secured. One example is in the room, which can be secured by using a door lock, either conventionally (manually) or automatically (Lonika & Hariyanto, 2019; Pavelic, Loncaric, Vukovic, & Kusek, 2018). Some of the shortcomings that are often encountered in manual door lock systems are that it is difficult to open the lock when you want to use it and keys that can be damaged or lost, or broken into; also, they provide very simple ways to copy or copy, which reduce the level of security and efficiency in use. Therefore, starting now, we have designed the first stage of developing electronic and automatic room security performance (Hasan, Abdurrahman, Wijanarko, Muslimin, & Maulidda, 2020; Oktafian, Desriyanti, & Vidyastari, 2020)

Manual or conventional lock systems have weaknesses, namely keys that are easily damaged or lost, easy to break into, and straightforward ways to copy. In addition, the manual lock system can affect the increase in transmission of the covid-19 virus because the User must be in direct contact with the key attached to the door (Wijaya & Yulianto, 2021). Arduino is one of the ATmega microcontrollers with serial 328. On the other hand, it has about 14 input and output markers, which are located with six markers that can be used as PWM outputs, equipped with six analog inputs, a 16 MHz crystal oscillator, USB integration, head ICSP, power jack, and restart button. Besides, the ability of Arduino to support a microcontroller to connect to computers using USB wireless itself (Launuru, Mauhutu, & Leuhery, 2021). The Arduino has advantages for users compared to other microcontroller boards, such as being open source based, having programming languages such as C/C++, and being on the Arduino board installed in such a way that a USB-equipped

loader allows for efficiency (Devira Ramady & Juliana, 2019; Rahmi & Oktaferi, 2021). The performance of other microcontrollers is very dependent on the loader system characteristics. The last is that this USB part, except for the loader when processing it, can be used as a serial telecommunications part (Candra, Triyono, Zen Kadir, & Tusi, 2016)

RFID has a simple basic concept. RFID is a device that can receive and store information in a small scope by using a numbering system tool. RFID can be classified into two components, namely, readers and transponders. RFID optimizes system performance, maximizes obtaining information, and archives it remotely in digital form (Wijaya & Yulianto, 2021). In addition, the existing basis in RFID can highlight radio frequencies and detect information based on transponders.

On the other hand, a transponder is a minimalist form; examples are cards and stickers, which have been glued to the antenna or IC. If we pair the tag with the reader, the reader can certainly identify the code contained in the tag and then display it via the LCD. It will be done from the serial by entering the system using an ATmega type 328, which is used as a key for the automatic door (Simarangkir & Suryanto, 2020; Syukuryansyah, Setiyadi, & Rofiah, 2020).

This research aims to create a prototype, particularly a smart door, using updated RFID technology built on the Arduino Uno. It also aims to create an intelligent door lock system using RFID technology built on the Arduino Uno. RFID technology has several advantages, including users or company employees not having to enter the key when opening the room door. Having a fixed or stationary reader makes this RFID system more robust. A compelling picture or design can provide convenience when used in specific locations and is more resistant to certain conditions such as dust and chemical impurities. Lastly, the marker from scanning the most challenging RFID card can be imitated and duplicated (Devira Ramady & Juliana, 2019).

The benefits of research include advancements in science and technology, as well as a contribution to society through practical tools. Some systems, previously in the form of manual or analog, have to change to digital technology. This research develops RFID-based technology by combining it with current information technology developments. This research will contribute to the development of science-based digital technology.

RESEARCH METHODS

In compiling and completing this research, the author describes the design of the research method used through the process steps in determining the type of research data using qualitative methods (Sugiyono, 2017, 2019). A qualitative methodology is an approach to exploring and understanding a central phenomenon to produce scientific discoveries, but it cannot be achieved using statistical procedures. It can show certain aspects so that the data becomes a benchmark as a reference to obtain maximum results; in addition, the basis of this approach emphasizes the quality or the most important thing, the meaning behind the events that occur based on individual perceptions in a narrative or straightforward manner to find a definite answer (Creswell & Creswell, 2017; Lantu, Triady, Utami, & Ghazali, 2016). The steps in the research are (1) finding, determining, and setting a problem. (2) drafting a theoretical framework. (3) Make assumptions if necessary. (4) Determine certain factors. (5) Determine the data collection technique. (6) Regulating the research design. (7) Ensure the sample is addressed. (8) summarizing and presenting data. (9) processing and analyzing the data, and (10) clarifying the analysis reaction and determining the conditions.

Figure 1 below is a prototype design of a smart door lock system using Radio Frequency Identification ID-12 technology based on Arduino Uno R3 Atmega328, which is being developed, resulting in a useful product for its users. The research object review focuses on smart or automatic door locks using Arduino-based RFID technology. This innovative door lock replaces the existing manual or conventional lock. Because manual locks have the disadvantage of being easily damaged or lost, easy to break into, and also causing an effortless way of copying, they can reduce the level of security and efficiency in use. Manual or conventional lock systems can also affect the increase in transmission of the COVID-19 virus because users have to come into direct contact with the key attached to the door.

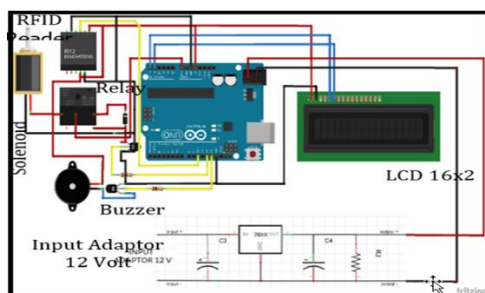


Figure 1. Design Prototype

Then in this study, the author uses a tool design consisting of analysis, design, or testing of the tool results. The solution needed to overcome an existing problem is in the form of a prototype of a device from an innovative door lock system using RFID technology.

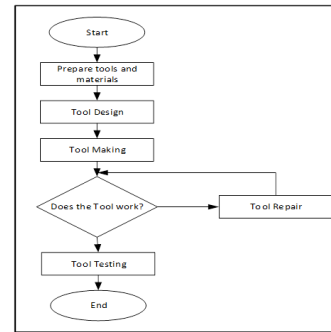


Figure 2. Research Method

Figure 3, the flowchart below, is a process system running on a smart door lock using Radio Frequency Identification technology based on Arduino Uno R3 Atmega328.

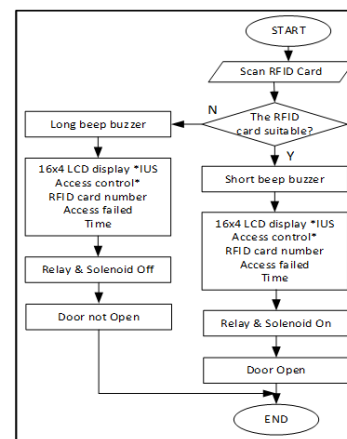


Figure 3. Process System

If the intelligent door lock system is on standby, the 16x4 LCDs the words "*IUS Access Control*" in the first line "there is no writing yet (will display the RFID Card number)." The second line shows the unique code or number of the RFID card. "there is no writing yet" (Figure 4).

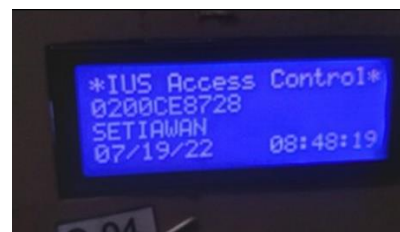


Figure 4. Display

In the third line it shows the name of the employee who has been registered in the system or on the RFID server. When the scanned RFID Card is registered, the buzzer sounds a short beep, the drop bolt lock or solenoid opens, and the 16x4 LCDs the words "*IUS Access Control*" on the first line, "0200CE8728" on the second line, "SETIAWAN" on the third line, and "07/19/22 08:48:19" on the fourth line. When the scanned RFID Card is not registered, the buzzer sounds a long beep, the drop bolt lock or solenoid opens, and the 16x2 LCDs the words "*IUS Access Control*" on the first line, "0200CE8728" on the second line, "Access Failed" on the second line. Third, and "07/19/22 08:44:57" on the fourth line. The fourth line shows the real-time date, month, year, hour, minute, and second.

If the prototype for developing a smart door lock system using RFID ID-12 technology is made on standby, the 16x2 LCDs have the words "Smart Door Lock" on the first line and "Scan Your RFID" on the second line. If the scanned RFID Card is registered, the 16x2 LCDs the words "Welcome" on the first line and "Employee Name" on the second line, and the relay module will turn on and then forward the voltage to the solenoid so that the door opens. If the scanned RFID Card is not registered, the buzzer sounds a long beep, and the 16x2 LCDs the words "Your Card is Not" on the first line, "Registered" on the second line, and the relay module will remain inactive / off then do not transmit voltage to the solenoid, so the door doesn't open.

Starting from the features and functions that can be used for users, here are the functional requirements for the smart door lock tool, including (1) Users can perform scanning tests on registered and unregistered RFID cards so that the safety of this tool will be maintained. (2) The system can lock the door again according to the time set by the User. In terms of functional requirements, there are also non-functional requirements of the tool, which are carried out by knowing specifically the security needs of door locks. The following are the non-functional requirements for an innovative door lock system using RFID technology: (1) voltage reduction of the L7805 Regulator IC on the smart door lock system device. (2) The User can perform a scan test of the RFID card at a certain distance. (3) This tool will not function if the electricity goes out (no current), and the door will be locked.

RESULTS AND DISCUSSION

The working principle of the tool is (1) Microcontroller Initialization, which describes turning on this smart door lock system. (2) Scan the RFID card. (3) If the scanned RFID card is registered,

the 16x2 LCDs the words "Welcome" on the first line and "User Name" on the second line, and the relay module will turn on and then forward the voltage to the solenoid so that the door opens. (4) If the scanned RFID Card is not registered, the buzzer sounds a long beep, the 16x2 LCDs the words "Your Card is Not" on the first line, "Registered" on the second line, and the relay module will remain inactive/off, and then no current will continue. (5) Storage of the Proximity Integrated Circuit Card/RFID Card ID Number This is written in the Arduino IDE sketch program, which is then uploaded to the Arduino Uno R3. After uploading, the PICC (Proximity Integrated Circuit Card)/RFID Card ID Number will be stored in the Arduino Uno R3 Atmega328 memory.

The working process of the intelligent door lock system using Radio Frequency Identification ID-12 technology based on Arduino Uno R3 Atmega328 is as follows. The scanned RFID tag/card/transponder will send hexadecimal data to the RFID Reader ID-12, which then, from the RFID Reader, will receive and send data to the Arduino. Then the Arduino UNO will process it by reading the program module (data from the RFID Tag/Card/Transponder) and giving commands to the buzzer to make a sound or notification, the relay module as a connector or breaker for the drop bolt lock or solenoid to open and lock the door, and 16x2 LCD to display the status of the scanned RFID card. The LCDs say "Smart Door Lock Scan Your RFID" when on standby. When the scanned RFID card is registered and the bolt lock or solenoid is open, the LCDs the words "Welcome." When the scanned RFID Card is not registered, and the drop bolt lock or solenoid is not open, the LCDs the words "Your Card is Unregistered."

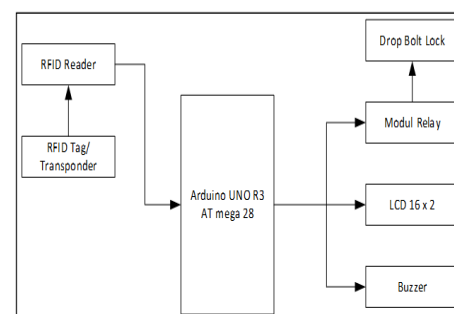


Figure 5. The process

The RFID system is tested by creating an RFID card recognition or registration program on the Arduino Uno R3 microcontroller. The RFID card data will be recognized and entered into the Arduino Uno R3 microcontroller memory database. The scanning test for registered and unregistered RFID

cards aims to ensure the system runs appropriately and as expected (both for registered and unregistered RFID cards).

RFID testing was carried out with 4 RFID cards, of which 2 RFID cards were registered to the system (Arduino Uno R3 Atmega328) memory, and the other two RFID cards were not registered to the system. The data in the table shows that an RFID reader can read the RFID card above according to the output. If the scanned RFID card is registered, the 16x2 LCDs the words "Welcome and Employee Name," the solenoid will open (on), and the door will open. If the scanned RFID card is not registered, the 16x2 LCDs "Your Card is Unregistered," the solenoid will not open (off), and the door will not open.

The RFID system is tested by automatically setting an automatic unlock and closing program when the scanned RFID card is registered. The relay will be active (on) and transmit current to the solenoid so that the solenoid becomes active (open) for a predetermined time. Then, the solenoid will be inactive (closed), and the relay will also be inactive (off) again.

RFID testing is carried out with 1 RFID card registered to the system (Arduino Uno R3 Atmega328) memory and set on the Arduino program for delay or solenoid time to close automatically. The data in table 1 shows that the RFID reader can read RFID cards according to the expected output on the Arduino program that has been made.

Tabel 1. Automatic Unlock and Close Test

Test	Time (Second)	Solenoid	Result
1	1	Auto close after 1"	OK
2	2	Auto close after 2"	OK
3	3	Auto close after 3"	OK
4	4	Auto close after 4"	OK
5	5	Auto close after 5"	OK
6	6	Auto close after 6"	OK
7	7	Auto close after 7"	OK
8	8	Auto close after 8"	OK
9	9	Auto close after 9"	OK
10	10	Auto close after 10"	OK

The purpose of testing the RFID system is to determine how far the RFID reader's reading distance is. The type of RFID reader used is ID-12, which has a unique function of detecting RFID cards with a frequency of 125kHz. The RFID card/tag is of type GK4001 because it is compatible with the RFID Reader ID-12. The test is carried out from 0 cm to 9 cm. It tested the detection distance of the card against the RFID reader.

When the electricity goes out (no voltage), the intelligent door lock system using Radio

Frequency Identification (RFID) ID-12 technology based on Arduino Uno R3 Atmega328 must not work, and the door condition (solenoid) will be locked. RFID testing is done in two directions: the top and the side. The data in the table shows that an RFID reader can read the RFID card above up to a distance of 7.5 cm. At the same time, the RFID card on the side can be read up to a distance of 6 cm.

The device can function with a voltage, as evidenced by the standby 16x2 LCD displaying "Smart Door Lock" in the first row, "Scan Your RFID" in the second row, and the fluke multimeter displaying a voltage of 209.4 Volt AC.

The tool cannot function when there is no mains voltage, as evidenced by the state of the 16x2 LCD not displaying anything and the fluke multimeter displaying a voltage of 0.0001 Volt AC.

This research has been attempted and carried out following existing scientific procedures, but still has some limitations that can affect the conditions of the research that has been carried out, such as the lack of time to conduct research and make a perfect prototype it would be nice to use a Raspberry Pi, the funds provided in completion of this research is very limited. There is no dedicated experimental laboratory on campus.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the study's results, it was concluded that the overall work process of the prototype system, especially the smart door using Radio Frequency Identification ID-12 technology based on Arduino Uno R3 Atmega328, produced by the system could be used for intelligent door locking. Company employees do not have to enter the key when opening the office door. Automatic doors can also reduce the transmission of the Covid-19 virus. System development adds several supporting components that are used to reduce the occurrence of problems with relays that affect the drop bolt lock or solenoid door lock.

Suggestion

The following are suggestions related to system development tailored to the needs of an organization. The intelligent door lock system using Radio Frequency Identification technology based on Arduino Uno R3 Atmega328 can also be used as employee attendance. This system is easy to implement or use; all employees are advised to use the 125kHz RFID card specification; It is recommended to replace the Arduino UNO R3 Atmega328 with a Raspberry Pi, which has better hardware specifications, is also modified as needed,

has an SD card that is useful for storage, and has provided an Ethernet port to connect to the network. Suggestions can be in the form of input for the next researcher, and they can also be implicative recommendations from the research findings

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