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Intelligent Security System in A Campus Building Using RFID to Improve Security for Elevator Users

Desmira[1,2], Mustofa Abi Hamid[1,3]*, Lilis Noviawati[1], Tubagus Ai Munandar[4], Martias[5], Didik Aribowo[1,6]

[1]Department of Electrical Engineering Vocational Education, Universitas Sultan Ageng Tirtayasa, Serang, Indonesia
[2]Department of Electrical Engineering, Universiti Teknikal Malaysia Melaka, Durian Tunggal, Malaysia
[3]Center for Vocational and Technical Education and Training, Mahiad Research Institute, Serang, Indonesia
[4]Department of Informatics, Universitas Bhayangkara Jakarta Raya, Jakarta Selatan, Indonesia
[5]Universitas Bina Sarana Informatika, Jakarta, Indonesia
[6]Department of Engineering Science, Postgraduate Programme, Universitas Sriwijaya, Palembang, Indonesia
*E-mail: abi.mustofa@untirta.ac.id

ABSTRACT

This study aims to develop an intelligent system of elevator access with RFID (Radio Frequency Identification) using fuzzy logic as an intelligent system, a safety controller of elevator doors that will open when the power goes out. This research made an Arduino Uno-based elevator access system with an RFID card using fuzzy logic as an intelligence system and markers for each floor. Each floor has an RFID card that contains the information data of each floor. This research uses research and development (R&D) methods with a waterfall development model. The research procedure consists of several stages, namely the requirement analysis stage, design, implementation, testing, operation, and maintenance. Based on the research and development of the elevator control intelligent system, it can be concluded that the intelligent control lift system was developed using a waterfall model. integration and system testing includes RFID-RC522 reading distance testing, component function testing, and RFID response time measurement testing. The test results show that the RFID-RC522 is readable, and the RFID response time is fast. In addition, the components and all features function well as an elevator control system.

Keywords: *RFID, intelligent security, elevator, security system, control system*

INTRODUCTION

Intelligent systems that are utilized as security and comfort systems in human activities are widely applied in various fields, for example RFID [1], [2], [3]. RFID is also utilized as a home security intelligent system [4][5] and an intelligent toll road security system [6][7]. The use of RFID integrated with IoT is also used in Guandong and Fujian Kindergartens to carry out various controls for the safety and security of children when playing in the school area [8]. To solve security problems in a theft that occurs, such as in a car, RFID using a GSM module can be used in case of suspicious actions [9]. The utilization of RFID in various fields of life is also widely used, for example in the intelligent parking system [10]. RFID is also widely used in the health sector to improve security and health in a hospital [11]. RFID also contributes positively to the intelligent system of safety and convenience in the production process [12][2]. High-rise buildings with elevator facilities require a high-security system so as not to cause crimes due to the actions of irresponsible people, so RFID is needed to improve the security and comfort of users of the building [13][14] [15].

One of the advantages of implementing an intelligent system using RFID is to get a more accurate position according to the desired target [16][17]. In addition, fuzzy research was developed to adaptively adjust environmental parameters [18][19][20]. In this study, an intelligent system model of control on the elevator was developed with various properties in the main object that can be controlled in an integrated manner. The intelligent system of elevator access security integrated with RFID technology is developing very rapidly because it

has a fairly good confidentiality code, although this system is very dependent on an operator. RFID (Radio Frequency Identification) which is used as control access to certain resources such as room rooms, elevators, meeting rooms, or other rooms must require an intelligent control system contained in the tag card as a security control.

This study aims to develop an intelligent system of elevator access with RFID (Radio Frequency Identification) using fuzzy logic as an intelligent system, a safety controller of elevator doors that will open when the power goes out. This research made an Arduino Uno-based elevator access system with an RFID card using fuzzy logic as an intelligence system and markers for each floor. Each floor has an RFID card that contains the information data of each floor.

METHODS

This research uses research and development (R&D) methods [21] with a waterfall development model [22] [23]. The stages of the waterfall model can be seen in Figure 1.

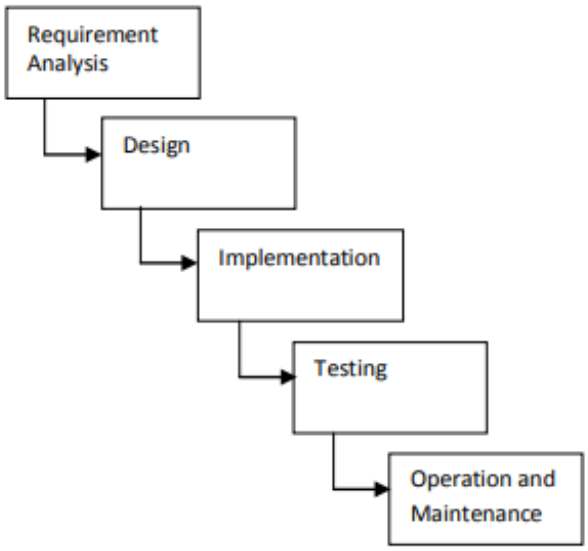

Figure 1. Waterfall model [24]

A. Requirement Analysis

The Requirement analysis stage is related to goal setting and design of the intelligent control lift system. At this stage, it defines in detail and sets the specifications of the intelligent elevator control system with RFID using Arduino-based fuzzy logic. This stage consists of two steps, namely literature review and field research. These hardware needs consist of DC motors, LEDs, LCD displays, buzzers, power supplies, reed switches, push buttons, and RFID tags. The software used is Arduino Integrated Development Environment (IDE) and by using the Matlab 2013a application. The elevator access rights system and goals are set through the system's user consultation. It is then defined in detail and serves as a specification of the design system for the elevator access prototype.

B. Design

At this stage, the smart lift control system is designed using Arduino ATMEGA2560. This stage adjusts the layout of the components to be used, such as DC motors, limit switch sensors, Push Buttons, and so on. Details of the Arduino-based lift control intelligent system can be seen in Figure 2. While this elevator door mechanic works when the elevator box has reached the destination floor, then the door on this elevator prototype is designed using a stepper and sg90 servo as the elevator drive.

Figure 2. Elevator Access Control Intelligent System Design

C. Implementation

Design an intelligent system-based elevator access with Arduino ATMEGA2560 integrated and tested as a complete intelligent system to ensure that the tool requirements have been met. Testing ensures that all features can run properly and on the external function, that is, directing the test to find errors and ensuring that

the restricted input will provide actual results that match the required results. Figure 3 is programming the Arduino IDE.

arduino_sistem_hak_akses_lift_27-02-2022

```
#include <SPI.h>
#include <MFRC522.h>
#include <Servo.h>
#include <LiquidCrystal_I2C.h>

// set the LCD number of columns and rows
int lcdColumns = 16;
int lcdRows = 2;

// set LCD address, number of columns and rows
// if you don't know your display address, run an I2C scanner sketch
LiquidCrystal_I2C lcd(0x3F, lcdColumns, lcdRows);
```

Figure 3. Arduino programming

Arduino is programmed using an IDE, so it can control sensors and a wide variety of electronic components. In addition, the program can instruct arduino to be able to communicate between electronic devices in such a way that it can serve to control the stepper motor, push button, LCD viewer, RFID reader and activate the relay.

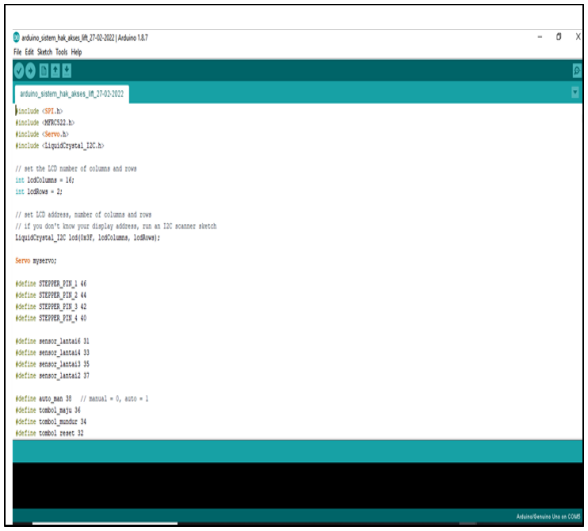

Figure 4. RFID Reader Response Time Measurement

D. Testing

These tests and measurements were carried out using an analog multimeter and the data obtained have been presented in figure 5.

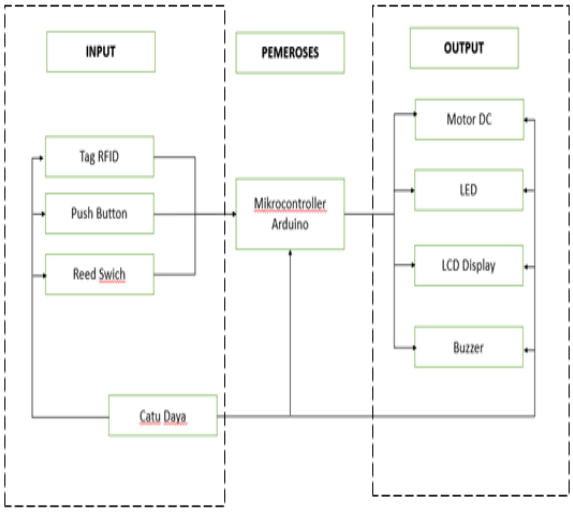

Figure 5. Analysis Diagram

Tests are carried out on inputs, processes and outputs by taking real measurements using a multimeter.

E. Operation and Maintenance

Operation and maintenance are the longest in the waterfall cycle phase. This intelligent system is installed and put into simple use. Maintenance involves correcting errors not found at the beginning of that stage of the waterfall cycle, improving the implementation of the unit's intelligent system and improving the service of the intelligent system as new requirements are discovered.

RESULT AND DISCUSSION

The following is a fuzzy inference system (FIS) mamdani applied to the RFID Tag input and push button lift output, where the variable value of the RFID Tag input set with 2 categories is accepted and rejected. Then for the output set value in the form of push button Lift with 2 active and inactive categories. From here, you will get fuzzy rules that are formed as desired. In fis intelligent systems designed using the Matlab 2013a application.

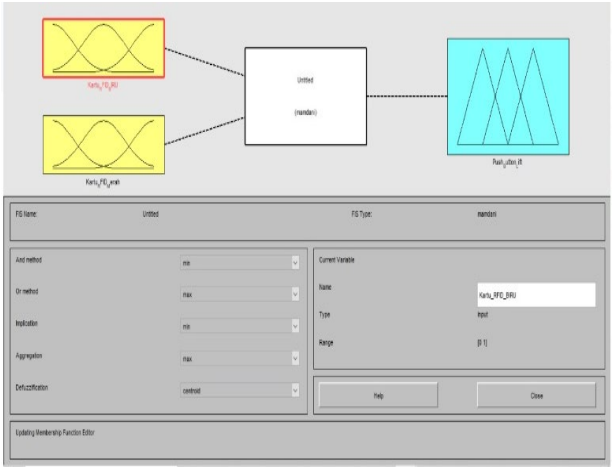

Figure 6. RFID Reader Response Time Measurement

A. Input on intelligent system

There are 2 input inputs on intelligent system, namely the Blue RFID Tag and the Red RFID Tag.

Table 1. Interval linguistic value

Lingustic value	Interval
Accepted	≤ 3.36 Volt
Rejected	>3.58

The representation with the graph can be seen in figure 7.

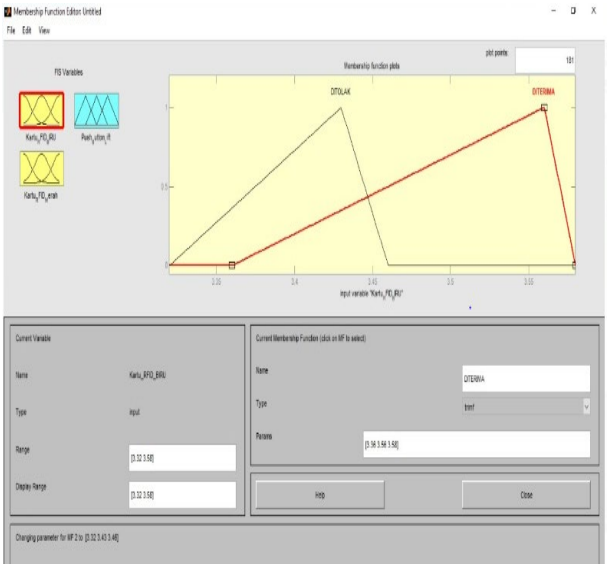

Figure 7. Blue RFID Tag graph diagram

Table 2. Interval linguistic value

Lingustic value	Interval
Accepted	≤ 3.38 Volt
Rejected	>3.58

The representation with the graph can be seen in figure 8.

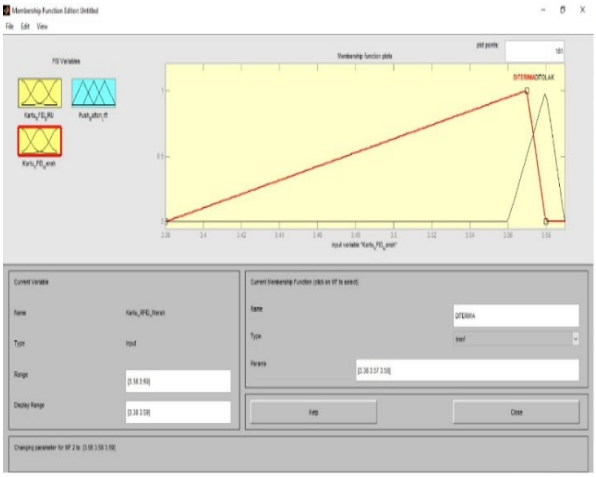

Figure 8. Red RFID Tag graph diagram

B. Output on Intelligent system

In this intelligent system output, there is an output in the form of an Elevator Button.

Table 3. Interval linguistic value

Lingustic value	Interval
Accepted	≤ 35Volt
Rejected	> 60 volt

The representation with the graph can be seen in figure 9

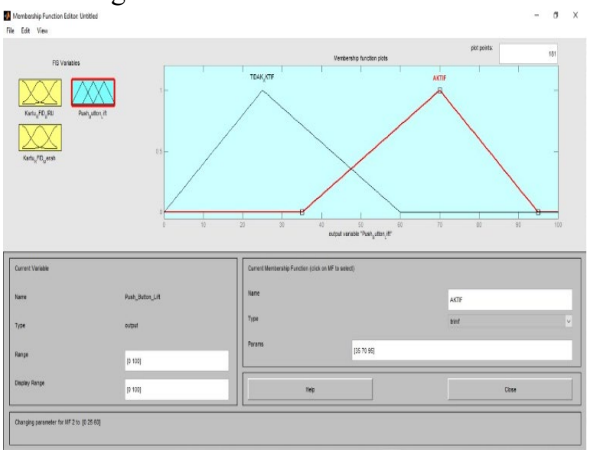

Figure 9. Push button Set Variable Output

C. Formation of rules

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled.

There are 4 rules formed to make an intelligent system of elevator access in making decisions these rules are as follows:

1. If (RFID_CARD is ACCEPTED) and (RED_RFID_CARD is ACCEPTED) Then (Push _Button_Lift is ACTIVE)
2. If (RFID_CARD is REJECTED) and (RED_RFID_CARD is ACCEPTED) Then (Push _Button_Lift is NOT_ACTIVE)
3. If (RFID_CARD is ACCEPTED) and (BLUE_RFID_CARD is ACCEPTED) Then (Push _Button_Lift is NOT_ACTIVE)
4. If (RFID_CARD is REJECTED) and (BLUE_RFID_CARD is ACCEPTED) Then (Push _Button_Lift is ACTIVE)

A graph of the intelligent system of elevator control using the fuzzy logic method mamdani can be seen in figure 10.

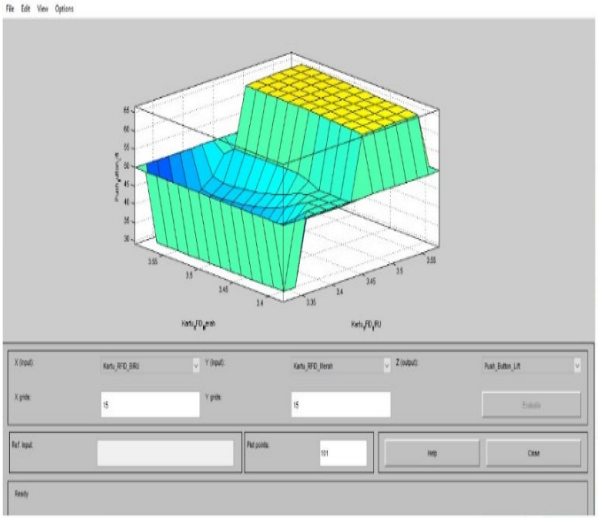

Figure 10. Graph Elevator control intelligent system

In determining the membership set of the elevator access intelligent system, the results of the reading of the voltage value obtained will be processed using the ascending and descending curve formula according to the curve of each membership set which is then the curve formula is changed into the C language program using if-Else instructions through the Arduino IDE application.

```
if (content.substring(1) == "4A 20 C0 80") //change here the UID of the card/cards that you want to give access
{

  digitalWrite (biru1, HIGH);
  digitalWrite (biru3, HIGH);
  digitalWrite (biru6, LOW);

  digitalWrite (biru2, LOW);
  digitalWrite (biru4, LOW);
  digitalWrite (biru5, LOW);

  digitalWrite (merah1, LOW);
  digitalWrite (merah2, LOW);
  digitalWrite (merah3, LOW);
  digitalWrite (merah4, LOW);
  digitalWrite (merah5, LOW);
  digitalWrite (merah6, LOW);

  akses_pb1 = 1;
  akses_pb3 = 1;
  akses_pb6 = 0;
  akses_pb2 = 0;
  akses_pb4 = 0;
  akses_pb5 = 0;
```

Figure 11. Fuzzyfication of RFID Tag Input In The Program

Arduino and RFID-RC522 are active hardware components because they are connected to a serial cable with a PC / Laptop to send UID (User ID) on the elevator control intelligent system card. Arduino and RFID are connected at Vcc 3.3 Vdc. Test results of the intelligent lift control system using fuzzy logic with RFID based on microcontroller atmega 2560 are as follows in table 4 and table 5.

Table 4. Blue RFID Tag Distance and Voltage Testing results when tapped and not tapped

No	Reading Distance	Blue RFID Tag (when tapped)		Blue RFID Tag (when not tapped)	
		Voltage	RFID RC522 Modul	Voltage	RFID RC522 Modul
1	0.5 cm	3,36 V	readable	3.33 V	readable
2	1 cm	3,54 V	readable	3.33 V	readable
3	1.5 cm	3,54 V	readable	3.32 V	readable
4	2 cm	3.56 V	readable	3.34 V	readable
5	2.5 cm	3.55 V	readable	3.43 V	readable
6	3 cm	3.58 V	readable	3.33 V	readable
7	3.5 cm	3.36 V	readable	3.46 V	readable
8	3.9 cm	3.58 V	unreadable	3.43 V	unreadable

Table 5. Red RFID Tag Distance and Voltage Testing results when tapped and not tapped

No	Reading Distance	Red RFID Tag (when tapped)		Red RFID Tag (when not tapped)	
		Voltage	RFID RC522 Modul	Voltage	RFID RC522 Modul
1	0.5 cm	3.38 V	readable	3.58 V	readable
2	1 cm	3.39 V	readable	3.56 V	readable
3	1.5 cm	3.39 V	readable	3.56 V	readable
4	2 cm	3.56 V	readable	3.59 V	readable
5	2.5 cm	3.56 V	readable	3.59 V	readable
6	3 cm	3.57 V	readable	3.57 V	readable
7	3.5 cm	3.55 V	readable	3.56 V	readable
8	3.9	3.58 V	unreadable	3.57 V	unreadable

CONCLUSION

Based on the results of the research and development of the elevator control intelligent system, it can be concluded that the intelligent control lift system was developed using a waterfall model. integration and system testing includes RFID-RC522 reading distance testing, component function testing, RFID response time measurement testing. The test results show that the RFID-RC522 is readable and the RFID response time is fast. In addition, the components and all features function well as an elevator control system

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