Published online on the page: https://journal.orange-institute.org/index.php/cister/index

International Journal CISTER

| ISSN (Online) 2963-2994 |

Orange Institute

Implementation of fuzzy logic controller for TV viewing distance detector tool

Selamat Muslimin [a,*]

[a] *Sriwijaya State Polytechnic, Palembang, Indonesia*

ARTICLE INFORMATION

Article History:
Received: 14 May 2023
Final Revision: 16 May 2023
Published *Online*: 17 May 2023

KEYWORDS

Fuzzy logic
TV
distance

CORRESPONDENCE

E-mail: selamet_muslimin@polsri.ac.id *

A B S T R A C T

This study describes the design of a safe distance detection device for watching TV using Arduino Uno. This system is expected to help reduce the risk of eye damage, especially those caused by viewing TV that is too close. This system functions to provide a warning in the form of an alarm where at a close distance the buzzer will activate and at a safe distance the buzzer will turn off. The system also provides warnings in the form of LEDs and LCDs as visual notification features, so that they can provide information to the audience to stay at a safe distance. In this study using the fuzzy logic method because this method is suitable for use in most real-time problems such as in making decisions to find variable and uncertain distances. With this fuzzy logic method, a mathematical framework is obtained that is used to represent uncertainty, ambiguity, inaccuracy, lack of information and partial truth.

I. Introduction

Leisure in watching television is indeed an important role that makes us feel at home for a long time watching television. But the behavior of people in Indonesia who watch television without regard to their distance and position while watching television, can endanger the condition of eye health [1].

When watching television, there are different safety distance provisions. Different sizes of televisions make the safe distance different too. However, in this system the safe distance reference used is 166 cm or 5.5 ft, which is a safe distance for watching television with a size of 42 inches and a screen resolution of 1080p [2]. To minimize losses from the negative impact of exposure to television rays, it will be very interesting to conduct research on safe distances when watching television using Arduino Uno. Arduino Uno is an Atmega328p microcontroller in the form of a circuit board.

To calculate the distance between the television and the object (audience) an ultrasonic sensor is used. Ultrasonic sensor is a sensor that has a function to convert physical or sound quantities into electrical quantities and vice versa. In the series of tools used there is a notification in the form of an LED light, buzzer and LCD.

LED (Light Emitting Diode) is a component that can emit monochromatic light when given a voltage made of semiconductor materials. While the buzzer is an electronic component that is included in the transducer family, which can convert electrical signals into sound vibrations [3]. The last component that functions as a warning is the LCD (Liquid Crystal Display) which is a type of display media that uses liquid crystals as the main viewer [4].

So that the television can be turned off automatically, a servo motor is added, which is a rotary device or actuator (motor) designed with a closed loop feedback control system (servo), so that it can be set-up or adjusted to determine and ensure the angular position of the output shaft Motor [5].

That way, besides helping to provide information to television viewers regarding safe distances. This tool will also immediately turn off the TV if the audience is outside a safe distance. The way this tool works is by applying a microcontroller-based fuzzy logic method.

To make it easier to understand the tools to be used, a flowchart is made. Flowchart is a chart with certain symbols that describe the sequence of processes in detail and the relationship between a process (instructions) and other processes in a program [6].

https://doi.org/10. 56481/cister.v2i01.153

II. Method

This study uses the Fuzzy Logic method. Where fuzzy logic is a problem-solving control system methodology, which is suitable to be implemented in systems, ranging from simple systems, small systems, embedded systems, PC networks, multi-channel or data acquisition-based workstations, and control systems. This methodology can be applied to hardware, software, or a combination of both. Fuzzy logic is used to estimate something, make decisions, and as a mechanical control. In a fuzzy set, it is known that the degree of membership has a range of values from 0 to 1. In contrast to a crisp set with membership values, there are only two possibilities, namely 1 and 0. Fuzzy theory provides a mechanism for representing linguistic variable sizes such as "dense", "medium ", "not dense", and so on[7].

The safety distance warning for watching TV has 2 linguistic variables, namely safe and unsafe. Then you will get input in the form of an ultrasonic sensor distance that detects a distance of 0-500 cm from the object, the range of values will be explained according to linguistic variables as shown in Table 1.

Table 1. Fuzzy Sets

No.	State Variable	Distance Value
1	Near	0 - 166 cm
2	Far	167 - 500 cm

With this range of values, when the ultrasonic sensor detects an unsafe distance, the system will automatically turn off the TV along with giving a warning in the form of a buzzer and a red LED. The status can also be seen on the LCD display. However, when the ultrasonic sensor detects a safe distance, the buzzer and LED are not active. However, the system will remain in the standby position, which is indicated by the active LCD.

Block diagrams are very helpful for the system design process, for that a system block diagram is made that describes the design made. The block diagram can be observed in the image below.

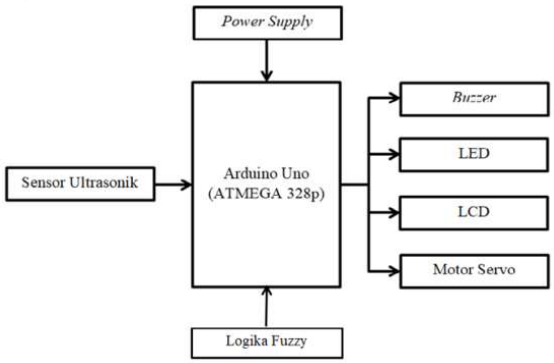

Figure 1. Block Diagram of the Design System

Figure 1 shows a work diagram for the development of a safe distance detection device for watching TV. The fuzzy logic method in this study is used to turn on the buzzer, LED and LCD as well as adjust the position of the servo motor at an angle that has been determined in the fuzzy logic rules, and detect the distance of objects using data from sensor output so that the audience stays at a safe distance.

2.1. Mechanical Design

Figures 2, 3, and 4 show the mechanical design of the TV viewing distance detector. On the inside of this tool box is placed Arduino Uno which is the controller of all components that will be used.

In this part of the tool is installed an ultrasonic sensor, LCD, LED, and also a buzzer. On the left side there is a DC power jack as the main power input for the system with a voltage of 7 – 12 V. On the top side is a servo motor that will be used to turn off the TV automatically.

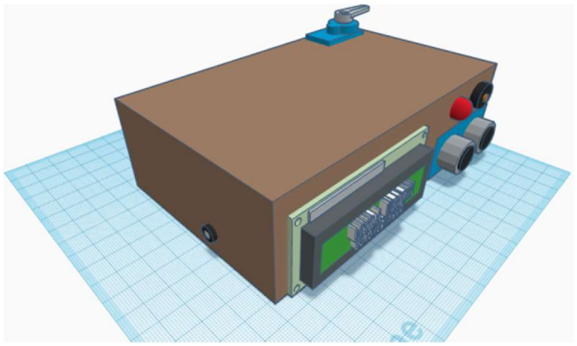

Figure 2. Figure 2. Design of a Safe Distance Detector for Watching TV Side View

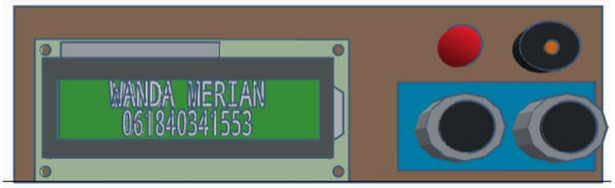

Figure 3. Figure 3. Design of a Front View Safe Distance Detector for Watching TV

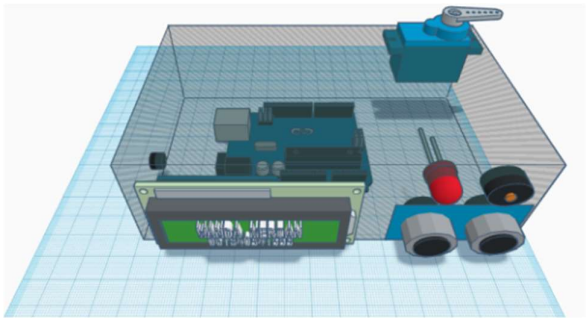

Figure 4. Design of a Safe Distance Detector for Watching TV Top View

https://doi.org/10.56481/cister.v2i01.153

E-ISSN : 2963-2994

2.2. Electrical Design

Figure 5 shows a schematic diagram of a safe distance detector for watching TV made using the Proteus application. While Figure 6 is a component design made using Tinkercad. The circuit consists of an HC-SR04 ultrasonic sensor, 16x2 LCD, red LED, buzzer, servo motor, and an Atmega 328 microcontroller.

The function of each component is the ultrasonic sensor as a detector for the distance between the device and the object in front of it, the Atmega 328 microcontroller as the brain that processes motion commands and how the entire system works, servo motors to turn off the TV automatically when an object is detected outside the distance. safe, while the LCD, LED, and buzzer also function to provide visual and audio warnings.

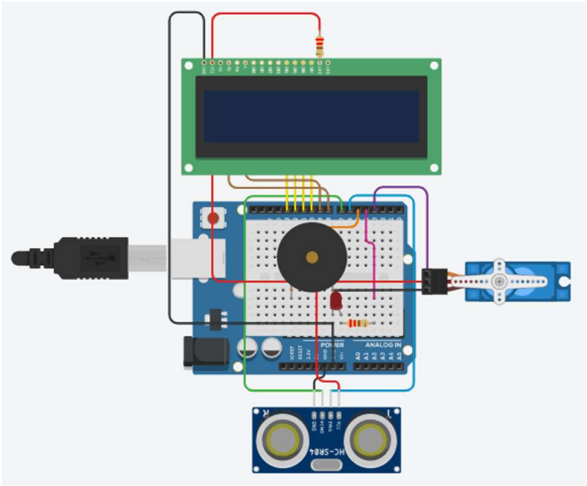

Figure 5. System Component Design

mamdani method in the simulation process. Fuzzy logic was chosen because it has several advantages, such as simple control, low cost, and can be described as counting words instead of numbers or controlling with equation sentences. In this case fuzzy logic shows the extent to which a value can be said to be true or false [8].

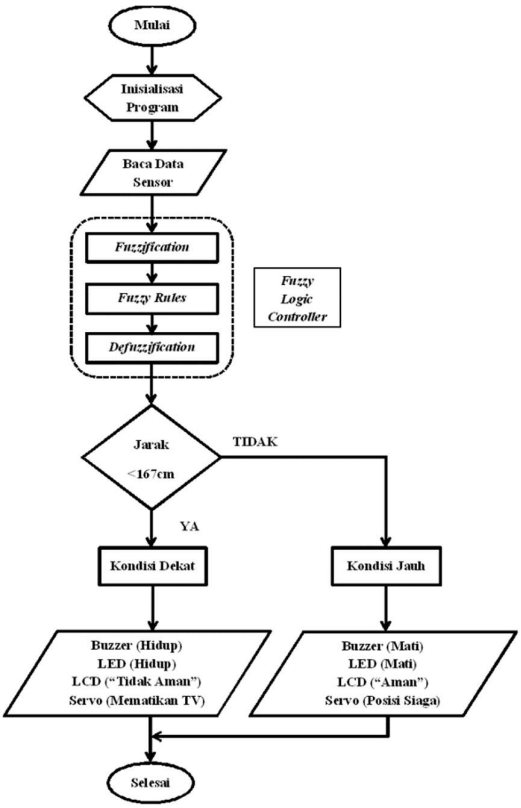

Figure 6. System Flowchart

III. Results and Discussion

In this study, there are two linguistic variables used to indicate the distance between objects and television, namely "Near" and "Far". Fuzzy rules are then designed using these linguistic variables. Ground rules are useful for the system to decide what to do. The overall fuzzy process flow chart is shown in Figure 6.

In Table 2, Figures 7 and 8 show the rules, inputs and outputs of the fuzzy logic used in this study for a safe distance control system for watching TV and using the

The results of the fuzzy set have a process system, the process system includes fuzzification, which is the process of mapping crisp input from the controlled system into a fuzzy set according to its function [9], which is in the form of linguistic values used in the form of "Near" and "Far", based on the function of certain membership. The fuzzification process can be seen in equations (1) and (2). Next, there is inference¸ inference, which is reasoning using predetermined fuzzy input and fuzzy rules to produce fuzzy output [8].

Table 2. An example of a table if it is too large is placed in the middle of the page

No.	Input	Output			
		LED	Buzzer	Servo	LCD
R1	Near	On	On	Turn off the TV	"Not safe"
R2	Far	Off	Off	Standby Position	"Safe"

E-ISSN : 2963-2994
https://doi.org/10.56481/cister.v2i01.153

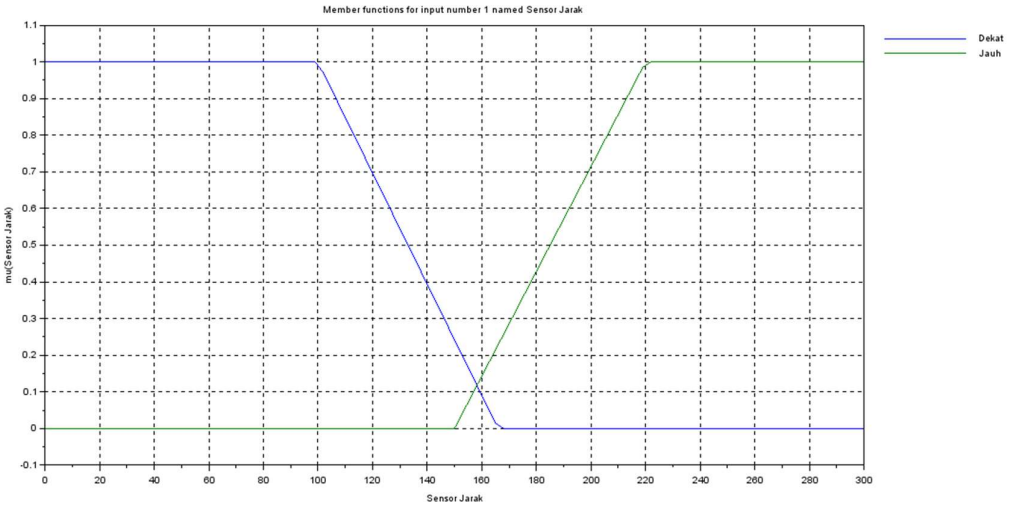

Figure 7. Membership Function of Input simulated with SciLab

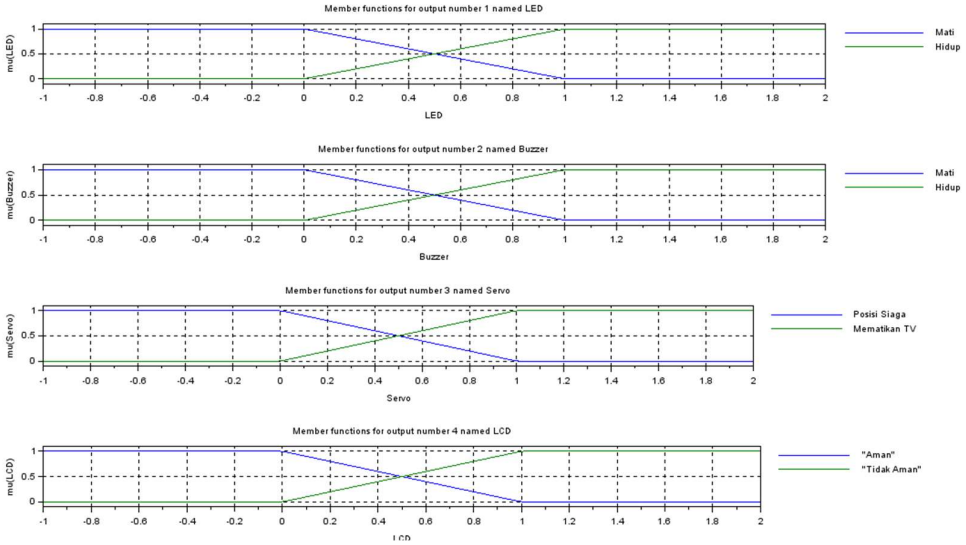

Figure 8. Membership Function of Output simulated with SciLab

$$Dekat\ [X] = \begin{cases} 1;\ x \le 100 \\ \frac{x-100}{166-100};\ 100 \le x \le 166 \\ 0;\ x \ge 166 \end{cases} \quad (1)$$

$$Jauh\ [X] = \begin{cases} 0;\ x \le 150 \\ \frac{x-150}{220-150};\ 150 \le x \le 220 \\ 1;\ x \ge 220 \end{cases} \quad (2)$$

The next process, namely defuzzification, is the last step in a fuzzy logic system with the aim of converting every result from the inference engine expressed in the form of a fuzzy set to a real number [10]. This process is shown in equations (3)-(15).

The equation obtained from each output:

$$Mati\ [X] = \begin{cases} 1;\ x \le 1 \\ \frac{1-x}{1-(-1)};\ -1 \le x \le 1 \\ 0;\ x \ge 1 \end{cases} \quad (3)$$

$$Hidup\ [X] = \begin{cases} 0;\ x \le 0 \\ \frac{1-x}{1-0};\ 0 \le x \le 1 \\ 1;\ x \ge 2 \end{cases} \quad (4)$$

$$Posisi\ Siaga\ [X] = \begin{cases} 1;\ x \le 1 \\ \frac{1-x}{1-(-1)};\ -1 \le x \le 1 \\ 0;\ x \ge 1 \end{cases} \quad (5)$$

$$Mematikan\ TV\ [X] = \begin{cases} 0;\ x \le 0 \\ \frac{1-x}{1-0};\ 0 \le x \le 1 \\ 1;\ x \ge 2 \end{cases} \quad (6)$$

https://doi.org/10.56481/cister.v2i01.153

E-ISSN : 2963-2994

$$"Aman"[X] = \begin{cases} 1;\ x \le 1 \\ \frac{1-x}{1-(-1)};\ -1 \le x \le 1 \\ 0;\ x \ge 1 \end{cases} \quad (7)$$

$$"Tidak\ Aman"[X] = \begin{cases} 0;\ x \le 0 \\ \frac{1-x}{1-0};\ 0 \le x \le 1 \\ 1;\ x \ge 2 \end{cases} \quad (8)$$

An example of an equation to find the moment:

$$M1 = \int_0^1 (0.25)z\ dz = 0.125 \quad (9)$$

$$M2 = \int_1^2 \frac{z-1}{2-1} z\ dz = 0.833 \quad (10)$$

$$M3 = \int_0^2 (0.75)z\ dz = 1.5 \quad (11)$$

An example of an equation to find the area of an area:

$$A1 = 0.25 \times 1 = 0.25 \quad (12)$$

$$A2 = \frac{(0.25+0.75)\times(2-1)}{2} = 0.5 \quad (13)$$

$$A3 = 0.75 \times (2-1) = 0.75 \quad (14)$$

So, the defuzzification value of the example is:

$$z = \frac{M1+M2+M3}{A1+A2+A3} = 1.638 \quad (15)$$

The fuzzy logic applied in this study is designed to provide feedback from the distance sensor to the servo rotation angle to turn off the television and the outputs are LED, buzzer, servo, and LCD as indicators.

3.1. System Simulation

Figure 9 shows that in this study, the fuzzy logic method for detecting safe distances for watching TV that was implemented was proven by conducting experimental simulations using Tinkercad Circuits. Tinkercad Circuits allows anyone to create and program Arduino projects virtually without the need for physical hardware[11]. This Tinkercad simulation is enabled to show the system's response to information received from the proximity sensor.

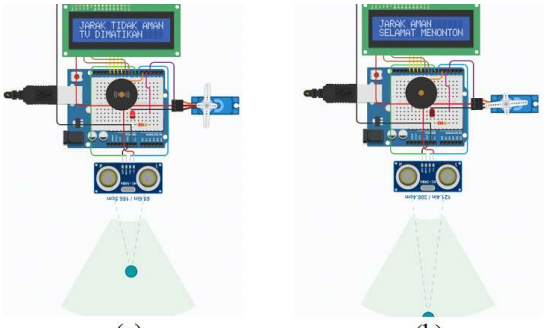

Figure 9. System Simulation (a) Unsafe Position, (b) Safe Position

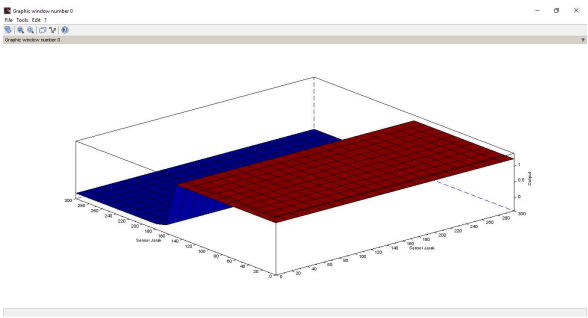

Figure 10. Graphic

```
#include <Servo.h>
#define MAX_DISTANCE 500
Servo servo;

int pinTrigger = 6;
int pinEcho = 7;
int Buzzer = 5;
int LED = 4;
float durasi, jarak;
void setup()
{
pinMode(pinTrigger, OUTPUT);
pinMode(pinEcho, INPUT);
pinMode(Buzzer, OUTPUT);
pinMode(LED, OUTPUT);
Serial.begin(9600);
servo.attach(3);
}
void loop()
{
digitalWrite(pinTrigger, LOW);
delayMicroseconds(2);
digitalWrite(pinTrigger, HIGH);
delayMicroseconds(10);
digitalWrite(pinTrigger, LOW);

durasi = pulseIn(pinEcho, HIGH);
jarak = (durasi * 0.034) / 2;
```

IV. Conclusion

From the research that has been done, this system was created with the aim of building public awareness of a safe distance to watch TV to reduce the risk of eye damage. Where the system control process uses the fuzzy logic method. With the fuzzy logic method for system control, even though the object distance varies and is uncertain, a final decision can be made according to the program that has been made in a fairly short response time.

https://doi.org/10.56481/cister.v2i01.153

References

[1] W. Slamet, L. Laipaka, and N. Putriani, Eka, "Rancang bangun alat pendeteksi jarak aman menonton tv menggunakan mikrokontroler atmega," *Forum Res. Sci. Technol.*, pp. 137–141, 2015, [Online]. Available: http://eprints.polsri.ac.id/2523/.

[2] Argaaditya, 2013. Jarak Optimum Menonton Sesuai Ukuran TV. [Online] Tersedia di : http://www.argaaditya.com/2013/12/jarak-optimummenonton-sesuai-ukuran-tv.html. [Accessed 15 May 2021]

[3] R. Agusli, R. Setiyanto, and F. Maulana, "Sensor Jarak Aman Saat Menonton Televisi Pada Anak Berbasis Arduino," vol. 11, no. 1, pp. 8–14, 2021.

[4] Wikipedia, 2020. *Penampil Kristal Cair*. [Online] (Updated 23 July 2020) Tersedia di: https://id.wikipedia.org/wiki/Penampil_kristal_cair#:~:text=Penampil%20kristal%20cair%20(Inggris%3A%20liquid,televisi%2C%20kalkulator%20ataupun%20layar%20komputer. [Accessed 15 May 2021]

[5] Trikueni, 2014. *Pengertian dan Prinsip Kerja Motor Servo*. [Online] Tersedia di: http://trikueni-desain-sistem.blogspot.com/2014/03/Pengertian-Motor-Servo.html. [Accessed 15 May 2021]

[6] Informatikalogi, 2021. *Pengertian Flowchart dan Jenis – Jenisnya*. [Online] Tersedia di : https://informatikalogi.com/pengertian-flowchart-dan-jenis-jenisnya/. [Accessed 15 May 2021]

[7] S. Samsudin, M. Ikhsan, and M. J. Ritonga, "Penerapan Logika Fuzzy Pada Sistem Peringatan Jarak Aman Sepeda Motor Berbasis Mikrokontroler," *J. Resist. (Rekayasa Sist. Komputer)*, vol. 3, no. 2, pp. 114–119, 2020, doi: 10.31598/jurnalresistor.v3i2.657.

[8] M. R. Kenawas, P. Risma, T. Dewi, S. Muslimin, and Y. Oktarina, "JOURNAL OF APPLIED SMART ELECTRICAL NETWORK AND SYSTEMS (JASENS) Fuzzy Logic Controller sebagai Penentu Gerak Mobile Robot Pembasmi Hama," vol. 1, no. 1, pp. 19–24, 2020.

[9] N. L. Husni, N. Lukita, M. Anisah, A. S. Handayani, S. Nurmaini, and I. Yani, "Enhancement of Navigation Systems of Mobile Robots in Gas Leakage Searching," *J. Phys. Conf. Ser.*, vol. 1167, no. 1, pp. 2–11, 2019, doi: 10.1088/1742-6596/1167/1/012005.

[10] S. Sutikno and I. Waspada, "Perbandingan Metode Defuzzifikasi Sistem Kendali Logika Fuzzy Model Mamdani Pada Motor Dc," *J. Masy. Inform.*, vol. 2, no. 3, pp. 27–38, 2012, doi: 10.14710/jmasif.2.3.27-38.

[11] Craftcloud, 2020. *Tinkercad & Arduino: How to Design and Simulate Circuit*. [Online] Tersedia di : https://all3dp.com/2/tinkercad-arduino-how-to-design-simulate-circuits/.[Accessed 23 May 2021]

AUTHOR BIO

First Author

Teaching at the Department of Electrical Engineering, Electronics Engineering Study Program, Sriwijaya State Polytechnic. Since 2007 until now. 2012 - now teaching Robotics and Industrial Automation courses. The field of research currently being carried out is the Electric Vehicle (EV)

https://doi.org/10.56481/cister.v2i01.153

E-ISSN : 2963-2994