ISSN 2614-4859

Design and Implementation of Stepper 28BYJ-48 and Servo MG996R as a Roasting Arm Robot in an Arduino Uno-based Automatic Satay Grill Tool

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Keywords
Automation
Satay
Arduino
Robotic Arm

ABSTRACT

In industry, almost all factories use an automation system, because faster results and better quality are certainly the main factors in using this automation system. However, in home industries such as satay stalls, it is rare to find the use of this automation technology. Generally, satay stalls still use the traditional (manual) method when grilling satay. So we need a tool that is capable of baking the satay automatically. The solution was obtained by creating a roasting arm robot using the Arduino Uno microcontroller. This research is qualitative research, quantitative and experimental experiments. Data were collected by direct observation of the tools and interviews with traders. The results show that the roasting arm robot can carry out its function according to the duration of each type of meat selected.

1. Introduction

Technological developments have affected everyday life. The effect is that almost all circles do not escape the use of technology, because technology can ease the work of the user, both in terms of time and energy efficiency. Current technology cannot be separated from a control system to control a process to get optimal results, or we can also call it an automation system.

In the industrial world, almost all factories use an automation system, because the results are faster and the quality is better, of course the main factors in the utilization of this automation system [1]. However, in home industries such as satay stalls, it is rare to find the use of this automation technology. In general, satay stalls still use the traditional (manual) method when grilling satay, which of course takes a lot of time and energy as grilling satay [2].

This research aims to solve the problem, namely that there are still many satay stalls that still use traditional concepts in the grilling process. The problem faced is that the grill has to turn the satay back and forth and then remove it after cooking it manually [3][4], so it takes more time and effort for the grill. Therefore, an automation system is designed for the automatic roasting process.

This automation system is made with a specially designed system for controlling the roasting arm robot [5][6]. Different from previous studies where the drive mechanism can only rotate the satay 360°[3]. This research has the advantage, namely the mechanism in this study, namely every time the satay is cooked, the driving mechanism will automatically lift the satay, and also the movement of turning the satay will occur at 180° for a certain time, so that the grilling process will automatically be in accordance with traditional grilling of satay.

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2. Method

2.1. Research Flow and Design

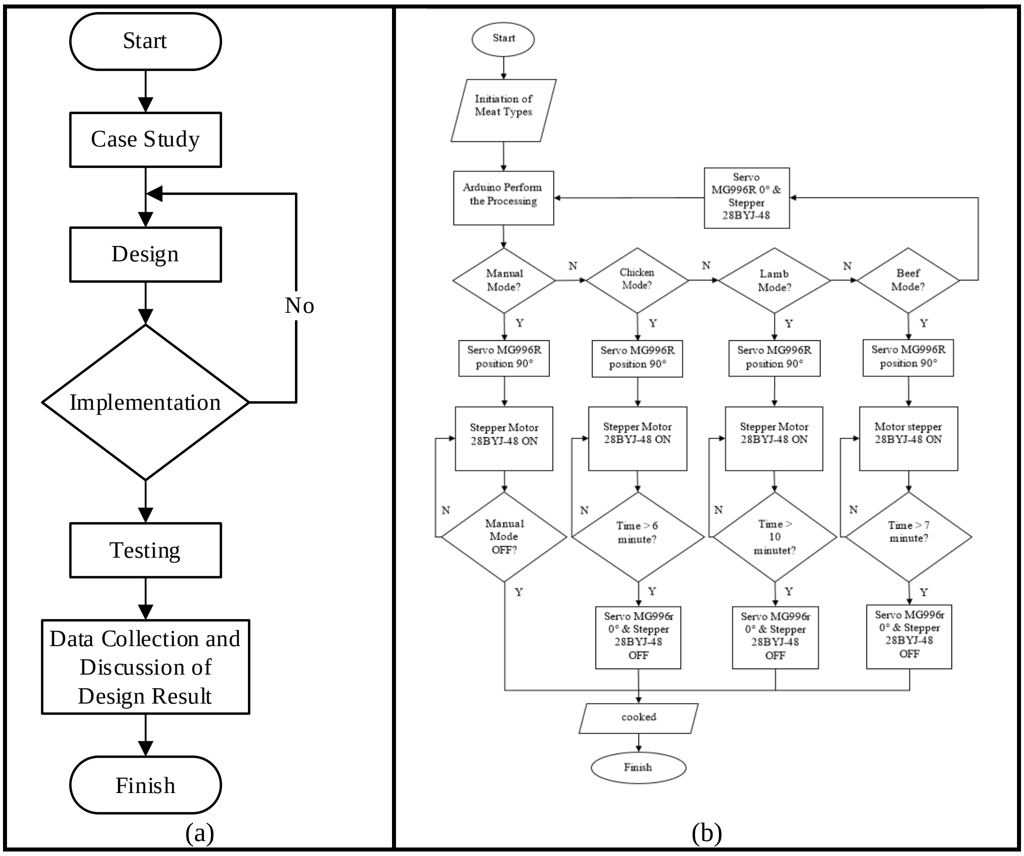

Fig. 1. (a) Research Methodology Flowchart, (b) Flowchart of Design System (The Roasting Arm Robot Model Diagram)

This research was conducted based on 5 stages, the first was conducting a case study by reading previous research and interviewing the informants. Second, designing the roasting arm robot mechanism [7][8]. Then in the third stage implement the design that has been made. After implementing the design as expected, the next step is to test the roasting arm robot. Then in the fifth stage, data collection and discussion of the design results are carried out.

2.2. Hardware Design

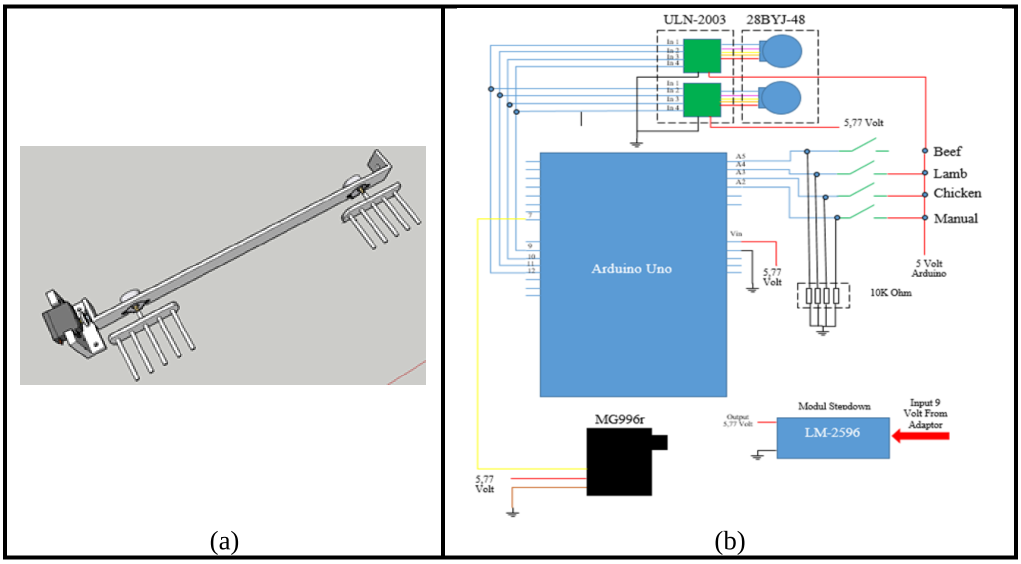

Fig. 2. (a) Roasting Arm Robot Design, (b) Roasting Arm Robot Circuit

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Fig.2. shows the design of the baking arm system. The design of the holder for the 28BYJ-48 stepper motor is made horizontally lengthwise so that it can be applied to rotate two stepper motors, where the two stepper motors are in charge of turning the grilled satay. At the end of each stepper motor connected with aluminum to grip the satay, each stepper motor can flip five skewers. The position of the MG996r servo motor is made to support the stepper motor mount, this is so that the servo motor is able to lift and lower the satay according to the working principle of the grilling arm system that has been previously described [9][10].

3. Results and Discussion

3.1. Implementation of the Roasting Arm Robot

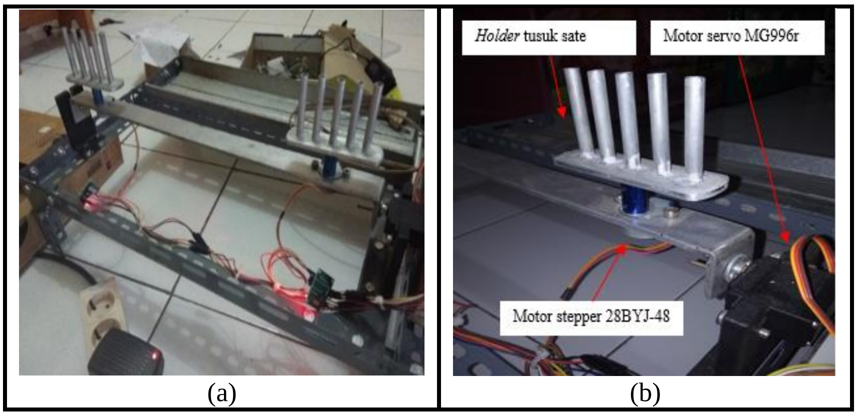

Fig. 3. (a) The Physical Shape of the Roasting Arm Robot, (b) Toaster Arm Robot Component Layout

Testing stepper motor rotation:

a. 28BYJ-48 Stepper Motor Rotation Testing

The rotation test of the 28BYJ-48 stepper motor is carried out to determine the performance of the stepper motor, whether it is as desired or not. Testing is done by the method of observation. The parameters observed in the stepper motor test include rotation angle, pause duration, and rotation speed. From these observations, the following results were obtained:

Table 1. Stepper Motor Rotation Test Results

Motor Stepper 28BYJ-48	Angle of Rotation	Pause Duration (Minute)	Rotation Speed (Sec.)
Stepper Motor 1	180°	1	1.74
Stepper Motor 2	180°	1	1.74

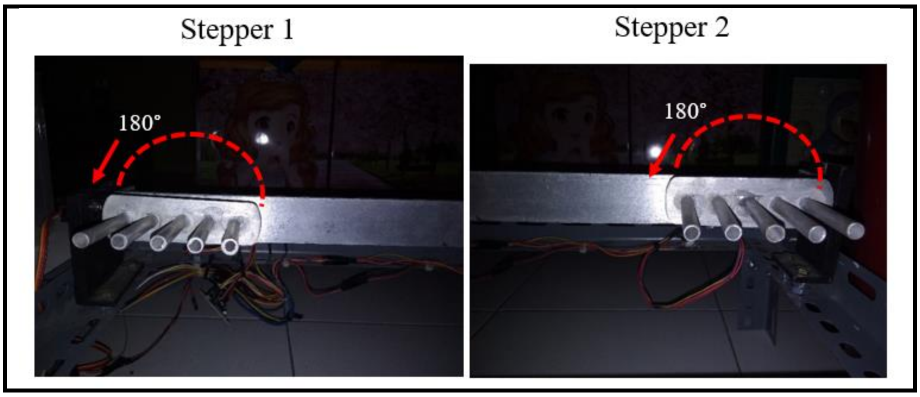

Fig. 4. Stepper motor rotation angle

b. Testing Current and Voltage on Stepper Motor 28BYJ-48

This test is done to determine the amount of power consumption on the stepper that is not working and when the stepper is working. Here are the results:

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Table 2. Stepper Motor Power Requirements Testing.

Stepper Condition	Current (mA)	Voltage (Volt)	Power (Watt)
Before turning	0.05	5.77	0.00028
1st Round	0.20	5.17	0.00103
2nd Round	0.20	5.17	0.00103
3rd Round	0.20	5.17	0.00103

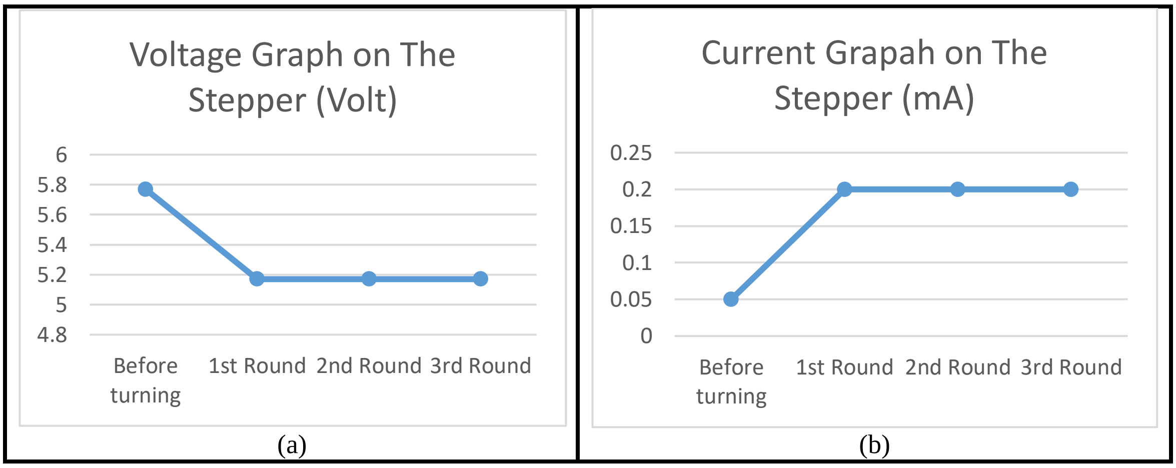

Fig. 5. (a) Stepper Motor Voltage Graph, (b) Stepper Motor Current Graph

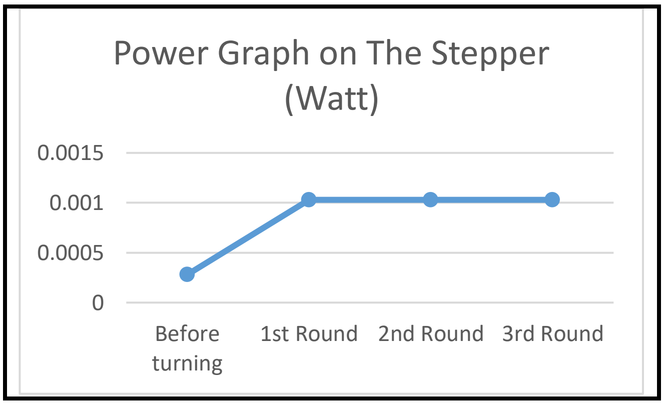

Fig. 6. Stepper Motor Power Graph

Based on the tests presented in the graph above, shows that the voltage has decreased after the stepper rotates. Voltage stabilizes after the first turn. The voltage drop occurs because when the stepper starts rotating there is an increase in the amount of power consumption.

The voltage drop when there is an increase in power in one of the components will result if two or more components are connected in parallel to a voltage source that has internal resistance.

c. Testing the Angle of Rotation of the MG996R Servo Motor

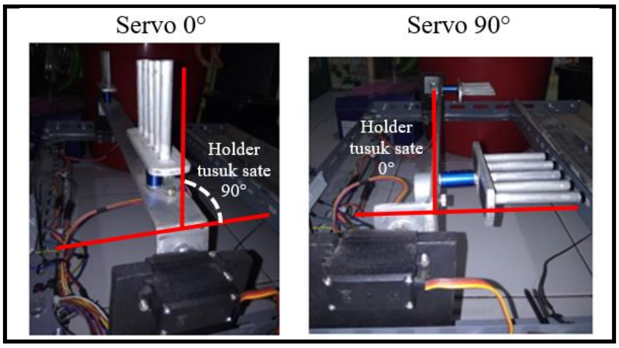

Fig. 7. MG996R Servo Turning Angle

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Table 3. MG996R Servo Turning Angle

Tool Condition	Servo (0°-90°)	Skewer Holder (0°-90°)
Before baking	0	90
baking	90	0
After baking	0	90

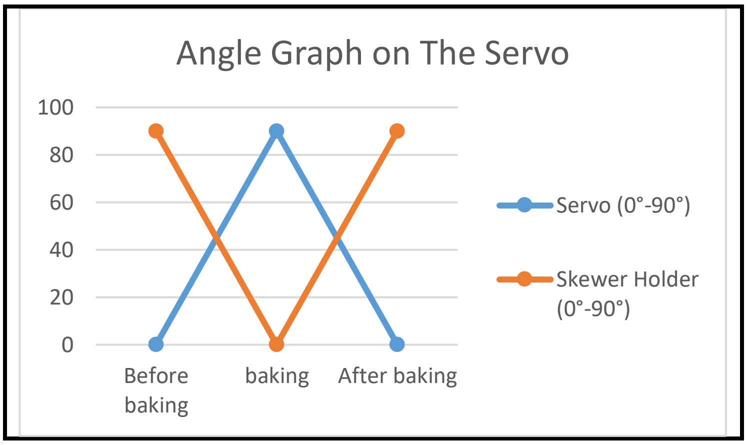

Fig. 8. Servo Angle Graph

This test is conducted to determine the rotation angle of the servo motor. Testing is done by the method of observation. Observations were made in three conditions. The conditions observed included, before the appliance carried out the grilling process, when the appliance was grilling, and when the appliance finished baking. From the observations, the following results were obtained:

d. Testing Servo MG996R Current and Voltage

This test was conducted to determine the power requirements of the MG996R servo motor. testing is done by measuring using a multimeter. From the measurement results, the following results were found:

- Servo power consumption when the stepper is not rotating

Table 4. Servo power consumption when the stepper is not rotating

Servo Status	Current (mA)	Voltage (Volt)	Power (Watt)
Not turning	0.34	5.77	0.0019
When spinning without satay	0.51	5.77	0.0029
When rotating with satay (minimum amount)	0.51	5.77	0.0029
When rotating with satay (maximum amount)	0.51	5.77	0.0029

- Servo power consumption after the stepper rotated

Table 5. Servo power consumption when the stepper is rotating

Servo Status	Current (mA)	Voltage (Volt)	Power (Watt)
Not turning	0.30	5.17	0.0015
When spinning without satay	0.45	5.17	0.0026
When rotating with satay (minimum amount)	0.45	5.17	0.0026
When rotating with satay (maximum amount)	0.45	5.17	0.0026

From the results of this test, it was found that the power consumed by the servo motor has changed. The change in power is caused by the voltage starting to change when the stepper motor starts rotating. But overall the power on the servo motor is stable, that is, the servo is not affected by the load it is lifting (in this case satay[11]. The following is a graph of the comparison of the power currents in the servo motor before and after the stepper motor rotates:

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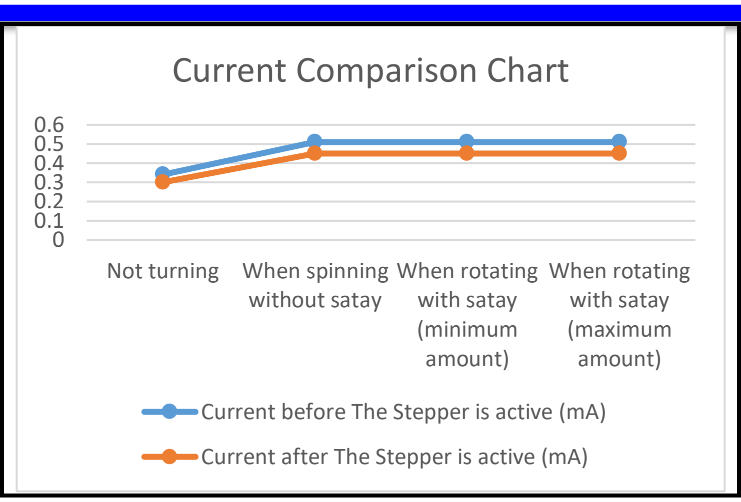

Fig. 9. Servo Current Ratio

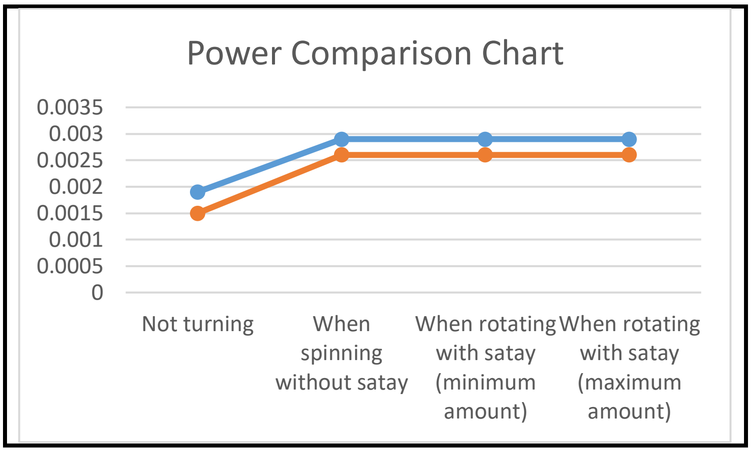

Fig. 10. Servo Power Ratio

e. Baking Process Testing

This test aims to determine whether the satay is cooked according to the specified duration. Based on interviews conducted with satay traders, the following data were found:

Table 6. Result of Interview with Resource Persons

Kind of Meat	Minutes of Ripeness
Chicken	± 6 minute
Lamb	± 10 minute
Beef	± 7 minute

Based on the data obtained from the informants, it was found that mutton was a meat that took longer to cook than chicken and beef. Goat meat takes longer to cook because the texture of the meat is tighter than chicken and beef.

To ensure whether the data obtained from the source is correct, testing is carried out, following the test results:

- Chicken meat

Table 7. Chicken Meat Testing

Duration (Minute)	Information	Status
2	Raw	Information In accordance with the data from the source
3	Raw	
4	Almost ripe	
5	Amlost ripe	

6	Mature
7	Mature
8	Too ripe

- Lamb

Table 8. Lamb Testing

Duration (Minute)	Information	Status
6	Mentah	Information In accordance with the data from the source
7	Mentah	
8	Mentah	
9	Hampir matang	
10	Matang	
11	Matang	
12	Terlalu matang	

- Beef

Table 9. Beff Testing

Duration (Minute)	Information	Status
3	Raw	Information In accordance with the data from the source
4	Almost done	
5	Almost done	
6	Almost done	
7	Mature	
8	Mature	
9	Too ripe	

f. Validate the Success of the System

Validation aims to present the test results on several parameters tested to determine whether the system is working successfully or not. The success of the system is based on the maturity level of the satay. The maturity of the meat with a duration that matches the grilling mode is a reference for the success of the roasting arm robot system. Here's the explanation:

Table 10. Roasting Arm Robot Validation

Mode	Baking Duration	Is the Satay Cooked ?	Status
Manual	Baking ends when the reset button is pressed	adjust	It works
Chicken Meat	6 minutes	Yes	It works
Lamb	10 minutes	Yes	It works
Beef	7 minutes	Yes	It works

Based on the above validation, it was concluded that the entire system was as expected. The success is based on the control response carried out by Arduino after pressing one of the grilling mode switches and also the maturity of the satay according to the predetermined duration. However, apart from the duration of grilling, the level of maturity of the satay is also influenced by the temperature of the coals. The temperature of the coals must be just right in the grilling process. The temperature accuracy is found by the automatic fan control system which is part of the Arduino Uno based automatic satay grill.

4. Conclusion

Based on the research that has been done, it can be concluded that:

1. The stepper motor and the servo motor are able to work together well, creating a sate grilling arm movement;

2. The rotation of the servo motor is not affected by the maximum load capacity of the satay;
3. Two stepper motors connected in parallel are capable of producing the same motion;
4. The voltage at the source will decrease if one of the components has an increase in power consumption;
5. Cooked satay according to the specified duration;
6. The maturity of the satay is not only based on the duration of grilling but also by the temperature of the coals.

References

[1] D. Setiawan, "Dampak perkembangan teknologi informasi dan komunikasi terhadap budaya," *JURNAL SIMBOLIKA: Research and Learning in Communication Study (E-Journal)*, vol. 4, no. 1, pp. 62–72, 2018.

[2] H. J. B. H. A. Bakar, "PENAPAIAN MAKANAN DAN PERKEMBANGAN INDUSTRI".

[3] R. Y. Nababan and S. Sulindawaty, "RANCANG BANGUN ALAT PEMANGGANG SATE OTOMATIS DENGAN METODE PWM BERBASIS MIKROKONTROLER," *Jurnal Ilmiah Kaputama (JIKA)*, vol. 4, no. 1, 2020.

[4] G. Ramadan, O. Haris, and Y. Nata, "DESAIN KONSEPTUAL ALAT PEMOTONG & PENUSUK SATE PADA DAGING DENGAN KAPASITAS 36 TUSUK," *Jurnal Rekayasa Teknologi Nusa Putra*, vol. 8, no. 1, pp. 74–80, 2022.

[5] A. Kadir, "Pemrograman arduino menggunakan ardublock," *Yogyakarta: Andi*, 2017.

[6] S. Muhammad, "Panduan Mudah Simulasi & Praktek Mikrokontroler Arduino," *Yogyakarta: Penerbit Andi*, 2013.

[7] A. Z. Alassar, I. M. Abuhadrous, and H. A. Elaydi, "Modeling and control of 5 DOF robot arm using supervisory control," in *2010 The 2nd International Conference on Computer and Automation Engineering (ICCAE)*, 2010, vol. 3, pp. 351–355.

[8] H. Ibnu, "PENGEMBANGAN MEDIA PEMBELAJARAN LENGAN ROBOT 3 DOF (DEGREE OF FREEDOM) PADA MATA PELAJARAN PEREKAYASAAN SISTEM KONTROL PROGRAM KEAHLIAN TEKNIK ELEKTRONIKA INDUSTRI DI SMK NEGERI 2 WONOSARI," Jan. 2018.

[9] A. Hilal and S. Manan, "Pemanfaatan Motor Servo Sebagai Penggerak Cctv Untuk Melihat Alat-Alat Monitor Dan Kondisi Pasien Di Ruang Icu," *Gema Teknologi*, vol. 17, no. 2, 2015.

[10] I. Ramdhani, "Aplikasi Driver Relay ULN-2003 Sebagai Penggerak Konveyor Otomatis Pengelompokan Buku Menggunakan Inisialisasi Barcode"," 2012.

[11] A. Z. Alassar, I. M. Abuhadrous, and H. A. Elaydi, "Modeling and control of 5 DOF robot arm using supervisory control," in *2010 The 2nd International Conference on Computer and Automation Engineering (ICCAE)*, 2010, vol. 3, pp. 351–355.