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Object-Moving Robot Arm based on Color

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ABSTRACT

The aim of this research is to make a robot arm moving objects based on color using 2 servo motors and 6 light photodiode sensors integrated with the Arduino Mega 2560 microcontroller. The light photodiode sensor is used to detect red, green and blue colors. This system is equipped with an LCD to display the output of the Arduino Mega 2560 which is a notice of the color detected. The process of moving objects based on color is simulated using 3 colored objects namely red, green, and blue. The robot arm gripper will move to pick and move objects based on color, when the light photodiode sensor detects a color input. Based on system testing, overall the robot arm is functioning properly, i.e. it shows that the robot arm is able to move objects automatically with large test results obtained by 0 °, 40 °, 60 °, 90 °, and 120 °. Whereas for sensor testing the value of red is> 400, the value of green is> 150, and the value of blue is> 600.

1. Introduction

Technology has a very important role. The role of technology has been widely used in various human lives today. The increasingly high level of community mobility is now a factor in developing more efficient technology. Utilization of technology is widely used in today's society, for example; educational environment as a learning media [1] and robotics field [2] [3] [4]. One type of robot is a robot arm. Robot arm or robot manipulator is a type of robot that has a hand-shaped structure and has a complete one-arm section starting from the shoulders, elbows, palms and fingers. Robot arms cannot move or static positions, so the work area of the robot arm is limited in scope [5]. Arduino Mega 2560 microcontroller has advantages that can make automation on a tool that can be used to help for users [6].

This study will design the design and implementation of moving equipment based on color using a photodiode sensor and a micro 25controller Mega contained in the robot arm. Mega 2560 is a microcontroller board that uses ATmega2560 [7]. The light photodiode sensor is used for color detection of RGB (red green blue), the LED will emit light to the object and the photodiode will receive the light reflected by the object. The intensity of the light received by the photodiode will affect the value of the resistance. Objects in the form of red, green and blue will reflect light with different intensities [8].

The Arduino Mega 2560 has 54 digital input/output pins (15 of which can be used as PWM outputs), 16 analog inputs, 4UART (serial port hardware), 16MHz crystal oscillator, USB connection, power jack, ICSP header, and reset buttons [9]. Servo motor is a motor with closed feedback system, the position of the motor will be informed back to the control circuit in the servo motor. Servo motors usually only move to a certain angle and are not continuous such as DC motors or stepper motors [10].

Power supply is used as a voltage provider that has an input power of 6V to 20V, but the recommended use for power supply is obtained from a USB cable connection or passing through an external power supply, thus the recommended voltage for use is 7V to 12V [11]. UBEC is a circuit to change the voltage, high to low or vice versa, requiring the right circuit so that power can be delivered with the highest level of efficiency. [12] The LCD functions to display information on sensor results, display text, or display menus on microcontroller applications [13]. This robot arm has a degree of freedom or Degree of Freedom (DOF) linear motion on an axis (axis) [14]. Researchers want to make a robot arm using 4 servo motors (DOF). This tool will later be equipped with a light photodiode sensor to scan items by color, which will be moved to each of the boxes that have been determined.

The structure of the paper is as follow. The first section is about introduction. The second section is methods that consist of block diagram system and algorithm. The third section is result and discussion that consist of ADC sensor testing, servo motor testing, color identification testing and robot movement testing. The last section is conclusions.

2. Methods

2.1. Design of Robot Arm System

The block diagram of the robot arm system is shown in Figure 1. Based on Figure 1, the system will input a 12-volt voltage source through the power supply, the voltage is stabilized using UBEC 5A to activate the Arduino Mega 2560. The photodiode and push button circuits provide input that will be processed by Arduino Mega2560 in Arduino programming. Furthermore, the LCD will display the output of the Arduino Mega 2560 which is a color notification that is detected by a light photodiode sensor, after which the servo motor will move automatically to pinch a colored object, then move it to the box according to the selected color.

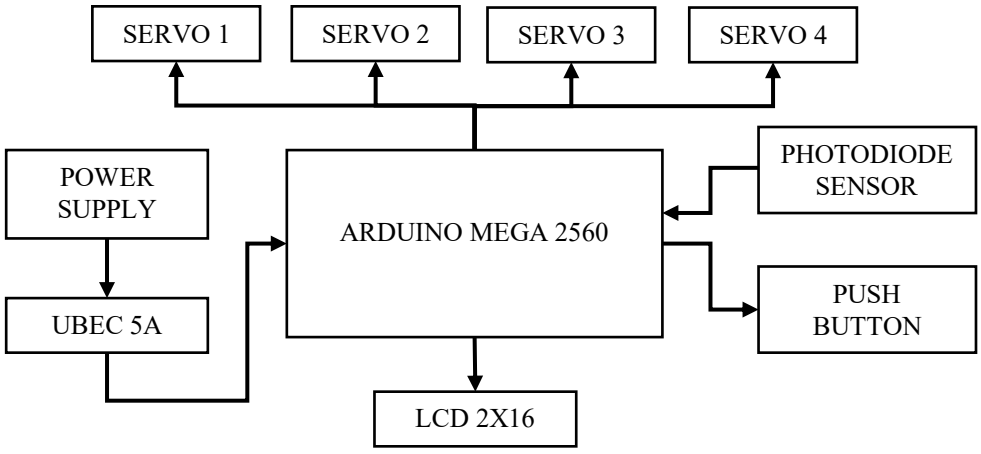

Fig. 1. Block Diagram of Robot Arm

2.2. System Flowchart

The design of the software system on a robotic arm moving objects based on color is represented in a flowchart. Flowchart diagram in system design can be seen in Figure 2. In Figure 2, it is explained that the software system starts from the library declaration and input and output variables, then goes into I / O realization, then enters the photodiode sensor processing where it is the main position to detect color, then the system will check the condition of color detection or no, so if color detection occurs, the servo gripper will take the color objects, then the servo gripper will put the objects into the specified color target box.

3. Results and Discussion

This research conducts a variety of tests both in the circuit system, sensor performance, to the integrated system testing. This test is carried out to ensure all system units are running and functioning properly.

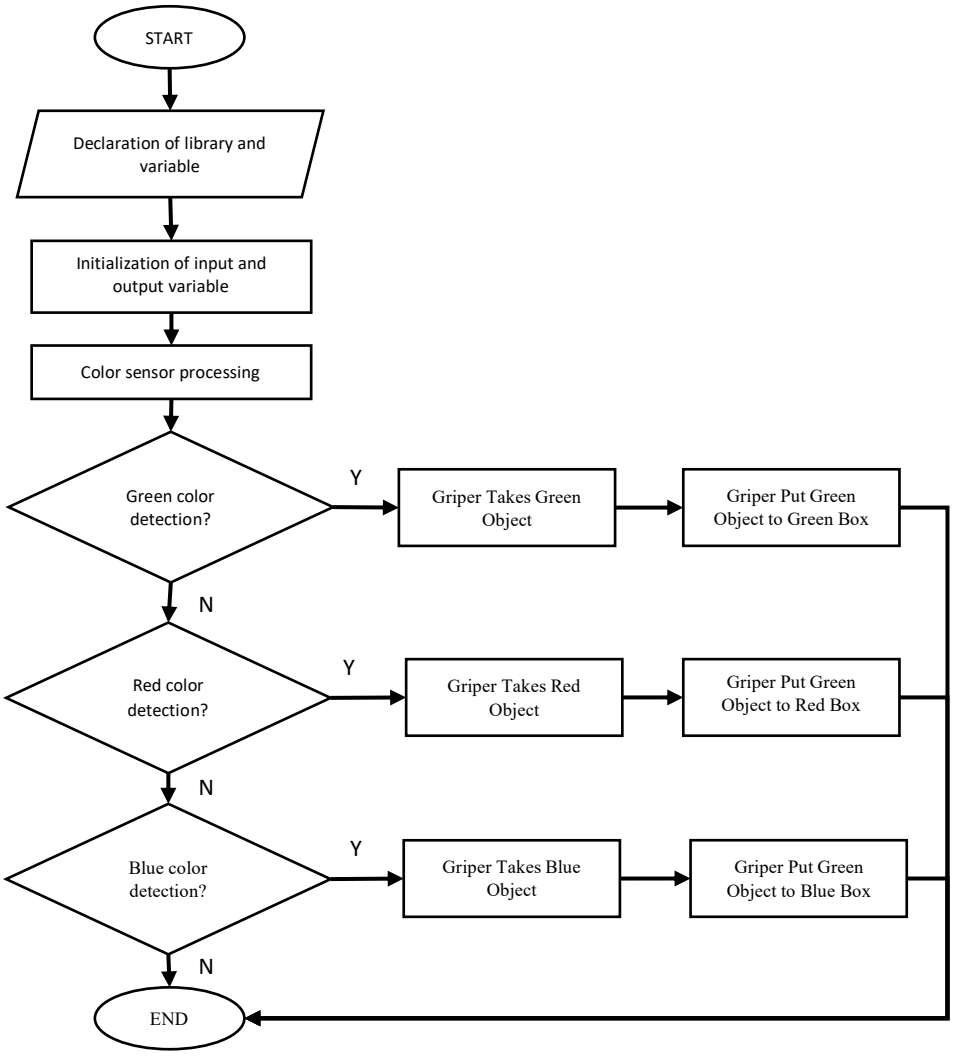

Fig. 2. Flowchart of Robot Arm System

3.1. ADC Color Sensor Testing

This test aims to determine the ability of the photodiode sensor to detect colors between color objects and the sensor. Color testing on the sensor is done by placing a color object in front of it with a certain distance and its value can be seen on the LCD screen. The output voltage from this photodiode will be processed using the ADC (Analog to Digital Converter) method in order to display a digital value to be processed so as to be able to distinguish red, green, and blue.

In this test, 10 times of the experiments were carried out, in which the sensor readings data were displayed on the LCD and the results data was shown in Table 1. Based on Table 1, the average ADC data for the red color is 432, the average ADC data for the red color is 175, and the average ADC data for the red color is 619. It can be concluding that the ADC data for red, green and blue color have the different value. Thus the sensor robot can determine the color based on the ADC data.

Table 1. ADC Color Sensor Test Results

Iteration	Red Color Object ADC Value	Green Color Object ADC Value	Blue Color Object ADC Value
1.	423	154	608
2.	426	166	613
3.	442	132	624
4.	432	175	622
5.	422	201	612
6.	442	220	634
7.	452	185	644

Iteration	Red Color Object ADC Value	Green Color Object ADC Value	Blue Color Object ADC Value
8.	419	174	620
9.	428	165	614
10.	435	180	601
Average	432	175	619

Based on Table 1, it can be seen that the photodiode sensor has succeeded in detecting colors with a fairly stable, with an average value of 432 red ADC, 175 green, and 619 blue. 4.16. The following graph shows the results of the ADC color sensor testing shown in Figure 3. Based on the diagram graph shown in Figure 3, it can be seen the comparison of ADC values. When the ADC color sensor reads colored objects with an average value of red> 400, green> 150, and blue> 600.

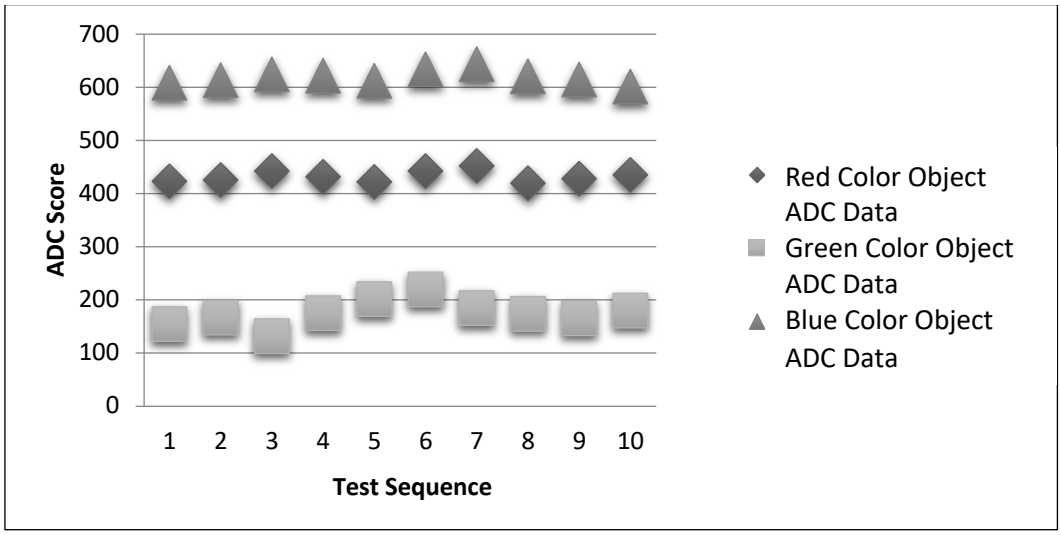

Fig. 3. Comparison of ADC RGB Color Sensor Scores

3.2. Servo Motor Testing

The parameter of the success of servo motor testing is done by making a program on the Arduino Mega 2560 microcontroller in the form of a clamping and moving object based on the ADC color detected by the photodiode sensor. Table 2 shows the results of testing the success of servo motor 1 and Table 3 shows the results of testing the servo motor 2.

Table 2. Servo Motor 1 (Base) Test Results

No.	Pulse Motor Servo Base (A)	Actual Angle(°) (B)	Difference (C)
1.	0	0	0
2.	40	50	10
3.	60	80	20
4.	90	110	20
5.	120	135	15

Table 3. Servo Motor 2 (Gripper) Test Results

No.	Pulse Motor Servo Gripper (A)	Actual Angle(°) (B)	Difference (C)
1.	0	0	0
2.	20	20	0
3.	40	50	10
4.	60	70	10
5.	90	95	5

The test results shown in Table 2 and Table 3, the actual condition column of the servo motor (Actual Angle section in Table 2), it can be seen the difference in the direction of the servo motor when a pulse value of 0, 40, 60, 90, and 120 is given. Variable (A) is a robot rotation angle measurement based on an adjusted program on the Arduino Mega 2560 microcontroller, while variable (B) manually measures the actual angle using a protractor and for variable C the difference between measurements according to the program (A) and protractor manually (B). Based on Table 3, it appears that the measurement results have a significant difference that is less than the motor pulse value and the actual angle, the servo part of the gripper is declared capable of moving properly and can be used for the work piece retrieval process. So that the servo motor works well.

3.3. Color Identification Testing

The color identification test is done by placing an ADC color object in front of the photodiode sensor, then detected and the output can be seen on the LCD screen. Output results in the form of detected color notifications, red output is RED, green output is GREEN and blue output is BLUE. In this test, each color was tested 5 times, in which the sensor readings are displayed on the LCD and the results data is shown in Table 4.

Table 4. Color Identification Test Results.

Test No.	Red Object LCD Display	Green Object LCD Display	Blue Object LCD Display	Examination Status
1.	RED	GREEN	BLUE	Success
2.	RED	GREEN	BLUE	Success
3.	RED	GREEN	BLUE	Success
4.	RED	GREEN	BLUE	Success
5.	RED	GREEN	BLUE	Success

Based on Table 4 the results of testing the color identification with the test status declared successful, the color sensor works well, obtained the following percentage of success.

$$ADC\ Color\ Percentage = \frac{No.of\ Success\ data}{Total\ Test\ Data} x\ 100\% \quad (1)$$

$$ADC\ Color = \frac{5}{5} x\ 100\% = 100\% \quad (2)$$

The total percentage of successful identification of red, green and blue colors is 100%. With the results obtained it can be said that the color sensor on the robot arm can identify red, green, and blue colors.

3.4. Ability Test of Tools in Moving Objects Based on Color

This test is carried out to test the ability of the tool to place objects in accordance with the color of the box that will be the target of laying the work piece. This testing mechanism is by giving a color object to the ADC color sensor, then the robot arm will clamp the object according to the color detected by the color sensor. After clamping the bottom servo object will move according to the position of the target box then the work piece object will be inserted into the target box, each of which has red, green, and blue colors. The test was carried out an experiment of 5 times for each color of the ADC. The test results are shown in Table 5.

Table 5. Red Object Placement Test Results

Test No.	Color Object	No. of Success of Robot Arm Flanking the Work piece	No. of Successes of Robot Arm Removing the Work piece	Target Box Color		
				RED	GREEN	BLUE
1	RED	Success	Success	V		
2	RED	Success	Success	V		
3	RED	Success	Success	V		

Test No.	Color Object	No. of Success of Robot Arm Flanking the Work piece	No. of Successes of Robot Arm Removing the Work piece	Target Box Color		
				RED	GREEN	BLUE
4	RED	Success	Success	V		
5	RED	Success	Success	V		

Based on the data obtained from Table 5, it can be seen that the robot arm is able to flank the work piece 5 times, and successfully release the work piece 5 times according to the color of the target red box.

Table 6. Green Object Placement Test Results

Test No.	Color Object	No. of Success of Robot Arm Flanking the Work piece	No. of Successes of Robot Arm Removing the Work piece	Target Box Color		
				RED	GREEN	BLUE
1	GREEN	Success	Success		V	
2	GREEN	Success	Success		V	
3	GREEN	Success	Success		V	
4	GREEN	Success	Success		V	
5	GREEN	Success	Success		V	

Based on the data obtained from Table 6 it can be seen that the robot arm is able to flank the work piece 5 times, and successfully release the work piece 5 times according to the color of the target box in green.

Table 7. Blue Object Placement Test Results

Test No.	Color Object	No. of Success of Robot Arm Flanking the Work piece	No. of Successes of Robot Arm Removing the Work piece	Target Box Color		
				RED	GREEN	BLUE
1	BLUE	Success	Success			V
2	BLUE	Success	Success			V
3	BLUE	Success	Success			V
4	BLUE	Success	Success			V
5	BLUE	Success	Success			V

Based on the data obtained from Table 7, it can be seen that the robot arm is able to flank the work piece 5 times, and successfully release the work piece 5 times according to the color of the blue target box.

4. Conclusion

Based on the results of research and discussion that has been done, it can be concluded that the robot arm that is made, the robot arm that moves objects based on color, has been functioning properly. The photodiode sensor can detect colors with an average ADC value of red 432, green color 175 and blue color 619. And servo motors can clamp objects and move objects based on color well.

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