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Tomato Sorting Automation Prototype Based on Color

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***Abstract*—The process of sorting tomatoes can be done using visual methods by paying attention to color. The purpose of this research is to improve the process of sorting tomatoes based on color in distinguishing ripe tomatoes and immature tomatoes. Streamline the time of sorting tomato fruit in order to avoid losses due to spoilage. This research method is with a sample of tomato fruit taken RGB value through TCS 3200 color sensor according to the level of maturity. After the RGB value is obtained, it will be processed into the Arduino Uno to obtain maturity information through the rules that have been made and sorted using a servo motor. The results of this study indicate that a good condition for detecting tomato fruit is with a closer distance to the fruit with a dark background. This is because there is no excess light reflection so that the TCS sensor can take RGB values well and reduce the occurrence of misreading of ripeness information in the sorting process.**

Keywords— ***Tomato, Sensor TCS 3200, Arduino uno, Motor Servo.***

I. Introduction

Tomato plants have fruit of different colors, generally green, yellow and red. The color of the tomato has an influence on the selling price. The process of selecting tomatoes carried out by humans is relatively inconsistent in determining ripe and immature tomatoes [1]. This is caused by several factors such as human fatigue, visual diversity, and differences in perception for each human [2]. Another weakness is that human judgment is still subjective towards fruit objects and work that is done repeatedly can cause boredom, so it is necessary to implement a system that can carry out an automatic sorting process based on color [1], [3].

The level of fruit ripeness can be seen from several aspects, namely from the color or from the shape. In the color aspect, fruit maturity can be seen by adjusting the color of the ripe fruit and the level of ripeness of the fruit to be tested. In general, ripe tomatoes are yellow or red. The red color is more expensive because it is ripe and good for consumption [3].

This research will design and create an automatic tomato sorting and packaging system. This research was also developed based on previous research [1]–[4]. Designing an automatic system based on color and size using the TSC3200 sensor and ultrasonic sensor. With this system, it is hoped that it will increase efficiency and effectiveness in sorting tomatoes [5], [6].

A prototype is a model or simulation of all aspects of the actual product that will be developed, this model must be representative of the final product. In system development, situations often occur where system users have actually defined the general purpose or objectives of the software even though they have not defined the input, process and output in detail [4].

Automation is a technology related to the application of mechanical, electronic and computer-based systems to operate and control production. For this purpose, automated production systems can best be classified into three basic types, namely Fixed automation, Programmable automation, and Flexible automation.[4], [7]-[12].

The working principle of the TCS3200 color sensor works by reading the light intensity value emitted by the super bright object. The reading of the light intensity value is done through an 8x8 photodiode matrix, where the 64 photodiodes are divided into four groups of color readers, each color illuminated by the LED will reflect the light. The LED goes to the photodiode, the reflection of the light has different light reflections depending on the color of the object being detected, this is what makes the TCS3200 color sensor able to read several kinds of colors [5]-[6].

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The servo motor used is the Towerpro MG995 which has a voltage input of 5V and has a maximum rotation of 1800. This servo motor has 3 inputs, namely power, ground and control. The working principle of a servo motor is controlled by providing a pulse width modulation (pwm) signal via a control cable, the pulse width of the control signal provided will determine the angular position of rotation of the servo motor shaft [11]-[14].

RGB colors are the main colors in an image with three primary colors, namely red, green and blue. The range of values that an RGB image has in each image pixel is 0 to 225. The vector of the RGB component of an RGB image is shown in Table 1 below [5]-[6].

Table 1. RGB component vectors

Color	Vector (R,G,B)
Red	(1, 0 , 0)
Green	(0, 1 , 0)
Blue	(0, 0 , 1)
White	(1, 1 , 1)
Black	(0, 0 , 0)

Gearboxes are widely used in the field of industrial needs or machinery on a ship. The gearbox has the function of transferring power from the driving force (diesel engine or electric motor dynamo) to the machine that you want to move. There are at least 2 key reasons why the use of Gearboxes in the world of machinery plays an important role, firstly, the main function of the Gearbox is to shift the rotational speed resulting from the rotation of the dynamo of a diesel engine, and the second is to strengthen the rotational power produced by the dynamo of a diesel engine [15].

A power supply is needed for almost all electronic circuits that require a regular DC voltage source to operate. This supply can be done directly by the battery, but more commonly the power supply is obtained from a standard ac source which is then converted to DC voltage[]. The source input has a relatively high voltage, namely 220V AC, so a step down transformer with an appropriate turns ratio is used to convert this voltage to a low voltage.[7]-[12]

A conveyor is a mechanical system that has the function of moving goods from one place to another. Conveyors are widely used in industry for the transportation of goods in large quantities and continuously. In certain conditions, conveyors are widely used because they have economic value compared to heavy transportation such as trucks and transport cars. This type of conveyor makes handling heavy equipment/products easier and more effective. Many roller conveyors can move as fast as 75 feet/minute. Conveyors can mobilize goods in large quantities and continuously from one place to another [3], [11].

II. Research Methodology

A. Components

a) Arduino Uno AT 328 functions as the main controller which can receive input from sensors and can provide previously programmed instructions.
b) Color sensor that can detect the red color of tomatoes and can differentiate between ripe and unripe tomatoes.
c) Gearbox is used to move the conveyor.
d) The servo motor is intended for sorting tomatoes.
e) The holding tank is used as a container to hold tomatoes that have been sorted

B. System Working Principles

This system works through a gerabox which functions to move the conveyor, after that the system sorts red ripe fruit and green immature fruit using the TCS3200 color sensor, the servo motor will move to sort tomatoes according to predetermined criteria, after The tomatoes will go into the container.

C. Hardware Design

In this design the hardware will be connected into one circuit starting from the TCS3200 Color Sensor which can be seen in figure 1 and the PIN configuration in table 2.

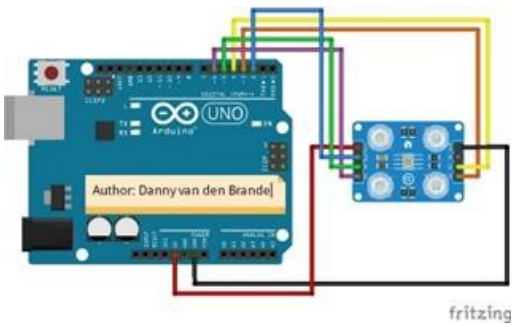

Figure 1. TCS3200 Color Sensor

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Table 2. Color Sensor Pin Configuration

TCS3200	**Arduino**
VCC	5V
S0	D3
S1	D4
S2	D5
S3	D6
OUT	D2
GND	GND

Then confirm the condition of the Servo Motor, which can be seen in Figure 2 and the PIN configuration in Table 3.

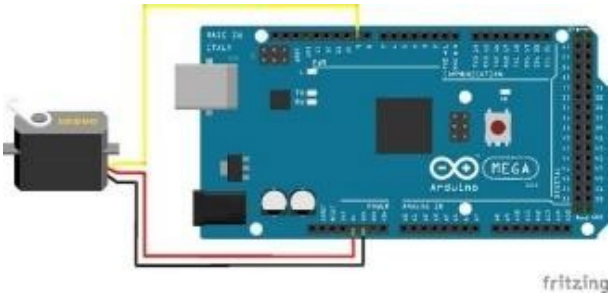

Figure 2. Servo motor

Table 3. Servo motor pin configuration

Motor Servo	**Arduino**
VCC	5V
Pulse	P9
GND	GND

D. Software Design

The software design uses the Arduino IDE application to manage the system program in this research. This application is provided free of charge by Arduino, including a library.

III. Results and Discussion

A. TCS3200 Color Sensor Testing

In the test results, the color sensor can detect colors in RGB format. If the tomato is green, the tomato will be passed into a glass container and the green ball color data will be detected, as shown in Figure 3.

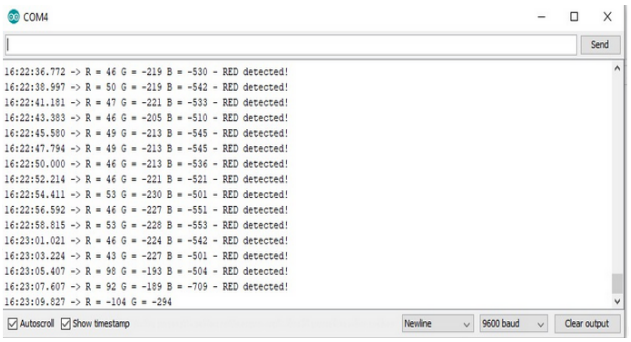

Figure 3. is the result of data obtained from the color sensor on green objects

If the tomatoes are red, the servo motor will move to sort them and will be transferred to the glass container and the red ball color data will be detected, as shown in Figure 4.

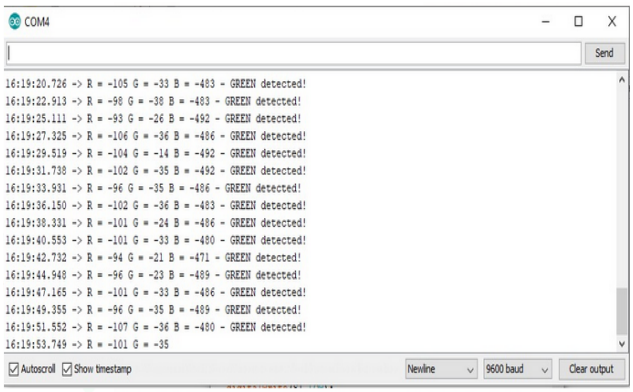

Figure 4. Data results obtained from the color sensor on red objects

B. Accuracy Testing

The accuracy of the results in this test requires 20 tomato samples consisting of green tomatoes and red tomatoes. The level of accuracy can be seen from table 4 below.

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Table 4. Accuracy Test Results

Tomato Category	Number of Samples	In accordance	Error
Raw	**10**	**3**	**7**
Ripe	**10**	**8**	**2**

Accuracy Rate of Raw Tomatoes :

$$= \frac{appropriate\ amount\ of\ Tomatoes}{number\ of\ samples} \text{ x } 100\%$$

$$= \frac{3}{10} \text{x } 100\%$$

$$= 30\ \%$$

Accuracy Level Tomatoes are not yet ripe

$$\frac{Appropriate\ number\ of\ tomatoes}{Jumlah\ Sampel} \text{x} 100\%$$

$$= \frac{8}{10} \text{ x } 100\%$$

$$= 80\ \%$$

C. Servo motor

Servo motors can move tomatoes that do not meet the qualifications of tomato size and tomato color. The servo motor will close the way to the glass container if it does not pass the qualifications, whereas if the tomatoes pass the qualifications then the servo will make way for the tomatoes to be ready to be packaged. The results of the Servo Motor test can be seen in Figure 5.

Figure 5. Servo Motor Test Results

D. Software Design

At the stage of detecting ripeness of tomatoes, as is known, the color of unripe tomatoes will be closer to green and the color of ripe tomatoes will be closer to red. Because the difference between red and green looks striking. So the color sensor can read accurately.

In identification there is a process, namely sorting based on color to determine the level of ripeness of the tomatoes. Where in this process the RGB value will be displayed. From this RGB value, you can determine which tomatoes are ripe and which tomatoes are not yet ripe.

E. System Maintenance

Things that must be done so that this tool can run well are:

1. Weight that corresponds to the capacity that can be used on the conveyor.
2. The distance between the color sensor and the object to be read should not be too far.
3. The base on the conveyor must be flat so that the conveyor can run smoothly.

F. Overall System Testing

This test aims to find out whether the system can run well in terms of tools based on the system design that has been created. Following are the testing steps : In figure 6 the gearbox will move the conveyor to run the tomatoes, figure 7 the color sensor (TCS 3200) will read the color on the skin of the tomatoes.

Figure 6. Results of Gearbox Design on the Tool

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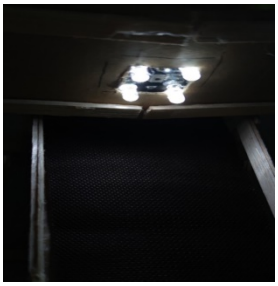

Figure 7. Design Results of the TCS 3200 Color Sensor

A tool that uses a servo motor, as shown in Figure 8, is used to sort tomatoes based on the color of the tomatoes themselves. If the tomato is red, the servo motor will not move and the tomato will continue to walk until it reaches the container, whereas if the tomato is green, the servo motor will move and direct the fruit to the container as shown in Figure 9.

Figure 8. Results of Servo Motor Design on the Tool

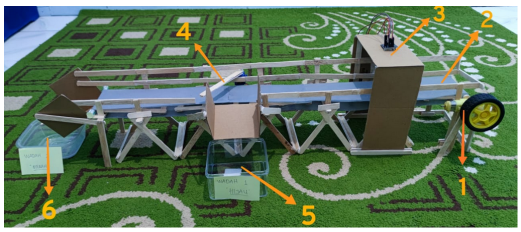

Figure 9. Design results of a tomato sorter prototype based on color

This prototype contains a Control Box. In this control box container there is a board and Arduino Uno to control any data sent from the color sensor and which will be sent to the servo motor. Apart from that, this control container also functions to unite the control system in one place so that the tool or prototype looks neat and not messy, as seen in Figure 10.

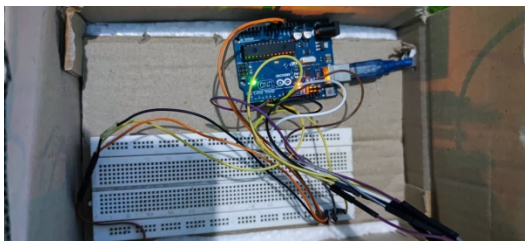

Figure 10. Control Box

IV. Conclusion

After conducting experiments on the tool created, it can be concluded as follows :

1. This automatic tomato sorter prototype uses an Arduinno Uno microcontroller with a color sensor as a tool to detect the level of ripeness in the tomatoes, a Servo motor as a tomato sorter, and the addition of teeth on the conveyor belt which functions to prevent it from rolling, so that the tomatoes can can be detected one by one well.
2. This prototype can sort ripe and unripe tomatoes automatically with equipment controlled by a gearbox on a conveyor that can move in the appropriate direction and a servo motor that can be adjusted for time and movement so that it can be used to change roles. humans in terms of sorting.

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