Sorting System Based on Color Using Line Follower Robot

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Keywords: Robot, Sorting System, Line Follower, Conveyor, Color Sensor, Proximity Sensor.

Abstract: Robot is a mechanical device that can perform tasks to ease human work, both in supervision and control. The robot is programmed with artificial intelligence in accordance with the conditions of each process of working on its task. Robots are used by humans to do heavy, dangerous, repetitive and dirty work. Another use is to lift or move goods without having to use human power. In this study, a color sorting system was created which aims to make it easier to carry objects and sort colour. In terms of transporting objects, a line follower robot is used which will automatically deliver the objects to the conveyor. after arriving at the conveyor the goods will be sorted based on the color of the goods. The line follower robot based on the test results can bring each item to the conveyor with an average time of 14.20 seconds and return to its original place in 32.30 seconds. On the conveyor the TCS 3200 color sensor can read the color of the goods according to the input data from the TCS 3200 sensor. The colors of the goods used in the test are red, green and blue. After the color of the goods is detected, the servo will automatically sort the goods according to the color in each prepared container.

1 INTRODUCTION

Industrial needs in terms of machines always increase every year along with increasing industrial performance in Indonesia. (Herlambang, Purba, & Jaqin, 2021) Today's modern technology, especially in the world of robot technology, has experienced very rapid development. Robot technology in Indonesia is not only mechanical sophistication but also in its control system that uses computerization. (Budiharto, Irwansyah, Suroso, & Gunawan, 2020)

Robots are also defined as having artificial intelligence that can overcome problems to replace humans when working in hazardous areas, repetitive work, and dirty. (Nahavandi, 2019) The manufacture of robots with special features is closely related to the modern industrial world which demands a tool that has high capabilities that can complete human work. (Chen, 2017) Goods delivery robots to lift heavy goods are also very necessary in industry, usually to automatically transport goods to aircraft cargo. (Karabegović, Karabegović, Mahmić, & Husak, 2015)

A mobile robot is a robot that uses propulsion in the form of legs or wheels that can move from one point to another. (Lauria et al., 2006)Mobile robots can be applied in several applications, one of which is grouping goods and object followers. (Larasati, Dewi, & Oktarina, 2017) To overcome this problem, research was conducted on the incorporation of delivery robots using line followers and conveyors to detect and separate types of goods based on color.

2 METHODS

The design of the system was made before creating the robot. It was made to ensure that the system can run properly and in accordance with its function. The design of the system includes the design of hardware and software. Figure 1 is a line follower robot system using a close loop system. This robot uses a servo as a gripper which is used to move goods.

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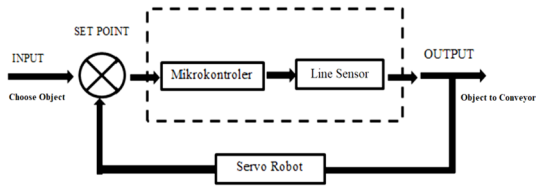


Figure 1: Block diagram of line follower robot.

Figure 1 is a line follower robot system using a close loop system. The use of line sensors using infrared will follow the line in delivering goods. Infrared is placed on the front right and front left side of the robot. It aims to have an inverse relationship between the resistance of the infrared sensor. On a white surface the amount of light refracted by the IR sensor is very high and its resistance increases when the robot follows a line on a black line. (Tayal, Rao, Bhardwaj, & Aggarwal, 2020) Each surface has the ability to reflect light differently. White has the ability to reflect lighter. On the other hand, dark colors have the ability to reflect less light. (Latif, Widodo, Rahim, & Kunal, 2020).

Line followers use 3 IR sensors on the robot to make it more accurate. the sensor that is being placed on the black line, when turning to the left, the sensor on the left side will be on the black line so the motor on the left will stop. The right motor will keep moving so the robot will turn right so that it will return to the right track. (Geetha, Salvi, Saini, Yadav, & Singh Tomar, 2021) The workflow of the motor system can be seen in Figure 2.

This system using several sensors, i.e. photodiode sensor and infrared sensor. The photodiode sensor is used to detect the line, thus it can be delivered according to the path while the infrared sensor is used in the gripper to detect the presence of objects on the gripper. So that, when there is an object the gripper opens and at a certain distance the gripper will close.

Flowchart of the line follower robot for carry goods is shown in Figure 3. There are two sensors used in the conveyor block diagram menu, namely the Proximity sensor and the TCS 3200 sensor. The proximity sensor detects objects while the TCS 3200 detects the color of the goods. The TC3200 sensor has the main components, namely a photodiode and a current-to-frequency converter. The photodiode on the TCS3200 IC is arranged in an x 8 arrangement which can later be arranged through the S2 and S3 sectors. Photodiode will emit a current of magnitude proportional to the level of the basic color of the light.

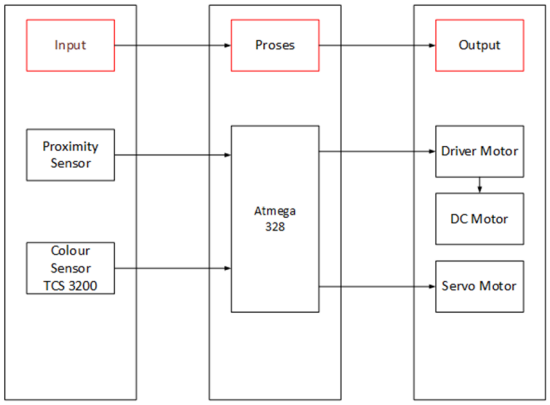


Figure 2: Block diagram of line follower robot system.

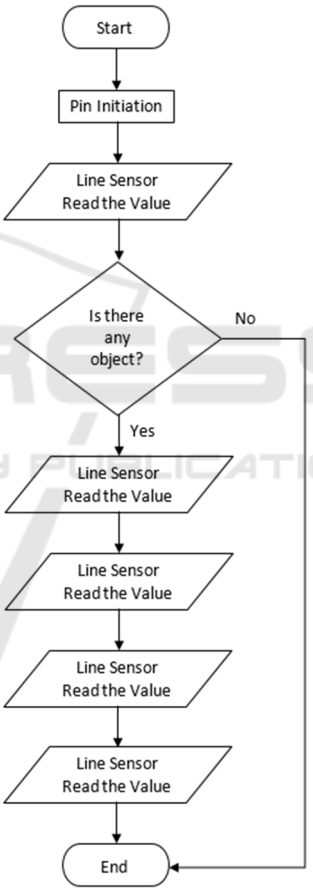


Figure 3: Flowchart of the line follower robot for carrygoods.

The current is then converted into a square signal with a frequency proportional to the magnitude of the current. (Riskiawan, Rizaldi, Setyohadi, & Leksono, 2017) In the block diagram of the conveyor there are two sensors used, namely the Proximity sensor and the TCS 3200 sensor. The proximity sensor will detect objects while the TCS 3200 will detect the

color of the goods. Flowchart of the carrier conveyor is shown in Figure 4 and the mechanical design is shown in Figure 5.

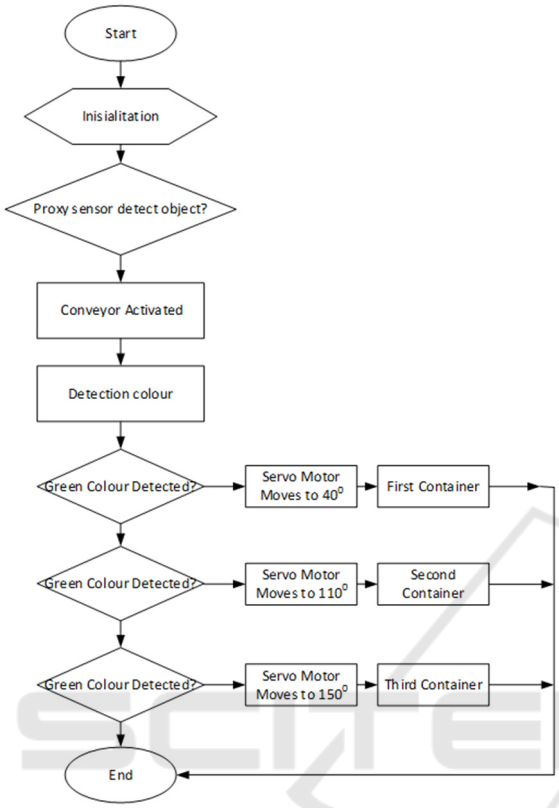


Figure 4: Flowchart of the Carrier conveyor.

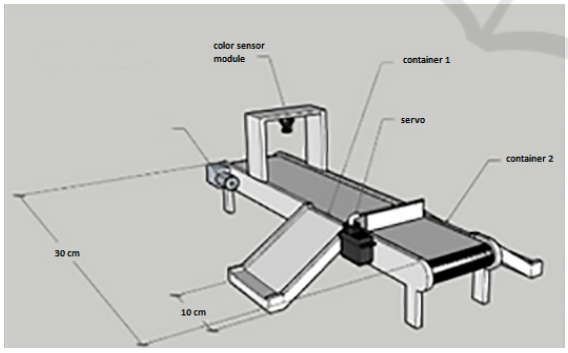


Figure 5: Conveyor mechanical design.

Some materials in the conveyor used are acrylic, PVC pipe, one DC motor, and one servo motor. The roller on the conveyor uses PVC pipe, as well as a servo motor to bring goods to a shelf or container from the sorting results. On the line follower robot there are two servos that are used for manipulators that are applied to the robot. At the wheel using a dc motor and at the front there are four photodiode sensors. Mechanical Mechanical design of delivery robot can be seen in Figure 6.

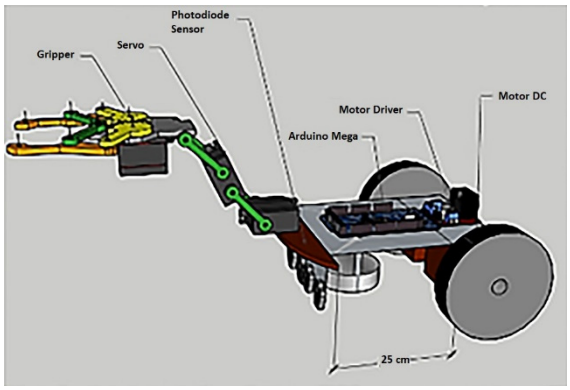


Figure 6: Mechanical design of delivery robot.

3 RESULTS AND DISCUSSION

The TCS 3200 sensor is very sensitive to light, thus needed a mechanic that can control the light, which made the light intensity value does not change.

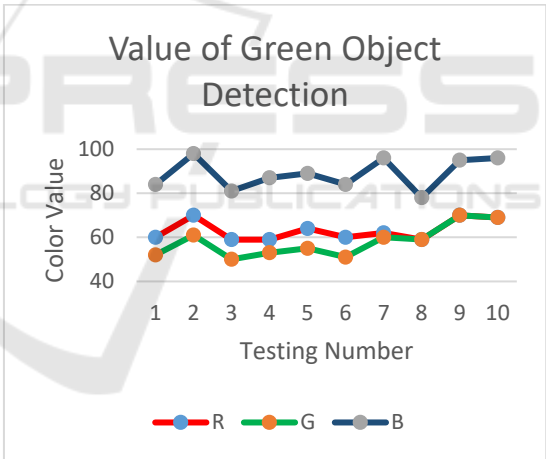


Figure 7: Value of green object detection.

When the goods pass through the TCS 3200 sensor then the resistance value will be read. And also, when resistance value according to a certain color, the servo will move and place the goods according to the color. The results of testing the color sensor of the goods are as shown in Figure 7, Figure 8, and Figure 9.

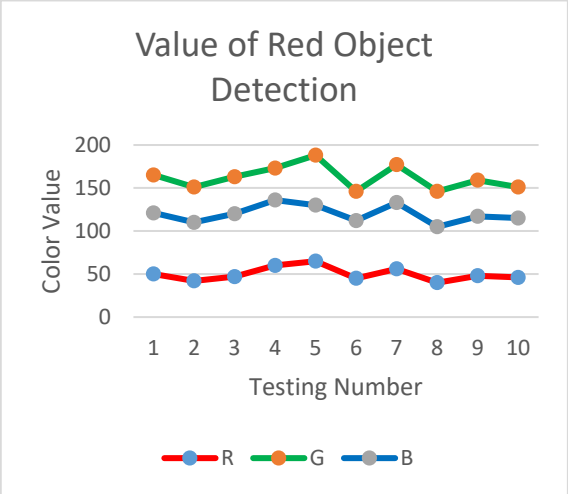


Figure 8: Value of red object detection.

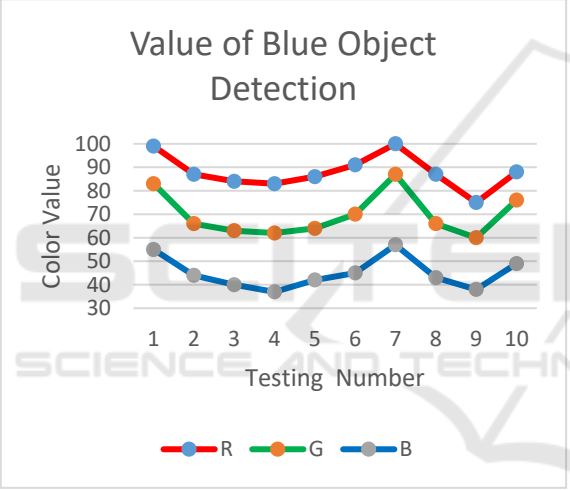


Figure 9: Value of blue object detection.

The R, G., B color detection data on the object to be moved is used as a reference for servo control in separating goods according to their color.

3.1 Time Testing of Line Follower Robot Bringing Goods to Conveyor

Tests are carried out to determine the time needed in sending goods to conveyors for sorting. In the experiment a good average time to get is 14.20 seconds. The results are shown in Table 1 and Figure 10.

Table 1: Estimated time used toward conveyor.

No	Estimated time used toward conveyor (second)	Description
1	13.98	Robot Walking Stable
2	14.48	Robot Walking Stable
3	14.33	Robot Walking Stable
4	16.90	Robot Walking Unstable
5	15.78	Robot Walking Stable
6	15.57	Robot Walking Stable
7	16.83	Robot Walking Unstable
8	17.54	Robot Walking Unstable
9	13.95	Robot Walking Stable
10	19.62	Robot Walking Unstable

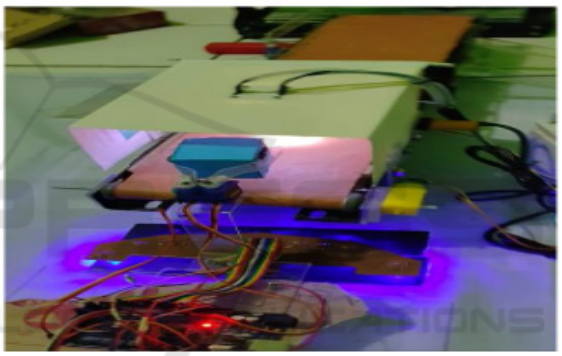


Figure 10: Robot delivering goods to conveyor.

In the test, there were four times the robot was running in an unstable state when the line follower robot followed the line. It was because there is a change in the intensity of light that changes and there is a net that bends sharply so the speed of the robot needs to adjust.

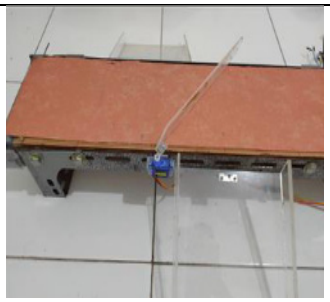
3.2 Conveyor Test with TCS 3200 Sensor and Servo Motor

Testing the rotational position of the servo motor needs to be done to get the right angle so that it can move according to the position of the shelf which will be the position of the goods according to color. The result is shown in Table 2.

Table 2: Servo Motor Position Testing.

No	Servo Motor Position	Position in Mechanical
1	180^0	 Towards the Container 3
2	160^0	 Unable towards the Container 3
3	140^0	 Unable towards the Container 2
4	120^0	 Unable towards the Container 2
5	110^0	 Towards the Container 2
6	100^0	 Interrupted towards the Container 2
7	80^0	 Unable towards the Container 2
8	60^0	 Unable towards the Container 1

Table 2: Servo Motor Position Testing. (cont.)

9	40^0	 Towards the Container 1

Based on the test results in Table 2, conclude that the appropriate servo position so that the goods can go every receptacle prepared without any obstructions are position 40 degree for the first container, position 110 degree for the second container and position 180 degree for the third container.

3.3 Test Sort Items by Color

Table 3 showt test sort items by color. There are errors in the red color sorting twice and the green color 2 times while the blue color is 100% running well.

Table 3: Testing of Color Sorting Results.

No	Red		Green		Blue	
	Towards Well		Towards Well		Towards Well	
	Yes	No	Yes	No	Yes	No
1	√		√		√	
2		√	√		√	
3	√		√			√
4		√	√			√
5	√		√		√	
6	√		√		√	
7	√		√		√	
8	√		√		√	
9	√		√		√	
10	√		√		√	

4 CONCLUSION

The results of this study found that the delivery of goods using a line follower robot still has interference from the interference of changes in light intensity. The use of a line follower robot should only be done in a room with a fixed light intensity. The winding road can also slow down the time for the line follower robot to deliver goods. In the delivery goods the fastest time obtained is 14.20 seconds. In the sorting goods the system can work well, the goods that are sorted can be placed accordingly.

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