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# SMART TROLLY DESIGN BASED ON MARKER DETECTION

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## ABSTRACT

In this modern era, robots are very instrumental in helping the human work and even replace their work. From the various human works, humans will need a trolley to carry goods. As in supermarkets, people will need a trolley to make it easier to carry groceries and other luggage. But with a trolley that is commonly used, users must encourage the trolley to move so that it reduces hand activity to do other activities. Therefore, we need a trolley that can move to follow the user automatically, so the user no longer needs to push the trolley, and the user's hand can be more free to do other activities. This research discusses about trolley robot using marker detection. With the application of this method will help the robot determine the object so as to facilitate the movement of the robot to follow the user. In the testing process carried out in the study, the system accuracy in detecting markers on objects was 70 %.

Keyword: Trolly, Image processing, and Automatic

## INTRODUCTION

The development of science and technology has an important role in the progress of the nation. Increasingly sophisticated and cutting edge technology is expected to improve, speed up and facilitate human work. At present the existence of supermarkets has circulated quite widely in Indonesia. Shopping is an activity that involves consideration of a product or service, finding a store that provides the best product or service, searching for the desired product or service in the store, and determining the decision to buy. However, when people shop at supermarkets using shopping baskets, they do not know how much is the accumulated price of all items taken. Not to mention when there are many consumers who have to queue at the cashier for a long time to be able to know the amount of accumulated prices and pay. This is very ineffective and inefficient.

As we have discussed above that in this modern era robots are very instrumental in helping human work and even replacing human work, trolly is very needed by humans in carrying various kinds of goods As in supermarkets where trolleys make it easy to carry groceries, goods and other luggage, but with a trolley that is commonly used, the user must encourage the trolley to move so as to reduce hand activity to do other activities. Therefore, we need a trolley that can move to follow the user automatically, so users no longer need to push the trolley so it is very practical and the user's hand can also be more free to do other activities

In every supermarket in Indonesia has a place or container provided by the supermarket in order to facilitate consumers in placing their groceries in the form of trolly or shopping basket. In the current technological era, a smart trolly system is needed to facilitate consumers in carrying out shopping activities. With the features created are creating a

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trolly that can follow every step of the consumer wherever the consumer goes.With this system, consumers no longer need to bother to push their trolly.

With this smart trolly, consumers can do other activities besides encouraging their shopping trolly. This can increase the work efficiency of consumers. Equipped with a price information system for groceries taken by consumers in shopping, helping consumers to limit the amount of their purchases in accordance with the costs they have or that have been previously planned.

## METHODOLOGY

The research methodology is a description of the stages carried out in carrying out the design and testing. In general, the stages set out in Beginning of research with the design and preparation of hardware and software. From the results of the design carried out testing, if it is not suitable yet, return to the preparation and design. When completed, the study is analyzed and concluded.

### a. System Block Diagram

In a smart trollie system the input is taken from the IMAGE PROCESSING sensor as a determinant of the movement of the motor that moves the trollies. The intended movements here are forward, backward, right turn, or left-hand movements of shopping trollies. Laying the IMAGE PROCESSING sensor on consumers can have an influence on the movement of shopping trollies that are expected to follow the wishes of consumers in walking and can follow consumers wherever they go.

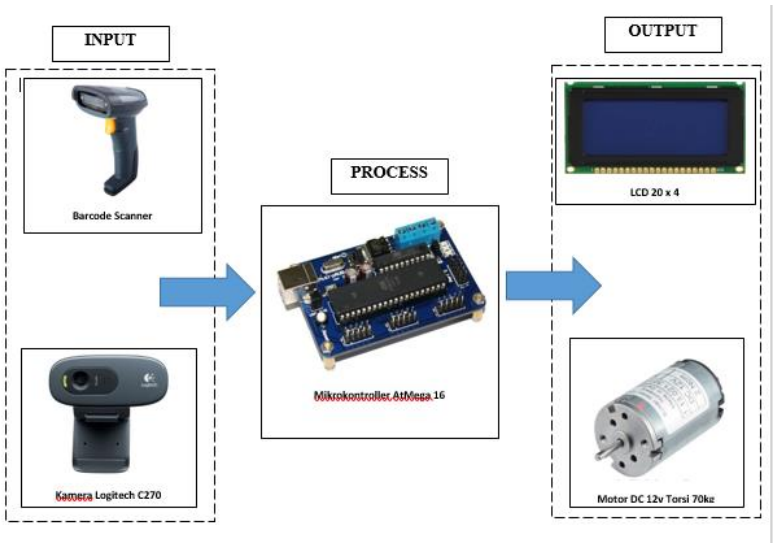


Figure 1. Hardware Connection Block

In addition to the movement process that is controlled using image processing sensors, the smart trollie system is also equipped with a barcode scanner to scan shopping items from consumers. The result of the barcode scanner is the price of items that have been picked up and included in the trollie. After being scanned using a barcode scanner the price results of the goods will be displayed using a 16X2 LCD through a microcontroller which is sent using the HC-05 Bluetooth module. Following is the flowchart on the trollies movement control system and the item price information system on the trolly.

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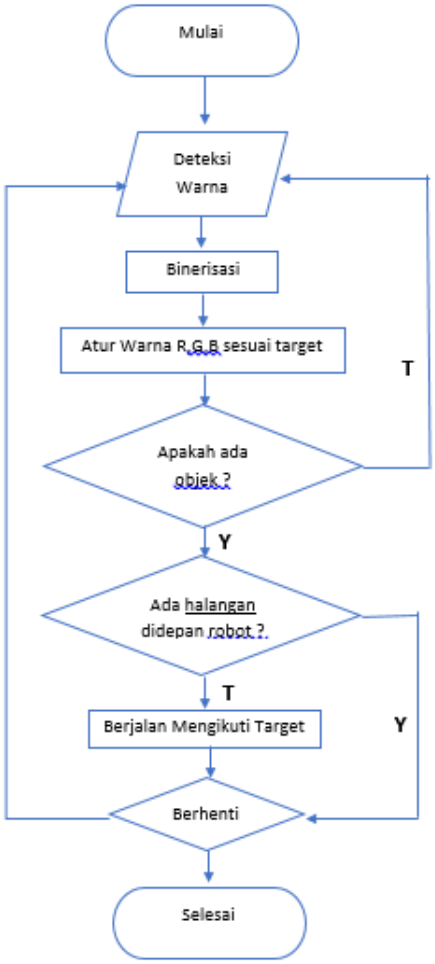


Picture 2. General Flowchart of Trolly Movement Control

**b. Designing ultrasonic sensor configuration to Atmega 16**

The Ultrasonic Sensor HC-SR04 uses sonar to determine the distance to an object, as do bats or dolphins. This sensor has a pretty good accuracy and a fairly stable reading. Operations are not influenced by sunlight or dark colored material, but are influenced by acoustic material. This sensor has a specification range of 2 cm - 400 cm with a resolution of 0.3 sm, and an angle range of less than 15 degrees. From the above circuit explained that the Ulrasonic HC-SR04 sensor has 4 legs connected to the microcontroller. The pin marked with the red line is connected to vcc and the pin marked with the black line is connected to GND. The pins are marked with green lines PB 0 and PB 1 to see the output results that have been detected by the HC-SR04 ultrasonic sensor.

**c. Designing a motor configuration of 16V to Atmega 16**

DC motor is a device that converts electrical energy into kinetic or motion energy. This DC motor can be called as direct current motor as the name suggests, DC motor has two terminals and requires direct current voltage or DC (Direct Current) to be able to move it. DC Electric Motors are usually used in electronic and electrical devices that use DC power sources such as mobile phones, DC fans and DC Electric

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Drills. From the above circuit explained that the DC motor has 2 legs connected to the microcontroller. The pin marked with the red line is connected to vcc and the pin marked with the black line is connected to GND.

**d. Logitec camera design to PC**

Webcam or abbreviation of the web and camera is the designation for a real camera whose images can be viewed through a computer or PC (personal computer) connected to the camera, consisting of instant message processing programs and video calling applications. Webcam Logitech C270. This webcam camera is used as a real-time video image capture media that is connected by a USB cable to a personal computer or laptop. This camera is mounted at the front of the vehicle when shooting video. Personal computers or laptops are used as a central image processing (image processing) and as a server in web and database processing. The video data obtained on the camera will be processed by the computer's image using supporting software to detect highway damage.

**e. Design of *barcode scanner* to PC**

Barcode (item code) is a collection of data that develops lines and spacing (space). Barcodes also use vertical bar sequences and distances between lines to represent numbers or other symbols. Thus, the entire thickness of the bar line, the distance between the lines with each other must always be different according to the contents of the data contained by the barcode or barcode. Barcode scanner serves to detect or determine the price of goods. Personal computers or laptops are used as central processing prices and as servers on web and database processing. The video data obtained on the camera will be processed by the computer's image using supporting software to detect highway damage.

**f. Design LCD to Atmega 16**

Graphic LCD is a module that functions as a display that can display images that have a resolution of 128 columns and 64 lines. This LCD has a blue base color and white characters using backlight. This LCD is based on ST7920 with a supply voltage of 5V DC. From the above circuit explained that the LCD has 20 feet connected to the microcontroller. Pins 2 and 19 marked with red lines are connected to vcc and pins 1 and 20 that are marked with black lines are connected to GND. Pin 3 Vo with bitu (contrast adjustment), pin 4 RS with blue line (data / instruction select signal), pin 5 R / W with blue line (read / write select signal), pin 6 E with blue line (enable signal ), pins 7-14 DB0-DB7 with green pins (data bus line).

**g. Implementation of Testing Tools**

This implementation aims to determine the mechanism of the tool to be tested in fulfilling its function. In this implementation it is expected to be able to find out some elements of the Smart Trolly system including the advantages and disadvantages of this Smart Trolly. The overall shape of the Smart Trolly is like in Figure 3 below.

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Picture 3. Smart Troly

Smart Trolly has several components such as a shopping basket, pvc pipe with a size of ½ "which is used to support the tool frame such as ultrasonic sensors and cameras. This ultrasonic sensor is used to respond to the distance between Trolly and the object being followed. The camera is used to detect the color found in the human body in this case the color of clothes worn.

### h. Testing

Testing is done by ensuring Trolly can run with a maximum load of 15 kg and the speed depends on the load carried. The heavier the load Trolly carries, the slower the speed of Trolly. The system has been created using the Python programming language that runs on the Windows 7 operating system.

## SYSTEM RESULT AND ANALYSIS

On the results and analysis of this system, testing of smart Trolly is made. The system trial consists of several stages, starting from testing each supporting part of the system to testing the whole system. From the test results, it can be analyzed the performance of each part of the system that interacts with each other to form an Image Procesing based Smart Trolly. Testing of the whole system is useful to find out how the performance and level of success of the smart Trolly.

### a. Tracking Testing

In this Smart Trolly when it will be used as its previous function Smart Trolly must be tested Tracking first and for the following stages:

**1. Detection of Objek**

In this stage Smart Trolly recognizes objects through a camera that has been determined as a reference for the Smart Trolly system to recognize which objects should be followed and not moved on other objects. Smart Trolly is made in such a way that the program can receive commands in the form of forward, turn right, turn left and stop with parameters that have been determined in this case as for the parameters made by Trolly smart reference to understand

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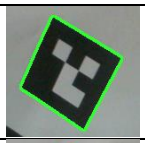
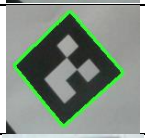
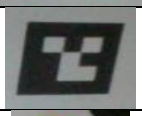
the position of the object how the object is located using the x-axis starting from 0 (zero) up to <(less than) the value of 480 pixels to the right of the x-axis, while the y-axis only functions when there is a stop command and in addition to using the y-axis the stop command also uses the x-axis when both are equally valued (-1) or no command or object detected. This test uses an image maker as a reference for the Smart Trolly system. The results of testing object detection using a camera can be seen in Table 1.

Table 1. Test Results of Camera Position in Detecting Objects

| Camera Position | Description | Detected |
|---|---|---|
|  | Front facing camera position | Yes |
|  | Camera position tilted to the right | Yes |
|  | Camera position is tilted to the right | Yes |
|  | Camera position facing top | No |
|  | Camera position facing up | Yes |
|  | Position the camera facing the bottom | No |
|  | Position the camera facing up and tilted to the left | Yes |

Based on the results of tests conducted above the camera's position is not good making the camera unable to function optimally in object detection.

## 2. Run the Object command

In the system that is made, given basic commands such as forward, backward, turn right, turn left and stop (stop). The following is an example of a calculation from an advanced command. Forward commands can function when the object is in the middle in the position x ≥ 280 and x <310.

a. The First Step

$$CG = \frac{E_{EST}}{E_{EST} + E_{MEA}} \quad (1)$$

$$= \frac{10}{10 + 20}$$

$$= \frac{10}{30}$$

$$= 0,3$$

b. Secon Step

$$EST_T = EST_{T-1} + CG[MEA + EST_{T-1}] \quad (2)$$

$$= 280 + 0,3[290 + 280]$$

$$= 280,3[10]$$

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$= 290{,}3$

c. Third Step

$$E_{EST_T} = [1 - CG](E_{EST_{T-1}}) \quad (3)$$
$$= [1 - 0{,}7](10)$$
$$= [0{,}7](10)$$
$$= 10{,}7$$

Description:

CG : Coordinate Gain (Cordinate Value)

$E_{EST_T}$ : Estimated Error

$E_{MEA}$ : Error Sensor

Input:

Original Distance = 300°

J. Estimates = 280°

Error J.E = 10°

Sensor Value = 290°

E.Sensor Value = 20°

The results of the forward command experiment can be seen in table 2.

Table 2. Results of the forward command experiment

| No | MEA | $E_{MEA}$ | EST | $E_{EST_{T-1}}$ | $E_{EST_T}$ | $E_{EST_T}$ |
|---|---|---|---|---|---|---|
| **t-1** | - | - | 280 | 10 | | |
| **T** | 290 | 20 | 280 | 10 | 0.3 | 10,7 |
| **t+1** | 290,3 | 20 | 290,3 | 10,7 | 0.3 | 11,4 |
| **t+2** | 290,6 | 20 | 290,6 | 11,4 | 0.3 | 12,1 |
| **t+3** | | 20 | 291 | | 0.34 | |
| **t+4** | - | - | 280 | 10 | | |

### 3. Testing of HC-SR04 Ultrasound Sensor Readings

Smart Trolly is given a tool in the form of an Ultrasonic Sensor HC-SR04 which functions to respond to the distance from Trolly to the object being followed, so that the motion and response of Trolly can be more sensitive. Ultrasonic sensor testing, carried out tenth of a cm of testing to read how accurate the reading is according to the original distance. For testing starting from a distance of 10 cm to 150 cm and the magnitude of the sensor error can be calculated using equation 4

$$Error\,(\%) = \frac{(JP - JS)}{JS}\ x\ 100\% \quad (4)$$

Where, JP is the sensor reading distance, and JS is the actual distance. In this case the actual distance is the distance obtained through manual measurement using a ruler and / or meter. For the results of testing the distance between the sensor and the color of the clothes can be seen in table 3.

Table 3. Results of Testing the Distance Between Sensors and Objects

| Actual Distance (CM) | Distance Read by Sensor (CM) | Distance Different (CM) | Presentage Error (%) |
|---|---|---|---|
| **10** | 10 | 0 | 0 |
| **20** | 21 | -1 | 4,76 |
| **30** | 31 | -1 | 3,23 |

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| | | | |
|---|---|---|---|
| **40** | 41 | -1 | 2,44 |
| **50** | 51 | -1 | 1,96 |
| **60** | 61 | -1 | 1,64 |
| **70** | 71 | -1 | 1,41 |
| **80** | 81 | -1 | 1,23 |
| **90** | 91 | -1 | 1,1 |
| **100** | 102 | -2 | 1,96 |
| **110** | 111 | -1 | 0,9 |
| **120** | 120 | 0 | 0 |
| **130** | 131 | -1 | 0,76 |
| **140** | 140 | 0 | 0 |
| **150** | 150 | 0 | 0 |

In table 3 there are differences or sensor errors from the actual distance testing with the distance testing that is read by the sensor. As an example at a distance of 110 cm is the actual measurement distance has a difference with the measurement read by the sensor so that it has an error percentage of 0.9%. Based on Table 3 we can make a comparison graph of the actual distance measurements and the distance read by the sensor, as in Figure 4.

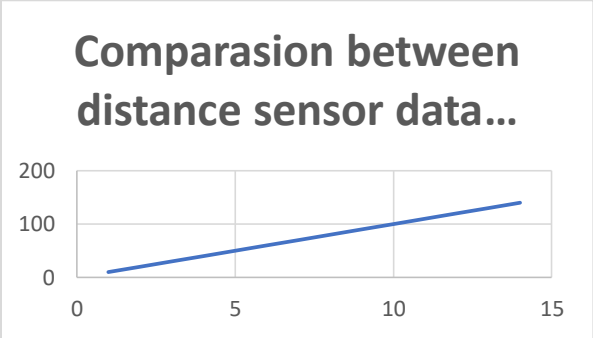


Figure 4. Comparison of actual distance graph with the distance that is read by a sensor

**4. Testing The Walking Speed In Front Of The Trolley**

In testing the walking speed in front of the trolley, the authors tested as many as 6 testing the speed of walking someone in front of the trolley. The results are made in table 5.

Table 5. Results of Testing Walking Speed in Front of Trolley

| Running Time | Needed Time (s) | Distance Traveled (m) | Speed | | Trolley Can Follow Users |
|---|---|---|---|---|---|
| | | | **m/s** | **km/hr** | |
| **Very Slow** | 18,8 | 8 | 0,42 | 1,53 | Successful |
| **Slightly Slow** | 17 | 8 | 0,47 | 1,69 | Successful |
| **Slow** | 15,15 | 8 | 0,52 | 1,9 | Successful |
| **Rather Fast** | 12,1 | 8 | 0,66 | 2,38 | Successful |

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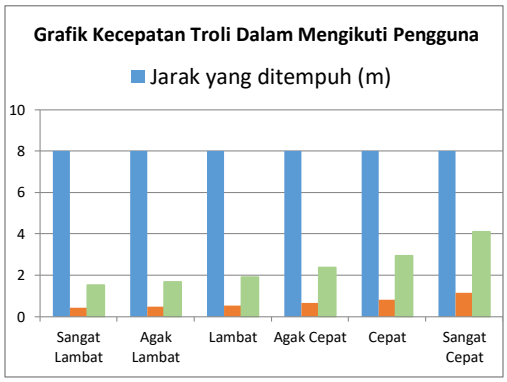
| | | | | | |
|---|---|---|---|---|---|
| **Fast** | 9,8 | 8 | 0,81 | 2,93 | Failed |
| **Very Fast** | 7 | 8 | 1,14 | 4,11 | Failed |

In testing the user's speed walking in front of the trolley is done by walking in front of the trolley with various speeds such as very slow, rather slow, slow, rather fast, fast, and very fast. In table 4 it can be seen what is the maximum speed of the trolley when following the user who is walking in front of the trolley. In this test an example can be taken how much time is needed to reach a distance of 8 meters so that it can be seen how much the speed of users in units (m / s) and (km / hour). The formula used to calculate the user's speed in units (m / s) as in equation 5 and to calculate the user's speed in units (km / hr) in equation 4.3 is as follows:

$$Kecepatan\ (^{m}/_{s}) = \frac{Jarak\ (m)}{Waktu\ (s)} \qquad (5)$$

$$1\ m/s = 3.6\ km/jam$$

Based on Table 3, we can make a comparison graph of the actual distance measurements and the distance read by the sensor, as in Figure 5.




Picture 5. Trolley Speed Chart in Following Usage

## 5. Trolley Movement Testing Based on Shirt Color

This test is carried out to determine the movement of the trolley based on the color of the clothes detected. The sensor test results to detect the color of the clothes used can be seen in table 6. For the results of trolley movement testing can be seen in table 7.

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Table 6. Test Results of Sensor Detection of Shirt Colour

| Actual Distance (CM) | Distance Read By Sensor (CM ) | Detected |
|---|---|---|
| **30** | 31 | Yes |
| **50** | 51 | Yes |
| **75** | 76 | Yes |
| **100** | 101 | Yes |
| **125** | 127 | Yes |
| **150** | 155 | Yes |
| **175** | 185 | Yes |
| **200** | 218 | Yes |
| **225** | 230 | No |
| **250** | 270 | No |

Table 7. Test Results of Sensor Detection of Trolly Movements

| Object Initial Distance (CM) | Object Motion | Detected | Object Movement |
|---|---|---|---|
| **30** | Straight Back | Yes | Backward |
| **50** | Straight Forward | Yes | Forward |
| **75** | Straight Forward | Yes | Forward |
| **100** | Straight Forward | Yes | Forward |
| **100** | Swipe right more than 20 cm | Yes | Forward Turn Right |
| **100** | Turn right more than 20 cm | Yes | Forward Turn Left |
| **125** | Straight Forward | Yes | Forward |
| **125** | Swipe right more than 20 cm | Yes | Forward Turn Right |
| **125** | Swipe right more than 20 cm | Yes | Forward Turn Left |
| **175** | Straight Forward | No | Stop |
| **175** | Swipe right more than 20 cm | No | Stop |
| **175** | Swipe left more than 20 cm | No | Stop |
| **200** | Straight Forward | Yes | Forward |
| **200** | Swipe right more than 20 cm | No | Stop |
| **200** | Swipe left more than 20 cm | No | Stop |
| **225** | Straight Forward | No | Stop |
| **225** | Swipe right more than 20 cm | No | Stop |
| **225** | Slide left more than 20 cm | No | Stop |
| **250** | Straight Forward | No | Stop |
| **250** | Swipe right more than 20 cm | No | Stop |
| **250** | Swipe left more than 20 cm | No | Stop |

## CONCLUSION

Based on the research results of the design, implementation and results of testing the results of tools and systems made can be concluded that:

1. From the results of this study can design a tool in the form of Smart Image-Based Trolly as a color detector on objects.
2. From some of the object detection tests that were followed it can be concluded that the test still could not be said to be perfect or in accordance with the provisions.

Smart Trolly Based on Image Processing that has been designed to function properly and is expected to help in shopping activities in shops without having to push trolly manually.

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