DESIGN OF CONE DETECTION SYSTEM ON ROBOMAGELLAN (JELAJAH V-18)

Feki Pangestu Wijaya[1], Didit Andri Jatmiko[2]

Jurusan Teknik Informatika, Universitas Komputer Indonesia
Jl. Dipati Ukur N0.114-116 Bandung, 40132
E-mail : fekipangestu@email.unikom.ac.id[1], didit@unikom.ac.id[2]

ABSTRACT

Robomagellan Jelajah V-18 is a prototype of a smart car where the robot can run automatically by using GPS and can know the surroundings by using the camera and other sensors. The robot also has a system where the robot can search and recognize an object. By using image processing the robot can process each input image and distinguish between the object being searched and other objects. By using HSV method that is able to recognize objects of its color, then the binary method by which the robot can recognize the object and contour where the robot can recognize the shape of the object, with these methods the robot can search for objects that exist around the robot.

Keyword : robots, prototypes, cameras, HSV, binary, contour

1. INTRODUCTION

Autonomous cars or cars without a driver are vehicles that are able to sense the surrounding environment and navigate without human help. Autonomous cars consist of several tools and sensors to find out the surroundings such as radar, cameras, laser light, GPS, lidar and computer vision. All devices will be connected to a main system to control and process information from sensors to identify the right navigation path [1].

To develop Autonomous cars, various competitions were held to make prototypes of smart cars where the prototype had to use various sensors applied to Autonomous cars such as GPS and cameras. Robogames is a robot contest where one of the competitions is to make prototypes of smart robots where the main objective of the race is that the robot must be able to navigate automatically using GPS and pass various obstacles by using various proximity sensors from the initial GPS coordinate point to the final GPS coordinates . These coordinate points will be marked with an orange traffic cone, therefore the robot must be able to recognize an orange traffic cone object and touch it to complete the race [2].

2. *LITERATURE REVIEW*

A. *Image Processing*

Image processing is an image processing process to get the information needed in an image [3]. *Image processing can be divided into three categories, namely low, medium, and high categories. Low categories involve simple operations such as image pre-processing to reduce noise, contrast settings, and sharpness settings. Intermediate category processing involves processes such as image segmentation and clarification. High category image processing involves the process of identifying and describing images* [4].

1) *Digital Image*

In general, digital image processing refers to 2-dimensional image processing using a computer. In a broader context, digital image processing refers to the processing of every 2-dimensional data. Digital images are arrays that contain real and complex values that are represented by a certain row of bits [4].

An image can be defined as a function of f (x, y) measuring M lines and N columns, with x and y being spatial coordinates, and amplitude f at coordinate points (x, y) called the intensity or gray level of the image at that point. If the value of x, y and the value of amplitude f is finite overall and has a discrete value then it can be said that the image is a digital image [4]. *Figure 1 shows the position of digital image coordinates.*

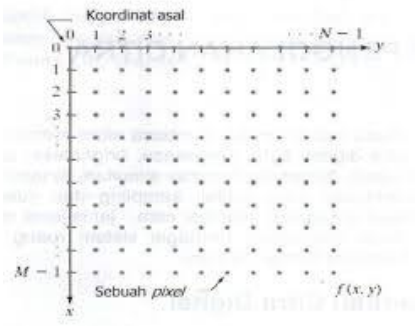


Figure 1 Digital Image Coordinate

2) *Binary Image*

Binary image is a digital image that only has two possible pixel values (values 0 and 1) or commonly called monochrome images [4]. *A value of 0 represents black and 1 states white. This type of image is widely used in image processing, usually to get the edge of the shape of an object* [5]. *In Figure 2 the original image and the image that has been converted into binary image will be compared.*

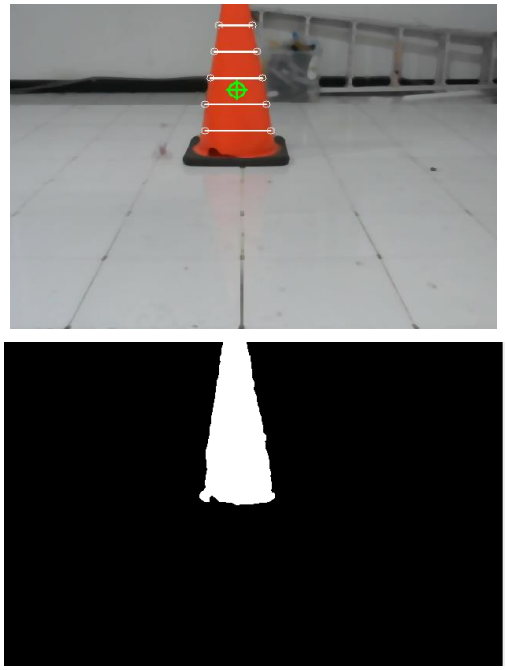


Figure 2 Original Image & Binary Image

3) *Contour*

Is a method used to get the edge of an object. There are terms of external contours and internal contours, external contours are located outside the object, while internal contours are located inside objects [4]. *In Figure 4, an illustration of the difference between the two types of contours is shown.*

4) *Color Space*

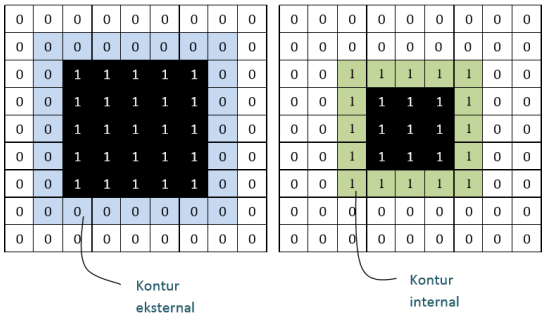


Figure 4 External Contour and Internal Contour

Color space (or sometimes called a color system or color model) as a specification of the coordinate system and a subspace in the system with each color expressed with a single point in it [6]. *The purpose of forming a color space is to facilitate color specifications in the form of a standard* [4].

5) *RGB Color Space*

RGB color space is a color space consisting of three color components (red, green, blue). RGB is widely used in hardware design such as electronic equipment (television, computer monitors, etc.) because of its ease in design, but actually not ideal for some applications because red, green, and blue are closely correlated and very difficult to process for several algorithms [4]. With a resolution of 24 the number of colors on the RGB model reaches 16,777,216. In Figure 4, the RGB model will be shown in the form of a three-dimensional cube

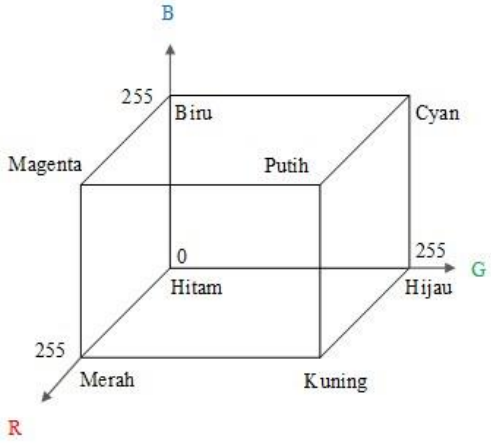


Figure 5 RGB Color Scheme in Cube Shape

6) *HSV Color Space*

Derived from the words hue, saturation, and value are color spaces that represent as seen by the human

eye or more easily the same colors as those captured by the human eye [4].

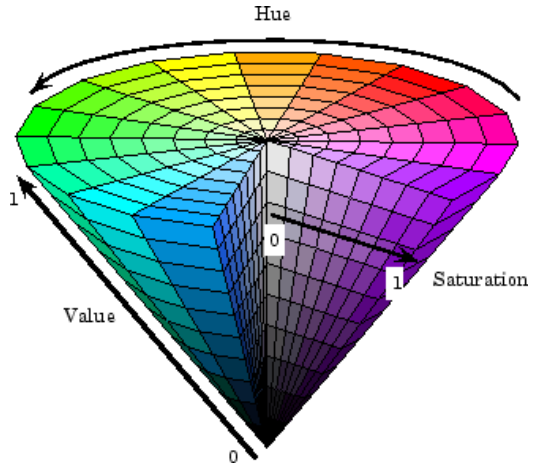


Figure 6 HSV Color Space

3. METHOD AND DISCUSSION

A. System Planning

In designing the Magellan Jelajah V-18 robe traffic cone detection system, there are three main constituent parts of the system, namely input, processing part and output. These three parts are the determinants of the system to work as desired. In Figure 9 will describe the system block diagram as a whole.

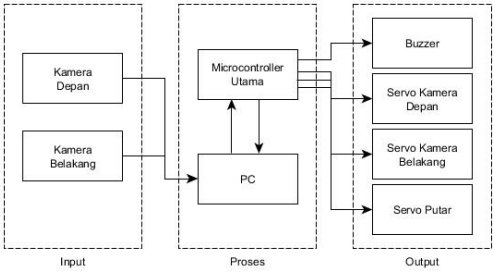


Figure 9 Main System Block

B. Hardware Design

1) Hardware Design of Traffic Cone Detection System

The detection system here is a system used to search traffic cones. This system uses two input devices, three propulsion devices, two processing tools and one sound indicator. In the design of the input device will be placed on the front and the back of the robot with the aim to facilitate the search process of the traffic cone. The input device itself will be paired with each of the movers that can speed up the search process. Then in the body part of the robot will be placed two processing devices that are the core of the system to be built, processing equipment stored in the robot body with the aim to protect from external disturbances such as dust, splashes of water, or other factors that can interfere with the performance of the device . Then on the back of the robot will be paired with a tool that is used as an indicator the robot has found a traffic cone. The following is a description of the system to be built can be seen in Figure 10.

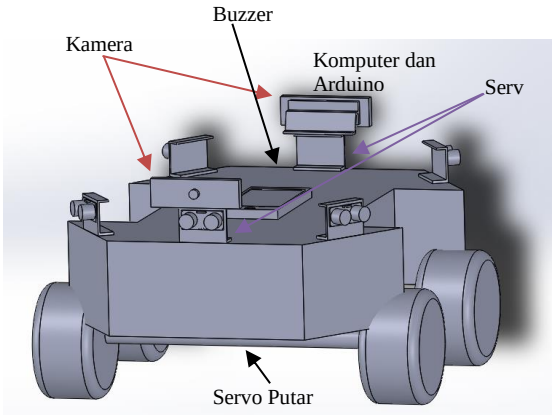


Figure 10 Designing Traffic Cone Detectors

2) Hardware Design of the Traffic Cone Search System

This system is a system to help object detection process which will regulate the movement of the servo motor to rotate the camera. This is done to speed up and simplify the detection process which will expand the search area without having to move the robot. With this system, the camera will be rotated one hundred and eighty degrees, whether it's a second camera or a rear camera. using a servo motor. Object search system can be selected in Figure 11.

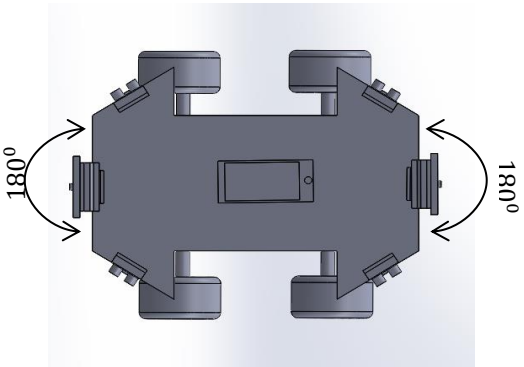


Figure 11 Search System

C. Algorithm Design

Algorithm design includes search traffic cone algorithms that exist in microcontrollers and traffic cone detection algorithms on personal computers

. Following is the algorithm on the microcontroller, this algorithm is used to search traffic cones. The algorithm starts from taking orders from a personal computer, performing the search process, and sending search results data on a personal computer.

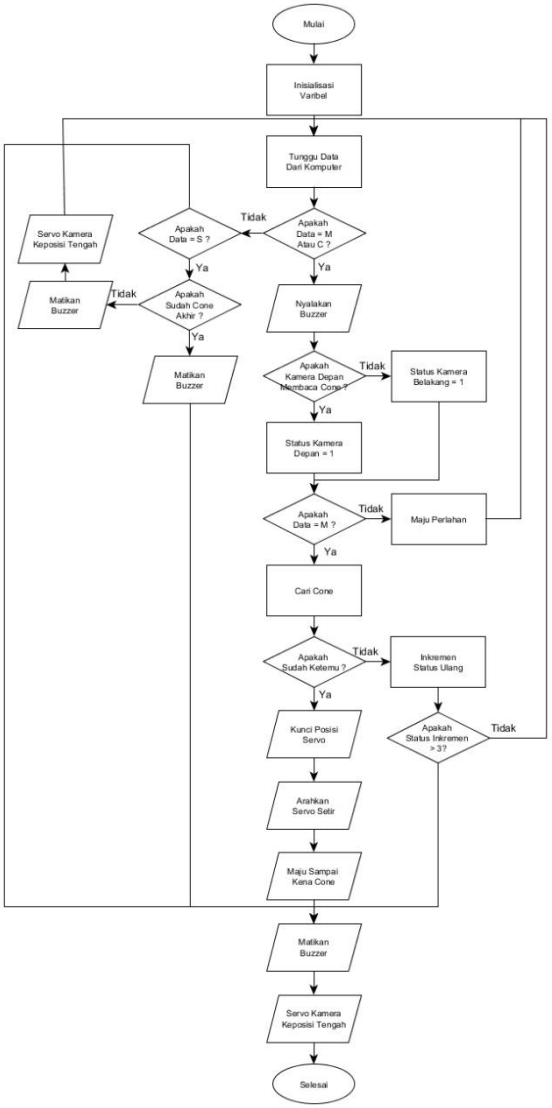


Figure 12 Traffic Cone Search Algorithm

The traffic cone algorithm will then be attached to the personal computer to detect the presence of traffic cones in the area around the robot, then the personal computer will get the image data around the robot from the camera then it will be processed by the algorithm before it becomes data that will be sent to the microcontroller. If one camera manages to detect the traffic cone, the computer will focus on the camera that detects the traffic cone and turns off the other camera.

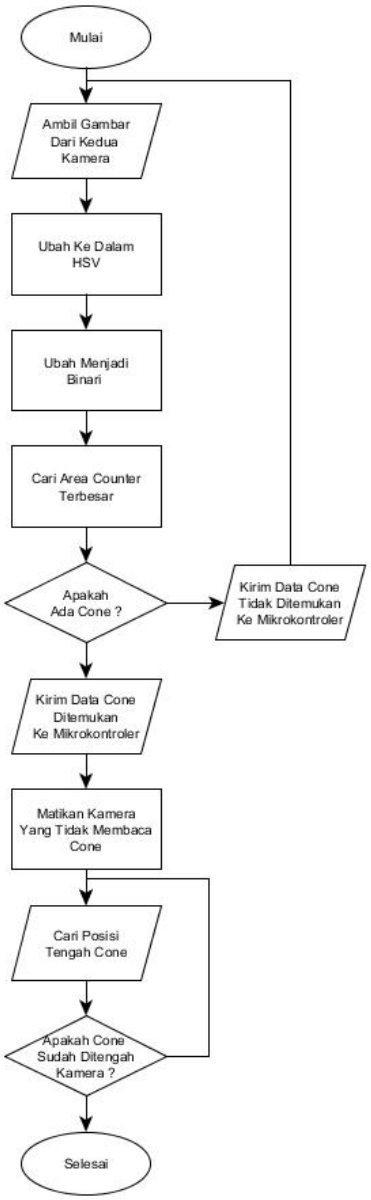


Figure 13 Traffic Cone Detection Algorithm

D. Implementation

When Robomagellan is run and has found the specified coordinates, the detection process will run. The front and rear robotic cameras will automatically take pictures of the conditions around the robot simultaneously, and the system will combine the two images into one image before traffic cone will be detected in the image.



Figure 14 Shooting

In Figure 14 we can see that the image panel on the left is a picture of the front camera and on the right is a picture of the rear camera. Simultaneously the camera will be rotated 180 degrees to find traffic cone objects around the robot. If one camera can find an object, the system will focus on the camera and turn off the other camera. After that the search will be carried out again until the object's position is right in the center of the camera.



Figure 15 Cameras Focus On One Camera That Detects Traffic Cones

When the system starts detection, some conversions are made to the image taken in order to detect traffic cone. The first conversion will be from the original image that is still in the RGB (Red Green Blue) color space into the HSV color space (Hue Saturation Value). This is done to improve the accuracy of object search. In Figure 16, the conversion results are shown.

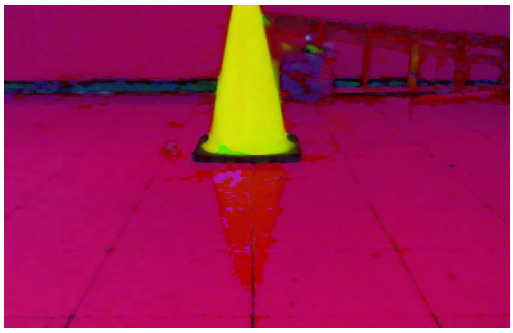


Figure 16 HSV Conversion

From the results of the trial the HSV value for traffic cone will be explained in table 1

Table 1 HSV Value Range

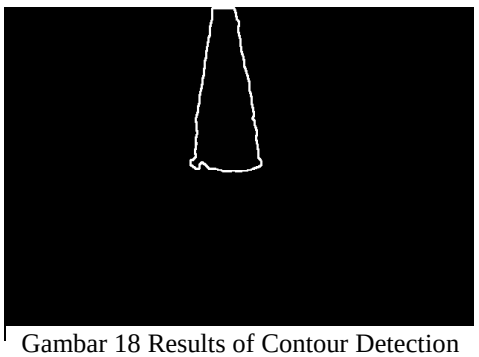
Hue	Saturation	Value
Hmin = 0	Smin = 209	Vmin = 142
Hmax = 23	Smax = 255	Vmax = 255

Images that have been converted into HSV will then be converted back into binary, where the purpose of this conversion is to find the border of the traffic cone object.



Figure 17 Binary Conversion

After finding the edge of the object, then the biggest contour area will be searched. After that the contour will be divided into 6 parts to later be compared with one another to determine the shape of the object is a triangle.



Gambar 18 Results of Contour Detection

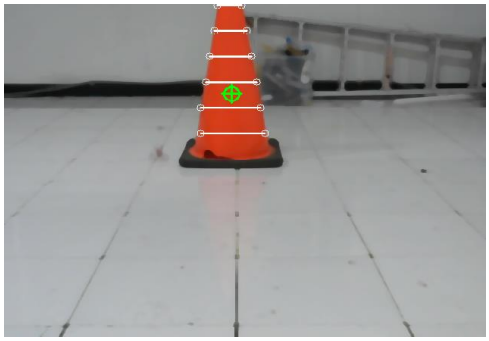


Figure 19 The Final Result

In Figure 19 it can be seen that the image found on the edge will be counted as high as the height of the object will be divided into six parts and a straight line will be drawn at each point to be calculated in length, then the value of the bottom line will be compared to the line above and will be compared again with the line above it to the last line. If the length of the line becomes smaller, the system will assume that the object is the object that is sought.

E. Testing

Testing includes the successful detection of objects in the Robomagellan Exploring V-18. The trial was conducted in an open field, testing was done by calculating the distance between robots and objects and calculating the success of robots detecting objects in table 2.

Table 2 Test Result

Jarak	Frame	Keberhasilan
1 Meter	241	100%
2 Meter	310	100%
3 Meter	192	100%
4 Meter	199	100%
5 Meter	192	100%
6 Meter	212	100%
7 Meter	185	35.67%

When viewed from table 2 the success rate of the system from a distance of one meter to six meters reaches 100% and at a distance of seven meters the percentage of success of the robot is only 35.67%. At a distance of seven meters the robot has been difficult to determine whether the object is a traffic cone or not.

4. TESTING RESULT

Based on testing and analysis of object detection and search systems, it was concluded that :

- *The robot can recognize orange and triangular traffic cones.*
- *The control system can recognize objects up to a distance of six meters with a percentage of success reaching one hundred percent.*
- *At a distance of six meters more the percentage of system success in recognizing objects dropped dramatically to thirty-five percent.*

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