EFFECT OF IMAGE RESOLUTION IN DETECTING CIRCULAR TRAFFIC SIGNS USING HOUGH CIRCLE TRANSFORM

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Abstract

The traffic signs have several shapes, one of which is circular. Hough Circle Transform is a function that detects a circular in an image based on the gradient. This function also needs some parameters, one of which is the image resolution. The traffic signs in the frame will have varying sizes. If after cropping, it will produce images with varying resolution sizes. Therefore, resizing image resolution is required so that all image data have the exact image resolution. Image resolutions to be tested are 25 × 25 pixels, 50 × 50 pixels, 75 × 75 pixels, 100 × 100 pixels, 125 × 125 pixels, 150 × 150 pixels, 175 × 175 pixels, and 200 × 200 pixels. This research proves that the image resolution in shape detection using Hough Circle Transform affects the shape detection accuracy. The data used are No Stopping signs and No Parking signs for True detection test, whereas Other Dangers signs and Pedestrian Crossing signs for False detection test. The highest accuracy was generated at a resolution of 75 × 75 pixels.

Keywords: *Image Resolution, Circular Shape Detection, Traffic Signs Detection, Hough Circle Transform, OpenCV*

1. INTRODUCTION

ADAS (Advanced driver-assistance systems) is an electronic system designed to support driving duties. The general difference of ADAS compared to these passive safety systems is that ADAS directly intervenes in the complex driving task leaving it a delicate task for the automotive industry to integrate these systems in their vehicles, get the drivers to accept this system, and most importantly, having ADAS systems improve traffic safety in the way they intended to [6].

Automatic traffic signs recognition is an essential part of ADAS, no less important than a car radar system that can track objects around the car. Traffic signs aim to improve driving safety on the highway. Automatic traffic signs recognition can provide traffic signs information to ADAS, increasing driving safety.

The traffic signs have several shapes, one of which is circular. The Hough Circle Transform method can detect this circular shape. Hough Circle Transform is a function that detects a circular in an image based on the gradient of the image [1]. The input of this function is the binary image. This function also requires some parameters such as image resolution, minimum detection distance, canny threshold, accumulator threshold, and the minimum and maximum circle radius [2].

The image of traffic signs in the frame will have varying sizes. If after cropping, it will produce images with varying resolution sizes. Therefore, resizing image resolution is required so that all image data have a consistent image

resolution. Thus, to determine the effect of image resolution on detecting circular shapes using Hough Circle Transform, this study was conducted.

2. RESEARCH METHODOLOGY

The procedure of this research is as follows:

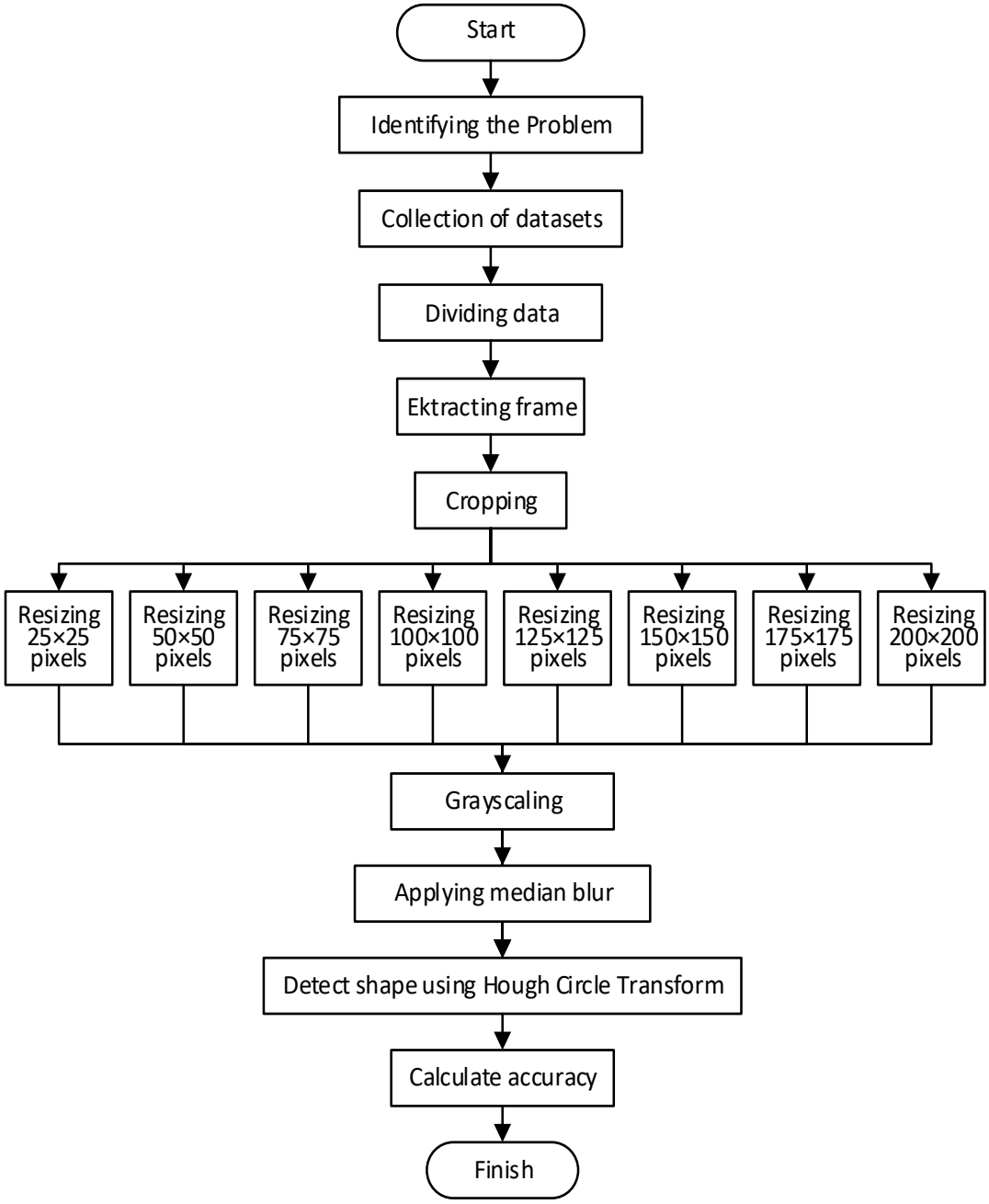

Figure 1 Research Flow

2.1 Identifying the Problem

The first step in this research is to identify problems by gathering various information about this research needs, such as conducting a study of literature studies and observing cases [9].

2.2 Collection of Datasets

In this study, data collection methods were used, namely observation. Observations were made by visiting the research location directly [4]. The data will be recorded using a camera with 1080p resolution, the data comes from Ahmad Yani street, Ujung Murung street, Kebun Karet street, Mentaos Raya street, Rahayu Sungai Paring street, Mentaos Raya street and P. Suriansyah Ujung street in South Kalimantan province.

There are two types of data, namely circular sign and diamond-shaped sign. The circular data will be used to determine whether the Hough Circle Transform can detect it correctly. Diamond-shaped data will be used to evaluate whether the Hough Circle Transform can detect it is not as a circular object.

2.3 Dividing Data

The results from video recording will be cut per object to be grouped and make testing easier. Similar signs will be grouped based on the label.

2.4 Extracting Frame

Each data extracted into a collection of frames. Extracted frames will be grouped based on their labels.

2.5 Cropping

The cropping process will crop the extracted frame on the traffic sign image. The resulting image will have an aspect ratio of 1:1 with inconsistent image resolution.

2.6 Resizing

The grayscale image that is blurred has an inconsistent image resolution outcome from the cropping process. The data is ready to be processed when it is consistent [10]. The image will be resized at the image resolution to be consistent so that it is prepared to be processed.

2.7 Grayscaling

An image has one sample at each pixel value known as a grayscale digital image. Also, it only conveys intensity information. The grayscale image shows representing the nonexistence of any chromatic discrepancy [3].

2.8 Apply Median Blur

Applying a median blur to a grayscale image can reduce noise and avoid false circle detection of the Hough Circle Transform method. A median blur is designed to remove salt-and-pepper noise, making it effective at eliminating outlier depth values [5].

2.9 Detect Shape using Hough Circle Transform

This detection process will use the Hough Circle Transform function from OpenCV. The Hough Circle Transform method (Hough gradient) works as follows. In

the first phase, the edge of the image will be detected. Next, use a local gradient for any nonzero points on the edge image. Using this gradient, every point along the line indicated by this slope from a specified minimum to a specified maximum distance is incremented in the accumulator [1].

At the same time, the location of each nonzero pixel in the edge image is noted. Candidate centres are selected from points in the accumulator above the threshold and greater than their closest neighbours [1]. The following process will sort these candidate centres in descending order from their accumulator values for the centres with the most supporting pixels to appear first.

Next, all of the nonzero pixels are considered. A centre is kept if it has sufficient support from the nonzero pixels in the edge image and an adequate distance from any previously selected centre [1]. According to their distance from the centre, these pixels are sorted. The nonzero pixels that are best supported will select a single radius.

2.10 Calculate Accuracy

In this section, the accuracy is obtained by calculating the detection results during testing. The detection accuracy measured using equation (1) [11].

$$Accuracy\ (\%) = \frac{total\ true}{(total\ true + total\ false)} \times 100 \quad ...(1)$$

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Collection of Datasets

The data obtained were as many as 21 video recordings. The data consists of No Stopping signs, No Parking signs, Other Dangers signs, and Pedestrian Crossing signs. Full details of the raw data are in table 1.

Table 1 Raw video

No	Street Name	Length
1	Ahmad Yani	00:00:42
2	Ahmad Yani	00:00:12
3	Ujung Murung	00:00:26
4	Ahmad Yani	00:00:18
5	Ahmad Yani	00:00:14
6	Ahmad Yani	00:00:16
7	Ujung Murung	00:00:21
8	Ahmad Yani	00:00:10
9	Ahmad Yani	00:00:16
10	Ahmad Yani	00:00:23
11	Ahmad Yani	00:00:03
12	Ahmad Yani	00:00:11
13	Ahmad Yani	00:00:52
14	Ahmad Yani	00:00:02
15	Kebun Karet	00:00:11

16	Kebun Karet	00:00:11
17	Kebun Karet	00:00:20
18	Mentaos Raya	00:00:24
19	Rahayu Sungai Paring	00:00:35
20	Mentaos Raya	00:00:32
21	Pangeran Suriansyah Ujung	00:00:03

3.1.2 Dividing Data

Twenty-one raw data in the form of videos has been divided per traffic signs object. The total number obtained is 28 objects of traffic signs.

Table 2 Divided data

Signs (label)	Total Object
No Stopping	7
No Parking	7
Other Dangers	7
Pedestrian Crossing	7

3.1.3 Extracting Frame

The frames of 28 objects of traffic signs will be extracted and grouped according to their labels. The example results are in figure 2.

Figure 2 Example of frame

The complete information from the frame extraction process result is shown in table 3.

Table 3 Extracted frame

Signs (label)	Frame
No Stopping	207
No Parking	200
Other Dangers	210
Pedestrian Crossing	210

3.1.4 Cropping

The example results of the cropping process are in figure 3.

Figure 3 After cropping

3.1.5 Resizing

The research will do tests by changing the image resolution size on the shape detection process using the Hough Circle Transform function. Image resolutions to be tested are 25 × 25 pixels, 50 × 50 pixels, 75 × 75 pixels, 100 × 100 pixels, 125 × 125 pixels, 150 × 150 pixels, 175 × 175 pixels, and 200 × 200 pixels.

3.1.6 Grayscaling

The example results of grayscaling are in figure 4.

Figure 4 Grayscale

3.1.7 Applying Median Blur

The example results of median blur are in figure 5.

Figure 5 Median blur

3.1.8 Detect Shape using Hough Circle Transform

Some arguments (parameters) must set before doing a detection using Hough Circle Transform. Some of these arguments are in table 4.

Table 4 Hough Circle Transform function implementation arguments [7,8]

Arguments	**Information**	**Value**
Image resolution	Size of image resolution	50×50-200×200 pixels
dp	The inverse ratio of resolution	1
min_dist	The minimum distance between detected centres	1× Image resolution
param_1	Internal Canny edge threshold	100
param_2	The threshold for centre detection	30
min_radius	Minimum radius to be detected	¼ × Image resolution
max_radius	Maximum radius to be detected	0

The circular sign in the image has a radius of approximately half the image resolution. Then the radius is divided by 2 to increase the probability of detecting a circle. The specified threshold min_radius is 1/4 of the image resolution to prevent any detections that catch a smaller circle image. The max_radius is set to 0 because the cropped image contains the most prominent object, the traffic sign image.

3.1.9 Calculate Accuracy

From the detection process that has been done, it will produce True and False values. The True detection result comes from a circular sign detected as a circular shape, and the False detection obtained comes from a diamond-shaped sign who catches it as a circular shape.

Table 5 Result of image resolution testing at No Stopping signs

Resolution	True	False	Accuracy (%)
25×25	8	199	3.86
50×50	207	0	100.00
75×75	207	0	100.00
100×100	207	0	100.00
125×125	207	0	100.00
150×150	207	0	100.00
175×175	207	0	100.00
200×200	207	0	100.00

Table 6 Result of image resolution testing at No Parking signs

Resolution	True	False	Accuracy (%)
25×25	9	191	4.50
50×50	193	7	96.50
75×75	199	1	99.50
100×100	200	0	100.00
125×125	200	0	100.00

150×150	200	0	100.00
175×175	199	1	99.50
200×200	193	7	96.50

Table 7 Result of image resolution testing at Pedestrian Crossing signs

Resolution	True	False	Accuracy (%)
25×25	210	0	100.00
50×50	210	0	100.00
75×75	209	1	99.52
100×100	163	47	77.62
125×125	84	126	40.00
150×150	46	165	21.80
175×175	34	176	16.19
200×200	35	175	16.67

Table 8 Result of image resolution testing at Other Dangers signs

Resolution	True	False	Accuracy (%)
25×25	210	0	100.00
50×50	210	0	100.00
75×75	210	0	100.00
100×100	210	0	100.00
125×125	197	13	93.81
150×150	182	28	86.67
175×175	160	50	76.19
200×200	146	64	69.52

The following is a graph of the accuracy conclusions generated from the image resolution test:

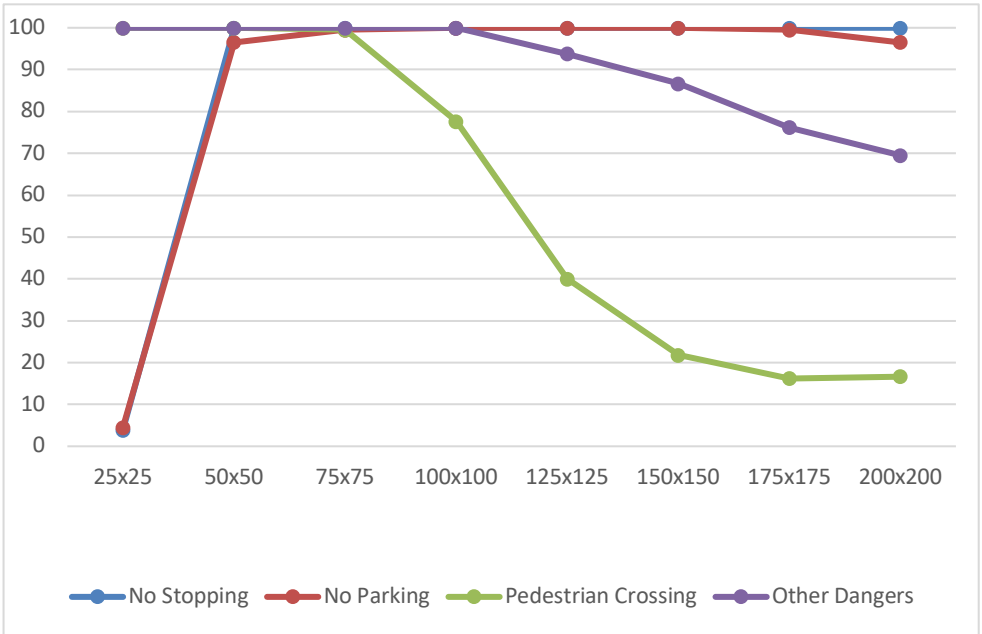

Figure 6 Accuracy comparison graph

3.2 Discussion

Figure 7 shows a True circular detection by Hough Circle Transform. The detection of circular signs with an image resolution of 25 × 25 pixels has a low accuracy of 3.86% for No Stopping signs. Low accuracy also happens to other circular shape signs, No Parking signs with an accuracy of 4.50%. However, the detection of circular shape signs shows good results start from an image resolution of 50 × 50 pixels to 200 × 200 pixels with an accuracy of at least 96.50%.

Figure 7 True detection

Figure 8 shows an error detection by Hough Circle Transform. On the Pedestrian Crossing, the diamond-shaped object detected as a circular shape occurred from the image resolution of 75 × 75 pixels even though the accuracy is still high of 99.52%. Then at an image resolution of 100 × 100 pixels, the accuracy began to decrease drastically, resulting in an accuracy of 77.62%. On the diamond-shaped signs, Other Dangers signs detected as a circular shape occurred from the image resolution of 125 × 125 pixels even though the accuracy is still high at 93.81%. The lowest accuracy resulted is 69.52%.

Figure 8 False detection

4. CONCLUSION

Results of testing concluded that the image resolution affects detecting circular traffic signs using Hough Circle Transform. The data used are No Stopping signs and No Parking signs for True detection, whereas Other Dangers signs and Pedestrian Crossing signs for False detection. The highest accuracy was obtained at a resolution of 75 × 75 pixels.

REFERENCES

[1] Bradski, G., & Kaehler, A. 2008. "**Learning OpenCV: Computer vision with the OpenCV library**". IEEE Robotics & Automation Magazine.

[2] Cornelia, A., & Setyawan, I. 2017. "**Ball Detection Algorithm For Robot Soccer Based on Contour and Gradient Hough Circle Transform**". Proceedings - 2017 4th International Conference on Information Technology, Computer, and Electrical Engineering, ICITACEE 2017.

[3] Deepthi, R. S., & Sankaraiah, S. 2011. "**Implementation of mobile platform using Qt and OpenCV for image processing applications**". 2011 IEEE Conference on Open Systems, ICOS 2011.

[4] Khasanah, N. S., Farmadi, A., Nugrahadi, D. T., & Herteno, R. 2020. "**Sensitivity Test Fuzzy Topsis And Fuzzy TOPSIS ROC Methods For The Selection Of The Sasirangan Banjar Fabric Motifs**". Journal of Data Science and Software Engineering.

[5] Ku, J., Harakeh, A., & Waslander, S. L. 2018. "**In defense of classical image processing: Fast depth completion on the CPU**". Proceedings - 2018 15th Conference on Computer and Robot Vision, CRV 2018.

[6] Lindgren, A., & Chen, F. 2006. "**State of the Art Analysis: An Overview of Advanced Driver Assistance Systems (ADAS) and Possible Human Factors Issues**". Proceedings of the Swedish Human Factors Network (HFN) Conference.

[7] Mordvintsev, A., & Abid, K. 2017. "**OpenCV-Python Tutorials Documentation, Release 1**". Retrieved May 2, 2018.

[8] OpenCV. 2017. "**Open Source Computer Vision**". https://docs.opencv.org/3.4/

[9] Pratama, A., Kartini, D., Yusuf, A., Farmadi, A., & Budiman, I. 2020. "**Implementation Of The Convolutional Neural Network Method For Predicting LQ45 Stock Prices**". Journal of Data Science and Software Engineering.

[10] Prisilla, E. N., Farmadi, A., & Chandra, H. K. 2017. "**Implementasi Metode Algoritma Apriori Pada Sistem Pendukung Keputusan Order Barang**". KLIK : Kumpulan Jurnal Ilmu Komputer.

[11] Yousry, A., Taha, M. & Selim, M. M. 2018. "**Currency Recognition System for Blind People using ORB Algorithm**". International Arab Journal of e-Technology