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MEASUREMENT OF IMAGE DISTANCE USING ONLY CAMERA ON OBJECT DETECTION OPENCV

F. Friendly[1], Harizahayu[2] RahmatWidyaSembiring[2]Berti Sari Br Sembiring [3]

friendly@polmed.ac.id , harizahayu@polmed.ac.id , rahmatws@polmed.ac.id, Bertisari0@gmail.com

[1]Teknik Komputer, Politeknik Negeri Medan, Sumatera Utara, Indonesia
[2]Manajemen Informatikat, Politeknik Negeri Medan, Sumatera Utara, Indonesia
[3]STMIK Kristen Neumann Indonesia,Sumatera Utara,Indonesia

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Image processing combine with machine learning is used widely in image recognition, image classification, and image detection. By using camera to detect an object has been done within several article. The other usage of image and object detection is in measurement of distance. Distance measurement is possible by using additional peripheral such as sensor and extra camera. This research is intended to elaborate the usage of single camera in detecting and measuring distance. The distance set between the camera and the object. In this research, author used a square object with different size and different distance range. By using one of the known data as a pivot in calculating other image distance, the average error between 4%-7% . These result was achieved by using different object size. The bigger the size of the object used as reference, the smaller the error percentage of the measurement.

***Keywords**: image processing, opencv, machine learning, distance measurement.*

1. Introduction

Measurement is the act of determining the target size, length, weight, capacity or any other aspect. The distance between an object is determined using measurements. Distance measurements can be performed using rulers, sensors, and other devices. In this journal, the author tries to find a way to measure distance using only a camera.The use of cameras is more common in everyday life because the camera has become part of the gadgets around us. Cameras can be found in almost everyday devices such as smartphones and laptops. Many studies have been conducted to determine the distance between the object and the camera[1][2]. One method is to use object classification and machine learning. The most common library for image classification is OpenCv[3]. To help people expand the camera's functionality, this research tries to formulate measurements and experiment parameters and formulas to calculate the distance between the camera and the object. By using only the camera and the proposed method, the camera can be used for measurements This study will use image classification and edge detection in detecting the distance between the camera and the object. The library used is OpenCv. This study is used to measure short distances between 20 cm to 200 cm.

2. Method

One study states how a modified camera with the help of a sensor can improve distance measurement (Valocký, Drahoš, & Haffner, 2020). In the study by Valocký, Drahoš, & Haffner, distance measurement was used for detection of object measurements in the range between 110cm and 163cm with a mean error of 41μm. This research is about measuring the distance between objects and patterns.

Meanwhile, Shi-Huang Chen in his research (Chen & Chen, 2011) uses distance measurements using a camera with a car number plate as an object reference. In Shi-Huang Chen's research, the method used is the triangle method and establishes the focal length of the camera.

Table 1: Recapitulation of Distance Measurement Results (Chen & Chen & Chen, 2011)

Real Distance	Sparse Method			Dense Method		
	CalculatedDistance	% Error	Deviation	CalculatedDistance	% Error	Deviation
13,8	14.59	5,72	0.79	13,81	0,07	0,01
20,6	21,39	3,83	0.79	20.,97	1,8	0,37
22,7	23,28	2,56	0.58	23	1,32	0,3
23,2	23,7	2,16	0,5	23,46	1,12	0,26
29,9	30,29	1,3	0,39	30,68	2,61	0,78
32,2	31,77	1,34	0,43	32,32	0,37	0,12

The distance measured is between 13m-31m. The image recognition used is by taking pictures in the range of 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, and 5. Research data contained in Shi's article -Huang Cen is present in the following table. From the data presented, the measurements are set in meters, so the deviation is about 39 cm to 79 cm. The shorter the distance, the greater the deviation.

3. Results and Analysis

Image detection implementations are common especially in image processing. The measurement process in this study follows the general concept of taking pictures in a camera lens. The illustration of the image is described in Figure 1.

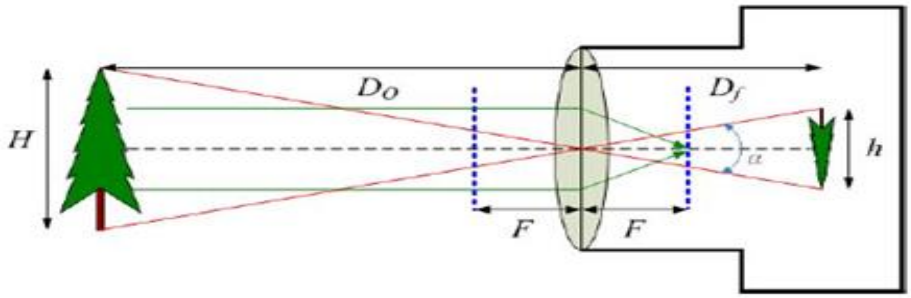

Figure 1. The process of taking pictures on the camera.

This study will use 2 different objects to calculate the object distance. The first objects are 16cm x 16cm and 20cm x 20cm. The method proposed in this paper is to make a comparison between the measured distances to get the ideal pivot used for the measurement.In contrast to the process of taking pictures by a camera, this research will approach using the concept of a triangle. This deduction comes from the perspective of the image that we get from the captured image. The further away the object is from the camera, the smaller the captured image will be.

Image Captured

Real Distance	Sparse Method			Dense Method		
	Calculated Distance	% error	Deviation	Calculated Distance	% error	Deviation
13,8	14,59	5,72	0,79	13,81	0,07	0,01
20,6	21,39	3,83	0,79	20,97	1,8	0,37
22,7	23,28	2,56	0,58	23	1,32	0,3
23,2	23,7	2,16	0,5	23,46	1,12	0,26
29,9	30,29	1,3	0,39	30,68	2,61	0,78
32,2	31,77	1,34	0,43	32,32	0,37	0,12

Figure 2.Activities depicting the process of taking pictures

The image shows that the farther the distance from the object to the camera, the smaller the image. Even if the angle of shooting on the camera uses a different angle, the proportion of the image will remain as long as the direction in which the image is taken is the same.To generate the formula, we must assume that the angle in Figure 1 is the same at both the real and the image distances. If we assume that is the tangent formula, then the formula can be described as:

$$\tan(\frac{\alpha}{2}) = \frac{H}{2} : D_o = \frac{h}{2} : D_f \quad (1)$$

Therefore

$$D_f = \frac{D_o x h}{H} : \quad (2)$$

Using this formula, we can have the initial distance. When we follow the rule of triangular equations, as the image moves further, so does the distance and the image becomes smaller. We can use any of the images taken and with the distance referred to as a reference. Using this distance as a reference, we can obtain a formula by comparing the distance in the reference image (D_r) and the height of the image from the capture. picture taken. The formula for calculated distance Dr can be calculated using the following formula:

$$D_r = \frac{H x D_f}{h_r} \quad (3)$$

To calculate the distance in the image, this study will use this formula.

3.1. OvenCV Image Classification Workflow

The algorithm used in testing the method in this study will use opencv image classification and then use the image as a reference and calculate the error percentage. The proposed algorithm is as described in figure 3.

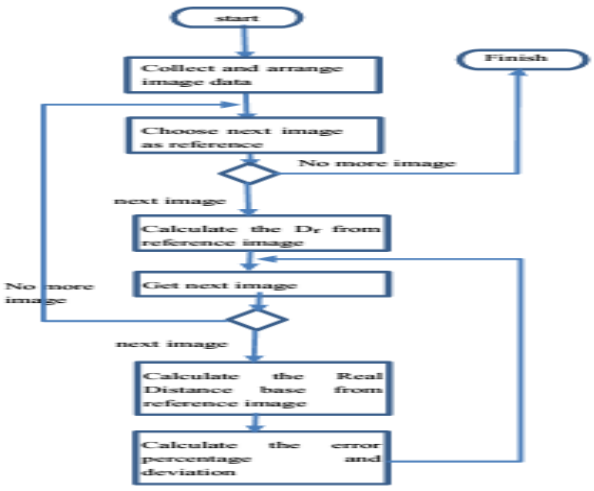

Figure 3. Testing Algorithm of Remote Measurement

This process starts by collecting and organizing the images into an array. The images are thus selected one by one to be used as referensi. Untuk setiap referensi, the formula will be calculated against other data. The calculated distance is then compared with the actual image distance. The percentage of errors and deviations is thus calculated to generate the report.

3.2. OvenCV . Image Classification Results

In this paper, the object is defined and the experiment uses 2 objects as a reference. The first is a square paper with a width of 16cm x 16cm and a square paper with a width of 20cm x 20cm. The distance of the object is thus measured with a ruler and the image is taken by the camera. The distance is set in multiplication of 10. The number of samples taken is 20 for each object. Some pictures of objects taken are shown in Figure .

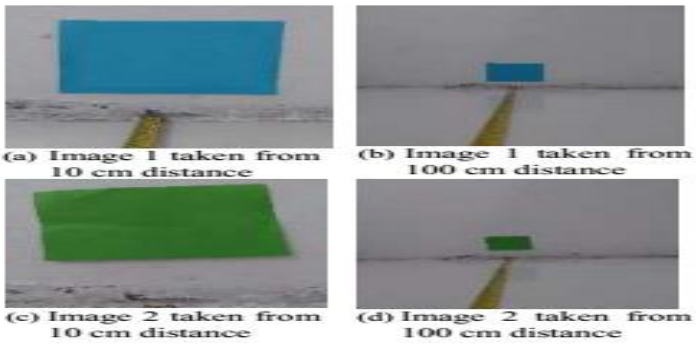

Figure 4. Pictures taken from different distances

The process of calculating the distance is done by iterating the image in the dataset. The process includes image masking, image detection and measurement of the reference object area. Since the object used is a square, the side of the object can be calculated as the square root of the area. Thus the side of the object can be calculated easily. After the object side calculation, the calculation will continue to calculate the distance by comparing the imaginary distance and then the reference distance and will return the actual distance. As dataset information is available, the process continues to calculate the deviation and measurement error. The calculated data will be written in the image and displayed. The simulation is shown in Figure 5.

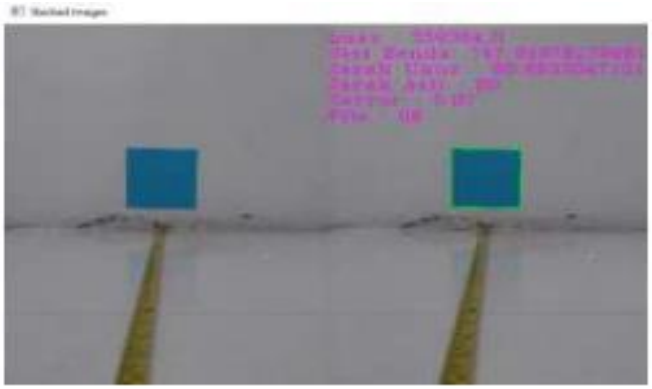

Figure 5. Simulation Process

The results of the simulation tests can be seen in table 2 and table 3. Table 2 shows the results of the simulation test using a square object reference with dimensions of 16 cm x 16 cm. Table 3 shows the results of simulation tests using a square object reference with dimensions of 20 cm x 20 cm. In order to eliminate the decrease in the percentage of errors and unnecessary deviations, the test results using the reference image against the reference image itself are deleted because the test results always show no deviations and no errors.

Tabel 2. Hasil Tes Menggunakan Referensi Objek Objek Persegi 16 cm x 16 cm

Do	Error (%)			Deviation (in cm)		
	Avg	Max	Min	Avg	Max	Min
10	76.59	99.03	38.6	48.48	99.51	5.57
20	30.19	43.6	9.59	27.04	60.72	2.63
30	20.54	34.17	7.08	19.85	47.36	1.92
40	14.56	38.52	6.18	14.25	36.55	2.12
50	10.22	42.1	0.22	9.26	26.45	0.13
60	10.08	42.23	0.22	9.08	26.06	0.11
70	8.91	43.58	2.34	7.28	21.9	1.31
80	8	44.9	1.01	5.61	17.62	0.9
90	7.72	45.45	0.69	4.97	15.79	0.69
100	7.6	45.83	0.69	4.59	14.51	0.62
110	7.53	46.78	0.1	3.86	11.18	0.13
120	7.51	46.47	0.48	4.04	12.27	0.63
130	7.52	46.73	0.1	3.88	11.36	0.11
140	7.7	47.19	0.4	3.78	9.72	0.6
150	7.84	47.4	0.37	3.79	9.01	0.56

160	7.99	47.6	0.04	3.86	9.08	0.08
170	8.17	47.75	0.26	4.01	9.14	0.46
180	8.01	47.62	0.04	3.88	9.09	0.07
190	8.42	47.93	0.35	4.26	9.21	0.59
200	11.28	49.76	3.5	7.5	9.9	6.51

Tabel 3. Hasil Tes Menggunakan Referensi Objek Objek Persegi 20 cm x 20 cm

Do	Error (%)			Deviation (in cm)		
	Avg	Max	Min	Avg	Max	Min
20	27.66	39.52	12.07	25.49	54.19	3.23
30	14.99	24.5	8.59	15.77	36.6	2.41
40	7.48	17.82	2.19	8.29	22.57	1.07
50	5.82	19.58	1.53	6.3	18.69	0.87
60	4.05	22.21	0.08	3.69	13.37	0.06
70	4.06	22.15	0.05	3.73	13.5	0.05
70	4.04	22.33	0.02	3.63	13.12	0.02
80	4.27	21.65	0.33	4.12	14.48	0.33
90	4.83	20.8	0.76	4.96	16.16	0.75
100	4.42	21.39	0.33	4.35	14.99	0.26
110	4.04	22.35	0.02	3.62	13.09	0.01
120	4.07	22.1	0.05	3.75	13.58	0.04
130	4.1	22.63	0.36	3.55	12.52	0.26
140	4.28	23.16	0.07	3.5	11.44	0.11
150	4.3	23.21	0.07	3.5	11.33	0.1
160	4.36	23.3	0.12	3.53	11.14	0.18
170	8.5	28.33	1.61	7.12	11.22	2.94
180	7.17	27.16	0.06	5.54	8.46	0.11
190	7.12	27.11	0.02	5.49	8.36	0.04
200	7.11	27.1	0.02	5.48	8.33	0.04

Based on table 1 and table 2, the results can be seen that the deviation of distance measurement is highest when the reference uses a smaller image reference. As the pixel size tends to get smaller, the accuracy increases. In Table 2, the highest accuracy occurs when using a 120cm object reference and when using a larger image. As in Table 3 shows that the accuracy of obtaining better results when the object reference is 110cm. The measurement deviation decreases as the object reference is higher. This occurs in both tables.

4. Conclusions

By using the method of comparison and similarity of triangles, this study shows an error accuracy of 96% or 4.04%. The measurement deviation achieved from this experiment was an average of 3.02%. Although some measurement results show small deviations, other captured images show larger deviations. The irregular results in this study indicate that the methods and formulas need to be improved. But compared to larger deviations in other studies, this method can be demonstrated in the measurement of less accuracy required.

Acknowledgements

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