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Effect of Features and Angle on GLCM Feature Extraction on Accuracy for Object Classification

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Abstract— **The cars that can move on their own or have the ability to drive without assistance from humans are called autonomous cars. The development of various types of driverless vehicles is currently underway. Where in the future the computer system will replace the role of humans in driving vehicles. However, the problem in autonomous cars that deserves attention is the need for high security. Early warning systems are needed in autonomous car systems to detect objects in front of them. This is necessary to avoid accidents, especially when on the highway. In this study, researchers designed a system for vision-based vehicle detection in detecting cars in front of them. The detection algorithm used has two main components, namely color feature extraction using GLCM values, and 6 parameter testing of GLCM dissimilarity, correlation, homogeneity, contrast, ASM and energy. In this study using the SVM (Support Vector Machine) algorithm for the classification algorithm. Good accuracy results are found in the ASM feature and using an angle of 450, which is 88%.**

Index Terms— **Autonomous Car; GLCM; SVM**

Abstrak–- **Mobil yang dapat melakukan pergerakan sendiri atau memiliki kemampuan dalam berkendara tanpa bantuan dari manusia disebut dengan mobil otonom. Pengembangan berbagai jenis kendaraan tanpa pengemudi saat ini sedang dilakukan. Dimana kedepannya sistem komputer akan menggantikan peran manusia dalam mengemudi kendaraan. Akan tetapi, permasalahan dalam mobil otonom yang patut diperhatikan adalah perlunya keamanan yang tinggi. Sistem peringatan dini sangat diperlukan dalam sistem mobil otonom dalam mendeteksi objek di depannya. Hal ini diperlukan untuk menghindari kecelakaan khususnya pada saat di jalan raya. Pada penelitian ini, peneliti merancana sebuah sistem untuk pendeteksian kendaraan berbasis visi dalam mendeteksi kendaraan mobil didepannya. Algoritma deteksi yang digunakan memiliki dua komponen utama yaitu Ekstraksi ciri warna menggunakan nilai GLCM , dan pengujian 6 parameter dari GLCM dissimilarity, correlation, homogeneity, contrast, ASM dan energy. Pada penelitian ini menggunakan algoritma SVM (Support Vector Machine) untuk algoritma klasifikasi. Hasil akurasi yang baik terdapat pada fitur ASM dan menggunakan angle 45^0 yaitu sebesar 88%.**

Kata Kunci— **Autonomous Car; GLCM; SVM**

I. INTRODUCTION

Indonesia has very long highways, and the number of road users is increasing every year. These users on average use two-wheeled vehicles, four wheels or more. The growth of the number of motorized vehicles in Indonesia is increasing every year. According to the Central Statistics Agency, the number of motorized vehicles in Indonesia is increasing every year. The total number of motorized vehicles in Indonesia in 2017 was 118,922,708, in 2018 it was 126,508,776 and in 2019 the number of motorized vehicles was also significant, namely 133,617,012. if on average the number of motorized vehicles in Indonesia increased by about 8 million vehicles.

Along with the development of the number of motorized vehicles, of course, the number of accidents on the highway also increases. This is due to the increasing number of roads built by the government, as well as the number of vehicles that continue to be supplied from neighboring countries. Data from the Traffic Corps of the Indonesian National Police (Korlantas Polri) recorded that there were 100,028 traffic accidents (lakalantas) in 2020 in Indonesia. The Korlantas Polri also recorded that there were 113,518 minor injuries due to traffic accidents in 2020. Meanwhile, the number of seriously injured victims was 10,751 in 2020. The number of deaths due to traffic accidents was recorded at 23,529 cases in 2020. Thus, the average death toll from traffic accidents 1,960 people per month. Meanwhile, the average death toll is 65 people per day or 2-3 people per hour.

Seeing this phenomenon, technology such as autonomous vehicles will be very useful to reduce the number of accidents when applied in Indonesia. Currently, many automotive companies are developing autonomous cars. The automotive industry currently has the latest innovations to improve the quality of the products made. They can be built with knowledge of GPS sensing to aid navigation. They may use sensors and other equipment to avoid collisions. Autonomous cars have a variety of technologies, whereby vehicles present information to drivers in new and innovative ways. The early warning system is used to improve safety for the driver when there is an obstacle in front of the vehicle. The method that has been developed at this time to detect on the highway is to use sensors. One of the studies that uses sensors is research from Budilaksono ([2]; [3]; [10]).

This study compares between 5 classification methods, either supervised classification or unsupervised classification. This research uses Decission tree, K Nearest Beighbour, Random Forest and Multi layer perceptron methods. The best results are the K Nearest Neighbor and Multi layer Perceptron methods which have an accuracy of 99.4%. this study has several weaknesses, to find out the obstacles must have a lot of sensors installed in the car.

The technology that is developing rapidly today is computer vision. Computer Vision is the science and technology of machine vision, in which machines are able to extract information from an image that is needed to complete a particular task. As a discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. Image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from medical scanners. Meanwhile, as a technological discipline, computer vision seeks to apply theories and models for the development of computer vision systems.

In recent decades, computer vision-based driving assistance systems have attracted a great deal of interest to researchers. Computer vision has advantages in terms of low cost, and very easy to use. Just enough to use a camera and software that has been made we can create various systems that are very helpful. Computer vision has a main component, namely the camera. The camera can be used to detect various objects such as road detection, traffic sigh detection or obstacle detection. Research performed by ([1];[5]) uses camera technology to detect various objects such as people, pedestrians, cars and to detect obstacles.

Referring to previous research, vehicle or object detection can be detected properly using GLCM feature extraction. GLCM feature extraction has good results for detecting obstacles in the form of vehicles. Therefore, in this study we propose feature extraction using GLCM (Grey Level Co-Occurrence Matrix). The results of research using GLCM feature extraction have a fairly good accuracy. The classification method used in this study is the Support Vector Machine. Research conducted by (Kim et al., nd) has compared the SVM method with other methods. Kim's research classified objects in the form of planes, cars, faces and motorcycles. The result is that the SVM method has a better accuracy of 4%. Based on previous research, the results of the classification using SVM have quite good results. Therefore, in this study we tried to use the SVM classification method, because in previous studies SVM had high accuracy.

II. METHOD

A. Identification of problems

With the high number of accidents in Indonesia, it is necessary to have a system that can detect vehicles early. This is needed to reduce the number of accidents in Indonesia by giving early notification to the driver when there is an obstacle in front of him.

B. Study of literature

Literature study is a process to solve a problem by finding sources related to the existing problem. This is used to provide insight to researchers regarding the research topic to be carried out. This research utilizes references from sources such as national scientific journals, international scientific journals, books and others. This reference is used as a theoretical basis that can support research.

C. Retrieval of training data and test data

Data collection is divided into two, namely for training data and test data. Training data retrieval was carried out in the protocol in the city of Malang. We put the camera under the mirror in the middle of the car. The data generated is data in the form of video measuring 1280x720 pixels. The tool used in this

study is a Smartphone camera and assisted by a tool in the form of Gymbal B steady Pro to stabilize the video. The videos taken need to use a stabilizer because to avoid blurring when shooting videos.

If the video taken is unstable, it will cause the video to become blurry when it is converted into image form. The device that we use to retrieve data is the camera phone xiaomi redmi note 8 using a frame rate of 24 fps. From the resulting video, the next step is to convert it to image. So every second will produce as many as 24 images. After the image has been obtained, the next step is to select the objects contained in the image. These objects are divided into 3 types of objects, including objects in the form of cars, motorcycles and humans.

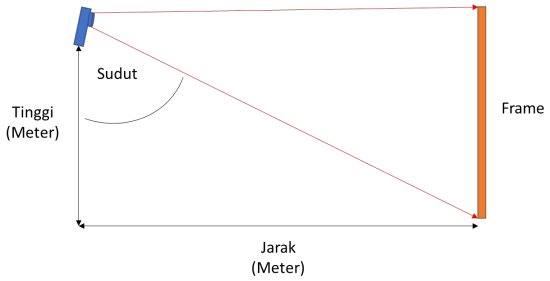

Fig. 1. Camera Location, Angle and Distance

Fig. 2. Position of retrieval of training data and test data

The number of training data used is 887 images consisting of motorcycles and humans. Details of the amount of training data can be seen from Table 1, namely the table for the amount of each data.

Table 1 Total Data

Barrier Data	Amount
Car	300
Motorcycle	290
Man	297

The process of retrieving training data is described in the block diagram in Fig. 4.

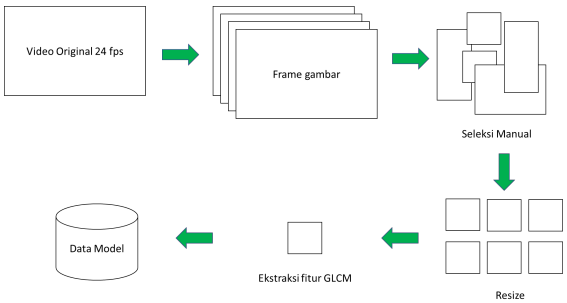

Fig. 4 . Block diagram of feature extraction process

D. Algorithm Implementation

Implementation describes what is done to get a test result. This sub-chapter explains in detail what libraries are used and how the implementation is carried out by the author. The following is one of the program code used to import the library.

```
import numpy as np
import cv2
import os
import re
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC


# -------------------- Utility function ------------------------
def normalize_label (str_):
str_ = str_.replace( " " , "" )
str_ = str_.translate(str_ .maketrans( "" , "" , "()" ))
str_ = str_.split( "_" )
    return '' .join(str_[: 2 ])


def normalize_desc (folder , sub_folder):
text = folder + " - " + sub_folder
text = re.sub( r'\d+' , '' , text)
text = text. replace( "." , "" )
text = text.strip() return text


def print_progress (val , val_len , folder , sub_folder , filename ,
bar_size= 10 ):
progr = "#" * round ((val) * bar_size / val_len) + " " * round ((val_len -
(val)) * bar_size / val_len)
    if val == 0 :
        print ( "" , end = " \n " )
    else :
        print ( "[%s] folder : %s/%s/ ----> file : %s" % ( progr , folder ,
sub_folder , filename) , end = " \r " )
```

E. Testing

Analysis of the test results is carried out to obtain conclusions based on the data obtained from the tests that have been carried out. In this section, we will discuss how the test results are descriptive and visual. This can help readers to understand the content of the test results more easily.

F. Research Tools

Research tools are divided into 2 types, namely hardware and software. Hardware is the hardware used for retrieval of training data and test data. Tools in the form of hardware are in the form of Camera and Gymbal. Gymbals are used to stabilize video results for training data retrieval. This research uses a dataset that we took ourselves in the Malang city area. The camera we use is a mobile camera / cellphone.

While the tools in the form of software are in the form of Python programming language and text editor Pycharm jetbrain editor. Python is a programming language that is very often used to analyze methods and feature extraction. All the libraries needed for the needs of processing an image can be found in the Python programming language. What distinguishes this Python programming language from other programming languages is the number of libraries that can be used.

III. RESULTS AND DISCUSSION

The table of the results achieved answers related to what is described in the problem formulation. This chapter explains whether the parameters used in GLCM feature extraction affect the accuracy of classification using the SVM method.

The results obtained from this study are certainly very varied, because they use various angles. The features used determine the accuracy value obtained. The features used in this study are dissimilarity, Correlation Homogenity, Contrast, ASM and Energy

A. The effect of GLCM parameters on accuracy with the SVM method

Feature extraction for vehicle images in the form of Cars, Motorcycles and Pedestrians can be done well. Value obtained. The following is a table of results for each of the features used and their accuracy results. The features used are 6 features, namely dissimilarity, correlation, homogeneity, contrast, ASM, energy. The angle used in this first test is random, which is 45 degrees.

The stages of GLCM include:

1. Converts a grayscale image to a 4-level grayscale matrix.
2. Determine the spatial relationship between pixels based on the selected distance and angle.
3. Count the number of credits.
4. Add the co-occurrence matrix with the transpose matrix being symmetrical.
5. Normalize the matrix to convert it to the form

The GLCM extraction used by [7] uses GLCM by using 5 features, namely Energy, Enthrophy, Countrast, Correlation, and Homogenity. research detects normal or abnormal shape of the image in the form of the brain. The results of this study have good accuracy.Research conducted by [4] uses 5 features on GLCM, namely energy, Enthropy, Contrast, Homogenity and Correlation, this study detects the movement of the car. The method used is using the SVM classification. GLCM extraction has many useful features. But researchers generally use only a few characteristics [6], because GLCM has a lot of values so that if the process needed is fast, there will be a long delay.

In this study, we use 6 features, namely Disimilarity, Correlation, Homogenity, Contrast, ASM and Energy. What distinguishes it from the two previous studies is that we added the ASM feature. The test table is described in Table 2.

Table 2 Test table based on the value of the features used

angle	Features	Accuracy
45^0	Dissimilarity	81%
	Correlation	77%
	Homogeneity	64%
	Contrast	80%
	ASM	88%
	Energy	67%

From the test results described in Table 2, the best accuracy is to use the ASM feature, which is 88%. The feature we added is Angular Second Moment (ASM) which has the best accuracy at angle 45^0. The worst accuracy is using the Homogeneity feature. In this test, it is explained that each feature used has a different accuracy value.

The difference is obtained from the formula used for each different feature. Each feature has advantages under certain conditions. For example, to detect vehicles with more precise or better features is to use ASM, but in other conditions, ASM may not necessarily have good accuracy. Another factor is lighting, if the lighting is low (low light) then GLCM will give a less than maximum accuracy value as well. But this can be overcome by doing pre-processing.

B. Effect of Angle Used on GLCM Feature Extraction

The use of different angle values is carried out to determine the difference in the results of the angle used in GLCM feature extraction. The angles used are 0, 45, 90 and 135 degrees. The angle we use is a multiple of 45 because that angle is the most commonly used in GLCM feature extraction.

Research conducted by [4] uses GLCM to detect faces which also uses 4 variations of angles, namely 0, 45, 90 and 135. Therefore, the authors chose these angles to find out the difference if GLCM is used for vehicle detection. Angle analysis was performed by [9] to determine the type of nail. An illustration of the angle in GLCM feature extraction can be seen in Fig. 5.

An important process carried out by feature extraction from GLCM is determining the angle to be used. In this case the angle used is 0, 45, 90 and 135. After determining the angle, what is done is to choose the distance between pixels. The distance between pixels in this case is the default, i.e. d = 2. In this study, we did not analyze the distance but what we studied were angles and features.

The results of the tests were carried out using different angles. In table 3, each angle used has a different output in Table 3. The percentage value is obtained from 80% of training data and 20% of test data.

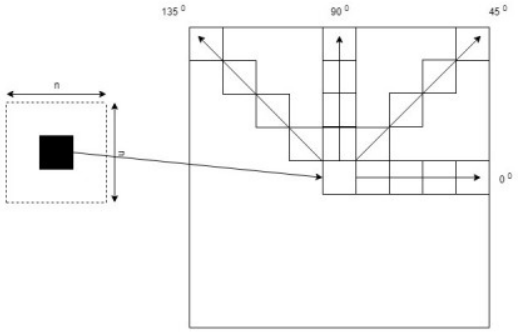

Fig. 3. GLCM sudut angle illustration

From Table 3 it can be seen that the best accuracy is obtained on the asm feature with the angle of the GLCM feature extraction is 45 ^{0} while the worst accuracy is obtained on the Energy feature with an angle of 90 ^{0} . From the results obtained, all have accuracy values, so each feature can be used for object classification using SVM classification.

Table 3 The results of the accuracy of the influence of the Angle used on the accuracy

Feature	Angle ^{0}	Accuracy (%)
Dissimilarity	0	71
	45	75
	90	53
	135	67
Correlation	0	56
	45	77
	90	78
	135	56
Homogeneity	0	57
	45	56
	90	51
	135	70
Contrast	0	58
	45	77
	90	67
	135	77
ASM	0	81
	45	88
	90	83
	135	79
Energy	0	46
	45	57
	90	41
	135	43

C. Results of Using Sigmoid Kernel in SVM classification

The SVM method has 3 approach models or commonly called kernels, namely radial, linear and sigmoid kernels. In this study we only used the sigmoid kernel. We use the sigmoid kernel because in previous studies it has a fairly high accuracy.

SVM classification using the sigmoid kernel can be applied to GLCM feature extraction. The results obtained from all the features used in GLCM feature extraction can be combined with SVM classification. Research conducted by [8] used the SVM method to analyze abnormalities in the human brain. In our research, we also use the SVM classification and the results obtained have a high accuracy.

Based on previous research and the results obtained in this study, the SVM method can work well with GLCM feature extraction.

IV. CONCLUSION

Based on the research that has been done, it can be concluded that the features used in GLCM feature extraction can affect the accuracy for classifying objects. The angle value used in GLCM affects the accuracy. Based on the tests carried out, SVM classification can be used to classify objects with good accuracy.

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