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Vehicle Identification using Support Vector Machines

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Abstract: *Nowadays, there is a tremendous advancement in areas of automation and computer vision. Object identification is an essential process in these technologies. It identifies any specific object from an image or video sequence and the action is taken accordingly. Machine learning algorithms are extensively used for object identification in various applications. The necessary features are extracted from the images and are trained using various classifiers. This paper proposes an object identification technique using Support Vector Machines (SVM). The proposed system is compared with Decision Tree (DT) and K-Nearest Neighbor (KNN) classification algorithms. The object identification system is assessed on identification accuracy, prevision and recall.*

Keywords: *Decision Tree, K-Nearest Neighbor, Support Vector Machines,*

I. Introduction

The number of consumer vehicles is growing enormously on daily basis. The need of techniques for efficient management of real time traffic density, calculation of toll taxes according to the type of the vehicle, control the traffic signal by identifying the number of vehicles in a highway lane of a particular type, number of vehicles in a parking system, etc. are increasing. Using image processing techniques target objects can be detected from images and thus can be extensively used in variety of application domains. Machine Learning algorithms enable more efficient detection and classification of objects as compared to the traditional mechanical methods. In object detection process, instances of real world objects such as vehicles, fruits, vegetables, buildings, face, etc. are identified from images or videos.

The proposed system uses support vector machines classification algorithm to identify the vehicle from an image using the various features extracted from the images. The sections of the paper are arranged as follows. Section II contains literature review on similar studies. Section III details the proposed system. Section IV depicts the results and observations and the conclusion is included in section V.

II. Background Study

Noorpreet Kaur Gill & Anand Sharma [1] in their paper describes an approach to find out the accuracy rate of the vehicles captured from the satellite images. In this research they are finding the number of vehicles on a desired space in the satellite image and these vehicles are shown underneath the bounding box as small spots. Their proposed approach uses image enhancement techniques like spatial and frequency domain strategies. Other techniques are morphological image processing, segmentation, otsu threshold and edge detection using detection criterion, localization criterion and one response criterion.

Luigi Di Stefano, Enrico Viarani [2] proposed an approach to detect and track the vehicle on the basis of Block Matching Algorithm. This algorithm is used to estimate motion which operates on MPEG compression standard. Their proposed system uses correlation threshold procedure of BMA along with adaptive filtering, grouping of the vehicles and tracking them. Some vehicles are enormous as compared to the block size due to which there may be over segmentation effect. Their aim is to develop a vision-based traffic monitoring system which would be reliable in performing fundamental traffic parameters measurements.

A system using template matching, NN and SVM is proposed [3]. The detection of the objects is based on their shape and color. The color based approaches used are color thresholding, HIS or Other Color Space Transformation, Color Indexing. The shape based approaches used are Fourier descriptor, Hough Transform and moment. The classifications of the objects are performed using template matching, neural network and support vector machines.

R.Muralidharan and Dr.C.Chandrasekar [4] focused on combining two popular image classification methods i.e. SVM and KNN based on the geometric moment invariant feature of the object. The edges of the image were extracted using Canny's edge detection method. To calculate the feature vector Hu's seven moment invariant are calculated along with the extracted features of the image. The proposed method proved that fusion

of SVM and KNN along with geometric moment invariant feature of the object produces better results than the conventional techniques like SVM and KNN. The kernel function is polynomial.

Khushboo Khurana, Reetu Awasthi proposed a system to detect multiple objects in an image. They also focused on the problems faced during object detection such as lightning, positioning, rotation, mirroring, occlusion and scale. To detect multiple objects from an image k object detectors are trained. This paper does a comparison study on object identification methods such as template matching technique, passive and active, shape based, color based, global and local features. This paper also discusses on the applications of object recognition. [5]

III. Proposed System

The proposed system helps to identify and classify the vehicle as a van, bus, SAAB (car) and OPEL (car). The major processes in the proposed system are shown in Fig 1.

Fig 1: vehicle identification system process flow

The first step is the data collection. In this phase, images of different objects are taken from various angles. This data acts as an input for feature extraction. The extracted features differ according to the object chosen. The model is trained using the training dataset. To evaluate the model, testing dataset is used. Testing dataset is used to provide unbiased evaluation of the model and to check if the model is fit for applications.

In this work, we have used a standard vehicle dataset with eighteen attributes. The dataset has images acquired using a camera with the model below it. 60 images taken in sets of two were captured in 360 degree rotation for each of the vehicles. The attributes of this dataset are distance circularity, compactness, pr. axis aspect ratio, elongatedness, circularity, maximum length aspect ratio, scaled variance along major axis, scatter ratio, kurtosis among major axis, maximum length rectangularity, scaled variance along minor axis radius ratio, pr. axis rectangularity, skewness along minor axis, , skewness about major axis, kurtosis among minor axis and hollows ratio [6].

The uniqueness of this dataset is that the image used in building the dataset was taken from one of many different angles. This dataset has four classes namely opel, saab, van, bus. The dataset contains 212 examples of opel, 217 examples of saab, 218 examples of bus and 199 examples of van making a total of 846 examples. The training and testing data constitutes a 80:20 distribution. The proposed system using Support Vector Machines are compared with the state-of-art classification techniques K-Nearest Neighbor and Decision Tree.

IV. Results And Discussions

The evaluation of the system was performed with the test dataset from the vehicle dataset using SVM, DT and KNN Algorithms.

The identification accuracy obtained using SVM classifier for various kernels are shown in Table 1. By using SVM algorithm, the highest accuracy achieved is 81.17% with Linear Kernel. Using SVM Linear kernel the precision and recall achieved is 80.80% and 81.1% respectively.

Table 1. Accuracy achieved using SVM

Kernel	Accuracy (%)
Linear	81.17
Polynomial	77.64
Radial Basis Function	27.64

The confusion matrix using linear Kernel in SVM is shown in Table 2. It states that van was detected 35 times exact, Saab was detected as a van and bus once, 10 times as Opel and 34 times exact, bus was detected as Saab once, 44 times exact and Opel was detected as a van twice and bus once, 15 times as Saab and 27 times exact.

Table 2: Confusion Matrix using SVM

Classes	Van	Saab	Bus	Opel
Van	35	0	0	0
Saab	1	34	1	10
Bus	0	1	44	0
Opel	2	16	1	25

The results obtained using K- Nearest Neighbor algorithm for various k values are shown in Table 3.

Table 3: Accuracy achieved using K-NN

K values	Accuracy (%)
1	67.64
3	68.235
5	68.235

The confusion matrix using K values as 5 in KNN algorithm is shown in Table 4.

Table 4: Confusion Matrix

Classes	Van	Saab	Bus	Opel
Van	39	2	1	0
Saab	2	25	3	12
Bus	1	2	33	1
Opel	7	20	3	19

By using KNN algorithm, the accuracy achieved is 68.235%. The confusion matrix states that van was detected 39 times exact and as Saab 2 times and as a bus once. Saab was detected 25 times exact and as a van twice and as a bus thrice and as Opel 12 times. Bus was detected 33 times exact and as van, Opel once and as a Saab twice. Opel was detected 19 times exact and as Van 7 times, as a Saab 20 times and as a bus thrice.
The results obtained using Decision Tree algorithm is shown in Table 5.

Table 5: Accuracy achieved using Decision Tree

Algorithm	Accuracy (%)
Decision tree	73.529

The identification matrix for Decision tree algorithm is shown in Table 6.

Table 6: Confusion Matrix using Decision Tree

Classes	Van	Saab	Bus	Opel
Van	36	4	1	1
Saab	1	27	1	13
Bus	0	0	37	0
Opel	4	20	0	25

CART (Classification and Regression Tree) algorithm is used in Decision tree Classifier. The accuracy achieved by this model is 73.529%. The confusion matrix states that van was detected 36 times exact and as Saab 4 times and bus, Opel once. Saab was detected 27 times exact, as a van and bus once and 13 times Opel, bus was detected 37 times exact and Opel was detected 25 times exact and as a van 4 times and as Saab 20 times.
After analyzing the results, the class of a vehicle is predicted using SVM Classifier.
Based on the feature values passed as input the expected class is 2 and the result obtained is also 2 which shows the correct prediction by the system. The prediction is shown in Fig 2.

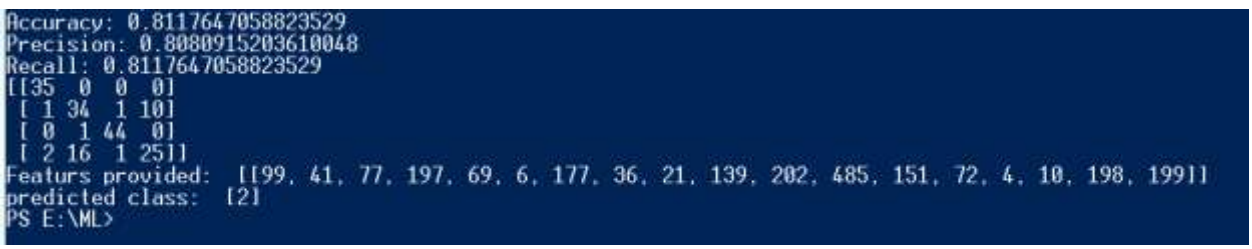

Fig. 2 Prediction of a vehicle class

V. Conclusion

The study was performed on the vehicle dataset which had 18 features. This research proved that detecting and classifying the vehicle images using SVM classifier with linear kernel is far more efficient in terms of accuracy, precision and recall when compared with KNN and decision tree classification algorithms. For vehicle identification and classification applications, we can use SVM classifier with linear kernel to achieve the highest possible result. In the future, more number of vehicles can be introduced in the dataset.

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