Vehicle Classification: Using CNN

1. Introduction

Vehicle detection and classification is crucial in several applications, such as traffic-control, monitoring, and self-governing driving. Advances in machine-learning and deep-learning algorithms have enabled the automatic identification and categorization of different types of vehicles based on their visual features. This process involves collecting images of vehicles from cameras installed in various locations and using algorithms used in the field of ML to analyze the features of vehicles, such as shape and size of vehicle. A large dataset of vehicles from different categories is required to train the machine learning model accurately. After being trained, the model is capable of real-time classification of new images or video footage of vehicles. However, this technique may not work well in complex environments where the background is dynamic, and lighting conditions change frequently.

To overcome these limitations, Convolutional Neural Networks(CNNs), have been developed. CNN can automatically learn features from images and classify them accurately, making them useful for vehicle classification. The vehicle detection and classification pipeline involve using background subtraction for detection and CNN for classification. The approach involves pre-processing the video stream to detect moving objects using background subtraction. The resulting foreground mask is then passed to the CNN for classification, where it analyses the features of the detected vehicles and classifies them into different categories. The accuracy and efficiency of vehicle detection and classification using background subtraction and CNN algorithms depend on the quality of the data and the complexity of the environment. High-quality data is essential to overcome the limitations and errors in the classification process. In complex environments where the background is dynamic, CNNs can provide better performance than traditional methods.

2. Related Work

Zhou et al. [4] proposed deep neural network or deep learning approaches for vehicle detection and vehicle classification. In detection, they used YOLO [16] as a detection model. Alexnet [9] was used as classification approaches.

Saripan et al. [5] proposed a tree-based vehicle classification system.This work is proposed based on search system. The system consists of three modules, i.e. feature extraction, classification, and search manager.

3. Materials and Experimental Evaluation

3.1 Dataset

Dataset is taken from Kaggle (https://www.kaggle.com/datasets/kaggleashwin/vehicle-type-recognition). This is a vehicle image classification dataset containing images of four different types of vehicles: Car, Truck, Bus, and Motorcycle.

The dataset is organized into four classes, each representing a different type of vehicle:

Car: Images of different car models and types, captured from various angles and under different lighting conditions.

Truck: Images of different types of trucks, including pickup trucks, delivery trucks, and heavy-duty trucks.

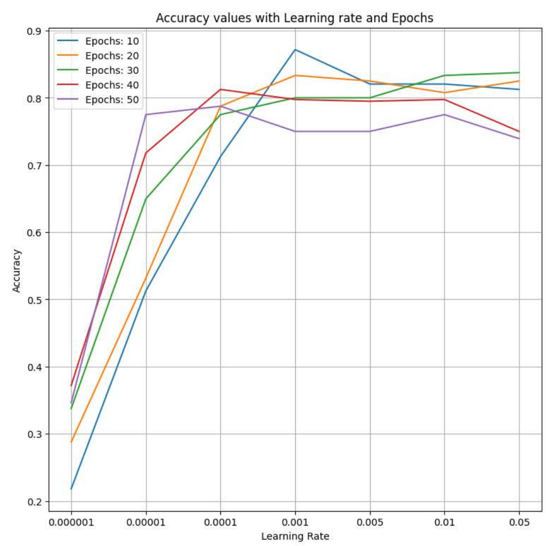
Bus: Images of buses used for public transportation, school buses, and other types of buses.

Motorcycle: Images of motorcycles and motorbikes.

Each class contains 100 images. We used 80% of the data for training and 20% for Validation

3.2 Methodology

The hyperparameters are shown in Table IV. These parameters are the main components which affect to the performance of the CNN models. In the experiment, the classifier is Softmax. The learning rate of Adam optimizer is initialized to be 0.000001 to 0.05. Batch size is 32. The number of epochs is 10 to 50. We used 80% of the data for training and 20% for Validation



3.3 Results

TABLE IV. HYPERPARAMETERS OF THE PROPOSED CNN

Classifier	Softmax
Batch Size	32
Optimizer	Adam
Learning Rate	0.005

Epochs	20

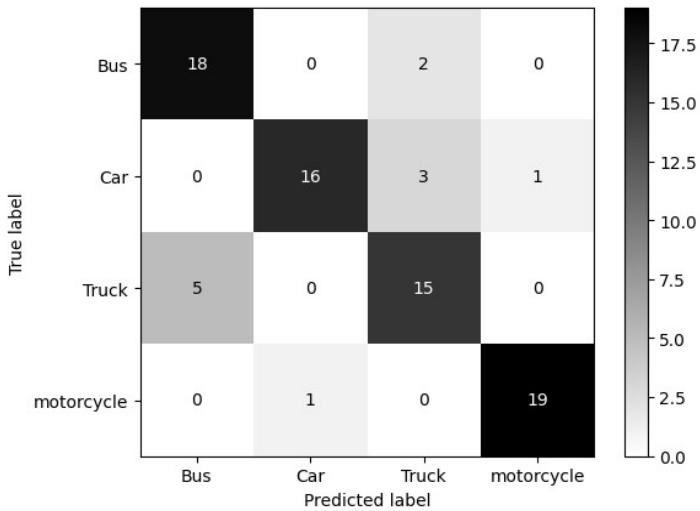


TABLE V. VEHICLE TYPE CLASSIFICATION RESULTS

Method	**Accuracy (%)**
Decision tree [4]	79.38
Random forest [5]	79.82
DNN(Densely)	65.52
CNN	85

The input layer neurons are 224x224x3(image size).The dense layer neurons are 100 with Relu classifier.The output layer's neurons are 04 (equal to the number of possible classes) with Softmax classifier. The Pooling layers is GlobalAveragePooling2D, Batch Size is 32, Learning Rate is 0.001, number of epochs is 10.

The Result if Type classification is shown in Table V. In type classification experiment, the proposed method achieves more than 80%. In this work, the proposed method has been run 10 times. One vehicle type classification result of those experiments have been shown as confusion matrices in Table VII.

Classification Report :

	precision	recall	f1-score	support
0	0.72	0.90	0.80	20
1	0.94	0.80	0.86	20
2	0.76	0.65	0.70	20
3	0.90	0.95	0.93	20
accuracy			0.82	80
macro avg	0.83	0.82	0.82	80
weighted avg	0.83	0.82	0.82	80

3.4 Discussion

In conclusion, the experiment results are shown in Table IX, these experiments demonstrate that CNN could achieve better results, 85% in type. However, the results are not quite stable with a little bit change.

4. Future Work

Many aspects should be explored and experimented, e.g. different input image size also, deeper CNN structure and fine-tuned the structure and different hyperparameters.

5. Conclusion

CNN is proposed as a type classifiers to classify vehicle characteristics from vehicle image which systematically cropped by machine. The experiment's results show that CNN outperforms other methods in type classification. Furthermore, many aspects should be explored and experimented, e.g. different input image size also, deeper CNN structure and fine-tuned the structure and different hyperparameters.

6.Reference

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