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Vehicle Type Classification Using an Enhanced Sparse-Filtered Convolutional Neural Network With Layer-Skipping Strategy

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ABSTRACT In this paper, a vehicle type classification approach is proposed by using an enhanced feature extraction technique based on Sparse-Filtered Convolutional Neural Network with Layer-Skipping strategy (SF-CNNLS). To extract rich and discriminant vehicle features, we introduce Three-Channels of SF-CNNLS (TC-SF-CNNLS) as the feature extraction technique. Local and global features of vehicles are extracted from three channels of an image which are, luminance and chromatic components. This technique is inspired by how human eyes differentiating objects that share almost similar features. TC-SF-CNNLS is tested with a benchmark dataset that provides frontal-view images to classify vehicle types of the bus, passenger car, taxi, minivan, SUV, and truck with Softmax Regression as a classifier. This test aims to observe the ability of this technique in differentiating vehicles with almost similar features but different classes. A test is also conducted with the self-obtained dataset (SPINT) to observe the effectiveness of this technique. The results are observed based on accuracy, precision, recall, and f-score, whereby, TCSF-NNLS has successfully recognized all the classes with an average accuracy of 0.905, precision is between 0.8629 to 0.9548, recall is between 0.83 to 0.96 and f-score is between 0.8564 to 0.9523. In addition, this technique is able to outperform other existing techniques with an average accuracy of 93.% compared to only 89.2% when 5 classes of vehicles are tested.

INDEX TERMS Vehicle type recognition, convolutions neural network, deep learning, computational intelligence.

I. INTRODUCTION

Vehicle type classification is one of the applications that is able to increase the efficiency of road and transportation infrastructure. This application can be implemented in various related systems, for instance, Automatic Toll Collection (ATC), Vehicle Counting System (VCS) and Traffic Monitoring System [1], [2]. The systems can increase the efficiency of many related things including traffic census, traffic surveillance, traffic control, and forecast. The application can be grouped into camera-based or sensor-based. This paper will focus on the camera-based whereby a vehicle is classified based on a processed vehicle image.

Nowadays, traffic surveillance cameras are provided everywhere in big or medium cities to assist in the monitoring process. The process can be more efficient with the implementation of Artificial Intelligence applications, for instance, vehicle type classification. However, a vehicle from the same class can appear in various appearances, and a vehicle from a different class may have a similar appearance. For instance, passenger car and taxi, as well as bus and truck share almost similar features, especially frontal-view images. These variations make visual recognition becomes challenging.

In a vehicle type classification, classifying each vehicle type according to the class that has been determined by the road and transportation ministry is crucial in order to provide an accurate result for further implementation. In Malaysia, the determined vehicle classes are passenger car, taxi, SUV, van, minivan, lorry, truck, and bus. However, due to the challenges that have been mentioned, most of the related studies provide a classification of general classes. For example,

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