Automated Vehicle Classification with Image Processing and Computational Intelligence

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Abstract

Classification of vehicles is an important part of an Intelligent Transportation System. In this study, image processing and machine learning techniques are used to classify vehicles in dedicated lanes. Images containing side view profile of vehicles are constructed using a commercially available light curtain. This capability makes the results robust to the variations in operational and environmental conditions. Time warping is applied to compensate for speed variations in traffic. Features such as windows and hollow areas are extracted to discriminate motorcycles against automobiles. The circularity and skeleton complexity values are used as features for the classifier. K-nearest neighbor and decision tree are chosen as the classifier models. The proposed method is evaluated on a public highway and promising classification results are achieved.

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1. Introduction

Automated vehicle classification is such an important problem that many Intelligent Transportation Systems (ITS) are facing with it. Classification is required for identifying specific vehicles such as motorcycles. Unquestionably, if vehicles are classified accurately in real-time, overall system efficiency can be improved significantly.

For vehicle classification, traditional hardware based methods that employ road sensors are widely used. Axle detectors and height sensors are being used for this purpose. However, these sensors may not provide accurate results in case of congested lanes. Additionally, these sensors performance tend to degrade over time. On the other hand, software based classification rely on image and video processing techniques and they are more robust than the
hardware based ones. Because of ease of installation and maintenance, software based classification is advantageous. Despite its advantages, software based methods have some drawbacks. Processing time is a major constraint of video processing, in addition ambient lighting affects overall performance. Additively occlusion is a major issue in case of congestion. Bad weather conditions such as rain, snow or fog will decrease imaging performance drastically.

In the past few decades, studies are made to find a solution to automated vehicle classification problem. Ryan et al. (2004) presented a video based vehicle classification which uses length information. Zhang et al. (2007) investigated a similar approach in classification. Videos are taken from cameras mounted on top of the road. In order to overcome slow processing times of video processing, image based methods are developed. Goyal et al. (2007) adopted neural network to classify vehicles. Features are extracted from vehicle images and used for training.

In summary, many solutions to unresolved problems exist in automated vehicle classification. In free flowing traffic, vehicle recognition is performed before classification; on the other for dedicated lanes, it is easier to detect vehicles. Additionally, dedicated lanes have slower cruising speeds compared to free flow, which improves sampling performance.

In this paper, a novel automated vehicle classification method is presented. Light curtain information is used to generate side view profile of ongoing vehicles through dedicated lanes. Moreover, this side view profile information is used to reconstruct a representative binary image of the vehicle. By combining image processing with machine learning techniques, motorcycles are differentiated from cars.

The rest of the paper is organized as follows. Section 2 describes our Automated Vehicle Classification method. Section 3 provides experimental results and discussion of highlight features. Finally, conclusions and future work are given in Section 4.

2. Automated vehicle classification scheme

Automated vehicle classification consists of three phases: data collection, feature extraction and training. In this section each of the phases are given in detail. Overall system diagram is given in Fig.1.
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