Chapter 8
Development of a Stop-Line Violation Detection System for Indian Vehicles

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ABSTRACT

In the present work, the authors designed and developed a complete system for generating the list of all violating vehicles that has violated the stop-line at a road crossing automatically from video snapshots of road-side surveillance cameras using background subtraction technique. It then localizes the license plates of the vehicles by analyzing the vertical edge map of the images, segments the license plate characters using connected component labeling algorithm, and recognizes the characters using back propagation neural network. Considering round-the-clock operations in a real-life test environment, the developed system could successfully track 92% images of vehicles with violations on the stop-line in a red traffic signal. The performance of the system is evaluated with a dataset of 4717 images collected from 13 different camera views in 4 different environmental conditions. The authors have achieved around 92% plate localization accuracy over different views and weather conditions. The average plate level recognition accuracy of 92.75% and character level recognition accuracy of 98.76% are achieved over the localized vehicle images.

INTRODUCTION

Integrated Traffic Management Systems (ITMS) are now implemented in recent years in different cities in India primarily to address the concerns of congestion, safety, security, efficiency etc. An automated Stop-Line Violation Detection System (SLVDS) is an integral part of the ITMS, which is not only used to track down the vehicles that has violated traffic rules at a road crossing but also to recognize the license number of them for implementing further legal actions. A complete stop-line violation detection system for Indian

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roads has been proposed in this chapter. The system consists of four main modules: (a) stop-line violation detection, (b) license plate localization, (c) character segmentation and (d) character recognition. The designed system is capable of detecting vehicles violating the stop-line at the traffic intersections, localizing license plates of various sizes and shapes, interpreting single line and two-line license plates, recognizing variable non-standard fonts and performing seamlessly in varying weather conditions, i.e. in bright sunlight, rainy conditions and at night.

Integrated traffic management systems (ITMS) are installed in most of the developed countries with an objective to track on-road traffic violations, using surveillance cameras and intelligent image analytic software. The different components of typical ITMS involve 1) monitoring of vehicle speed on road, 2) automatic estimation of traffic volumes at different traffic intersections, 3) synchronized signaling system in city roads, 4) detection/ localization of illegal parking and wrong way traffic, 5) detection of stop-line violating vehicles etc. Stop-Line Violation Detection System (SLVDS) when includes Automatic License Plate Recognition (ALPR) system becomes an integral part of ITMS, which has already been used in most of the developed countries during last decades or so for tracking unruly vehicles at road intersections. In recent years it has now being the growing need by different traffic monitoring authorities of government of India for automatic identification of vehicles that has violated traffic signal at a road crossing. The purpose of any SLVDS is to track down the vehicles that have violated the traffic signal at a road crossing. It is also implemented at toll plaza, in car parking area and in security zones for automatic recognition of license number of the vehicles that have entered into the area for specific purposes.

In this context it worth mentioning that in any road crossing when red signal is shown to a lane, the signal conveys the message to the vehicles rushing towards the crossing to stop immediately. To make the system more convenient, a uniform thick white line is drawn across the road before the crossing, which is commonly known as *Stop-Line*. A stop-line is usually placed perpendicular to the direction of flow of traffic and is normally parallel to the frontal vertical plane of the road. Each vehicle coming towards the crossing must stop before this line if red signal is seen by it. Even if the front wheel of the vehicle touches the stop-line partially then also it is decided as a stop-line violating vehicle.

In the developed countries and in most of the developing countries the attributes of the license plates are strictly maintained. For example, the size of the plate, color of the plate, font face/ size/ color of each character, spacing between subsequent characters, the number of lines in the license plate, script etc. are maintained very specifically. Some of the images of standard license plates, used in developed countries, are shown in Figure 1 (a). However, in India the license plates are not yet standardized across different states, making localization and subsequent recognition of license plates extremely difficult. Moreover, in India license plates are often written in multiple scripts. Figure 1(b) shows some of the typical Indian license plates with variety of shape, size, script etc. This large diversity in the features of the license plate makes its localization a challenging problem for the research community.

In India, the specification of the license plate and the format of the license number are generated and maintained by different state government traffic monitoring authorities. The format of the license plate has been changing for last decades or so because of the increasing growth of the number of vehicles. In the recent years two types of license plates are used in India for two categories of vehicles. For commercial vehicles, the license plate has a yellow background and black scripts on it. For private vehicles the license plate has a white background with black script is used. The current Indian vehicle registration scheme comprises of a two-letter identification code for