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An Efficient Approach for Detection and Speed Estimation of Moving Vehicles

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Abstract

An intelligent traffic management and surveillance is the basic need for the smart city development in India. This includes the detection of moving vehicles, estimation of their speed and detection of the speed limit violation and its registration number. This paper proposes an efficient and novel approach for the detection of moving vehicles as well as estimation of their speeds by using a single camera in daylight or properly illuminated environment. The proposed approach detects and tracks the vehicle passing through the surveillance area and keeps the record of vehicles position. In this paper vehicles tracking is based on the relative positions of the vehicles in consecutive frames. This information may be used in the Automatic Number Plate Recognition (ANPR) System for selection of those key frames where speed limit violation occurs. The average detection accuracy achieved by proposed approach is about 87.7%. The proposed approach uses cropping operation to minimize the scope of any false positive detection on both sides of road.

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Keywords: Background Subtraction; Image Filtering; Thresholding; Contours Processing; Camera Calibration; Moving Object Detection.

1. Introduction

Government of India aims to develop 100 smart cities in future. A Smart city delivers smart services like smart traffic management, traffic surveillance etc. To deliver these smart services, various information and communication technologies are used. The smart traffic monitoring is incomplete without a system that is capable of automatic detection of traffic rule violations. Automatic traffic surveillance system is the need of the smart traffic management. In urban areas, the detection of red light violations, speed limit violations and stop look and go protocol violations are the issues that usually arises. The detection of red light violation is generally manual process in India barring few cities where CCTV footage of traffic cameras is used for this. To detect the speed limit protocol violation, the speed guns are used. For smart city development, these issues need to be resolved. Smart city traffic surveillance system is the right solution to these issues. For detection of moving vehicles, detection of vehicles speed and automation recognition of number plates of the vehicles, various techniques have been proposed by many researchers but a comprehensive and cost effective solution is still missing. In the present era of computer vision, the detection of moving objects is intrinsic

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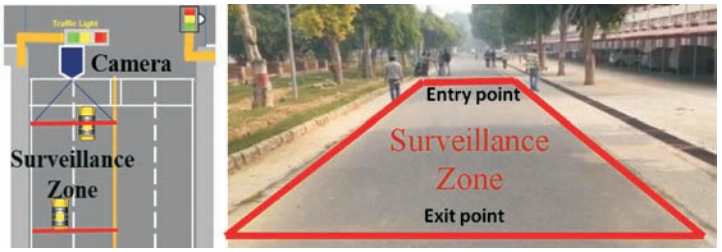

Fig. 1. Proposed System, Surveillance Zone Setup.

need of many image processing applications like traffic surveillance, vehicle classification, collision detection (such as accidents on roads) etc. There exist wide variety of methodologies for moving vehicle detection and tracking but efficient technique with higher accuracy and economy needs to be developed. In smart city traffic surveillance system[1], these techniques may play important roles. This paper proposed an efficient and novel approach for detection of the moving vehicles and their speed. The proposed approach can be integrated with existing traffic monitoring based on cameras system without major modifications.

2. Related Work

Moving object detection based on image processing techniques is composed of three major phases. The first phase begins with image acquisition and preprocessing of the frames. The next phase is background modeling. The final stage is detection of moving objects. Efficient background image modeling makes the moving object detection efficient. Many researchers have proposed different background modeling techniques in the past. Mittal *et al.* propose the background modeling based on segmentation of dynamic scenes[2] . Background modeling based on weighted average of current background and new image is also proposed by Gupte *et al.*[3] Sliding window concepts is also proposed by Hussain *et al.* in order to background modeling[4] but it required extra memory for keeping frames in buffer. To generate a good background image, an approach based on probability density function[5] , background modeling based on long term average of the image capture in a time interval[6] and principle component analysis based approach are also proposed Javed *et al.*[7]. In general, frame difference and background subtraction methods are used for moving object detection but frame differencing only detects the leading and trailing edge of a uniformly colored object. As a result very few pixels on the object are labeled, and it is very hard to detect an object moving towards or away from the camera. Javed *et al.*[7] and Sullivan *et al.*[8] propose an approach for moving vehicle detection based on background subtraction. Kasetkasem and Varshney achieve background subtraction by using feature extraction, template matching and contour processing techniques for identifying the presence of vehicles[9]. For tracking of moving vehicles, mean shift algorithm and template matching algorithm are proposed by Hsieh *et al.*[10]. Although numerous approaches have been proposed in the past, there exist some issues related to false positive detection in background subtraction method. Vehicles feature detection and mean shift calculation introduces memory and time overhead. In this work and approach that address the issues related to false positive vehicle detection and memory and time efficient tracking algorithm is proposed.

3. Proposed Work

This paper proposes a novel approach and technique so as to efficiently detect and track the vehicles. The proposed technique detects tracks and extracts the vehicles parameter for speed estimation by using a single camera.

This paper also proposed a cropping method for minimization of false positive vehicle detection. In such a system, the camera must be situated on the traffic signal pole, approximately 10 meters or more above the level of road projected towards the center of the road. This installation will minimize the effect of occlusion. The proposed installation is shown in Fig. 1. The work flow of proposed technique is shown in Fig. 2.