Computer Vision Based Traffic Monitoring System for Multi-track Freeways

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Abstract. Nowadays, development is synonymous with construction of infrastructure. Such road infrastructure needs constant attention in terms of traffic monitoring as even a single disaster on a major artery will disrupt the way of life. Humans cannot be expected to monitor these massive infrastructures over 24/7 and computer vision is increasingly being used to develop automated strategies to notify the human observers of any impending slowdowns and traffic bottlenecks. However, due to extreme costs associated with the current state of the art computer vision based networked monitoring systems, innovative computer vision based systems can be developed which are standalone and efficient in analyzing the traffic flow and tracking vehicles for speed detection. In this article, a traffic monitoring system is suggested that counts vehicles and tracks their speeds in realtime for multi-track freeways in Australia. Proposed algorithm uses Gaussian mixture model for detection of foreground and is capable of tracking the vehicle trajectory and extracts the useful traffic information for vehicle counting. This stationary surveillance system uses a fixed position overhead camera to monitor traffic.

Keywords: computer vision, surveillance system, Gaussian mixture model. Vehicle Trajectory.

1 Introduction

Computer vision is effectively used in manufacturing industry for assembling electronics control in vehicles by robots. Quality control in multi-Billion dollar electronics industry is maintained by computer vision where involvement of the human eye is unheard of during the past decade. Large infrastructure projects are too vast to monitor by humans alone. More and more computer vision based systems are developed for security and maintenance. Computer vision has been successfully used in the UK for monitoring traffic to avoid traffic bottlenecks. However, such systems cost tax payers millions of dollars every year and are far from economical in the current economic slowdown of the world. So, it is very desirable to develop new surveillance systems which are stand along and inexpensive that making use of the latest hardware developments even for smaller freeways. In a traffic monitoring system, vehicles can be detected and tracked for their speed for a short period of time
using a live video stream. This can be used for counting the traffic density of any track or section of the freeway and could potentially identify the traffic jams due to certain kind of breakdown or accidents. The propose can detect the event before the authorities are notified of any event. Major applications of such systems include intelligent traffic monitoring, counting vehicle on road, traffic rule violation detection, classification of E-TAG (Electronic tag) system. In recent years, there have been few instances of intelligent vehicles with autonomous driving. However, there are many challenges for such a system in practice. Major challenges in vehicle detection algorithm are weather conditions, poor road illumination, occlusions from other vehicles, view point orientation and the challenges posed by variety of vehicles with trailers. A lot of work has been attempted to handle some of these issues.

Vehicle detection can be classified as camera based systems or optical sensor based detection and tracking [1]. Computer vision has been successfully implemented in many vision-related scenarios with increasing reliability [2-11]. Camera quality and its sensing system have been improved a lot in recent times and same level of improvement can be seen in computational power of computer system. These factors are enabling researchers to enhance vehicle detection algorithm’s accuracy. Number of sensors and quality of sensing device are key factors in computer vision application. Major goal of many current research activities regarding vehicle monitoring is geared towards improving accuracy with reduction in complexity to handle different weather conditions and occlusion problems.

![Fig. 1. Categorization of Sensor based Vehicle Detection Methods](image)

### 1.1 Sensor Based Vehicle Detection

Sensor based vehicle detection system is a non-computer vision based system. It is based on the physical interaction or presence of vehicles. It is categorized in two