Road Traffic Parameters Estimation by Dynamic Scene Analysis: A Systematic Review

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ABSTRACT

Traffic congestion and violation of traffic rules are very common in most of the road transport system. Continuous monitoring is becoming difficult. To improve the quality of road transport monitoring and control, the best possible alternative is machine vision. In this review, several works by researchers on traffic analysis are detailed, studied and reviewed critically for the purpose. Further, an attempt is made to classify the different road traffic analysis approaches available in the literature. Classification is based on principle used, algorithm adopted, techniques used, technology behind and other special considerations of the researchers.

Keywords: Machine Vision, Road Transport Monitoring and Control, Road Transport System, Traffic Analysis, Traffic Congestion, Violation of Traffic Rules

INTRODUCTION

Vehicle traffic over the transportation infrastructure affects almost every factor of our life and has a primary impact on the economy. As vehicle traffic continues to grow exponentially while the resources to increase the road capacity are limited. The only answer to keep up with the ever increasing traffic is better management of traffic and available infrastructure. This in turn, depends on the availability of better traffic data i.e. timely information on almost every vehicle traveling on the transportation network.

Traffic analysis plays a significant role in the present day scenario. Traffic congestion and violation of traffic rules are very common nowadays in most of the road transport system. Continuous monitoring of the same for 24 hours a day and round the year is becoming difficult. The monotonic nature of the work leads to negligence. This certainly causes damage in terms of human life, property and man hours loss. Every minute, on an average, at least one person dies in a vehicle crash. Auto accidents also injure at least 10 million people each year out of that 2.5 million seriously injured and become disabled. The total damage adds up to 2-3% of world’s gross domestic product and...
this figure is ever increasing as highlighted in (John, 2002).

The above statement certainly needs the attention of the research community. To improve the quality of road transport monitoring and control, the best possible alternative is machine vision. This apart from traffic analysis helps in locating rules violators and tracking them. In the implementation of machine vision, dynamic scene analysis will play a significant role. It carries time and space information together. Mounted optical CCD camera inputs the continuous video information of the road. Dynamic scene analysis provides change taking place in these video frames. Now, the role of optical flow computation comes into picture significantly. Optical flow computation will provide velocity of the every changing pixel in the scene. Hence the velocity of the moving objects in the scene. The needle diagram representation will further enhance the information content of the optical flow computation. Several technical papers from the reputed national and international journal have been studied and reviewed critically in order to establish the infusion of the technique into the real field application. It is found that the time factor plays an important role in deciding which algorithm or method is better suited for the purpose. Real time analysis is the requirement and is the order of the day. It supports instantaneous action. Conventional optical flow computation is iterative in nature and hence delay the response or action time. It is justifiable that with certain modification optical flow computation is best suited for the purpose.

After reviewing several connected literature, the detailed work is presented to the readers under the following sections. In section 2 the term traffic flow in defined and described as per the requirement of the present topic. It suggests the short term and long term pattern and connected buzzwords. Optical flow analysis plays a very important role in the dynamic analysis. This provides a good mathematical base for the analysis. Hence, in section 3 optical flow and related topics has been addressed in detail for the benefit of the readers. An effort is made to study different literature on traffic analysis and classify the same based on several guiding principles. Section 4 presents the same. Section 5 highlights the challenges and recent trends in the road traffic analysis. In section 6 critical reviews of more than 50 papers has been highlighted. Final section is mainly to conclude the overall work with useful suggestions which benefits research community.

**TRAFFIC FLOW**

Traffic flow / Traffic flux is a generic term used to describe vehicle movement and volume over a transportation network. Two important parameters of traffic flow are average annual daily traffic (AADT) and Vehicle miles traveled. These are long term flow patterns. Short term pattern includes daily or hourly parameters broken down to vehicle categories are also of high interest. This data can be acquired only with limited spatial extent with traditional techniques. The use of airborne / satellite imagery, however offers an excellent temporal and spatial resolution that can easily provide for sizable area of sight coverage at fast sampling rates. This definitely makes the whole system uneconomical and complex because of satellites and allied infrastructure. Answer to this data acquisition with digital cameras and analysis through the computer/machine vision technique/algorithms.

Further, when we reduce the traffic analysis to minutes and seconds to a limited area resulting in a term “traffic flux”. It conveys the traffic density in a particular location at the limited packet of time. A typical traffic flux plot is as shown below.

Further, the following challenges are to be addressed in road traffic analysis:

- Moderately occluded cluster.
- Close vehicle cluster.
- Low resolution distributed vehicle cluster.
- Distant queue of irregular sizes.
- Large vehicle cluster.
- Rainy situation.
- Snowfall and fog.
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