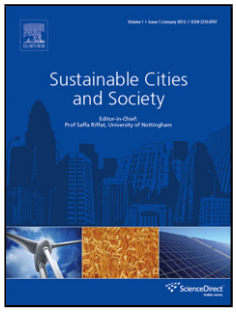

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Monitoring Road Traffic Congestion Using a Macroscopic Traffic Model and a Statistical Monitoring Scheme

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Abstract

Monitoring vehicle traffic flow plays a central role in enhancing traffic management, transportation safety and cost savings. In this paper, we propose an innovative approach for detection of traffic congestion. Specifically, we combine the flexibility and simplicity of a piecewise switched linear (PWSL) macroscopic traffic model and the greater capacity of the exponentially-weighted moving average (EWMA) monitoring chart. Macroscopic models, which have few, easily calibrated parameters, are employed to describe a free traffic flow at the macroscopic level. Then, we apply the EWMA monitoring chart to the uncorrelated residuals obtained from the constructed PWSL model to detect congested situations. In this strategy, wavelet-based multiscale filtering of data has been used before the application of the EWMA scheme to improve further the robustness of this method to measurement noise and reduce the false alarms due to modeling errors. The performance of the PWSL-EWMA approach is successfully tested on traffic data from the three lane highway portion of the Interstate 210 (I-210) highway of the west of California and the four lane highway portion of the State Route 60 (SR60) highway from the east of California, provided by the Caltrans Performance Measurement System (PeMS). Results show the ability of the PWSL-EWMA approach to monitor vehicle traffic, confirming the promising application of this statistical tool to the supervision of traffic flow congestion.

Keywords: Traffic congestion, Macroscopic traffic model, Statistical monitoring, Quality control chart.

1. Introduction

The management of vehicle traffic congestion in public road networks is becoming a key factor for economic growth. Indeed, road traffic congestion hampers economic growth: it has a profound impact on travel time, causing delays that result in the significant financial loss of billions of dollars spent on extra hours of travel and fuel consumption (Barria and Thajchayapong, 2011; Williams and Guin, 2007). Automotive industry growth, which has improved the quality of vehicles and significantly increased their number, has also increased the environmental impact and traffic congestion in many parts of the world. It has been reported in (Muneer et al., 2011) that the automobile sector