An Efficient Information Services-Centric Framework for Commuter

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ABSTRACT

One of the major objectives of Advanced Traffic Management Systems (ATMS) is to reduce traffic congestion in urban environments by improving the efficiency of utilization of existing transport infrastructures. Many creative and efficient technologies have been developed over the years. Although commuters, especially drivers, take a critical part in containing traffic congestion problems, they are playing a passive role in the traffic-management ecosystem. Considerably, this is due to the information asymmetry between ATMS decision makers and commuters; what is missing is a matching mechanism to create a bridge between information providers and information consumers in the mobile environment. The authors' solution provides an efficient services-centric framework for delivering pertinent information to commuters. Probe vehicles are used to estimate the real-time traffic flow and disseminate this information effectively to users' mobile devices. A 2-level indexing scheme is designed to effectively index the grid cells which contain the spatial information and a location-aware mobile application and back-end services are also implemented. Processed information is disseminated to users' mobile devices through wireless means and presented in a user friendly interface. Experimental results show that this system is scalable and responsive.

Keywords: Analytical Processing, Commuter Information Service, Mobile Technologies, Probe Vehicle, Services, Spatio-Temporal, Traffic Flow Prediction

INTRODUCTION

One of the critical components contributing to the success of Advanced Traffic Management Systems (ATMS) is the dissemination of real-time and predictive information of traffic conditions. In recent years, there have been some good developments for the ATMS technology. However, many problems, including traffic management and congestion control, still remain unsolved. Advanced in-depth analysis of historical and real-time trends of traffic flows therefore become fundamental tasks in order to improve mobility and safety in our
daily routines. Nevertheless, not only a well functioning detection and analysis system of traffic flow is important, it should disseminate the information in an effective way to the road users (i.e., especially drivers on the move) on a timely basis. We addressed this by providing pertinent information services for commuters. This information service will allow commuters to act more proactively in the transportation network. In general, the key advantages of pertinent information services are: reduction of the travel time delays, possibility to warn approaching drivers of any disturbances, possibility to recommend alternative routes and, last but not the least, better trip planning by providing real-time information such as weather forecasts.

Generally, there are two strategic components that need to be built in order for any systems to achieve these objectives: 1) Provide real-time traffic flow estimation by collecting, processing and effectively organizing data from a variety of sources 2) Disseminate this spatiotemporal information wirelessly and present it in a user-friendly visualized form. The necessary input for the first component is the underlying demand for use of the transportation network. The travel time information can be collected from various sources such as loop detectors, radar, video cameras, probe vehicles, etc. Information such as speed conditions for different times of day for each route, traffic volume, average speed and lane occupancy at fixed locations can be easily derived from the transportation network usage information. The data collected is stored in the traffic database for further analysis. It is, therefore, not surprising that much effort has gone into the development of real-time traffic rate estimation and traffic flow rate forecasting, which is to determine the traffic condition data in the next time interval, e.g., in the range of minutes to hours (Chen & Chien, 2000; Balke, Dudek, & Mountain, 1996; Gonzalez, Han, Li, Myslinska, & Sondag, 2007; Sun, Zhang, & Yu, 2006; Vlahogianni, Karlaftis, Golias, & Kourbelis, 2006). However, there are different monetary costs for collecting and analyzing the data associated with each approach. Among the available solutions, real time traffic flow analysis using probe vehicles has been shown to provide reliable and cost-effective real-time travel information (Chen & Chien, 2000; Balke et al., 1996).

In this paper, one of our emphases is on the efficient use of probe vehicles especially taxis for traffic flow analysis. The ubiquitous taxi is a transport staple in many countries around the world, providing a comfortable, convenient means of moving directly from one place to another. Service levels have also improved dramatically over the years with the introduction of telephone taxi-booking services and radio-paging. More recently users are able to make bookings via Short Message Service (ComfortDelGro, 2009), and benefit from the improvements provided by the Global Positioning System-enabled (GPS-enabled) systems that track and direct taxis to areas of high demand. While the penetration of GPS-enabled systems is increasing rapidly in most developed countries, such as Singapore, traffic monitoring, especially through the use of taxis as probe vehicles is still a nascent field compared to those in major cities in the United States. With the large taxi population outfitted with devices that update a central database of their status, mining this already-available data store for information allows us to develop more sophisticated external monitoring solutions.

Maps are traditionally used for the presentation of spatial information. The recent emergence of mobile devices (e.g., Java J2ME-enabled mobile phones, PDAs and other devices) with larger displays, internal GPS features, maps display APIs, and affordable high-speed wireless data networks have made it increasingly feasible to develop information rich mobile applications such as traffic monitoring, which rely on frequent data-transfer and real-time spatial visualization. With our system, we aim at provide a streamlined generalized visual pertinent information services for commuters with probe vehicles as the real-time demand collectors. To present such pertinent information to motorists and commuters, we developed a mobile application that aggregates and enhances
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