Recommendations and Implementation of Automatic Vehicle Identification for Incident Detection and Advanced Traveler Information Systems

Introduction

Implementation of Intelligent Transportation Systems (ITS) carries high promise of more efficient use of existing transportation networks through the application of advanced information processing and communication technologies to manage transportation systems and to control the flow of vehicles. Incident-related congestion results in billions of dollars a year in lost productivity, property damage, and personal injuries. According to the Federal Highway Administration (FHWA), in 1986 incidents accounted for 60% of the vehicle-hours lost to freeway congestion (Lindley, 1986). In addition, the FHWA predicts that by the year 2005 incidents will account for 70% of all delay caused by urban freeway congestion associated with a users' cost of $35 billion (Gordon, 1996).

Background and Motivation

The primary goal of Automatic Incident Detection (AID) is to reduce the detection time of an incident, i.e., the time elapsed between its occurrence and the moment it is brought to the attention of the Traffic Management Center (TMC) personnel. By focusing on the detection time, AID indirectly reduces the response and clearance times, thereby further contributing to a quick return to normal conditions.

Automatic vehicle identification (AVI) technology was first introduced in the United States during the early 1960s in the railroad industry. Interest in applications of AVI in traffic management has increased in the past decade because of the important role AVI could play in integrated ITS. The potential advantage of AVI technology over fixed-location detectors resides in its ability to collect point data as well as point-to-point data, which are expected to provide a better description of certain aspects of traffic conditions. The quality of the resulting data must be evaluated in light of the requirements for ATIS applications and for traffic management applications, particularly incident detection. The analysis will be of interest to departments of transportation at the local and national levels that are considering AVI systems for emerging ATIS and traffic management applications.

What We Did ...

AVI Algorithms Calibration and Testing

Typically, traffic parameters that are gathered using AVI or ILDs (Inductive Loop Detectors) are processed using mathematical or logical formulas, called algorithms, to automatically predict the current traffic state (i.e., normal congestion, accident expected, etc). This research studied two AVI algorithms and two ILD algorithms. Although the loop algorithms performed better than the AVI algorithms considered in this project, the performance of the AVI algorithms, especially the Upper Confidence Limit algorithm, holds the promise of comparable — if not superior — performance if the AVI readers are properly spaced and the level of tagged vehicles' market penetration is adequate. Also, owing to the fact that AVI provides link speed data rather than point speed data, faster incident detection is antici-

pated if AVI tags are widely used. If a system has AVI installed but no loop detectors, the AVI sensors may still be useful as a source of incident detection information.

What We Found ...

San Antonio System Assessment

The results of the on-line evaluation of the San Antonio AVI system primarily include the identification of technical difficulties that should be avoided in future AVI implementations. These difficulties include proper synchronization, monitoring all lanes of travel, and capturing the direction of tagged vehicles. The San Antonio AVI system is useful as installed; however, improved ATIS and incident detection systems are limited by the current installation.

The advantage of an AVI system is the ability to obtain travel times from a sample of vehicle probes. A statistical investigation in this research found that the current percentage of tagged vehicles to overall number of vehicles using San Antonio I-35 corridor is less than 3 percent.

There are many new and emerging applications for AVI and areas for further development of the technology to better serve travelers. The popularity of probe vehicle detection technology is poised to expand rapidly with the E-911 cellular location requirement. If an AVI system is installed, the collected data should be used for AID, since the marginal cost to implement an AID algorithm based on AVI data is low. The following

section provides recommendations for further expansion of the San Antonio AVI system, as well as suggestions for new AVI implementations.

The Researchers Recommend ...

Installation Configuration: The installation of an AVI system for ATIS applications is the most critical phase in AVI implementation. The reader spacing should be no more than 2 miles for metropolitan systems. Each AVI site should monitor all lanes of travel. When the decision whether to implement an ILD or an AVI system is to be made, the decision should be based not just on incident detection considerations, but also on considerations regarding all the anticipated users of the data. The AVI system implemented in San Antonio should be modified to reflect the direction of travel of a tagged vehicle — a modification that would thus increase the usable data obtained from the system for incident detection. The tagged vehicle penetrations are typically very low; the system should attempt to capture every tagged vehicle that passes a fixed-detector location. Additional sensors at all entrance and exit ramps would provide a significant benefit to transportation planners and would allow for effective toll collection. Origin-destination information could then be obtained for calibration of demand models. Other recommendations for TransGuide would be to investigate the causes of errors in traffic and incident data

and proceed in order to minimize their occurrence before the data is used as input for an AID algorithm. Regular monitoring and inspection of detectors, whether ILDs or AVI, are recommended to ensure continuous operation and swift remedial action in case problems are detected. Undetected problems render a system much less useful and can diminish confidence in its potential effectiveness.

Tag Types and Use: Tag reliability and accuracy are the most important factors in selecting a tag type for implementation. The battery-powered tags used in Houston are much more reliable for detection in high-speed applications. The San Antonio tags are not powered, relying instead on the radio signal being reflected from the reader antenna. Powered tags are preferred for the greater reliability that can be obtained from the system. Tags should be distributed to the widest number of travelers and traveler types. Transit vehicles, trucks, state vehicles, and passenger cars should all be represented for an effective system. The San Antonio AVI project initially desired to tag every vehicle registered in the county; however, cost and privacy concerns precluded such distribution. The ideal method to prompt travelers to obtain tags is to provide an incentive. While the most obvious incentive is for toll collection, there are many other potential incentives for equipping vehicles with AVI tags. Different systems and organizations should be encouraged to use tags compatible with the traffic management center implementation in order to

facilitate resource sharing.

Regional Applications: AVI systems installed between the major cities could provide intercity travelers with corridor congestion information — both pretrip and en-route. Variable message signs could be installed along the corridor to provide travel time estimates to the major cities. Information could also be updated on a Web page to allow travelers to modify their departure time if conditions are congested. The implementation challenge lies in the need for centralized coordinated control and for cooperation between multiple agencies. The initiative must come at the state level, while system coordination should occur at one of the metropolitan traffic management centers or at a statewide center. Commercial vehicle operations can provide the fleet and increased intercity penetration. Trucks would bias the travel times, insofar as they typically travel slower than the average vehicular travel stream. Separate treatment is generally required for commercial vehicles, as noted below.

Dynamic Traffic Input: The raw data obtained from a properly installed AVI system can provide real-time data to dynamic traffic assignment models. The output from such models can yield predictive information about travel time and speed and can suggest alternative routes. The delayed nature of AVI data limits the ability of AVI data for real-time dynamic traffic applications. However, the origin-destination demand data can be of significant benefit in calibrating dynamic traffic algorithms in near real-time. An AVI system can be used for dynamic traffic assignment verification. Fully integrated systems of the future will provide directions to users based on user characteristics (reduce delay, through traveler, optimize the system).

CVO Applications: Traffic management centers can obtain valuable truck and commodity flow information if existing AVI installations are compatible with technologies employed in commercial vehicle operations (CVO) applications. With readers located at entry and exit points of the network able to detect commercial vehicles, information about origin-destination and through truck travel can be obtained. The difficulty in obtaining commodity flow data is often institutional and not technical.

Future Work: Fusing the outcome of different AVI algorithms might lead to better results at little additional cost, as Zhou (2000) concluded in a previous study. Future efforts should concentrate on conducting similar experiments on real AVI data collected from other networks with varying conditions (e.g., tagged vehicle market penetration, link length, etc.) in an attempt to determine guidelines to be used in the design of new AVI systems and in their application for traffic management purposes. Most important, both traffic estimation techniques (for ATIS as well as for traffic management purposes) and incident detection procedures can be substantially improved by taking advantage of the characteristics of all available sources of data in a given network, including AVI, loop detectors, and cellular phone location technologies.

REFERENCES

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   The objective of this research project was to evaluate the performance of the Automatic Vehicle Identification (AVI) system in San Antonio. Four products were required for this project: 1.) Functional specifications for real-time incident detection utilizing AVI; 2.) Guidelines for dissemination of incident management process information to the public; 3.) Strategies for integrating commercial vehicle operations data within the overall AVI process; and 4.) Recommendations for the expansion of the AVI system in San Antonio, which could also serve as a model for other TxDOT districts. While the products serve as a basis for the successful deployment of an AVI system, the AVI system in San Antonio has been dismantled since the completion of this project. As a result, the recommendations developed in this project were not directly implemented in San Antonio. However, the recommendations can be implemented in future AVI installations in Texas.

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