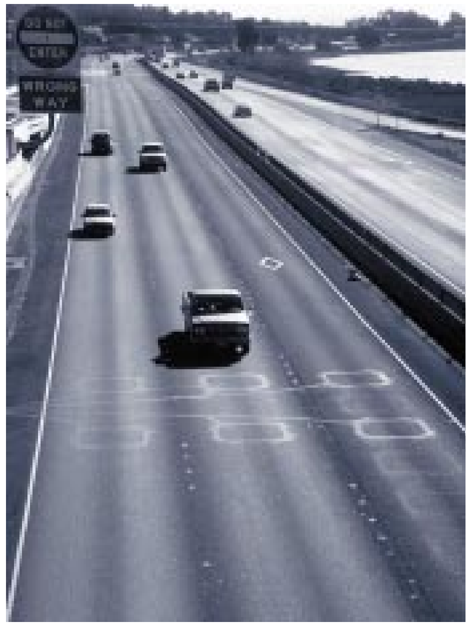
Traffic Surveillance



Above: Loop detectors in freeway. Above right: machine vision monitoring of traffic. Below right: CHP/Caltrans Transportation Management Center in Oakland, CA.

You can't have a usable Intelligent Transportation System (ITS) without surveillance. Intelligence requires information, and information requires data, which is generated by surveillance. So what types of data does an ITS need?

A major objective of ITS is to reduce the delay and risk caused by incidents-collisions, stalls, mattresses on the freeway, etc. It is commonly believed that about half of all congestion is induced by incidents. Finding and mitigating incidents (e.g. restoring the transportation system to its normal operational state) is perhaps the most valuable activity that a transportation agency can perform.

Travel time is perhaps the key quantitative parameter for ITS surveillance systems. Environmental emissions, fuel costs, accident risk, and driver stress are all a function of changes in travel time. Every person (implicitly or explicitly) assesses trip travel time in deciding if and when to embark on each trip.

The reduction of risk of secondary accidents is another concern of significance to transportation agencies. The California Highway Patrol (CHP), Freeway Service Patrol (FSP), and Call Box programs are all meant to minimize this risk. Surveillance systems that can quickly and efficiently identify travelers in need of assistance will always be useful.

PATH researchers throughout California are working on applying advanced technology to improve surveillance, some using new detection methods, some using existing detectors in new ways. Among PATH's current projects are:

Automated Travel Time Measurement Using Vehicle Lengths From Loop Detectors

A loop detector is a loop of wire buried beneath the road surface with a continuous current running through it. When a vehicle passes overhead it induces a surge of current through the loop. These surges can be measured and counted, yielding information about traffic flow and density. Often loops are installed in pairs a few meters apart so that speed can also be measured (see photo above). A UC Berkeley team is using these pairs of loop detectors in a new way, measuring vehicle lengths so that individual vehicles can be identified and reidentified at the next downstream pair of loops. By comparing the time when the vehicle crosses each pair, the travel time between loop pairs can be estimated. Three methods for matching vehicles have been tested, all resulting in travel time errors of less than five percent. These promise to be cost-effective methods for estimating travel times when paired loops are available. Travel time is of great interest to drivers; moreover, an abrupt change in travel time often indicates the occurrence of an incident.

Using Vehicle Induction Signatures to Estimate Travel Time

UC Irvine researchers are using loop detectors in a different way. They are using the characteristic inductance pattern made by a vehicle passing over the loop–its signature–to identify and reidentify vehicles. They have developed various methods to adjust for changes in signatures due to speed differences, loop detector variations, and the like. The ability to track vehicles also provides a means of determining origin and destination patterns.

Laser-based Travel Time Estimation

Laser detectors do not require installation in the pavement, and therefore can be useful where loop detectors are not available. UC Davis researchers are using overhead mounted laser detectors with two detection surfaces to determine vehicle speed and dimensions so that vehicles can be identified and reidentified downstream and travel time calculated.

Video-based Vehicle Signature Analysis and Tracking

Video surveillance, like laser surveillance, does not intrude on the roadway. Multiple vehicle features such as dimensions, light placement, and color are being used by Cal Poly San Luis Obispo researchers to iden-

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tify and reidentify vehicles. At night, pulsed infrared light illuminates vehicles as they pass through the camera view. At the test site, where detectors were 1800 feet apart, errors in travel times were less than one percent.

Image Sensing with Low Visibility

Conventional video surveillance requires good visibility. In conditions of dense fog, snow, rain or airborne particles (smoke or dust), and at times of low natural illumination, visible light sensing methods may be inadequate. Yet, it is precisely in these low-visibility conditions that the greatest need exists for reliable traffic monitoring, especially if the objective is the recognition of impending dangerous traffic situations. This PATH/Cal Poly project studies alternative imaging technologies for traffic surveillance and detection, technologies that have superior abilities to “see through” fog and particles, that do not depend on natural visible-spectrum illumination, and that may contain additional information of potential value in traffic management. The most probable candidates are infrared sensitive cameras and passive millimeter-wave radiometric imaging. Long wave infrared, short wave infrared, and millimeter wave bands have some intrinsic advantage under combined conditions of darkness and fog.

Probe Vehicle Surveillance

Most traffic surveillance methods use stationary sensors. In the case of probe vehicles, the sensor moves from place to place. Researchers at the University of Southern California are using the existing Los Angeles Freeway Service Patrol Automatic Vehicle Locator system to provide data on tow truck locations so that travel times can be estimated along the tow truck beat. This system is connected to the California Highway Patrol (CHP) Computer Aided Dispatch console located in the CHP/Caltrans Transportation Management Center in Los Angeles. Probe vehicles promise to provide a rich source of travel time data. ■

Field Testing

From top: Advanced Imaging Methods Field Test Site. Traffic in visible light; “seen” in short-wave infrared; “seen” in long-wave infared.

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California Partners for Advanced Transit and Highways

University of California, Berkeley
Institute of Transportation Studies
1357 S. 46th St. Bldg. 452 Richmond, CA 94804
(510) 231-9495 (510) 231-9565 (fax)
http://www.path.berkeley.edu