ITS INSTITUTE
SENSOR
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UNIVERSITY OF MINNESOTA
CENTER FOR TRANSPORTATION STUDIES

Welcome to the ITS INSTITUTE *Sensor*

Welcome to the first issue of the *Sensor*, the quarterly newsletter of the Intelligent Transportation Systems (ITS) Institute at the Center for Transportation Studies, University of Minnesota. In this publication, we hope to share with the community of ITS researchers, practitioners, and other interested parties the research, education, and outreach activities we are pursuing.

The Institute's theme is to enhance the safety and mobility of road and transit-based transportation through a focus on human-centered technology. As such, we promote partnering between technologists and those who study human behavior. This human-centered approach means that new developments in our core ITS technologies of computing, sensing, communications, and control systems will be used to approach significant safety and mobility problems with a fresh perspective.

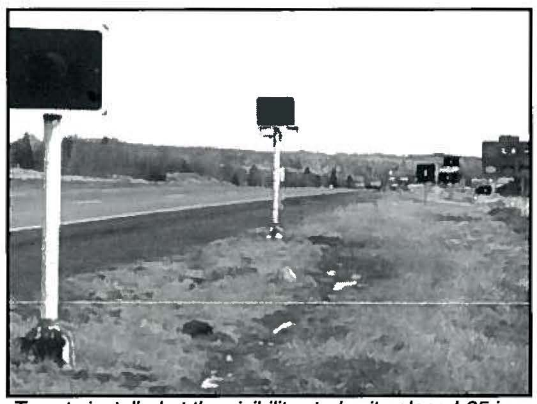
Clearly, trends in ITS are leading us into a radically new world. The questions that we must consider are how will these technologies contribute to a reduction in fatalities, injuries, and driver stress?

The ITS Institute is sponsored by the Transportation Equity Act for the 21st Century (TEA-21) to provide for the planning and conduct of a multidisciplinary program in transportation research, technology transfer, and education. In addition to information provided in this newsletter, our Web site at www.umn.edu/itsinst offers more coverage of our research and mission.

We hope that you will provide us with your comments and questions about the Institute through the Web site or by phone, fax, or mail.

Max Donath, Director
Intelligent Transportation Systems Institute

Video cameras focus on visibility



Targets installed at the visibility study site along I-35 in Duluth, Minnesota.

Visibility is one of the most critical pieces of environmental information in promoting safe traffic operation. Traffic managers often rely on visibility measures to make safety-related decisions, such as whether or not to close roads or reduce speed limits.

A researcher at the University of Minnesota, Duluth, is working to make their jobs easier. **Dr. Taek Kwon**, associate professor of electrical and computer engineering, recently developed a technique for automatically detecting and measuring visibility by using video cameras.

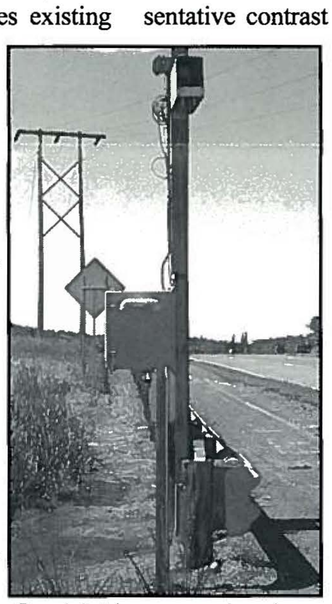
Taek Kwon

"A video-based approach overcomes the disadvantages and limitations of the prior methods by providing a system that can accurately measure atmospheric visibility in a manner similar to the way in which the human eye perceives it," says Kwon of his new system. What's more, because it uses existing equipment—video cameras already installed for traffic control and incident reporting—the new system is cost-efficient.

Most existing visibility measurement systems are based on the principle of measuring forward or backward light-scattering effects. However, this approach has its limitations, Kwon says. For example, light scattering by atmospheric particles such as moisture is only one factor that reduces visibility. Absorption or obscuration by large particulate matter, such as snow or dust, can have a much greater effect on visibility than the atmospheric moisture that causes fog.

Kwon, who began studying video-based visibility in 1996, realized a breakthrough in the form of a new daytime visibility algorithm using fixed targets. The targets used have contrasting portions and are positioned at distances of 40m, 100m, 150m, 200m, and 300m from a video camera. Besides the targets and the video camera, the system uses a digitizer with 640 x 480 pixel resolution.

The system works by aligning the video camera to detect the contrasting portions of the targets, from which it generates a signal indicative of the contrast levels of those portions. A processor produces a representative number from the contrast levels detected for each target. That in turn generates a nonlinear curve based on both the representative contrast number and the distance of each target from the video detector. A visibility number is then produced from the slope of that curve.



Special video camera housing protects the image from distortions caused by blowing snow, rain, frost, and fog.

An impediment to video-based technology was the incorrect assumption that since video cameras could not see objects at night, a video-based system would not be able to measure visibility at night. Kwon realized, however, that although cameras cannot see objects at night, they can see the light sources. So he designed a constant light source in a cylinder-like tube from which visibility can be estimated at night or in other low-light conditions.

Steve Bahler, deputy director of ITS for the Minnesota Department of Transportation's (Mn/DOT) Office of Advanced Transportation Systems, appreciates the system's potential to help those who manage traffic—and traffic safety—in adverse weather conditions. In Minnesota, visibility is Mn/DOT's standard representation for snow precipitation rates and driving conditions. The video camera system greatly aids traffic managers in deciding whether to adjust the speed limit or issue a warning on roadside variable message signs. Hazardous driving conditions can therefore be communicated to drivers ahead of time.

The collected visibility data can currently be accessed from remote sites through a dial-up modem to the main computer. The system also provides digitized color images for verification purposes. Within the next year, Kwon says the information should be available to the public on the Internet.

For additional coverage, visit the ITS Institute Web site at www.umn.edu/itsinst. For more on Taek Kwon's research, see www.d.umn.edu/~tkwon.

Real-life statistics drive Institute's work

"Human-centered technology to enhance safety and mobility." More than just a catch phrase, this theme sets forth the Institute's ultimate purpose: to develop real-life transportation solutions that save time and lives.

Some statistics underscore why this is so important. Although fatalities on U.S. roads dropped throughout the 1980s and bottomed out around 1991, they have increased to around 42,000 annually for the past several years. That is well over 100 fatalities a day. In comparison, plane crashes kill far fewer each year (roughly 1000), yet receive much more attention and media coverage.

In Minnesota, traffic-related deaths fell below 600 in 1982 but have not seen any marked decrease since. In fact, fatalities rose from 600 in 1997 to 650 in 1998. Alcohol-related traffic deaths in Minnesota rose by 53 percent in 1998 over 1997 (273 versus 178). That is more than twice the number of homicides last year.

Over 60 percent of U.S. fatalities occur on rural roads; in Minnesota rural fatalities represent an even higher fraction of the total, over 70 percent. The fatality rate for rural roads is two-and-a-half times the urban rate. Human error such as driver inattention, fatigue, and distraction are primary reasons.

On urban highways, crashes reduce speeds in an already congested road system. Building ourselves out of congestion is virtually impossible, so current roads will need to accommodate many more users. The Twin Cities area, for example, expects to attract 650,000 more residents by 2020. This will increase the number of daily trips by more than 25 percent, and the number of miles of severe congestion will more than double by 2020. Average speeds during rush hour will drop significantly.

What are we going to do, especially in light of new pressures that are being placed on the driving experience? We have become accustomed to the door-to-door, on-demand convenience of the automobile. We want to be there now. The result is traffic congestion, and the consequences are driver stress, intentional flouting of traffic laws, and road rage.

The Institute's work is to develop technologies that will reduce fatalities and congestion on our roads, thereby increasing safety and mobility. Current approaches cannot be sustained. We need new solutions. Finding these solutions is what the ITS Institute is all about.

New simulation can improve freeway management

Testing new traffic management strategies in the field is difficult, since the risks associated with failure are great. So researchers and professionals use simulation models to test new management strategies such as ramp metering algorithms. But because of the limitations of current simulation models, researchers at the University of Minnesota saw a need to improve them.

With input from the Minnesota Department of Transportation (Mn/DOT), Professor **Panos Michalopoulos**, research fellow **John Hourdakis,** and graduate student **Muralidhar Koka** of the Department of Civil Engineering developed a new computer-aided simulation method that can adapt to the unique characteristics of individual freeways and situations.

Rich Lau, traffic systems and research engineer at Mn/DOT's Traffic Management Center (TMC), was one who found previous simulation systems cumbersome. Not only is the researchers' system easier to use, he says, but "it's the first program that has been able to give us any kind of indication of the difference between [ramp] metering and non-metering."

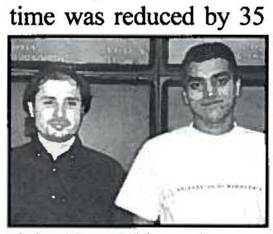
What makes the system unique is that the entire simulation, database, and control logic package can be used to estimate parameters and compare and evaluate ramp control strategies interactively. "It allows you to build and emulate your own traffic management center," says Michalopoulos. Improving existing methods and experimenting with new control algorithms will be easier and more practical.

A major problem in using simulation is the extensive and time-consuming task of entering initial and boundary conditions. To minimize this effort, the researchers prepared software to store data from 3,000 detectors, collected by the TMC, in a relational database. This demand tool can produce initial and boundary conditions for any modeled section by accessing the above database. As a result, a procedure that used to take days for entering the demand patterns is now accomplished in minutes.


Panos Michalopoulos

The researchers also addressed another problem associated with simulators: results are often hard to interpret because the user has to analyze large amounts of data before drawing conclusions about the effectiveness of the control or other traffic management strategy. So to give users a uniform and simplified way to view results, the researchers developed a visualization model that can be used to plot the relevant measures of effectiveness specific to a particular application, like ramp control, incident management or lane closures at the global, intermediate, and local levels.

To learn how well the new system worked, the research team developed a test case scenario for a 15-mile section of I-35W in which Mn/DOT's real-time ramp control strategy was compared with the no control alternative. The results revealed that total travel time in the freeway corridor decreased by 46 percent when control was used under normal congestion. Total ramp delays increased substantially as expected, but overall system total travel time was reduced by 35 percent and delays, by 62 percent. In heavy congestion, the total system travel time decreased by 24 percent and total delay by 39 percent. Generally, in both cases with control, higher speeds were achieved and flow was smoother throughout the freeway. The researchers stressed, however, that these results are only preliminary and will need to be confirmed with other simulators, improved modeling, better assumptions, and calibration.


John Hourdakis and Muralidhar Koka

A more important outcome of the test application, say the researchers, was that the new method allowed access to the quantitative results of continuously changing demand patterns without manual field measurements.

The system's potential for testing or developing new integrated solutions, parameter calibration, and algorithm optimization of specific freeways is significant. According to the researchers, the enhancements made to the system should aid in the widespread use of simulation in practice as well as improvements in ramp control strategies and other traffic management methods.

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