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Smartphone research aims to help visually impaired pedestrians

ITS Institute researchers are working to put a powerful suite of assistive technologies at the fingertips of visually impaired pedestrians. The prototype Mobile Accessible Pedestrian Signals (MAPS) system uses technologies built into the latest smartphones—including Global Positioning System (GPS) receivers, digital compasses, and wireless networking—to help people with limited or no eyesight cross intersections safely.

The MAPS concept takes a new approach to assistive technology for intersection crossing. Because MAPS puts the assistive technology directly in the hand of the user, the system avoids many of the drawbacks associated with conventional infrastructure-based Accessible Pedestrian Signals (APS) while offering greater flexibility and ease of use.

Minnesota Traffic Observatory (MTO) senior systems engineer Chen-Fu Liao worked with graduate student Avanish Rayankula to develop the MAPS concept. Former research associate Michael Rakauskas helped Liao evaluate a survey to determine what information blind pedestrians need.

MAPS research shows how advances in handheld devices are changing the way we think about personal assistive technologies, whether for drivers or pedestrians, says ITS Institute director Max Donath. (The Teen Driver Support System concept developed by Institute researchers is another application of smartphone technology to a transportation safety problem. See www.its.umn.edu/Research/FeaturedStudies/teendriver.html.)

MAPS research shows how advances in handheld devices are changing the way we think about personal assistive technologies.

Photo by Ed Yourdon

History

Signal technologies to assist visually impaired pedestrians have been around almost as long as electric traffic signals themselves. Signals that provide auditory cues first appeared in the United States as early as the 1920s, not long after the first electric traffic signal was installed in 1914. It was not until the 1970s, however, that Accessible Pedestrian Signals (APS) were widely deployed in the U.S. Attached to the top of pedestrian signal displays, these so-called "pedhead-mounted" units initially used two different auditory indicators to distinguish north-south and east-west crossing signals. National standards for APS were finally established in the 2000 edition of the *Manual on Uniform Traffic Control Devices.*

The most recent APS systems incorporate a repeating push-button beacon sound to help users find the crossing-request button; push-button units are equipped with a raised arrow indicating the direction of crossing and may provide a tactile indication of the walk signal in the form of vibration to assist users in noisy environments. Some systems can even adjust the volume of the auditory signal in response to ambient noise levels.

But despite these improvements, APS systems attached to traffic signal structures have several inherent drawbacks, including the cost of equipment and maintenance as well as complaints from nearby residents about the sound produced by the systems. From a usability perspective, because there is no standard location for push-button signals, visually impaired pedestrians must deviate from their preferred travel paths to request a crossing signal, which can make navigating the intersection more difficult.

Currently, infrastructure-based APS remains controversial within blind communities. While some organizations support the idea that APS can provide useful additional information for visually impaired pedestrians, others argue that current APS technology does not adequately address the needs of the visually impaired and the complexity of crossing an intersection without visual cues.

***MAPS** continued on page 2*

— www.its.umn.edu —

INSIDE

University of Minnesota startup to improve traffic flow on congested roads

The University of Minnesota's Office of Technology Commercialization recently signed a licensing agreement with startup company SMART Signal Technologies Inc. to commercialize a traffic management system developed by civil engineering professor Henry Liu. The SMART Signal system collects traffic data from signal controllers and generates real-time arterial performance measures. Traffic engineers can use this information to improve traffic flow on roads controlled by traffic lights—reducing congestion and saving drivers both time and fuel.

Henry Liu

The St. Paul startup aims to make the traffic management system affordable for municipalities to implement by allowing them to use existing equipment. The SMART Signal system has already been field tested on three major arterials in Minnesota: Highway 55 in Golden Valley, France Avenue in Bloomington, and Prairie Center Drive in Eden Prairie. It is also being used in Pasadena, California.

The research was funded by the ITS Institute, Minnesota Department of Transportation, and Minnesota Local Road Research Board, with in-kind support from Hennepin County. To learn more about SMART Signal research, visit www.its.umn.edu/Research.

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The MAPS system

The prototype smartphone application was developed using an Android developer phone, the HTC Magic, which offers features required by the MAPS concept: digital compass, GPS, accelerometer, WiFi, and a text-to-speech (TTS) interface.

Like other assistive-technology systems developed by ITS Institute researchers, the design of the MAPS system reflects the goal of helping users make better decisions. MAPS is not intended to serve as a user's only means of navigation, but to complement the orientation and mobility (O&M) training and techniques used by blind and visually impaired people.

The design of the MAPS system reflects the goal of helping users make better decisions.

In use, a MAPS unit monitors the user's position using GPS and collects information about traffic signal timing and phasing automatically when the user approaches a MAPS-enabled intersection. The prototype system uses the SMART Signal roadside data collection system developed by civil engineering professor Henry Liu, but future versions will interface directly with advanced traffic signal control units via the emerging Digital Short Range Communications (DSRC) networking standard for transportation applications.

To compensate for weak GPS signals at certain intersections, particularly in urban environments where tall buildings can interfere with satellite reception, MAPS is designed to connect to Bluetooth geo-ID modules at each intersection corner to determine the user's location. The MAPS application combines current signal information with an onboard geospatial database containing information such as intersection geometry, street names, the number of lanes in each street, and the direction of travel on each street.

While standing at an intersection, the user can point a smartphone in the direction he or she wants to cross and call up information about the intersection and the signal phase by tapping the unit's touchscreen once. A double tap confirms the desired crossing direction and sends a request for a crossing signal to the traffic signal controller. Feedback is given to the user via the TTS interface.

In a series of experiments designed to determine how well smartphone sensors could track the position and heading of MAPS users, the limitations of current sensors were readily apparent in the form of significant position and heading inaccuracies. The development of more precise sensors and enhancements such as Bluetooth geo-referencing modules can improve performance; the research team also envisions the development of new algorithms to improve dead-reckoning and image processing techniques using smartphone cameras to detect crosswalk "zebra" striping. Ultimately, however, the MAPS system will be most usable when combined with the user's knowledge of navigation techniques.

More information about the development of the MAPS prototype is available in a research report published by the ITS Institute: *Development of Mobile Accessible Pedestrian Signals (MAPS) for Blind Pedestrians at Signalized Intersections* (CTS 11-11), available from the ITS Institute website.

Institute promotes transportation careers at recent events

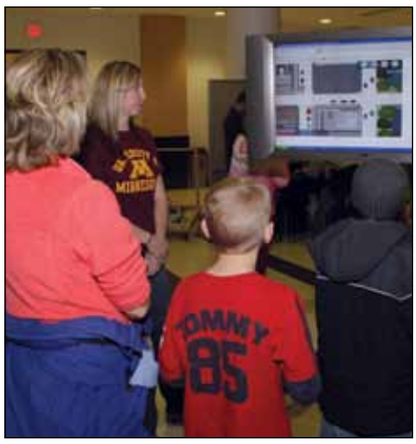
The ITS Institute and the Center for Transportation Studies (CTS) have been participating in recent local events to promote transportation degrees and careers.

At the Minnesota State Fair in late August, the Institute and CTS showcased innovative research with an exhibit featuring online crash-mapping tool *SafeRoadMaps* and traffic control game *Gridlock Buster.*

On September 20, the Institute took Gridlock Buster to the University of Minnesota Urban Research and Outreach-Engagement Center (UROC) Community Day. UROC is home to 10 University programs committed to research and problem-solving with individuals and organizations in Northside communities in Minneapolis.

Another event was the United Negro College Fund (UNCF) Empower Me Tour on October 8. The annual tour is a traveling career- and college-readiness road show created by UNCF in partnership with Wells Fargo. More than 1,000 Minnesota students (mostly high school age) plus their parents participated.

On November 19, the Institute participated in the U of M's College of Science and Engineering Math & Science Family Fun Fair, demonstrating both its *Gridlock Buster* and new *Distraction Dodger* games (see related article, at left).



Gridlock Buster on display at the Family Fun Fair

The ITS Institute also displayed its careers video—*Intelligent Transportation Systems: Your Road to the Future*—at the 18th World Congress on Intelligent Transport Systems in Orlando in October. Highlights from the 10-minute video are online at www.its.umn.edu/Education/careers/video.

New online game teaches risks of distracted driving

The ITS Institute continues to push the envelope in the development of "serious games" with the launch of Distraction Dodger, a new online game designed to help teens and young adults understand the risks of distracted driving. Serious games engage learners through entertainment while providing training and education. They can also reach a wide audience at low cost.

In Distraction Dodger, players get behind the wheel of a pizza delivery van and have to avoid obstacles and obey traffic laws. As they progress through the game's levels, they receive feedback on their driving—and how it is affected by their level of distraction.

Developed by Web Courseworks for the ITS Institute, the game has already received international attention with an award at the 2011 International Serious Play Conference. Mike Manser and Chris Edwards of the Institute's HumanFIRST program, along with consultant David Glick, contributed to the game's development.

Distraction Dodger builds on the success of Gridlock Buster, another online game from the ITS Institute. Gridlock Buster provides a fun way to teach students about traffic grid management. Since its original posting online, Gridlock Buster has received more than 3 million game plays and has garnered national interest.

The Institute uses Gridlock Buster and Distraction Dodger to introduce players to the field of transportation at outreach activities such as summer camps, public engagement events, and campus tours.

Try your hand at both games at www.its.umn.edu.

Fall seminar series features roundabout research

The ITS Institute's Advanced Transportation Technologies seminar series kicked off in September and continues into December. The seminars are held from 3:30 to 4:30 p.m. CST on most Thursdays on the Minneapolis east bank campus and are also broadcast live on the web and available for later viewing.

The September 29 seminar featured John Hourdos, director of the Institute's Minnesota Traffic Observatory (MTO) highlighting findings on roundabout safety research. Responding to reports that pedestrians and cyclists were finding it difficult to cross roundabout intersections, the Minnesota Department of Transportation asked MTO researchers to take a close look at interactions between motor vehicles, pedestrians, and cyclists.

Two sites were selected for the project—one in a suburban setting with a high volume of vehicle traffic, and another near a public park in Minneapolis. The City of Richfield, where the suburban site is located, was a key partner in the project. The two sites differ in terms of road geometry, traffic control features, and traffic characteristics, allowing the researchers to compare and contrast different roundabout situations.

The researchers used a mobile data collection system, designed by MTO lab manager Ted Morris, that consists of eight cameras mounted atop an extendable mast that continually recorded vehicles and pedestrians entering and leaving the intersections. The camera mast was attached to a trailer, which also housed a battery power source that allowed the unit to operate for nearly a month without recharging. Back at the lab, students carried out the painstaking work of combing through the data and logging every interaction between a pedestrian or cyclist and a motor vehicle for statistical analysis.

Hourdos explained that identifying factors that affected drivers' decision to yield was one of the project's principal objectives. The researchers looked at a wide variety of possible influencing factors, including whether the driver was entering or leaving the roundabout, the presence of other vehicles behind and in front of a target vehicle, the positions of other vehicles in the roundabout, time of day, volume of traffic, and the number and location of pedestrians and cyclists waiting for an opportunity to cross.

Several factors appeared to influence the willingness of a driver to yield. Drivers who were exiting a roundabout were significantly less likely to yield. However, drivers at both sites were more likely to yield to pedestrians standing in the center of the roundabout than to those waiting outside the intersection. In addition, drivers were more likely to yield to larger groups of pedestrians and cyclists. Overall, drivers at the Richfield site—where traffic volumes are higher and pedestrians and cyclists are fewer—were far less likely than drivers in Minneapolis to yield the right of way.

Analyzing the delay times experienced by pedestrians and cyclists produced some interesting results, Hourdos said. Taking into account all pedestrians—both those who had to wait to cross and those who did not encounter any vehicular traffic at the intersection—the average delay was around 2.3 seconds, and even those who had to wait for a car to stop waited an average of only 3.8 seconds. However, there was a huge variation in wait times, with some having to wait up to 30 seconds or longer. Compared to a signalized intersection, where the average delay is roughly half the time it takes for the signal to complete one full cycle, roundabouts offer much better average wait times, Hourdos said. But having to stand at the crosswalk while cars speed through (despite a state law requiring drivers to yield) could make the wait seem much more onerous, Hourdos noted.

Researchers installed a mobile data collection system to study interactions at this Richfield roundabout site.

Vision system for truck stops gets FHWA grant

The Federal Highway Administration (FHWA) selected the Minnesota Department of Transportation (MnDOT) to receive $2 million for a University of Minnesota research project designed to use intelligent transportation systems (ITS) technology to give truck drivers real-time information about parking availability at highway truck stops.

The University research team includes lead investigator Nikolaos Papanikolopoulos, professor in the Department of Computer Science and Engineering (CSE); Vassilios Morellas, program director with CSE; Max Donath, director of the ITS Institute; Panos Michalopoulos, professor in the Department of Civil Engineering; and Ted Morris, lab manager of the Institute's Minnesota Traffic Observatory.

The project is being directed by John Tompkins, MnDOT manager of freight planning and development. The American Transportation Research Institute (ATRI), part of the American Trucking Associations Federation, originally developed the concept for the system and is a key partner. The results of the study are expected to be of interest to the public and private sectors.

The funding is provided through the FHWA's Truck Parking Facilities Discretionary Grants Program. The program helps improve safety on the nation's interstates by promoting projects that allow trucks to park safely and securely in areas away from moving traffic, instead of alongside the road itself or on ramps.

Although only 53 percent of parking spaces at truck stops are occupied on any given night, 90 percent of truck drivers perceive a shortage of parking. Drivers unable to locate empty spaces may become fatigued, which is thought to be a contributing factor in a number of crashes.

The new project will implement and deploy findings from ITS Institute-funded research completed this year by Papanikolopoulos and Morellas. In that work, the researchers developed an automated parking space identification system that can compute occupancy at stops. This information could then be used to notify drivers about the availability of parking spots using variable message displays miles ahead of stops. The final report is available for download at www.its.umn.edu/Research.

The Intelligent Transportation Systems Institute
Center for Transportation Studies, University of Minnesota
200 Transportation and Safety Building, 511 Washington Avenue S.E., Minneapolis, MN 55455-0375
Phone: 612-626-1077 • Fax: 612-625-6381 • E-mail: its@umn.edu • Web: www.its.umn.edu
ITS Institute Director: Max Donath • Media Contact: Gina Baas • Editor: Amy Friebe • Writers: Peter Park Nelson, Christine Anderson, Megan Tsai, Pamela Snopl • Graphic Designer: Cadie Wright Adhikary

TechPlan research examines technology impacts on public health, travel behavior

Yingling Fan

Connecting theory and practice is essential to solving complex transportation problems. With that sentiment, Greg Lindsey, professor and associate dean of the Humphrey School of Public Affairs, welcomed attendees to an August 19 forum focused on current research by the TechPlan program.

TechPlan, directed by Frank Douma, associate director of the State and Local Policy Program (SLPP) at the Humphrey School, is a collaboration between the Intelligent Transportation Systems (ITS) Institute and SLPP. TechPlan researchers are conducting a set of federally sponsored studies on how transportation systems can be planned to accommodate an increasingly complex technological environment.

The intersection of public health and transportation serves as a starting point for the current work of Humphrey School assistant professor Yingling Fan, whose research group designed a smartphone application to gather data on travel behavior and help users better understand and shape their own travel behavior.

As part of a research project dubbed "UbiActive," Fan worked with Douma, senior systems engineer Chen-Fu Liao of the Minnesota Traffic Observatory, and Assistant Professor Julian Marshall of the civil engineering department to create a smartphone app for the Android mobile platform. The app will semi-automatically collect data about the user's travel and activity patterns. It also includes a self-reporting function, prompting users to provide information about their travel and secondary activities.

The UbiActive app will do more than gather data—it will also give users feedback about the health implications of their travel behavior. During an upcoming field study, Fan said, the researchers will try to determine if users will respond to feedback from their smartphones by altering their travel behavior. UbiActive is the first study to use smartphones to collect public health data in the context of travel behavior, Fan noted.

Turning to a different kind of health impact, Tom Horan and Ben Schooley, researchers with the ITS Institute and the Center for Excellence in Rural Safety, described their ongoing work aimed at improving emergency response and treatment by helping EMS providers share information quickly and easily with emergency room doctors.

Their CrashHelp system, now being tested as a prototype in Idaho, consists of a smartphone application for emergency responders and a web interface for emergency medical center workers. Using CrashHelp, paramedics can send videos, digital photos, and other information directly to physicians at the hospital. Data security is a key issue in the development of the system, they said.

Douma also discussed the importance of data security in a presentation on ITS data needs. Noting that the privacy issues raised by ITS technologies are both important and varied, Douma said that both the nature of the data collected and the privacy expectations of the people affected have to be taken into account.

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ITS INSTITUTE
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University of Minnesota
Center for Transportation Studies

ITS Institute
University of Minnesota
200 Transportation and Safety Building
511 Washington Avenue S.E.
Minneapolis, MN 55455-0375

Phone: 612-626-1077
Fax: 612-625-6381
E-mail: its@umn.edu
Web: www.its.umn.edu