Research recommends additional support for innovative shared-mobility services in Minnesota

Shared-mobility services have continued to provide essential transportation during the COVID-19 pandemic, and providers have introduced innovative service models to meet the needs the pandemic created. Still, the pandemic has influenced attitudes toward shared mobility and disrupted typical commute patterns for many Minnesotans, and both public and

Laurie McGinnis to retire in January

CTS director Laurie McGinnis is retiring after a distinguished career of leadership and innovation. Her last day will be January 15.

“For 10 years Laurie has nimbly led CTS, maintaining and building on its reputation for research excellence and delivering on the Center’s mission to improve transportation decision making in Minnesota and at a national level,” says Chris Cramer, the University of Minnesota’s vice president for research. “We thank her for her nearly 30 years of service to the Center and look forward to her
Electric scooters let riders move quickly between the roadway and the sidewalk, but these sometimes-unpredictable travel patterns can pose risk for riders and the people around them. Making scooters smarter is the goal of a new U of M research project funded by the National Science Foundation (NSF). Under the $1.2 million Cyber-Physical Systems grant, a cross-disciplinary team will study smart tracking systems on scooters for ensuring safe and smooth interaction with other vehicles and pedestrians.

Professor Rajesh Rajamani of the Department of Mechanical Engineering is the principal investigator. Nichole Morris, director of the HumanFIRST Laboratory, and Ju Sun, assistant professor in the Department of Computer Science and Engineering, are co-investigators.

“Our plan is to develop a platform technology that has applications beyond the scooter to other transportation systems for vulnerable transportation users, such as bicyclists and motorcyclists,” Rajamani says. “It could also be used for low-cost vehicles in developing countries and for other autonomous platforms such as indoor robots.”

The research builds on earlier work by Rajamani and Morris that developed an alert system to protect bicyclists from cars. The initial prototype was developed with funding from the Roadway Safety Institute, and additional work and testing continued with a nearly $1 million NSF grant (see article in the February 2020 Catalyst).

The smart e-scooter system will consist of inexpensive sensors, active-sensing-based estimation algorithms, and deep-learning-based robust image processing to enable trajectory tracking of all nearby vehicles on the road.

If the system detects the danger of a scooter-vehicle collision, it will automatically send an audiovisual alert to nearby car drivers to make them aware of the scooter. The system also monitors the scooter rider’s behavior, provides real-time feedback to improve rider compliance with traffic signals and sidewalk rules, and documents the information as a part of the rider’s safety record.

“One key attractive feature of the system is that it will be inexpensive—less than $500,” Rajamani says. “Also, it will be immediately useful on today’s roads without requiring vehicles to be equipped with additional technology.” Those qualities improve the potential for commercialization.

The team will conduct research to develop two novel vehicle-tracking technologies. One will be based on a low-cost, single-beam laser sensor, and the other on a low-cost, low-density Lidar sensor.

The computer vision system will handle rain, snow, and low lighting—factors that pose a major challenge by corrupting normal image data. New robust deep-learning-based recognition techniques will be developed that can effectively deal with corrupted image data sets. “This will allow for mixed corruption types, varying severity, and possible corruptions in the training data itself,” Sun says.

The project will also include human subject studies to evaluate the effectiveness of a variety of audio and visual mechanisms for alerting the motorist and the scooter rider. These will include innovations such as visual cues of biological motion on the scooter to help drivers locate it.

“E-scooter riders lack all the distinguishable movement cues that pedestrians and bicyclists display, making it harder to recognize them and predict their speeds, so augmenting these biological cues is an important goal of the study,” Morris says.
Exploring safety and behavior at pedestrian-activated crossings

An extensive video data collection effort by U of M researchers has yielded new insights into how drivers and pedestrians behave around pedestrian-activated crossing (PAC) systems. The project also created a rich data resource for the traffic engineering community related to pedestrian level of service and safety at such crossings.

“Little is known about the influence of implementation characteristics on the effectiveness of PACs in reducing pedestrian-vehicle accidents and injuries,” says John Hourdos, director of the U of M’s Minnesota Traffic Observatory. “In this study, our aim was to examine the relationships between driver yield rates and a variety of treatments and implementation alternative designs using video data from crossings.”

Researchers began by reviewing published research on driver behavior and pedestrian safety at PAC systems such as rectangular rapid-flashing beacons (RRFBs) and high-intensity activated crosswalk beacons (HAWKs). (RRFBs draw attention to pedestrian signs; HAWKS allow pedestrians to stop traffic at marked crosswalks.)

They then constructed a model to gauge the impact of the crossing treatments in reducing crashes based on traffic and roadway conditions and driver yielding rates. Next, they selected 34 sites in Minnesota for video monitoring and mounted battery-operated video systems at observation sites.

After collecting thousands of hours of video, researchers logged at least 100 interactions at each crossing, or an entire day’s worth of pedestrian-vehicle interactions at sites with fewer events. The research team recorded vehicle speeds, yielding behavior, a range of pedestrian characteristics, whether the system was activated, and who yielded to whom. Investigators then examined the logs to determine what correlations might exist between pedestrian and driver behavior.

While researchers were not able to correlate yield rates with pedestrian safety, they did uncover tendencies of drivers and pedestrians in interactions at crossings. For example, they found that HAWK systems have higher wait times due to the system activation sequence but a more stable crossing-time reliability, while RRFB systems have lower wait times because they activate immediately, but the pedestrian crossing time can be longer if drivers do not yield.

“Because of this finding, we believe that at RRFB sites currently experiencing low driver yield rates, HAWKs may improve pedestrian level of service,” Hourdos says.

The data also shed light on the impacts of RRFBs. RRFB benefits (in terms of driver yield rates) increase with the number of lanes and, more importantly, the number of conflicting movements. In addition, overhead placement of RRFBs may result in increased driver yield rates whether they are activated or not; the RRFB itself may not be what is most responsible for better yield rates, but rather, the accompanying static sign on the overhead mast.

“An overall finding from the comparison of driver yield rates with and without an activated PAC is that good visibility, extra static signage, and advanced notice could be sufficient for raising the driver yield rate to a satisfactory level,” Hourdos says. “It is at intersections with poor visibility that PAC systems increase the driver yield rate by a significant additional amount when activated.”

In the future, the large amount of data generated through this research could help advance knowledge of pedestrian and driver behavior and safety at pedestrian-activated crossings.

The project was funded by the Minnesota Department of Transportation. “The tracking and analysis of video data were innovative and answered some questions,” says Melissa Barnes, north area manager for MnDOT’s Metro District. “People can view this data and see how traffic control devices impact behavior.”
As momentum for connected and automated vehicles (CAVs) continues to build in Minnesota, researchers in the U’s Transportation Policy and Economic Competitiveness (TPEC) program are working to understand how CAV technology could serve transportation-disadvantaged communities. CAVs offer the potential to provide greater mobility and equity for many people, but public engagement is essential to ensure all user needs are understood and addressed.

Previous TPEC efforts gathered input from local officials, stakeholders, and community members in Grand Rapids, St. Cloud, Mankato, and Fergus Falls. Building on this work, more recent activities sought to uncover the needs of transportation-disadvantaged communities in the Twin Cities East Metro area and determine whether CAVs could be an appropriate solution.

The project team included Frank Douma, director of the State and Local Policy Program; Adeel Lari, director of innovative financing; and graduate students Kim Napoline and Erika Shepard, all of the Humphrey School of Public Affairs.

The researchers focused their work on the east side of Saint Paul, downtown, and the Frogtown area. They began by conducting “discovery interviews” with human service providers and transportation practitioners to gain an understanding of transportation challenges and opportunities, as well as potential CAV implications.

The team then hosted a virtual roundtable in May with transportation program staff from a variety of East Metro organizations to discuss the potential implications of CAVs in urban contexts, with an emphasis on equity. The roundtable included an interactive activity that built on the insights and themes from the discovery interviews to further the discussion of CAVs and equity.

Together, the interviews and roundtable produced a number of key findings involving access issues, CAV deployment considerations, and policy opportunities. “We found that limited access to personal vehicles, combined with transit service limitations—in terms of network coverage and service hours—inhibit transportation accessibility in the East Metro area,” Lari says.

Social barriers to transportation include limited income, different ability levels, language barriers, and driver’s license documentation restrictions. A lack of access to smartphones and banks, and a spatial mismatch of jobs and residences, are additional accessibility challenges.

Regarding deployment, the researchers say CAVs should be used in delivery, maintenance, and other services—not just passenger services—to improve the quality of life for those who do not drive. Safety is also a concern for many riders who may need the additional assistance now provided by transit drivers.

The findings also point to policy opportunities. “Public policy can guide private development to address equity issues as CAV technology develops,” Lari says. “CAV service models and equitable cost structures must be part of the discussion.”

The private sector, and particularly the freight industry, is interested in the economic potential of CAVs. “There could be ways to improve supply chains and address driver shortages,” Lari says. “A shared mobility model like that used by Uber and Lyft could be a business model for CAV implementation.”

The research continued this fall with a second roundtable focusing on government agencies that provide transportation services.

“Language is a common barrier to transportation, particularly for the region’s immigrant and refugee communities.”

—Discovery interview comment
Permeable pavements: Balancing the environmental benefits and safety risks

Sometimes tradeoffs are a necessity. Researchers from the St. Anthony Falls Laboratory (SAFL) set out to determine whether permeable pavement could be used to reduce the quantity of salt applied to roads while also keeping them safe in the winter. However, the study revealed pros and cons of permeable pavement, and pavement professionals considering its use will need to weigh their priorities.

The driving motivation behind the study was chloride—a worrisome contaminant in Minnesota’s streams, lakes, and groundwater that is commonly washed off in road salt.

“There are over 50 lakes and streams impaired for chloride in the Twin Cities metropolitan area,” says John Gulliver, professor in the Department of Civil, Environmental, and Geo-Engineering and principal investigator for the project, “which means that fish and other aquatic biota will not hatch and grow as well as they should, and in some cases cannot live.”

Icy winter roads, however, are still a concern. A literature review of prior research on permeable pavement—which features porous voids in the pavement and in the underlying crushed rock base—suggests that the material could potentially solve both the safety and environmental issues of icy roads.

To determine if this is in fact true, the SAFL researchers conducted friction surveys at various locations around Minnesota to compare the overall performance of unsalted permeable pavement to that of more traditional, salted impermeable pavement. Photographs and temperature readings were collected at each site, but the overall most reliable method for gauging conditions was surface friction measurements.

In the Twin Cities metro area, friction measurements were taken at 22 survey sites, and the comparison between permeable and impermeable pavement showed mixed results:

• Snow and ice tend to last longer on permeable pavement. The air voids in and below the pavement act as insulation, and the heat from the soil profile cannot reach the surface and melt snow and ice as rapidly.
• Melted water, however, will not refreeze on the surface of permeable pavement because the water will infiltrate into the rock base below the permeable pavement, where the temperature is warmer. This also occurs in temperatures substantially below freezing.

• Impermeable pavement, therefore, is more likely to have more pooled water on its surface than permeable pavement, which can refreeze into slick, dangerous ice patches.

One additional factor, the researchers found, is that the impermeable pavement being surveyed had the benefit of being salted, but the permeable pavement did not. Considering that it was not salted, the experimental permeable pavement actually performed well, they say.

“When you’re getting to the transitional time between winter and spring, when snow and ice melt during the day and refreeze on the surface at night, meltwater will instead drain through a permeable pavement,” says Richard McCoy, public works director for the City of Robbinsdale.

In the end, pavement engineers considering the use of permeable pavement would have to weigh their priorities. On a freeway, for instance, where high travel speeds make deicing critical and the pavement sees heavy wear and tear, the current designs for permeable pavement would likely not be an ideal choice. In a parking lot or a side road with low-speed, low-frequency travel, however, the environmental benefits of unsalted permeable pavement might outweigh the risk of ice, Gulliver says.

The investigators have conducted presentations and workshops in Minnesota and other parts of the Midwest to spread awareness of their research.
private providers have experienced large declines in ridership and revenue.

The Twin Cities Shared Mobility Collaborative (TCSMC), which includes transportation leaders, public agencies, private companies, city officials, and nonprofit organizations, turned to the University of Minnesota for guidance in navigating the challenging course ahead.

In September, a research team led by Humphrey School professor Jerry Zhao, director of the Institute for Urban and Regional Infrastructure Finance, published *Regional and Statewide Shared-Mobility Funding: Recommendations for Minnesota*. The white paper, the first in a planned TCSMC series about shared-mobility issues, makes recommendations for increased public support of innovative shared-mobility projects based on opportunities identified through discussions with a TCSMC advisory panel.

“Public support has been important for funding innovative shared-mobility services that can fill gaps in existing transportation options,” says Zhao, the principal investigator. “That support is especially important given the uncertainty the pandemic has brought for shared mobility.”

A variety of shared-mobility services such as public transit, ride sharing, ride sourcing, bike sharing, and scooter sharing play an important role in Minnesota’s transportation network. Recent technology innovations, evolving attitudes, and government interest have led to the proliferation of shared-mobility services to fill important transportation gaps, such as transportation to work, health care, and other essential services. Shared-mobility services also offer other benefits, including lower air pollution and transportation costs.

“Shared mobility is a key part of the future-focused transportation solution Minnesotans need to respond to the climate crisis,” says Mary Morse Marti, executive director of Move Minneapolis and TCSMC co-chair. “Innovation is happening all around us, and capital is typically the barrier to proof-of-concept.”

The research team developed two key recommendations intended to ensure consideration of shared-mobility options in public transportation funding decisions. The first proposes ways to improve shared-mobility funding through the Transportation Advisory Board of the Metropolitan Council, which awards federal funding to local transportation projects on a biannual basis. “It is an important source of transportation funding for the Twin Cities region and has provided previous funding for shared mobility,” Zhao says.

The recommendation, based on a national review of peer programs, focuses on encouraging innovation and increasing regional transportation equity, particularly through a special Met Council funding category for unique projects.

The second recommendation is for a $6–8 million competitive state grant program to fund innovative shared-mobility services that increase access to essential services in Minnesota. “The program would ensure that all areas of the state and the residents of those areas are prepared to take advantage of emerging technologies to make transportation more efficient and equitable,” Zhao says.

The framework for the proposed grant program was developed based on a review of shared-mobility funding programs in the United States. The suggested program shares many similarities with several innovative Federal Transit Administration programs and with the 2018 Michigan Mobility Challenge program.

“With relatively modest state and regional investments, we could seed entrepreneurial projects and build a transportation system that serves everyone: young and old, people at all income levels, people with disabilities, and certainly communities of color,” Morse Marti concludes. “These grant programs would be remarkably easy to implement by the Met Council, MnDOT, and other agencies and would result in big payoffs for Minnesota travelers.”
continued engagement with the transportation research community.”

McGinnis joined CTS as research coordinator in 1991 and later served as director of research and contract management (1997–2001) and associate director (2001–2010). She helped establish key CTS programs, including the CTS Scholars Program, the Accessibility Observatory, and the Initiative on the Sharing Economy. Most recently, she helped launch the U’s Connected and Automated Vehicle (CAV) MnEcosystem now under development and is interested in continuing involvement with the new program.

Nationally, McGinnis has long been active with the Transportation Research Board, where she has served as chair of the Research and Education Section and the Conduct of Research Committee. In addition, she currently serves on the Governor’s Advisory Council for Connected and Automated Vehicles.

“This has been a dream job for me,” McGinnis says. “I have been blessed in so many ways serving as director of CTS.”

CTS associate director Dawn Hood will serve as interim director until a new permanent director is named.

Laura Bloomberg, dean of the Humphrey School of Public Affairs, is chairing a search committee composed of CTS stakeholders both inside and outside the University:

- Jay Cowles, managing director, Lawrence Creek LLC; Minnesota State Board of Trustees (chair); Itasca Project Transportation Initiative (chair)
- Gary Davis, professor and Richard P. Braun/CTS Chair in Transportation Engineering
- Shawntera Hardy, chief strategy officer, Civic Eagle; former commissioner, Minnesota Department of Employment and Economic Development
- Dawn Hood, associate director, CTS
- Tim Henkel, assistant commissioner, Modal Planning and Program Management Division, Minnesota Department of Transportation
- Nichole Morris, director, U of M HumanFIRST Laboratory

“I expect significant local, regional, and national interest in the director position,” says Cramer, who has asked the search committee to forward finalists to him by early March. More information about the position will be available soon on the CTS website.

Timber-based bridges offer a cost-effective, durable alternative

As Minnesota’s local road agencies grapple with the challenges of renewing an aging bridge infrastructure with limited resources, alternatives to bridges made with concrete and steel are needed.

In a recent project, researchers found that timber-based bridges can be built more quickly than steel or concrete bridges for similar costs, perform well for 70 years or more, and help meet green construction standards. The project was sponsored by the Minnesota Department of Transportation and the Minnesota Local Road Research Board.

From 2000 through 2019, Minnesota local agencies built more than 4,000 bridges, yet only 26 were timber-based. “The design aids developed with this project will help increase the awareness of modern timber systems that have excellent long-term performance,” says Donald Fosnacht, associate director of the University of Minnesota Duluth's Natural Resources Research Institute.

Read more about the study at cts.umn.edu/news/2020/november/bridges.
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Team receives NSF grant to study ‘smart e-scooters’