

Catalyst



Accelerating the pace of transportation innovation

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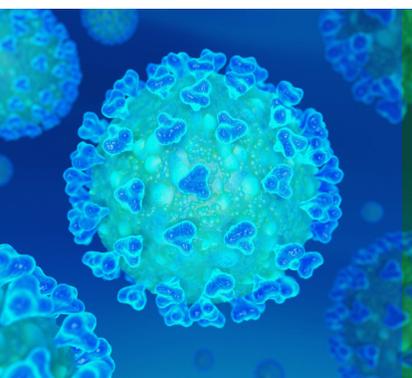
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New watering practices boost success of roadside turfgrass installations

In recent years, new salt-tolerant turfgrass mixtures have been developed by University of Minnesota researchers in collaboration with the Minnesota Department of Transportation (MnDOT) and the Minnesota Local Road Research Board (LRRB). Unfortunately, these new mixtures did not succeed on roadsides as well as predicted, often because of watering practices.

Turfgrass continued on page 6



Computing COVID-19: How location data could help track and control the spread

What if your phone knew you had been exposed to COVID-19 before you did? According to computer science and engineering professor Shashi Shekhar, data collected by the cellular devices we keep in our pockets could be a key weapon in the fight against the novel coronavirus.

Shekhar and his team analyze large sets of spatial data, defined as any data that has a location attached. Common examples include the United States census, daily satellite imagery, and location data from GPS-equipped devices such as vehicles and smartphones.

Computing continued on page 5

Researchers developing robot to disinfect areas for COVID-19



The DISTROY robot will be a modified version of a robot originally developed to measure the density of asphalt.

During the ongoing COVID-19 crisis, health and sanitation workers nationwide are putting themselves in harm's way to disinfect public places for the deadly virus. A College of Science and Engineering team in the Minnesota Robotics Institute's (MnRI) Distributed Robotics Lab is building a robot to lighten their load.

Dubbed the DISinfecting Tele-RObotic sYstem (DISTROY), the machine will be equipped with a robotic arm to disinfect areas like airplane cabins or hospital waiting rooms. Users will be able to operate the robot remotely through a virtual reality headset, moving its arm as if it were their own.

"The objective of the project is, first of all, to mitigate the spread of the contagion," said Vassilios Morellas, a research professor in the Department of Electrical and Computer Engineering and CTS Scholar. "And second, to increase the confidence in people and let them get back to their normal lives."

Morellas is co-leading the team, along with MnRI director and CTS Scholar Nikolaos Papanikolopoulos, research

engineer Ted Morris, and industry collaborator Mike Bazakos. They are in the process of applying for a National Science Foundation or National Institutes of Health grant to fund the project.

The idea for using immersive technology was spurred by another MnRI project that involves using virtual reality environments to treat mental illnesses in children. Why, Morellas asked, couldn't the same technology be used to fight COVID-19?

"We wanted to build on a platform that we already have," Morellas explained. "Because we were looking at the economic effects that this particular contagion has caused, we were thinking, 'How can we quickly increase public confidence in using transportation again?'"

To save time, the researchers are using an already-built robot from a previous project with the Minnesota Department of Transportation. Whereas that robot carried sensors to check the density of asphalt on roads, this robot will carry an ionized hydrogen peroxide mist to kill SARS CoV-2, the virus that causes COVID-19.

While the team is focusing on developing the technology for use in the transportation industry—airports, bus depots, and trains—the robot could be

tapped wherever it's needed.

Morellas said the robotic arm will mean more flexibility on the operator's end. For example, it can more easily disinfect hard-to-reach places, such as in between airplane seats.

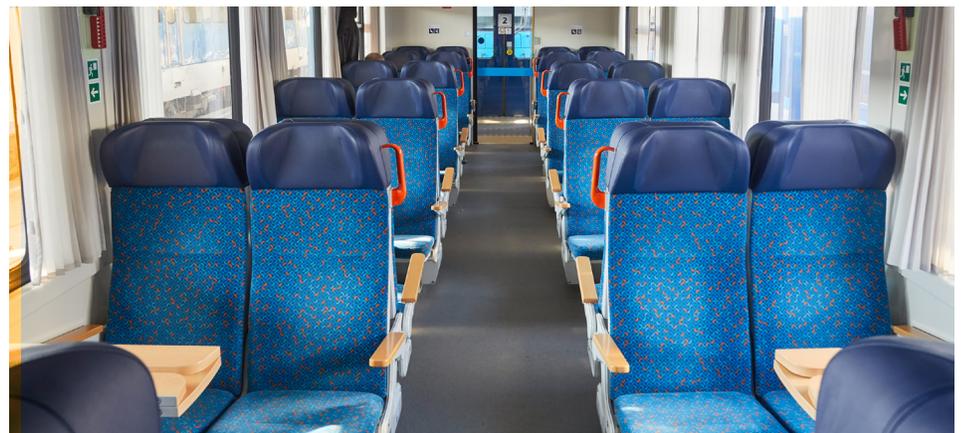
Another goal of this research is to reduce the number of workers who put their lives at risk to clean areas potentially infected with the virus. Plus, it could save personal protective equipment (PPE), which is already in short supply.

Morellas believes the DISTROY robot would prove beneficial long after the COVID-19 pandemic passes. Its remote setup could also protect those who perform other life-threatening tasks, such as cleaning up radiation pollution or hazardous chemical spills.

"The role of robotics is basically to give us the tools to do things that would be dangerous for a person to do," Morellas said. "There are many other occasions when you want to get people out of harm's way, and you might want to use a robot to do the dirty job for you without [endangering] a human life."

The researchers expect to have a robot ready for testing within the year.

(Adapted from an article by Olivia Hultgren published on the U's College of Science and Engineering website on May 19, 2020.)



The robot could be used to disinfect trains, airplanes, and other transportation facilities.

New frontier of shared mobility poses data security challenges

Shared mobility companies such as Uber, Lyft, and Lime are becoming increasingly common, but despite the benefits these companies offer, they also pose difficult questions regarding data security: To what degree are people tracked in these new modes of transportation, and who gets to see the data?

“As more and more data is being generated from individuals’ travel patterns and behaviors, the need for clarity around how to collect and process this data is growing,” writes University of Minnesota graduate Thomas Ebert in a paper prepared for the Twin Cities Shared Mobility Collaborative. The paper served toward Ebert’s master’s degree in public policy, which he received in December; his advisor was Frank Douma, director of the State and Local Policy Program at the Humphrey School of Public Affairs.

Shared mobility companies offer much potential. The City of Minneapolis, for example, launched a foot scooter program in 2019 designed to place scooters in low-income neighborhoods and provide alternative access options. To better understand how to streamline the program, however, the city needs data on scooter use—and that’s where things get complicated.

Laws and methodologies regarding shared mobility data are, Ebert notes, scattered in the US. There are no federal-level laws, and rules vary from state to state or even city to city. Consumers tend to be concerned about how their data is used, and this is not without basis; location data, if used carelessly, can be used to identify a person.

“Mobility data is becoming more available,” Ebert says, “and the chance for it to be abused or mishandled grows.”

A lot of this has to do with how new the technology is. “Five years ago, nobody was talking about this,” says Danielle Elkins, FUSE executive advisor with the City of Minneapolis Department of Public Works. (FUSE is a national nonprofit that partners with local government.) “Ten years ago, it didn’t exist.”

Creating methodology for handling this data, Elkins says, is challenging for such young technology. Uber was founded in 2009, but the rideshare business model has only really become viable in the last four years or so. Scooters are an even younger option, stretching back a mere two or three years. Understanding trends and developing systems accordingly is difficult with so little data.

Clarity and specificity will be key to making this work, Ebert says. Consumers should be fully aware of what information is being collected, and that data should be strictly limited. The Minneapolis scooter program, for example, collects only location information. The data is also very non-granular—only specifying what street a scooter is on within a 15- or 30-minute

SharedStreets, an independent, nonprofit platform designed to allow secure, standardized data sharing between public and private organizations.

Minneapolis, Elkins says, is also represented on the board of the Open Mobility Foundation, a global nonprofit that creates a governance structure around open-source mobility tools. Many of the transportation goals of Minneapolis 2040, the city’s comprehensive plan, will rely on the collection of data from shared mobility providers.

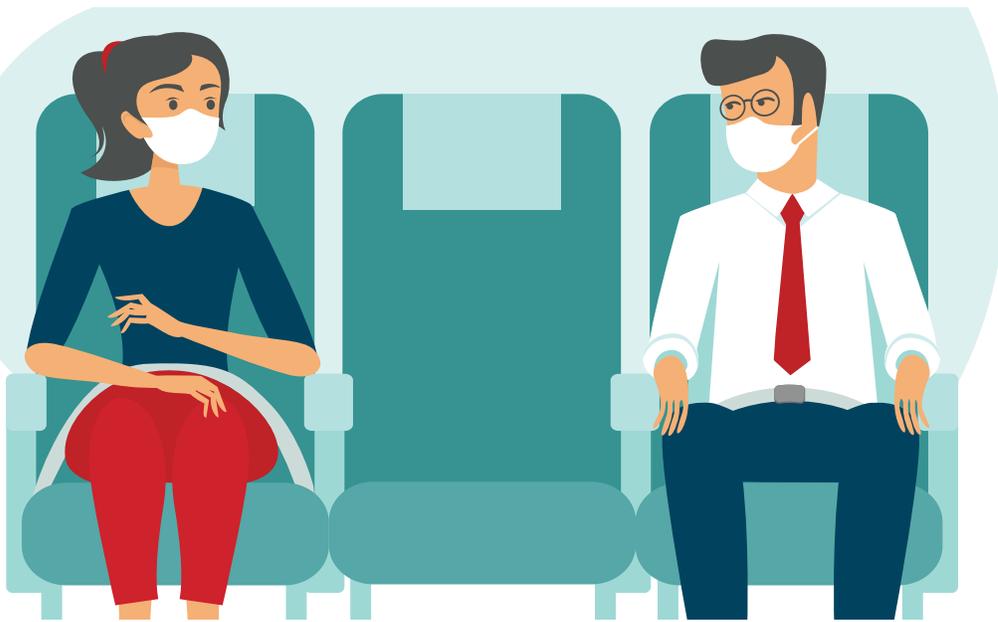
“Moving forward, the landscape of data privacy is going to be shifting,” Ebert says. “This means that governing bodies and transit planning organizations need to take careful steps when collecting, processing, and using data collected from shared mobility.”



interval—and the information is never saved to a server, but instead processed in-memory.

Efforts are also being made to standardize how cities handle shared mobility data. In 2018, the National Association of City Transportation Officials announced the launch of

Transportation researchers tackle the pandemic



Researchers and experts across the University of Minnesota system stepped up within a matter of weeks this spring to study COVID-19 and its impacts. Transportation-related projects—on topics such as contact tracing, pandemic transmission, and supply chains—are among the activities. Highlights follow.

Tracking outbreaks. Professor Shashi Shekhar (Computer Science and Engineering) and U-Spatial researchers are analyzing aggregate smartphone trajectory data to study the mobility impacts of COVID-19 policy interventions such as social distancing. In addition, Shekhar was part of the development team for the SafeDistance smartphone app. The free app, launched in April by the HealthPartners Institute, is intended to track COVID-19 outbreaks at the neighborhood level using crowd-sourced information from anonymous users. (See related story about Shekhar’s work.)

Transit and pandemic transmission. Alireza Khani (Civil, Environmental, and Geo- Engineering, CEGE) is continuing his studies of public transit and pandemic transmission, specifically of ways to meet core transit demand while maximizing rider safety through social distancing. “Ideally,” Khani says, “we want to estimate the origin-destination of transit-dependent riders and design service adjustments to serve these riders and ensure social distancing to minimize

public health risk.”

Rural food logistics: Kathy Draeger (Extension Regional Sustainable Development Partnerships) is lending her experience to discussions of transportation logistics for the state’s food supply, particularly in rural and tribal areas. “There’s a lot of work connecting available food to food-insecure communities right now,” she says. These activities build on her pilot project that developed and tested “backhauling” as a way to help farmers get their produce to wholesalers for wider distribution (see story, January 2018 *Catalyst*).

Modeling the spread of the virus. Raphael Stern (CEGE) is working with a collaborator at Purdue University to model the spread of the virus. They are exploring how recent changes in the transportation network, such as canceled flights and travel restrictions, help control the spread. Stern is also interested in learning how the different stay-at-home orders and related policies have influenced travel within Minnesota.

Social distancing and adherence. Ingrid Schneider (Forest Resources) is conducting observational research of social distancing and adherence to COVID-related recommendations by nonmotorized transportation users. Collected on park trails in six states, the behavioral data will inform design,

communications, and future planning. This novel longitudinal data set will also serve as a pilot for larger projects that integrate wearable technology and video data to more accurately assess physical distancing and health outcomes and better plan public spaces.

Medical supply chains. Lee Munnich (Humphrey School of Public Affairs) is studying medical supply chains as part of ongoing research in the Transportation Policy and Economic Competitiveness Program (TPEC).

Minnesota motorization trends. Also part of TPEC, Zhirong Zhao (Humphrey School) is expanding a periodical report on Minnesota motorization trends into one on Minnesota mobility trends and incorporating the impacts of COVID-19.

Telecommuting. Adeel Lari (Humphrey School) will explore whether telecommuting will become part of the “new normal” and what the impact will be on vehicle miles traveled and highway congestion. He also plans to study telecommuting’s geographical and equity implications. The work builds on research conducted under the eWorkplace program (see story, May 2019 *Catalyst*) and TPEC.

Social isolation. Carrie Henning-Smith (School of Public Health) and Yingling Fan (Humphrey School) are studying the role of transportation in addressing social isolation, with particular focus on older adults (see story, April 2020 *Catalyst*).

These and other researchers have also lent their expertise to state and national media. A U of M website features the panoply of work under way: twin-cities.umn.edu/news-events/covid-19.

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for links to research reports and other resources.

In the past, Shekhar has studied GPS trajectories for various transportation industries. Now, he says researchers can use location data from smartphones to not only track and control the spread of COVID-19, but also to evaluate how effective government responses to the disease have been.

For years, health workers have been tracking and containing the spread of diseases through a method called contact tracing. When patients test positive for a disease, health professionals interview them to find out who they have been in close contact with and where they could have spread the disease. While hospitals have been conducting this process manually for COVID-19 patients, Shekhar said using mobile location data would speed up the process significantly.

“COVID-19 is so fast-breaking and so large, you can see that it is overwhelming the manual contact tracing system,” he explains. “That’s why today we need to help the contact tracing professionals with new tools, and one of those tools is smartphone trajectories.”

Shekhar proposes a system in which medical records and spatial data work together. After compiling a dataset of patients who have tested positive for COVID-19, researchers could cross-check that data with smartphones that were near that person during the infected period. Then, public health organizations could contact those who may have been infected.

Countries like Israel and Singapore have already made use of this mobile contact tracing, sending texts to citizens alerting them of potential COVID-19 exposure. This would be harder to achieve in the United States, since current privacy norms impede the release of such specific data. However, considering the threat the novel coronavirus poses, Shekhar believes the US government should make an emergency exception and harness this data for good.

“COVID-19 is probably the biggest national emergency in almost 100 years, and during these times we need to think



a little differently,” he says.

Contact tracing just scratches the surface of the insights spatial data can provide related to COVID-19, according to Shekhar. For example, researchers have begun using smartphone data to study the impact of both statewide and nationwide measures such as social distancing and shelter-in-place orders. By using mobile data to compute average “daily range” over time—in other words, how far people are traveling from their homes—researchers can determine how effective shelter-in-place orders have been in reducing movement.

Shekhar is currently using anonymous aggregated smartphone data to analyze average daily distance traveled in the Twin Cities metro area and throughout Minnesota beginning in early March. Preliminary results show that people’s daily range decreased through March and early April, but then began to bounce back from April 17 to 30.

This kind of information can be

used to inform public policy and also to create improved COVID-19 transmission dynamics models, which policymakers can use to estimate the number of infections and deaths.

Shekhar also says there are numerous other ways science and engineering fields like spatial computing can help, and he encourages his fellow researchers to think about how their work can contribute. “I think people, in our college and others, need to take a look and see that many ideas they already have can make things better,” he says. “In this COVID-19 crisis, if science and engineering can help society, we need to do it.”

(Adapted from an article by Olivia Hultgren published on the U’s College of Science and Engineering website on April 10, 2020.)

Gridlock Buster educates and entertains during outbreak

The Gridlock Buster traffic control game has been promoted by MnDOT as an online learning resource for K–12 students during the COVID-19 outbreak. The game and curriculum were developed by CTS and U of M researchers. To play the game, visit cts.umn.edu/gridlockbuster.



In the latest LRRB-funded project, researchers studied ways to water new roadside installations more efficiently so the salt-tolerant mixes—which require different early watering regimens than other mixtures—establish more successfully without wasting water. As part of the effort, researchers evaluated several alternative methods of turfgrass watering, compared their effectiveness to existing practices, created guidance for homeowners who live near new turfgrass installations, and developed training for turfgrass installers.

The project, led by horticultural science professor Eric Watkins, began with the design and preliminary evaluation of several alternative watering systems. Next, researchers evaluated these new watering methods on four roadside research sites. In total, the team tested four drip-tape-style irrigation systems placed both above and below sod, two above-ground sprinkler system configurations, and eight types of water-truck nozzles. Researchers determined the effectiveness of the new test systems by collecting data on water used, irrigation efficiency and uniformity, and turf establishment, quality, and rooting characteristics.

Findings indicate that a non-permanent, programmable drip irrigation system using water from a fire hydrant was the ideal approach for watering roadside turfgrass. According to

Watkins, this system uses less water than truck watering practices, can be reused, and results in better establishment.

“Establishing salt-resistant roadside turfgrass requires an effective watering program,” says Dwayne Stenlund, erosion control specialist at MnDOT. “As labor and equipment can be sidetracked regardless of plant water needs, a computerized irrigation program overcomes this problem.”

At installations not located near a fire hydrant, the system can be converted to a gravity or other pressure-fed water supply. For sites where an irrigation system is not viable and water trucks are needed, researchers recommend using two specific nozzles for the best establishment.

As part of the project, the team also developed and added an entirely new section to its Roadside Turf website specifically to educate homeowners living near new turfgrass installations. The new information addresses common homeowner mistakes such as improper watering, mowing, fertilizing, and weed control. In addition, results from this and previous work were used to create an online course for contractors and other personnel who work on roadside turfgrass installations.

“We anticipate that this course will serve as an excellent continuing education opportunity for roadside turfgrass installers for years to come,” Watkins says.

City of Edina tests turfgrass irrigation system

The City of Edina Engineering Department received a grant through the LRRB’s Operational Research Assistance (OPERA) Program to adapt and test one of the temporary roadside turfgrass irrigation systems designed by U of M researchers.

The spark for the project was when Edina senior engineering technician Derek Northenscold shared his ideas for turfgrass irrigation at an LRRB meeting, where he connected with U of M turfgrass researcher Eric Watkins. Watkins described the University-developed drip irrigation system, which the Edina project team later assembled with parts readily available at most hardware retailers for less than \$200. The system is expected to shorten watering time, reduce water use, and cut costs.

With last year’s wet fall, the city did not see a difference in turf establishment between test and control sections. “We are looking to test the system again this year,” Northenscold says. Go to mnlta.p.umn.edu/opera/ to learn more and watch two videos highlighting the project.

Raising awareness of snow fence program could help reduce dangerous drifts

Snow fences, such as rows of trees, shrubs, or standing corn, can catch drifting snow and keep it off roadways. Because of their proven benefits, the Minnesota Department of Transportation (MnDOT) offers payments to landowners who add snow fences along highways. However, few landowners know about this program.

In a recent project, U of M researchers set out to better understand how landowners learn about the snow fence program and its financial compensation, why landowners who know about the program may not participate, and how MnDOT could better encourage snow fence adoption.

The new recommendations will be used to guide MnDOT's promotional and recruitment efforts to expand the use of snow fences around the state. Options include working with local conservation districts to help set up and establish fences, encouraging the use of trees or shrubs as living snow fences for their carbon- and snow-capturing abilities, and stacking hay bales as snow fences, which can then be used for agricultural purposes when winter ends.

A 2012 study found that if just 40 percent of the 3,700 sites along state and federal roadways that are suitable for snow fences adopted them, the state would save at least \$1.3 million. "To tap into those benefits, we wanted to find out why snow fence adoption by landowners has not been as robust as MnDOT would like," says Dean Current, co-director for the U's Center for Integrated Natural Resources and Agricultural Management.

Building on earlier work, researchers



began by dividing the state into four areas based on land use and snow experience. Next, they met with MnDOT staff in each region to determine internal knowledge of the program and identify the most troublesome transportation corridors for blowing snow. The team then held community meetings with stakeholders in each region to discuss snow management problems and snow fence program knowledge. Finally, the team members surveyed landowners along the problem corridors about their experience with blowing snow control and knowledge of and attitudes toward snow fences and their adoption.

Following the survey, the team promoted the snow fence program through posters and on Facebook and held outreach meetings with landowners from the trouble spots. Investigators then surveyed landowners again about snow management problems and the snow fence program. Finally, researchers analyzed both surveys and prepared their recommendations.

"We really got a more integrated and quantified understanding of how landowners understand the program,"

Current says. "The success of the project will really depend on how this understanding is applied."

Researchers found that few landowners are aware of the snow fence program and its safety and mobility benefits for their communities. As a result, researchers recommended promoting the program year-round and including city councils, community groups, and program advocates who manage farms in promotion efforts. Researchers also learned that the primary constraints for landowners were the potential for fences to affect cultivation practices and equipment needs, loss of productive land, the desire for help establishing fences, and moisture management.

"This project is providing valuable insight for our blowing snow control program with MnDOT's Project Management Shared Services and the five designers that are part of the team," says Dan Gullickson, MnDOT Operation's blowing snow control shared services supervisor.

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