

Research Spotlight

Project Information

REPORT NAME: Slippery Road Detection and Evaluation

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Slippery road detection is a promising benefit of connected vehicles

The measurement of road surface conditions, traffic and weather through expanded data collection can help MDOT better manage and operate the state's transportation system. This is one of the ideas behind the department's Data Use and Analysis Processing initiative to evaluate the uses and benefits of data generated through connected vehicle technologies. An important step in that initiative was a field test of the key technologies and methods involved.

Problem

Detecting slippery road conditions is a natural application for in-vehicle data collection and analysis in Michigan. A properly instrumented vehicle may be able to provide moment-to-moment road surface, weather and vehicle condition data. Properly analyzed, this information, along with data from a network of other vehicles, could help MDOT to respond quicker to slippery road conditions with traveler advisory warnings and winter maintenance response teams.

In practice, however, the requirements for collecting and analyzing the different kinds of necessary data are both technical and challenging. MDOT undertook a research study with the University of Michigan Transportation Research Institute to prove the concept.



In this study, researchers adapted a smartphone to collect vehicle and road data and to transmit the information wirelessly back to a central computer.

Research

The research team instrumented a fleet of vehicles to collect data using several on-board collection sources:

- A dashboard-mounted smartphone collected the date and time; the vehicle's position (latitude, longitude and altitude); and heading and speed derived from the built-in global positioning system (GPS).

“We do not know yet precisely how we’ll use all of the data that we can collect, but I can see a range of value-added applications that MDOT could use to support and enhance current data collection systems in the areas of operations, maintenance and asset management.”

Steven Cook, P.E.
Project Manager

- The vehicle’s on-board computer network—the Controller Area Network (CAN) bus—provided the status of a number of vehicle systems: engine and vehicle speed, position of the gas pedal and steering wheel, and activation of the brakes. The CAN bus also indicated whether several safety-related features were engaged, such as the anti-lock brakes, electronic stability control and traction control for the brakes and engine.
- The Surface Patrol HD subsystem featured exterior-mounted sensors to measure pavement temperature, air temperature and dew point.

Specially developed software on the smartphone collected data from all of these sources, recorded the information and wirelessly sent data files back to a central computer at five-minute intervals. Data analysis was another critical goal of the research, and investigators developed processes to learn what inferences could be made about road conditions from the raw data.

Results

The project included one vehicle fully equipped to measure all of the project parameters, as well as another 10 vehicles in MDOT’s fleet equipped to collect a smaller subset of data. During field testing, an excess of 13 gigabytes of data were collected over 30,000 road miles traveled.

The 2011-2012 winter season was uncharacteristically mild and provided few severe weather incidents. While the limited exposure of the vehicles to slippery road conditions led to inconclusive results, the demonstration of integrated technologies was highly encouraging and deemed successful as a proof of concept.

The research team also made significant progress in establishing how data can be analyzed to detect slippery roads and recommended considering several parameters together. For example, temperatures near freezing, simultaneous activation of safety systems like anti-lock brakes and traction control, and a mismatch of vehicle speed between the CAN bus and the GPS (characteristic of a skid) together provide a good indication of a slippery winter roadway.

Researchers also took advantage of the mild winter to extend the research beyond its original scope. Some of the same parameters used to detect slippery roads—vertical position and motion in particular—also served to help assess the state of road repair needs. This side avenue of investigation was promising, with researchers establishing good correlations between collected vehicle data and road surface roughness and pavement distress values.

Value

The project’s initial validation of the data collection and analysis tools is an important step, and has begun to suggest additional ways for MDOT to use this kind of rich data set. Applications include faster or automatic response to incidents, congestion and weather events, and improved planning

data for traffic and asset management.

The study findings have prompted a new proposed MDOT research project to further study correlations that exist between data collected automatically with instrumentation on pavement surface roughness and subjectively by inspectors in order to assign pavement distress values. The research also has led to MDOT’s involvement in a major national study on enhanced safety and vehicle connectivity, phase two of the Federal Highway Administration’s (FHWA) Integrated Mobile Observations program.

These benefits will be leveraged even further nationally. The FHWA study data will be provided to the maintenance support systems pooled fund study, an effort supported by MDOT and a number of other winter weather states.

Research Administration

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This final report is available online at

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