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RESEARCH SOLUTIONS

Improving roadway friction measurement methods to keep winter roads clear

Road friction sensors are a lower-maintenance tool for monitoring road surface conditions and identifying where salt or other winter maintenance treatments should be applied. However, different sensors may not measure friction consistently and their high cost means they can only be deployed on key road segments. Machine learning provides Iowa DOT and other state transportation agencies a potential new option to predict road surface conditions in real time without the need for sensors. Building on a variety of past studies, researchers developed a model using existing meteorological data and provided guidance for states to develop similar models of their own.

THE NEED

Roadway friction measurements help winter maintenance managers determine when snow and ice removal is needed. Mobile and stationary friction sensors can be mounted on vehicles, poles or other structures rather than embedded in the road, making them easy to maintain and unaffected by pavement maintenance or other road construction. However, these sensors do not all use the same technology nor focus on the same metrics, and measurements can vary among manufacturers.

As members of the Aurora transportation pooled fund study, Iowa DOT and 18 other states wanted to explore ways to standardize friction sensor measurements and learn if and how weather condition data could be used to predict road friction. While friction sensors can be an important data source, coverage on all roads

(continued)

"We now have guidance to use the data we currently collect to model road friction in places without road friction sensors. The resource savings from not buying additional sensors and retrofitting other infrastructure and equipment could be substantial."

— TINA GREENFIELD,
Iowa DOT RWIS Coordinator/Winter Operations Team

is cost-prohibitive. An accurate model for predicting road friction could provide guidance for winter road maintenance in areas without sensors.

RESEARCH APPROACH

Under simulated meteorological and road conditions representing light, moderate, and heavy snow events and varying pavement ice and snow levels, researchers compared the friction measurements collected from multiple sensors over a week. Investigators analyzed the relationship between the weather conditions and sensor responses, and modeled friction based on air, surface, and dew point temperatures; relative humidity; and water, snow, and ice thickness.

Next, using data from two previous studies in Maine and Minnesota, the team analyzed collocated meteorological and friction data to compare sensor performance and explore methods to standardize friction measurements.

Multiple data sets describing atmospheric and road surface conditions, optical friction measurements, and laboratory data facilitated the development of algorithms to power a road friction model. The team trained computer models to use meteorological measurements to infer road friction conditions. The team also explored whether friction models developed with data from the laboratory or particular states could be applied in other locations.

WHAT IOWA LEARNED

The research showed that state-specific road friction models are possible, which could alleviate the need for more friction sensors and infrastructure.

As expected, while different road friction sensors were generally consistent when measuring high friction values, the measurements differed as road surfaces became slicker and friction values lowered. While researchers demonstrated that measurements from multiple friction sensor types could be normalized by averaging or interpreting friction values as low, medium, and high, they recommended at least two full winter seasons of data for a robust standardization of different sensors' measurements.

Applying machine learning techniques to collocated meteorological and stationary friction sensor data accurately trained a computer model to estimate road surface friction at sites with existing meteorological data. Road and air temperatures, relative humidity, and dew point temperatures helped the model's accuracy, and water and snow thickness were especially successful variables in predicting road friction.

Analyses showed that machine learning friction models trained on one location's data are transferable to other locations with the same type of measured data and friction sensors. Researchers recommended Iowa DOT and other states collect data over at least one winter season to identify friction and validate predicted friction values. Using a robust data set, Iowa can create a model to predict road surface friction following the steps provided.

PUTTING IT TO WORK

With enough data, Iowa DOT can create a machine learning model for predicting road friction across the state. However, it's not only weather and atmospheric conditions that determine road friction, but also geography, pavement type, and maintenance practices. Further research could explore the impact these variables have on road surface friction.

ABOUT THIS PROJECT

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