Infrastructure

Harnessing the Power of Artificial Intelligence (AI) to Improve Winter Maintenance Practices

Winter road maintenance accounts for roughly 20 percent of State departments of transportation budgets;[1] State and local agencies spend more than $2.3 billion on winter maintenance.[1]

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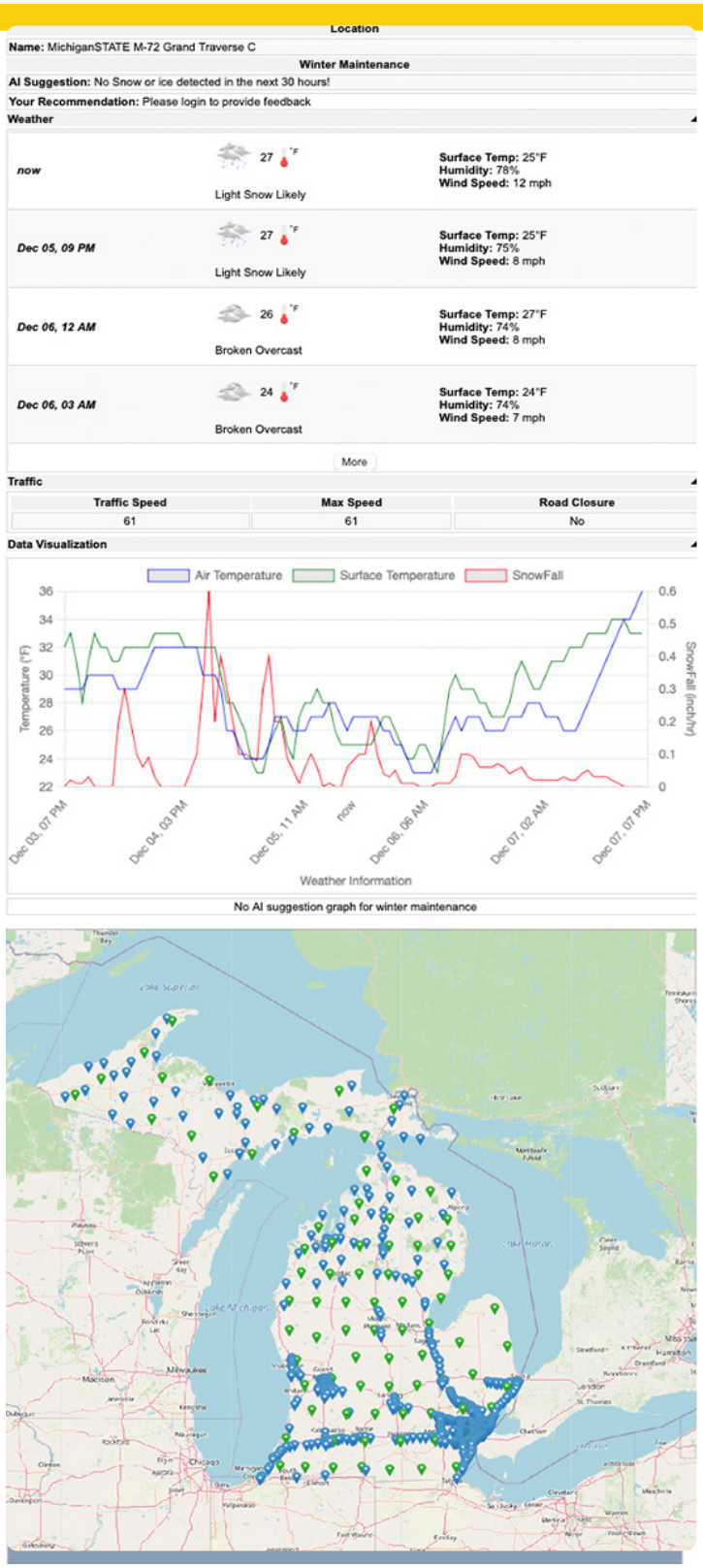
Snow on roads can create a host of operational problems for the traveling public and transportation agencies' road maintenance crew—not to mention damage to infrastructure. Twenty-four percent of weather-related vehicle crashes occur on snowy, slushy, or icy pavement, and 15 percent happen during snowfall or sleet.[1]

Exploratory Advanced Research (or EAR) Program-sponsored research examined how to make winter maintenance operations more efficient and effective. This research, led by Zhen (Leo) Liu, an associate professor at the University of Virginia (UVA), in collaboration with UVA and Michigan Technological University, developed into a "Smart" Maintenance Decision Support System (SmartMDSS) web-based application that enhances winter maintenance with big data and AI.

The research addressed three critical gaps in current winter maintenance practices. First, it harnessed the power of historical data—which are underutilized in conventional Maintenance Decision Support Systems for winter maintenance and other road operations—to better understand, predict, and interact with road conditions. Second, the research employed AI models that can continuously learn and adapt, enabling the models to improve as more data becomes available. Third, the research automated data analysis and decisionmaking, helping to reduce the need for manual input, minimize human error, and enable another way for knowledge transfer.

The target SmartMDSS uses deep- and reinforcement learning techniques to predict and sense changing road conditions and recommend maintenance actions. SmartMDSS leverages data from various sources like road weather information systems, traffic sensors, and surveillance cameras. Researchers used such data to train, support, and validate the AI models, which have been holistically deployed to better inform, advise, and train the winter road maintenance workforce. Training and validation are needed to ensure that the AI models come to accurate conclusions about the data and analysis undertaken by the AI entity.

The primary research deliverables, including various data, AI models, and cloud computing infrastructure, were incorporated into the development of an online portal (SmartMDSS.org), providing real-time decision support for winter road maintenance in Michigan and other States. The project's details, including the website, have been shared with broad audiences at local and national conferences and training events. With feedback from such audiences and users, the research team continuously improves, expands, and validates SmartMDSS for higher technical maturity and broader impacts.



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A series of screenshots of SmartMDSS

REFERENCE

1. FHWA. 2024. "Snow and Ice" (web page). https://ops.fhwa.dot.gov/weather/weather_events/snow_ice.htm, last accessed October 16, 2024.