Research Summary

Development of a Salt Spreader Controller Program Using Machine-Sensed Roadway Weather Parameters

Research Need

Massachusetts treats more than 15,000 lane miles during winter. Delivering the materials efficiently and effectively is critical to minimize the impacts of winter storms on road operations. In contrast, using the materials is maximized to reduce potential environmental impacts. Public agencies are actively searching for an optimized "formula" to minimize the utilization of the deicing material without affecting its effectiveness.

Goals/Objectives

An automated system for salt distribution based on pavement conditions was developed to create an effective system for intelligently delivering deicing materials by leveraging the existing instrumentation of Vaisala MD30 mobile RWIS sensors. By incorporating this data-driven approach, the system can deliver a salt distribution rate tailored to the specific pavement conditions, with improved deicing effectiveness while minimizing salt waste.

- To identify parameters and factors that influence the salt rate. MassDOT practice relies solely on grip or temperature values and operator judgment.
- To develop a computer vision/machine learning model to identify road surface conditions accurately.
- To develop an intelligent algorithm that holistically considers the derived road conditions and the real-time RWIS measurements and generates the optimized salt rate values specific to road conditions and environmental parameters.

Methodology

The research team developed this study's new salt application system by leveraging the instrumented mobile RWIS (i.e., Vaisala MD30 sensor), computer vision, and a new salt application model. The research team focused on developing four critical aspects of the intelligent salt application system, including hardware (i.e., data collection I/O and power supplies system), software (i.e., data logging, synchronization, and data fusion), algorithm (i.e., road surface classification (RSC) algorithm), and model (i.e., the salt rate prediction (SRP) model), so that an optimized salt application decision can be provided to the actuator to treat the road surfaces. Through this study, a complete hardware and software system with automated RSC and SRP algorithms has been developed, pilot-tested, and validated with promising performance.

Key Findings

A comparative analysis of the results derived from all experiments was performed based on grip improvement and salt usage. The salt rate prediction model simulation revealed an approximately 18% decrease in salt usage compared to auto grip mode. The salt rate prediction model demonstrated efficient performance through cumulative results analysis, particularly during use under moderate to heavy weather conditions and sleet mixed snow weather conditions.

Use of Findings

Future efforts by MassDOT and municipalities will directly translate the outcome of this study to facilitate a successful implementation of the sensor-based spreader controller system in a more extensive fleet of winter operation vehicles. Based on the findings from this study, the developed solution will significantly reduce salt usage without degrading the performance of the treatment. The sensor-based system will cost-effectively apply to snow/ice remediation, treating the conditions with minimum operation intervention, leading to more environment friendly deployment and safer winter operation.

The ultimate goal is to instrument the entire MassDOT winter operation fleet with a sensor-based system (with real-time in-situ weather conditions and regional weather prediction, and to manage winter operations using an integrated coordination portal.

Project Information

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