Ohio Department of Transportation Research Project Fact Sheet

ODOT's Snow and Ice Performance Evaluation Tools A Student Transportation Advancement Research (STAR) Project

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The Problem

Severe winter weather poses a significant threat to road users, primarily due to slippery road surfaces, which considerably increase the risk of crashes and injuries. Additionally, such conditions can disrupt traffic flow on highways, causing speed reductions, decreased highway capacity, or even complete traffic lockdowns. State Departments of Transportation (DOTs) and local agencies in snowy regions dedicate a significant portion of their budgets to maintaining and treating ice and snow during winter seasons. Many DOTs including the Ohio Department of Transportation (ODOT) primarily rely on Road Weather Information Systems (RWIS) installed on roadways to obtain weather data and make informed decisions during winter storms. However, the installation and operation of RWIS stations are costly, resulting in a limited number of stations being deployed to provide regional weather data. Furthermore, RWIS station malfunctions make it challenging to determine the start and end times of snow and inclement weather events. This necessitates the need for alternative weather data sources to complement RWIS.

Research Approach

The primary goal of this project is to identify alternative sources of weather data to supplement and complement the ODOT RWIS for winter maintenance operations. The specific project objectives are:

- collecting weather data from RWIS and alternative sources for validation,
- evaluating the accuracy of alternative weather data,
- developing and implementing frameworks for scraping weather data from the best-validated data sources.

To meet research goals, four tasks were undertaken: (1) a literature review, (2) data collection and validation, (3) development of a data scraping framework, and (4) a dashboard development concept.

1. The literature review task involved a comprehensive assessment of existing studies and publicly available dashboards featuring alternative weather sources used by agencies for winter maintenance. In addition, the research team explored the literature to identify other data sources popular in fields such as aviation, meteorology, hydrology, and climatology that can be used for roadway winter maintenance.
2. The data collection and validation task entailed scraping historical weather data from various sources and evaluating their strengths and limitations. This task also included assessing the accuracy of the data using RWIS as the ground truth. Visual graphics and error metrics, including mean square error and mean absolute error were adopted for this analysis.

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This research was sponsored by the Ohio Department of Transportation and the Federal Highway Administration.

3. Based on the findings from data collection and validation, the research team developed and implemented data scraping frameworks for the different sources using the Python programming language.
4. Finally, the team explored the possibility of creating a dashboard to visualize various weather variables including temperature, precipitation rate, precipitation type, wind speed, and wind gust.

Findings

Several potential alternative sources for weather data were identified from the literature review. Based on the accessibility and reliability of these sources, the research team proposes utilizing four key alternatives:

- Automated Surface Observing System (ASOS),
- Next Generation Weather Radar (NEXRAD),
- Meteorological Assimilation Data Ingest System (MADIS), and
- Multi-Radar/Multi-Sensor System (MRMS).

Data from these alternative sources were compared with those from the nearest Road Weather Information Systems (RWIS) stations. Table 1 reveals the findings from the comparison.

Table 1: Findings on the alternative data sources.

Source of weather data	Findings
Automated Surface Observing System (ASOS)	Closely matches RWIS data for temperature, wind speed, and wind gusts, but is less accurate for precipitation measurements.
Meteorological Assimilation Data Ingest System (MADIS)	Closely matches RWIS data for temperature, wind speed, wind gusts, and precipitation measurements (better alignment than ASOS).
Next Generation Weather Radar (NEXRAD)	Shows significant deviations from RWIS data for precipitation measurements.
Multi-Radar/Multi-Sensor System (MRMS)	Shows significant deviations from RWIS data for precipitation measurements.

To facilitate the use of these alternative sources, the research team developed scraping algorithms that automatically extract data from online databases. This framework scrapes, processes, and stores structured weather data in an online database. It was successfully tested by developing an example dashboard to visualize historical weather data, which is available here for review.

Recommendations

Among the four alternative sources identified, the research team recommends the following: -

- For temperature, wind speed, and wind gust data, ASOS and MADIS sources are recommended due to their high alignment with RWIS data, making them suitable for these measurements.
- For precipitation measurements, MADIS is preferred for its superior accuracy.
- Although radar-based systems like NEXRAD and MRMS are less accurate for precipitation, they are useful for visualizing weather patterns and intensities over large areas. It is recommended to include these sources in a dashboard to visualize storm patterns effectively.

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