Joint Transportation Research Program

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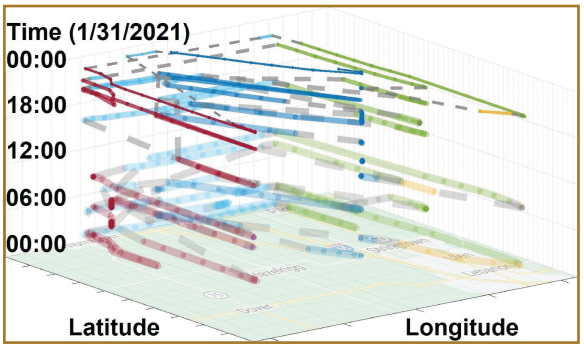
Automated Record Keeping for Maintenance Operations via Tracking of Maintenance Vehicles Using Telematics Tracks

Introduction

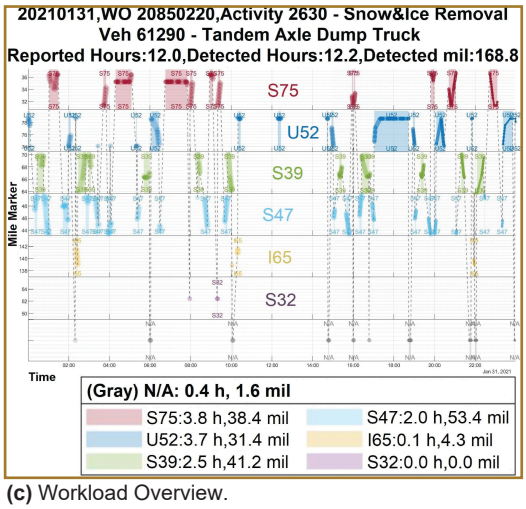
Efficient and accurate record keeping for maintenance vehicle operations is essential for optimizing resources, improving accountability, and supporting data-driven decision-making in transportation agencies. The Indiana Department of Transportation (INDOT) relies on maintenance work orders to track vehicle operations, but current methods are largely manual, prone to inconsistencies, and lack precise spatial and temporal accuracy. To address these challenges, this study developed an automated system leveraging GPS-based telematics data to enhance work order verification, streamline record keeping, and improve fleet management efficiency.

By integrating GPS data from INDOT's Data Warehouse with automated data processing and visualization tools, the project enables accurate tracking of vehicle movements, verification of maintenance activities, and improved decision making for winter highway operations. The study also examined key technical challenges, including data standardization, GPS accuracy, and time resolution, and developed solutions to ensure reliability and scalability. The findings and recommendations from this research provide a foundation for expanding automated record keeping to additional maintenance operations, such as asphalt patching and roadside mowing, improving overall efficiency in transportation management.

(a) Tracks on Map.



(b) 3D Visualization With Time.



(c) Workload Overview.

Figure 1. (Right) A snowplow conducting multi-road clearing operations over a single day. The (a) mapped tracks offer spatial context, while the (b) 3D visualization integrates temporal dynamics, illustrating movement patterns over time. The (c) workload overview provides a comprehensive summary of operations, detailing the cumulative duration and mileage of activity across various road segments.

Findings

The developed system successfully automated the verification of work orders for winter highway operations by matching vehicle GPS tracks with recorded work orders, reducing manual verification efforts and improving accuracy.

- Work order generation is partially automated, as the system can infer work activity based on GPS tracks, but full automation requires additional data, such as driver information and precise activity start and end timestamps. With these enhancements, the proposed algorithm could fully automate work order generation.
- A method was developed to standardize road naming conventions and establish a robust converter between INDOT's Reference Post System and GPS coordinates, enhancing consistency.
- Minute-level GPS tracking was found to be insufficient for accurate work order automation; a higher resolution (second-level tracking) is recommended to capture precise vehicle activity.
- A scalable and privacy-focused web application was developed to allow managers to efficiently access, visualize, and validate work orders using GPS records.
- Operational challenges, including the digital divide affecting real-time GPS data transmission in rural areas, were identified, along with the necessity of integrating precise start and end times in work orders.

Implementation

To improve record keeping, INDOT is advised to enhance GPS data collection frequency to second-level tracking, implement a standardized data processing framework, and expand work order recording methods to include precise start and end times. The developed web-based application can be expanded to additional maintenance operations such as asphalt patching and roadside mowing.

Future research should refine algorithms for multivehicle operations and optimize data transmission strategies to mitigate rural connectivity issues.

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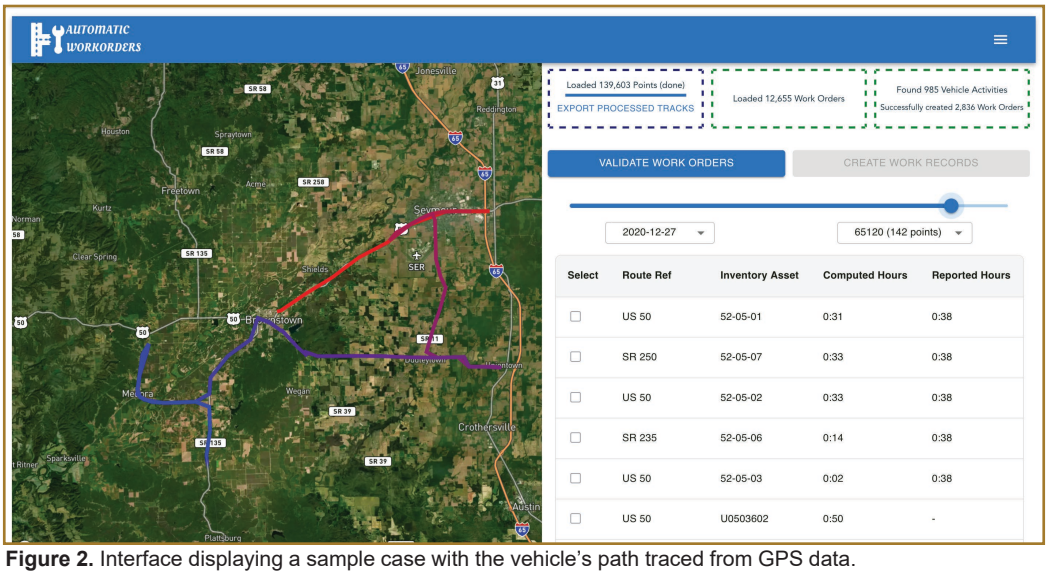

Figure 2. Interface displaying a sample case with the vehicle's path traced from GPS data.