

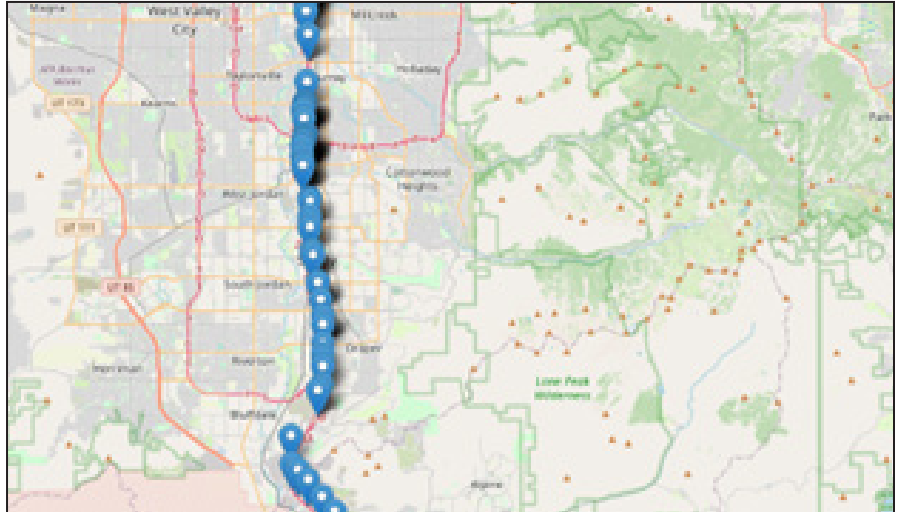
## RESEARCH BRIEF

CTIPS-25-002

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# Artificial Intelligence and Mobile Phone-Based Pavement Marking Condition Assessment and Litter Identification



## the ISSUE

Regular inspection and maintenance, such as repainting faded markings and removing litter, are essential to keep roadways in good, clean, and safe condition. However, traditional inspection methods rely heavily on manual labor, which is subjective, time-consuming, and unsuitable for large-scale and frequent assessments.

## the RESEARCH

This research developed advanced AI-based methods for automated inspection of transportation assets, focusing on pavement markings and roadside litter. The methodology involved expanding and annotating two large-scale image datasets, each containing more than 6,000 self-collected images. Faded pavement markings were classified into white and yellow categories, while roadside litter was divided into four classes: white litter, black litter, leaves, and dirt. Two deep learning detection models were trained using the You Only Look Once (YOLO) architecture. In addition to object detection, researchers developed a counting algorithm to quantify the number of detected objects within roadway segments or video clips. A geolocation model was also created by integrating GPS data through time-based interpolation, achieving precise spatial localization of detected assets. Finally, an interactive visualization interface was implemented using the Folium Python library to display the georeferenced inspection results, enabling intuitive mapping and data-driven asset management.

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### Project Title

Artificial Intelligence and  
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## the FINDINGS

The AI detection models achieved strong performance, with F1 scores of 0.88 for faded pavement markings and 0.84 for roadside litter. The counting module successfully quantified the number of identified objects within roadway segments or video clips, while the geolocation model achieved high positional accuracy, with an average distance error of only 0.27 meters in field validation along Utah's I-15. The resulting mapping interface displays each object's location, class, and inspection time, supporting comprehensive condition monitoring. Overall, the findings demonstrate the effectiveness of deep learning for automated, accurate, and scalable inspection of transportation assets.

## the IMPACT

The developed AI-based inspection system significantly improves the efficiency and accuracy of roadway asset monitoring. Compared with traditional manual methods, the automated models enable large-scale inspections with over 85% detection accuracy and sub-meter geolocation precision (average error: 0.27 m). The interactive mapping tool allows transportation agencies to visualize and prioritize maintenance needs in real time, reducing inspection time and labor costs.

For more information on this project, download the Main report at <https://www.ugpti.org/resources/reports/details.php?id=1269>

For more information or additional copies, visit the Web site at [www.ctips.org](http://www.ctips.org), call (701) 231-7767 or write to Center for Transformative Infrastructure Preservation and Sustainability, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.



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