# Minnesota Truck Parking

CASE STUDY

**Using machine vision to count unoccupied truck parking spaces at rest areas.**



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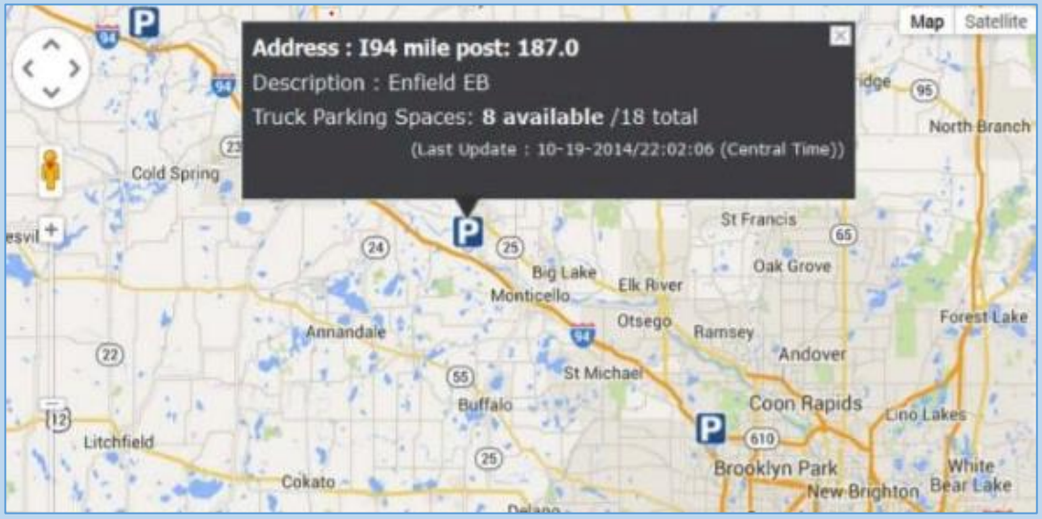
| **Freight Challenges** | Congestion, Land Use, Last Mile Access |
| **Data Sources Used** | Computer Vision |
| **Analytical Approaches** | Classification |




**Minnesota Truck Parking Real-Time Map**

*Source: MnDOT, "A Comprehensive System for Assessing Truck Parking Availability", 2017. Available: https://www.dot.state.mn.us/ofrw/PDF/assessing-truck-parking.pdf*

## WHAT ARE THE FREIGHT CHALLENGES?

Inadequate truck parking is a common problem in many metropolitan regions because their high concentrations of freight and trucking activity often results in high demand for scarce truck parking facilities. This high demand peaks at night when many drivers take their federally-required 10-hour rest break. However, truck parking spaces are comparatively rare, and truck parking demand exceeds the supply of truck parking spaces in metropolitan areas. This imbalance between supply and demand results in truck parking shortages. Parking shortages can result in truck drivers parking in illegal or inappropriate areas such as on highway shoulders, highway ramps, or at vacant commercial or industrial properties, and these actions have a negative impact on public safety and infrastructure condition. Alternately, truckers may choose to stop driving earlier and find parking before they reach their legal maximum number of driving hours for the day, which makes trucking operations less efficient.

## WHAT WAS THE GOAL OF THE PROJECT?

The Minnesota Department of Transportation, the University of Minnesota Center for Transportation Studies (CTS), and ATRI sought to evaluate the feasibility of using cameras and machine vision to determine whether or not specific truck parking spaces at rest stops were full. This parking occupancy information was collected for two purposes, first it was used to understand how parking utilization varies over time and space, and second it was used to create data products to inform truckers about the number of available parking spots at rest areas.

## WHAT DATA SOURCES WERE USED?

Cameras installed at each rest area collected still images of parking spaces at regular intervals. The images captured by cameras were sent to a centralized computer system equipped with the software needed to analyze the images. This machine vision system was deployed at three rest areas owned by MnDOT.

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**Parking Availability Visualization**
*Source: MnDOT, "A Comprehensive System for Assessing Truck Parking Availability", 2017. Available: https://www.dot.state.mn.us/ofrw/PDF/assessing-truck-parking.pdf*

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## WHAT ANALYTICAL APPROACHES WERE APPLIED?

Machine vision algorithms were used to analyze images of parking spaces, and identify changes in the placement of shapes and colors within the boundaries of the parking spots in the images. Based on these changes in shapes and colors, the system could classify a parking spot as either occupied or unoccupied. By evaluating the images for each parking spot, the total number of available truck parking spots for a specific rest area could be calculated.

## WHAT WERE THE RESULTS?

This study's machine vision system made over 530,000 evaluations of parking occupancy in over 98,000 images, and was capable of correctly evaluating a truck parking space's occupancy between 97.5 and 99% of the time, depending on location, time of day, and weather conditions. This technical evaluation of the system was important in demonstrating the potential value of machine vision for truck parking applications, but the most novel elements of this project were the methods used for communicating parking information to truckers.

## HOW WERE THE RESULTS VISUALIZED OR COMMUNICATED?

Real-time truck parking availability estimates were communicated to truck drivers in three ways: a website with real-time parking updates, an in-cab navigation system application that automatically provided information on parking, and roadside dynamic message signs "upstream" of the rest area. These different methods were selected in response to previous ATRI research on drivers' preferences for receiving parking information, and to test the feasibility of communicating parking information via different methods.

The efficacy of these communications systems was evaluated by a participating group of truckers who completed surveys about how the systems improved their decision making. A screenshot from the project's real-time website is shown on the previous page. This case study demonstrates the best practice of combining emerging freight data sources, like machine vision, with real-time communications channels. This combination of data collection and communication can help improve transportation system operations in near-real time by helping freight system users make more-informed decisions about topics such as what routes to use, or when to take a rest break.