CONDUENT Transportation

Case Study

Conduent® Vehicle Passenger Detection System

"VPDS proved itself as a tool worth considering, both for data collection, as well as a way to deter occupancy violators. For us, it all comes down to keeping traffic moving by making the best use of the infrastructure we have. The pilot was valuable because it demonstrated another tool to help us achieve that goal."

– Joe Rouse
Managed Lane Director, Caltrans

Background

Caltrans is the state agency that manages more than 50,000 miles of California highways and freeways - dedicated to providing a safe, efficient transportation system to the people it serves.

Since its inception, Caltrans has stayed at the forefront of innovation; effectively using technology to combat congestion, pollution, and keep drivers moving, despite a growing population.

As early adopters of HOV/HOT lanes for congestion management, Caltrans agency leaders knew the positive impact these types of solutions make—if they're used appropriately. The challenge is, these lanes operate on the "honor system" for compliance. It's up to the individual driver to set the tag correctly or voluntarily comply with the multi-passenger requirement.

The problem is, when HOV/HOT lane traffic consistently starts to slow and average speeds fall below the expectation, without hard data, it's difficult to identify why. Are the existing roadways pushed to capacity, or are drivers failing to abide by the rules? The answers to those questions are crucial to effectively remedy the situation—but more often than not, the data isn't there.

Although Caltrans has an experienced team of roadside observers monitoring specific highways, the sheer volume of vehicles often tops 1,000 every hour. That's more than can be accurately monitored by even the most skilled human eye. Yet, until recently, that was the only viable option.

Conduent Transportation has long partnered with Caltrans on their transportation innovation, so we knew this progressive organization would be the ideal pilot for our new Conduent® Vehicle Passenger Detection System (VPDS). This proprietary system uses advanced video analytics and geometric algorithms to detect the number of occupants in moving vehicles.

When we told Caltrans' Managed Lane Director Joe Rouse about VPDS, he wanted to hear more. In January 2015, he and other Caltrans leaders decided they wanted to see the system in action—and became our first U.S. pilot location.

A Faster, Safer Way to Assess Passenger Count and Throughput

Agency leaders had three very specific objectives for the pilot. They wanted to test the accuracy and performance of the system; they wanted to compare the system's vehicle count accuracy to that of its human counters, and finally, they wanted to gain a clear picture of their current violation rate, to see if it was high enough to contribute to HOV/HOT lane slowdowns.

Our Conduent Transportation team and VPDS were up for the challenge.

After much discussion, we identified a test area: a heavily traveled stretch of northbound I-5, which was selected for its traffic, as well as its close proximity to facilities, electricity, and other resources required for temporary set up. Once the location was set, we installed the test system - consisting of two cameras, an illuminator, a trigger, and a video image processor.

Once installed, we "trained" the system to recognize what multi-passenger and single-passenger vehicles "look like" through a technique called Computer Machine Visualization. Basically, this process involves members of our team feeding thousands of images into the system until it can accurately recognize these images on its own. In about two weeks, the solution was ready for action.

We collected data during the three-hour morning and three-hour evening rush hours on January 27th, 28th, and 29th, 2015, as did the agency's roadside observers. The question was: can an advanced, automated solution accurately identify violators, and calculate throughout without human intervention?

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Pilot Program for Advanced Vehicle Passenger Detection System Enables Caltrans to Estimate HOT/HOV Violation Rate With 95.94% Accuracy.

Always seeking out ways to reduce congestion and get traffic moving on its busy highways, Caltrans piloted the Conduent® Vehicle Passenger Detection System on a busy stretch of highway to test system accuracy, compare machine-driven results to those of its human counters, and to get a better picture of how much congestion was caused by violators on its HOV/HOT lanes. The system delivered, with a 95.94% accuracy—proving itself as a valid tool for throughput reports, compliance, and discouraging violators for better traffic flow.

The numbers tell the story.

Tangible Results

When Caltrans officials agreed to pilot VPDS, they had three specific objectives: test system performance, compare this to human observers, and gain a better understanding of the existing violation rate. The data did not disappoint.

System Accuracy

In our three-day rush hour pilot, involving 12,073 vehicles, VPDS achieved a 95.94% rate. Errors in terms of missed violators was 2.65%; with a 1.41% error rate in terms of wrongly identified non-violators. It's important to note that, in a real-world scenario with a back office system in place for an image double-check, these errors would likely be caught before driver notifications or erroneous toll adjustments occurred.

System Accuracy vs. Accuracy of Human Observers

When calculating Single Occupancy Vehicle (SOV) rate accuracy, VPDS came out on top. In the morning rush hour period, the average vehicle count was 1,774. VPDS logged a 95% accuracy rate, whereas roadside observers delivered 35.7% accuracy.
In the evening rush hour period, the average vehicle count was 2,250. VPDS logged a 95.3% accuracy rate, while roadside observers delivered 35.6% accuracy.

Current Violation Rate

When the data was tallied, Caltrans leaders learned that although the majority of its drivers complied with HOV/HOT occupancy requirements, approximately 14.75% did not. Even when single-passenger hybrid drivers, who are allowed to drive the HOV, are subtracted from this percentage, the number of violators are still significant enough to impact traffic flow. Using this information, Caltrans can now develop a strategy to increase compliance.

The accuracy of the system, without human intervention, and its accuracy compared to what is one of the best human observation teams in the country, surprised Caltrans leaders.

"I was stunned by the numbers—and impressed with the accuracy of the Conduent system," said Joe Rouse, managed lane director for Caltrans. "I think VPDS proved itself as a tool worth considering, both for data collection, as well as a way to deter occupancy violators. For us, it all comes down to keeping traffic moving by making the best use of the infrastructure we have. The pilot was valuable because it demonstrated another tool to help us achieve that goal."

Excellent insight from the agency that stays at the forefront of innovation—supported by a technology partner that does the same.

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