Vehicle Detection

TM 5

Photos: Courtesy of Neil Hetherington and Pat McGowen, WTI

Description: Vehicle detection, also called automated vehicle detection, uses sensors to detect the passage or presence of a vehicle. Vehicle detection sensors can determine vehicle presence, speed, vehicle gap, vehicle weight, direction, or occupancy. Vehicle detection is important for transportation planning and can enhance safety, reduce congestion, and provide access for travel time information when used in coordination with multiple sensors. These systems can be useful for monitoring traffic flow, adjusting signal timings in real time, providing vehicle counts for road diet or widening projects, assisting in weigh-in-motion (see #OM1), detecting queues in work zones (see #CC12), and detecting the presence of pedestrians or bicyclists at intersections.

Vehicle detection sensors can be installed in or over the roadway. In-roadway sensors are embedded into or are placed on the roadway; these include loop detectors, weigh in motion, magnetometers, tape switches, microloops, pneumatic road tubes, and piezoelectric cables. Over-the-roadway sensors are installed above or alongside the roadway: these include video image processors, microwave radar, ultrasonic, passive infrared, laser radar sensors, and acoustic sensors.

Rural Transportation Critical Needs

- ☐ Crash Countermeasures
- ☐ Emergency Services
- ☐ Operations & Maintenance
- ☐ Rural Transit & Mobility
- ☐ Surface Transportation & Weather
- ☐ Tourism & Travel Information
- ☑ Traffic Management

Issues Addressed

- ☐ Congestion and Delays
- ☑ Inefficient Signal Operations
- ☐ Parking Challenges
- ☑ Vehicle Detection
- ☐ Road Closures
- ☑ Travel Time
- ☑ Speed
- ☐ Alternate Routes
- ☑ Dynamic Traffic Control/Operations
- ☑ Special Event Management
- ☐ Inefficient Use of Road Network

Strategies Achieved

- ☐ Road User
- ☑ Road
- ☐ Vehicle
- ☐ Safety Culture
- ☑ Engineering
- ☐ Emergency Response
- ☐ Enforcement
- ☐ Education

Applicability	Partnerships	Key Components
•In the rural context, vehicle detection can enhance safety in work zones by notifying workers of a vehicle entering the work zone. Vehicle detection can reduce congestion by monitoring traffic and adjusting signal timings in real time. This is especially important during special events, which can have a large impact on a rural transportation network. There are many different types of vehicle detection systems; an agency should choose which type it wishes to deploy depending on the costs and needs.	•Applications benefit from collaboration among numerous agencies, which may include: •Departments of Transportation (Federal, State, Local) •Law Enforcement •Metropolitan/Rural Planning Organizations •Construction Companies	•Sensor •Inductive Loop •Pneumatic Road Tubes •Magnetometer •Infrared •Ultrasonic •Acoustic •Video Image Processor •Signal Processing Device •Data Processing Device

Examples of Implementation

- **Arizona Department of Transportation (AZDOT) Wrong Way Detection**

AZDOT is testing a combination of loop detectors, radar detectors, and cameras to detect wrong way drivers on state highways. If the system detects wrong way drivers, an illuminated sign flashes warning the drivers that they are headed the wrong direction.

- **Texas Department of Transportation (TXDOT) Advanced Dilemma-Zone Detection System**

TXDOT is testing vehicle detection systems used in coordination with signal timings at rural intersections in order to reduce delay and crash frequency.

- **Low-Cost Portable Video-Based Queue Detection for Work-Zone Safety**

The University of Minnesota used low cost video vehicle detection to detect if a queue was forming at a work zone. If a queue is detected, roadside dynamic message signs or flashing lights are set off before the work zone to warn drivers that there is traffic slowed or stopped ahead.

- **Rhode Island Wrong Way Driving Detection**

Rhode Island Department of Transportation (RIDOT) installed vehicle detection sensors at 24 high-risk locations for wrong way drivers. If a wrong way driver is detected the system alerts the driver and RIDOT, flashing wrong way signs are activated as well as messages on overhead DMS signs. This system detected 47 wrong way drivers in the first year.

- **I-35 Corridor Management**

Kansas Department of Transportation has installed 15 vehicle detection sensors along I-35 to provide real-time traffic data. This is a portion of the ongoing ITS Heartland Multistate Corridor Operations and Management Program (MCOMP), which has goals of providing real-time data on rural freeways and a regional information clearinghouse.

Implementation Considerations (General)	Implementation Considerations (Pro)	Implementation Considerations (Con)
•There are advantages and disadvantages to each type of vehicle detector. An agency must consider the type of data that it wants to obtain as well as the location and costs. The FHWA document (listed in the additional resources section) contains a table of strengths and weaknesses of each type of vehicle detector[1]. •Agencies must consider weather conditions when determining the type of detection sensors to install. In-pavement sensors are less effective with snow and plows but cameras are also affected by snow or dirt buildup.	•Can be used to make effective signal timing. •Can detect wrong way drivers. •Reduces collisions. •In-roadway sensors are less sensitive to the weather.	•In-roadway sensors require disruption to traffic in order to conduct installation or repairs. •In-roadway sensors require pavement cuts which reduces the pavement lifecycle. •Over-the-roadway sensors are more sensitive to the weather.

Opportunities for Future Expansion

- Some vehicle detection systems like video or radar detection can be modified to detect pedestrians or bicyclists to warn a driver of their presence.
- Connected vehicles will be able to communicate with a roadside vehicle detection sensor (V2I) to determine signal timings, travel times, etc.

Additional Resources

- *A Summary of Vehicle Detection and Surveillance Technologies Use in Intelligent Transportation Systems,* found here: https://www.fhwa.dot.gov/policyinformation/pubs/vdstits2007/index.cfm
- *Low-Cost, Minimally-Intrusive, Light-Based Sensors for Vehicle Detection*, found here: http://onlinepubs.trb.org/onlinepubs/conferences/2010/NATMEC/Miller.pdf
- *Traffic Detector Handbook*, found here: https://www.fhwa.dot.gov/publications/research/operations/its/06108/index.cfm
- *Effects of Fog, Snow, and Rain on Video Detection Systems at Intersections*, found here: http://www.tandfonline.com/doi/abs/10.3328/TL.2010.02.01.1-12

Useful Tip

Video image processors that are used for vehicle detection could also post camera feeds to a state's integrated traveler information system.

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital costs for this tool are low (less than $50,000). A microwave detector is estimated to cost $476[2]. The cost of a video detector is estimated at $2,731.23[3]. An infrared detector is estimated to cost $2,613[4].

Operations Costs: Maintenance and operations costs are low (less than $50,000). An agency needs to consider the costs to keep sensors cleaned and to close a roadway or lane of traffic for maintenance. In-pavement sensors can also reduce the life cycle of the pavement. Florida Department of Transportation's average maintenance costs per site in 2016 was $529, including both emergency and routine maintenance activities. Michigan Department of Transportation's annual maintenance costs are $25,951.50 for 474 detector sites.

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