Literature Search 621: Evaluating Different Detection Technologies for Signalized Intersections

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Resources searched: TRID, Pooledfund.org

Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: vehicle detector, vehicle detection, signalized intersection, video, radar, autoscope, wavetronics, gridsmart, miovision, iteris, acoustic, infrared, magnetic, magnetometer, microwave, optical, proximity. Results are listed in most and least relevant categories below.

Most Relevant Results

TRID

https://trid.trb.org/view/1630112

Abstract: The capabilities of radar-based vehicle detection (RVD) systems used at signalized intersections for stop bar and advanced detection are arguably underutilized. Underutilization happens because RVD systems can monitor the position and speed (i.e., trajectory) of multiple vehicles at the same time but these trajectories are only used to emulate the behavior of legacy detection systems such as inductive loop detectors. When full vehicle trajectories tracked by an RVD system are collected, detailed traffic operations and safety performance measures can be calculated for signalized intersections. Unfortunately, trajectory datasets obtained from RVD systems often contain significant noise which makes the computation of performance measures difficult. In this paper, a description of the type of trajectory datasets that can be obtained from RVD systems is presented along with a characterization of the noise expected in these datasets. Guidance on the noise removal procedures that can be applied to these datasets is also presented. This guidance can be applied to the use of data from commercially-available RVD systems to obtain advanced performance measures. To demonstrate the potential accuracy of the noise removal procedures, the procedures were applied to trajectory data obtained from an existing intersection, and data on a basic performance measure (vehicle volume) were extracted from the dataset. Volume data derived from the de-noised trajectory dataset was compared with ground truth volume and an absolute average difference of approximately one vehicle every 5 min was found, thus highlighting the potential accuracy of the noise removal procedures introduced.

Chamberlin, Robert; Fayyaz, Kiavash. Using ATSPM Data for Traffic Data Analytics. Resource System Group; Utah Department of Transportation; Federal Highway Administration, 2019, 53p
https://trid.trb.org/view/1671474

Abstract: The Utah Department of Transportation (UDOT) performs about 6000 short-duration counts over a three-year cycle to estimate and report annual average daily traffic (AADT) on roadways per Federal Highway Administration (FHWA) requirements. Many of these roadways are in proximity to signalized intersections equipped with radar detectors that provide approach and turning movement counts. This research investigates the use of volume data obtained from traffic-signal radar detectors (i.e. Advance and Matrix detectors) to estimate AADTs and related traffic engineering factors. An assessment of the accuracy of these radar detectors may enable the elimination of selected short-duration counts, and possibly complement Continuous Count Station (CCS) data for estimating seasonal factors. In this research, 27 Matrix detectors and 33 Advance detectors proximate to CCS sites were identified. The hourly count
data for an entire year, 2017, were collected from Automated Traffic-Signal Performance Measures (ATSPM) data archive and mapped with the associated CCS hourly counts as ground-truth. An anomaly detection method was implemented to clean the dataset of count data when significant outliers were identified. The accuracy of detector hourly counts was measured using linear regression with and without adjustment factors. The results show that hourly counts from Matrix detectors hourly are more accurate (i.e. average R-squared value of 0.93) than Advance detectors™ hourly counts (i.e. average R-squared value of 0.79). AADTs estimated from Matrix detectors had an 88 percent accuracy, with a range of -21% - +7%. Matrix detectors are sufficiently accurate for estimating AADT as the current methods utilizing short-duration counts have been estimated to be less than 80% accurate. The Matrix detectors are also very accurate in estimating the seasonal factors (i.e. about 97% accurate) and thus can be used to complement CCSs in calculating them. This would be particularly valuable to UDOT in measuring seasonal factors for lower functional class roadways which have sparse coverage by CCS sites.

Noyce, David A; Bill, Andrea R; Chitturi, Madhav V; Santiago-Chaparro, Kelvin R. Turning Movement Counts on Shared Lanes: Prototype Development and Analysis Procedures. NCHRP-IDEA Program Project Final Report, Issue 198, 2019, 60p
https://trid.trb.org/view/1652249

Abstract: Turning movement count data is key to evaluating the performance of signalized intersections. The use of radar-based vehicle detection systems as an alternative to loop detectors is arguably an underutilized vehicle detection technology. The underutilization argument is based on radar-based vehicle detection systems being capable of continuously tracking the position of vehicles but only reporting to the controller the presence of vehicles over a detection zone that emulates the location of an inductive loop. If vehicle trajectory data from an intersection approach is continuously logged, monitoring vehicle volumes over long periods of times is possible, including breaking down the volume into movements by analyzing the paths of the vehicle trajectories regardless of lane configurations. Results from the project include the development of a data collection device capable of logging vehicle trajectories from intersections instrumented with a commercially available radar-based vehicle detection system. The device can be installed inside a signal cabinet and is independent of the controller platform. The data collection device serves as a platform for algorithms that make performance measures monitoring possible. An example of these algorithms is the one developed as part of the Type 1 IDEA project which was streamlined and improved as part of the Type 2 project described in this report. The data collection device implements some of the key noise removal techniques described in this report thus making it possible to improve the quality of turning movement counts generated based on the trajectory data collected. Improvements made to the noise removal and summary procedures made commercializing the product possible and open the doors for future improvements and the introduction of analysis procedures beyond turning movement counts.

Sunkari, Srinivasa; Bibeka, Apoorba; Chaudhary, Nadeem; Balke, Kevin. Impact of Traffic Signal Controller Settings on the Use of Advanced Detection Devices. Texas A&M Transportation Institute; Texas Department of Transportation; Federal Highway Administration, 2019, 82p
https://trid.trb.org/view/1607199

Abstract: Traffic signal settings have historically been developed using inductive loops as the predominant detection device. Detection technology has changed significantly over the years. This research studied the impact of controller settings on design and operations of a signalized intersection where traditional detection technology is not used. Researchers developed guidelines that will aid practitioners in choosing the controller settings for both new intersections and intersections where detection is being upgraded. Researchers conducted simulation studies to assess different controller settings. The aim of simulation was to find settings suitable for various detection needs, the detection technologies, and operational scenarios. Following are a few of the salient findings of this research: (1) A passage time of 1.5 seconds was found to be appropriate for optimum intersection delay and queue lengths. Low and moderate volumes are not sensitive for the passage times. (2) For high-speed approaches, when the stop bar and upstream detectors are on the same channel, a higher delay was experienced, more vehicles were trapped in the decision zone and more max-outs were experienced. (3) Detector switching results in lower delay only at high left turn volumes. (4) Radar detectors with continuous vehicle tracking perform better than induction loops.

https://trid.trb.org/view/1542210
Abstract: Wireless magnetometers have been considered as a practical alternative to inductive loops and suitable for large intersections, where span wire is generally used for traffic signal support. In this paper, wireless magnetometers are evaluated for stop bar vehicle detection at signalized intersections. High-resolution detector data were collected in the field subjected to various weather and environmental conditions. Conditional inference trees were used to correlate detection errors with weather and environmental factors that potentially affect the performance of wireless magnetometers. The study results indicated that the wireless magnetometers are fairly robust to various environmental conditions, such as wind, lighting, and visibility. Frequent passing of heavy vehicles, common at large intersections, can cause communication interruption between in-pavement sensors and the access point. This likely increases false and stuck-on call errors, which could be aggravated by adverse weather (e.g., rain, fog, or snow). This communication interruption issue can be mitigated by proper installation of additional repeaters. Provided the interruption issues are site-specific, professional judgment and field test are required for proper system setup, which is critical to delivering accurate and reliable detection for the wireless magnetometer system.

Abstract: Typical vehicle detection systems used in traffic signal operations are composed of inductive loop detectors. Because of costs, installation challenges, and operation and maintenance issues, many alternative nonintrusive systems have been developed and are now commercially available. Field-testing was conducted to evaluate nine alternative vehicle detection systems (four video, two radar, one thermal, and two hybrid) at the stop-bar zone of a signalized intersection under varying time-of-day and weather conditions: (1) daytime versus nighttime; and (2) favorable versus windy, rainy, or snowy conditions. The systems were set up for two detection zones: one for the through and right-turn movements and one for the left-turn lane. Based on the results of this study, no single system universally performs best. Depending on a specific time of day or weather conditions, several of the system types tested could claim that their technology outperforms all others. However, based on the percentage of false and missed detections, all of the products representing different system types exhibit opportunities for improvement and enhancement.

Abstract: Transportation related emissions is a major contributing factor to air pollution. Among all transportation facilities, urban intersections have been identified as a major source for vehicle emissions. Therefore, emission modeling and estimation at intersection level is highly needed and desired. In this research, an operating mode based macroscopic emission model is developed by using both empirical data from radar based vehicle detection system and MOVES output as well as incorporating existing traffic flow dynamics model. This emission model is able to directly compute emissions based on traffic volume and traffic signal variables. This predictive model is based on estimating total time spent in each operating mode directly from traffic variables and signal variables. Total time idling is modeled using kinematic wave theory and queuing theory, while others are modeled using empirical data. The validation results showed that the model is able to achieve a high degree of accuracy, within approximately 10 percent of emission results computed using the radar data. In conclusion, the emission model developed showed to yield highly accurate results, and are applicable for estimating emissions at signalized intersections.

Abstract: Recent years have seen increasing deployment of radar-based technologies for vehicle detection at signalized intersections in the United States, mainly because they are nonintrusive, accurate, and robust to varying lighting, weather, and environmental conditions. In this paper, a radar-based detection technology is evaluated in the context of various weather and environmental conditions. High-resolution (100-ms sampling interval) data were collected in the field from two representative test sites. The detection errors were correlated with varying weather and environmental conditions using data-mining techniques, such as conditional inference trees and regression models. It shown that false and stuck-on call errors tend to increase under more-adverse weather conditions (e.g., rain and
thunderstorms). Visibility, glare, and uneven shadows appear to be irrelevant. The near-side mounting location is associated with reduced missed-call, false-call, and dropped-call errors.

https://trid.trb.org/view/1445923

Abstract: This article evaluates the stop-bar detection and count performance of three advanced vehicle detection sensors under various environmental conditions at a signalized intersection. Continuing advancements to vehicle detection technologies and improvements to their detection capabilities to overcome issues from impacting conditions necessitates testing the performance of new and upgraded sensor products to evaluate their performance and identify the most suitable products for various climates and weather conditions. The three evaluated sensors were Autoscope Encore video, Iteris Vantage Edge 2 video, and Wavetronix SmartSensor Matrix microwave sensors. The three sensors performed with high detection sensitivity during ideal environmental conditions with up to 99.9% detection accuracy levels and are suitable for traffic monitoring centers that rely on remote access to the monitored sites and the collected data. However, they were affected by some extreme adverse weather conditions, mainly daytime and nighttime snow, daytime fog, dawn lighting, and strong winds (for high mounted devices). The selection of a sensor product will depend on the type of application and the priority given to the type of traffic data being collected. Overall, the Iteris video sensor performed with the highest detection sensitivity levels, with the Wavetronix Matrix microwave sensor performing similarly under most conditions (14 of 19 evaluated conditions). Autoscope video provided the highest count accuracies and also provides a much broader data collection capability. The results of this study will help transportation agencies in selecting suitable vehicle detection sensor technologies for future installations within their jurisdiction and improved data collection.

Savolainen, Peter T; Sharma, Anuj; Gates, Timothy J. **Driver decision-making in the dilemma zone - Examining the influences of clearance intervals, enforcement cameras and the provision of advance warning through a panel data random parameters probit model.** Accident Analysis & Prevention, Volume 96, 2016, pp 351-360
https://trid.trb.org/view/1424802

Abstract: In recent years, there have been a series of innovations in the field of vehicle detection at intersection approaches. Modern radar-based smart sensors make it possible to track individual vehicles in close proximity to an intersection. These advancements in technology potentially enable the provision of vehicle- and site-specific decision dilemma zone protection at the onset of the yellow indication at signalized intersections. To exploit this opportunity, it is critical to develop an in-depth understanding of those factors influencing a driver's decision to stop or go at the onset of yellow. This study investigates how signal timing strategies such as yellow interval durations, all-red clearance intervals, advance warning flashers, and automated camera enforcement affect driver decision-making. Data from 87 intersection approaches across five regions of the United States are used to develop a series of decision (i.e., probability of stopping) curves using vehicle trajectory and signal phasing data. A panel data random parameters probit model is used to account for heterogeneity across locations, as well as correlation in driver decision-making, due to unobserved factors that are unique to each signalized intersection. The results demonstrate drivers are more likely to stop at locations where enforcement cameras or flashers are present. Stopping was also more prevalent at intersections with lower speed limits, longer crossing distances, and where pedestrian crosswalks were present.

Zender, Riannon L; Chang, Kevin; Abdel-Rahim, Ahmed. **Evaluation of Vehicle Detection Systems for Traffic Signal System Operations.** National Institute for Advanced Transportation Technology; Idaho Transportation Department; Federal Highway Administration, 2016, 49p
https://trid.trb.org/view/1504034

Abstract: Typical vehicle detection systems used in traffic signal operations are comprised of inductive loop detectors. Because of costs, installation challenges, and operation and maintenance issues, many alternative non-intrusive systems have been developed and are now commercially available. Field-testing was conducted to evaluate nine alternative vehicle detection systems (four video, two radar, one thermal, and two hybrid) at the stop bar zone of a signalized intersection under six conditions: (a) daytime, (b) nighttime, (c) favorable conditions, (d) windy conditions, (e) rain, and (f) snow. The sensors were set up with two detection zones: one for the through and right-turn movements (Zone 1) and one for the left-turn lane (Zone 2). Trained personnel installed all systems, and decisions on the mounting locations were made by each system manufacturer. Based on the results of this study, it can be concluded that there is no...
single system that universally performs better than all other systems. Depending on the time of day or weather condition, many of the system types tested could claim that their technology outperforms all others. However, based on the percentage of false and missed detections for all of the products representing the different system types, there are opportunities for future improvement and enhancement. The acceptable tolerance level ultimately must be decided upon by the agency operating a particular signal, and it is recommended, based on the results from this study, that specific performance standards be defined when solicitation of signal detection equipment occurs in the future.


Abstract: As train frequencies and traffic volumes increase, the need for safer at grade highway/rail crossings is paramount. Closing or grade separating crossings ultimately cannot work for all situations; therefore four quadrant gates may be used to provide a higher level of safety than conventional crossing treatments. At crossings between two adjacent signalized intersections, signal preemption may prevent vehicles from queuing within the crossing island, but some risk of vehicles becoming trapped by the timed exit gate descents still remains. Sensors can be installed to detect vehicles and would extend exit gate closure until the crossing island is clear or conversely allow for either simultaneous or near simultaneous entry and exit gate descents, if no vehicles are present. Radar detection was installed at three sites on North Carolina Railroad Company's H-Line in January 2014. Each crossing activation was broken down into 8 stages based on operating conditions of the gate system. The average duration of the time period when all gates are fully deployed increased considerably during the after period (when radar modified the exit gate behavior) by 10-17Â’s, providing a longer duration of a sealed crossing before the train arrived.

**Leveraging Connected Vehicles to Enhance Traffic Responsive Traffic Signal Control. [Project].** United States Department of Transportation - FHWA - LTAP, ECONorthwest, Marshall University, Huntington, Old Dominion University, Virginia Tech Transportation Institute, Office of the Assistant Secretary for Research and Technology, Mid-Atlantic Transportation Sustainability Center. Start date: 1 May. 2016. [https://trid.trb.org/view/1401178](https://trid.trb.org/view/1401178)

Description: Actuated traffic signal controllers rely on sensors to detect vehicles so that green time can be allocated on a second-by-second basis. Traffic signals that are part of a closed loop system running coordination plans can also utilize detector information to select different pre-programmed plans based on the current traffic state. These Traffic Responsive Plan Selection (TRPS) algorithms currently rely on point detectors that only measure volume and occupancy. With the anticipated implementation of Connected Vehicles, sensors can be installed at signalized intersections to collect the trajectory of these vehicles, which will allow queue lengths to be estimated. Additionally, many radar-based sensors that are currently on the market are capable of tracking vehicles approaching an intersection, which can also be used to estimate queue lengths. This queue length information can be fused with the volume and occupancy data from point detectors to gain an even better understanding of the state of the signal system. This enhanced information could likely allow even better selection of pre-programmed coordination plans. When trajectory-based vehicle information becomes widespread and reliable, it is entirely possible that this information will be used by the controller logic to directly make decisions. In the meantime, this research will investigate whether this information can be leveraged to further enhance TRPS control, which is widely available in most traffic signal controllers. An existing Central system-in-the-loop simulation of a traffic signal system in Morgantown, WV will be utilized to implement and test algorithms for estimating queue lengths from vehicle trajectory data in real-time, estimating the state of the system in real-time, and communicating information back to the controllers to change the timing plans, when appropriate. The advanced TRPS will be compared to basic coordination timing plans and basic TRPS control across various volume scenarios to estimate improvements in delay, emissions, and fuel consumption.

Ishak, Sherif; Codjoe, Julius; Mousa, Saleh; Jenkins, Syndney; Bonnette, Jennifer. **Traffic Counting Using Existing Video Detection Cameras.** Louisiana State University, Baton Rouge; Louisiana Department of Transportation and Development; Federal Highway Administration; National Center for Intermodal Transportation for Economic Competitiveness; Research and Innovative Technology Administration, 2016, 126p. [https://trid.trb.org/view/1416963](https://trid.trb.org/view/1416963)

Abstract: The purpose of this study is to evaluate the video detection technologies currently adopted by the city of Baton Rouge and the Louisiana Department of Transportation and Development. The main objective is to review the
performance of Econolite **Autoscope** cameras in terms of their ability to detect data, ease of use, accessibility to data, security issues and cost. The final goal of this project is to investigate the effectiveness of this **video detection** technology in traffic data collection at **signalized intersections** in Baton Rouge and to judge the reliability of integrating the traffic count data from the **Autoscopes** into a database that could be used to supplement traffic count information at any time. In order to accomplish these tasks, a sample of intersections was selected for analysis from an inventory detailing each site’s traffic volume, lighting conditions, turning movements, camera mounting type, technology used, and geometric characteristics. Volume counts from the **video detection** technology (camera counts) were statistically compared against ground truth data (manual counts) by means of Multiple Logistic Regression and t-tests. Using these data, the capabilities of the existing **video detection** system was assessed to determine the quality of the data collected under various settings. The results of this research indicate that the performance of the Solo Terra **Autoscopes** was not consistent across the sample. Of the 20 intersections sampled, eight locations (40%) proved to show significant statistical differences between the camera and manual counts. The results of the regression analysis showed only lane configuration, time of day, and actual traffic volumes were statistically affecting the performance of the **Autoscopes**. According to supplemental t-test analysis on the time of day, the least accurate counts were recorded during the morning and afternoon peak hours and late at night. When testing based on traffic volume, the camera performance worsened as the traffic volume increased; when considering lane configuration, there were statistical differences for the through lanes, right lanes, and shared right/through lanes. Due to the fact that 60% of the sampled intersections (the remaining 12 out of the 20) provided reliable performance under high traffic volumes and during the same study period and weather conditions, the research team attributed the poor performance of some of the cameras to poor calibration and maintenance of the system. It was concluded that the recalibration of the Econolite **Autoscopes** can significantly enhance the performance of the **video detection** system, and it can therefore be considered a reliable means for traffic counting.

**Abdel-Aty, Mohamed; Shi, Qi; Wang, Ling; Wu, Yina; Radwan, Essam; Zhang, Binya. Integration of Microscopic Big Traffic Data in Simulation-Based Safety Analysis.** University of Central Florida, Orlando; Safety Research Using Simulation University Transportation Center (SaferSim); Office of the Assistant Secretary for Research and Technology, 2016, 134p
https://trid.trb.org/view/1407244

Abstract: The main objectives of this study were to explore different **vehicle detection** systems, focusing on the most widely deployed infrastructure-based sensing technologies. This project used traffic data from two point-based over-roadway **detection** systems, namely the **Microwave Vehicle Detection** System (MVDS) and the **Video Image Processing** (VIP) system, and data from a segment-based probe-vehicle system, the Automatic Vehicle Identification (AVI) system, to conduct operation and safety evaluations. Applications of these types of data for efficiency and safety evaluation, and simulation, were investigated. To achieve the proposed objectives, several tasks were carried out. Task 1: Identify and collect continuous measurements of traffic conditions at different levels: segment-based, point-based, and vehicle based; Task 2: Validate the use of different microscopic data sources; Task 3: Measure traffic efficiency: congestion measurement and travel time reliability in real-time; Task 4: Evaluate traffic safety: relationship between traffic flow (speed, flow, density, congestion) and crash occurrence, crash precursors in real-time; Task 5: Simulate traffic flow under adverse weather conditions in microsimulation. Real-time traffic data (combined as needed with weather data) could be used to tune traffic flow under different conditions in micro-simulation; Task 6: Investigate the use of **video-based** data; Task 7: Develop a simulation model using **video**-based parameters; Task 8: Use the new simulation model to investigate dilemma zone decisions at **signalized intersections**.

**Yang, Jidong; Zuo, Bashan; Kim, Sung-Hee. Understanding the Factors Underlying Variation in Detection Errors of Video- and Thermal-Imaging Cameras.** Transportation Research Record: Journal of the Transportation Research Board, Issue 2557, 2016, pp 55-65
https://trid.trb.org/view/1393738

Abstract: **Video**-imaging technology has long been used for **vehicle detection** at **signalized intersections**. This technology provides many advantages over conventional inductive loops. **Video**-imaging cameras are easier and safer to install and maintain; the cameras cause no damage to the pavement; and **detection** zones can be adjusted or redrawn when travel lanes are realigned or reassigned as a result of widening or remarking of the pavement. Despite the advantages, **video**-imaging cameras are generally susceptible to varying lighting conditions. **Thermal**-imaging cameras produce images on the basis of the difference in thermal energy emitted by objects and do not rely on visible light. Thus, the cameras are more robust in various lighting conditions. In this paper, both **video**-imaging and **thermal**-imaging technologies were evaluated for stop bar **vehicle detection** at **signalized intersections**. The **detection** errors were correlated with concurrent weather and environmental conditions. The performance of both types of cameras appears to
be affected by wind and various weather events. In particular, uneven shade appears to be an issue for the video-imaging camera but not for the thermal-imaging camera. The video-imaging camera seems to be more susceptible to false calls at night, likely caused by vehicle headlights. A higher chance of missed calls and calls stuck on was experienced for the thermal-imaging camera at night.

Middleton, Dan; Songchitraksa, Praprut; Pratt, Michael P; Sunkari, Srinivasa; Geedipally, Srinivas; Charara, Hassan. Investigation of New Vehicle Detectors for High-Speed Signalized Intersections. Texas A&M Transportation Institute; Texas Department of Transportation; Federal Highway Administration, 2015, 190p https://trid.trb.org/view/1403381

Abstract: Early indications from the use of the newest vehicle detectors for high-speed signalized intersections suggested that they perform well as replacements for the Texas Department of Transportation’s (TxDOT’s) legacy systems, but this early conclusion needed verification based on rigorous field testing in a variety of traffic and environmental conditions. This research investigated the performance characteristics of detectors designed for the stop line area and indecision zone detection. In some cases, new detectors involved two technologies to cover both upstream and stop line areas. Increasing use of infrared (IR) cameras with video imaging systems was an attempt to overcome some of the limitations of traditional video detection. While these IR cameras may improve video detection for some lighting and temperature conditions, evidence suggested that they do not improve detection performance under all conditions. The objectives of this research were to: (1) Determine current TxDOT-specific needs for new vehicle detectors; (2) Identify the most promising detectors for both stop line and dilemma zone detection; and (3) Develop guidelines on each new technology and establish recommended controller and detector settings to guide TxDOT on installation and use of each detector and combination of detectors.


Abstract: Approaches considered to improve safety at rural high speed signalized intersections most likely will adversely affect the operational aspect of the intersection, and vice-versa. Vehicle Detection Systems and Advanced Warning Systems (AWS) have been used to end the green phase for the major road approaches in a safe manner and to warn drivers of an upcoming change of phase, respectively. If phase termination is by max-out, it will eliminate the expected safety benefit by ending the green phase without considering vehicles that may be traveling the dilemma zone. In order to address this concern, an intelligent detection control system (D-CS) was developed by Texas A&M University. The main feature of this system is to identify if trucks are located in the dilemma zone in order to extend the green beyond the maximum limit to allow them to safely cross the intersection. This research evaluates the D-CS and traditional vehicle detection systems in a Canadian environment. For this evaluation, operational and safety performance of both systems were determined and compared at high speed signalized intersections. This paper only presents results for the operational evaluation. Parameters considered for this evaluation include: control delay, percent of vehicles stopping on red, and percent of vehicles in the dilemma zone. For field data collection, video cameras were used to record actual data (traffic volume, signal timing, others) at two signalized intersections. Results indicated that the D-CS has a better operational performance than the traditional vehicle detection system.


Abstract: A variety of sensor technologies, such as loop detectors, traffic cameras, and radar, have been developed for real-time traffic monitoring at intersections most of which are limited to providing link traffic information with few being capable of detecting turning movements. Accurate real-time information on turning movement counts at signalized intersections is a critical requirement for many applications such as adaptive traffic signal control. Several attempts have been made in the past to develop algorithms for inferring turning movements at intersections from entry and exit counts; however, the estimation quality of these algorithms varies considerably. This paper introduces a method to improve robustness and accuracy of turning movement estimation at signalized intersections. The new algorithm makes use of signal phase status to minimize the underlying estimation ambiguity. A case study was conducted based on turning movement data obtained from a four-leg, two-phase signalized intersection to evaluate the performance of the proposed
method and compare it with two other existing methods. The results show that the algorithm is highly accurate and robust and fairly straightforward for real world implementation.

Medina, Juan C; Benekohal, Rahim (Ray) F; Ramezani, Hani. Field Evaluation of Smart Sensor Vehicle Detectors at Intersections, Volume 2: Performance Under Adverse Weather Conditions. University of Illinois, Urbana-Champaign; Illinois Department of Transportation; Federal Highway Administration, 2013, 44p
https://trid.trb.org/view/1250027
Abstract: Two microwave-based systems for vehicle detection (by Wavetronix and MS SEDCO) were evaluated at stop bar and advance zones of a signalized intersection under three adverse weather conditions: (1) wind, (2) snow-covered roadway, and (3) rain. Weather effects were very different for the two systems both in terms of the type of condition that could affect performance and in the magnitude of those effects. For Wavetronix, wind had significant effects on the advance zone by increasing false calls to over 50%, but it did not affect the stop bar zones. On the other hand, false calls in snow significantly increased to more than 40% in the stop bar zones and to about 30% in the advance zone. Snow also increased missed and stuck-on calls but in lower proportion than the false calls. Rain also affected the detection at stop bar zones, but all error types were below 8%, and it did not affect the advance zone. For Intersector, weather effects were less pronounced both at the stop bar and advance zones. Snow increased false calls to a range of about 4% to 8% compared to 1.65% to about 4% in normal weather. In addition, rain increased stuck-on calls to a range of 2.7% to 6.35% at the stop bar zones and increased missed calls at advance zones to 3.44%. Wind had no significant effects at stop bar or advance zones. In particular for the rain data, the intensity of the precipitation seemed to be related to the degree of performance degradation. In datasets with higher precipitation per unit of time, higher false calls were observed at Wavetronix stop bar zones, and a higher frequency of missed calls was observed at the Intersector advance zone. Findings from this evaluation can provide valuable information to users and manufacturers of these products regarding expected performance under adverse weather conditions at locations with similar mountings and settings, as well as insight about potential solutions to preventing negative effects in such scenarios.

https://trid.trb.org/view/1267211
Abstract: This issue contains 14 papers concerning traffic signal systems. Specific topics addressed include: intelligent dilemma-zone protection systems for high-speed rural intersections; adaptive signal control in Germany; queue length estimation under connected vehicle technology; signal timing optimization of full continuous flow intersections; transit priority strategies for multiple routes under headway-based operations; multiregime adaptive signal control for congested urban roadway networks; and metered entry volume on an oversaturated network with dynamic signal timing. Additional topics include: arterial queue spillback detection and signal control based on connected vehicle technology; transit priority control under arterial progression; dynamic programming approach for arterial signal optimization; self-organizing control logic for oversaturated arterials; microwave radar vehicle detectors at signalized intersections under adverse weather conditions; a performance diagnosis tool for arterial traffic signals; and the impact of adaptive traffic signal control on traffic and transit performance.

https://trid.trb.org/view/1260210
Abstract: Video detection systems (VIDS) are considered to be the smartest choice for detecting vehicles approaching signalized intersections. The VIDS typically have mast arm poles and the mounting platform provides a stable view and optimum location for positioning the camera sensor. However, traffic signals in most of the country are typically constructed with span-wire instead of the more expensive mast arm poles. Until now, the drawbacks for using VIDS at span-wired signals outweighed the benefits. This article presents the benefits of VIDS, which are: (1) a lower lifecycle cost; (2) the ability to gather more information; (3) the capability to redefine and add detection zones at will; (4) the ability to remotely view traffic conditions from the traffic manager’s desk; (5) the ability to remotely perform some maintenance from the traffic technician’s desk; (6) the avoidance of danger-filled and congestion-causing lane-blocking construction; (7) the ability to differentiate between bicycles and vehicles in the same processing unit; and (8) the ability via software updating to incorporate improved detection algorithms over time.
Medina, Juan C; Ramezani, Hani; Benekohal, Rahim (Ray) F. **Evaluation of Microwave Radar Vehicle Detectors at a Signalized Intersection Under Adverse Weather Conditions.** Transportation Research Record: Journal of the Transportation Research Board, Issue 2356, 2013, pp 100-108
https://trid.trb.org/view/1242010

Abstract: Two microwave radar systems for vehicle detection, manufactured by Wavetronix and MS SEDCO, were evaluated at stop bar and advance zones of a signalized intersection under three adverse conditions: (a) high wind speeds, (b) rain, and (c) fully or partially snow-covered roadway. Data under normal (favorable) weather conditions were also analyzed and used for comparison. Results show that the performance of the two systems deteriorated during adverse weather, and the type of detection errors and their frequency were system dependent. In general, wind increased false calls at the advance detection zone by more than 50%, depending on the location and sensor type; snow-covered roadway had more widespread effects and increased false calls at stop bar and advance zones, depending on the system, and also increased missed calls at stop bar zones; and rain affected the two systems by increasing false calls and stuck-on calls at the stop bar and false calls at the advance zones. Data also showed that frequencies of false and missed calls were likely to increase as precipitation intensity and wind speeds increased. Results from this evaluation show significant effects of adverse weather on microwave radar detection systems, providing information to researchers and practitioners regarding the potential performance of similar setups under such conditions. Details on the detection errors offer insight on situations that should be monitored and could be used to improve performance under adverse weather.

Medina, Juan C; Benekohal, Rahim (Ray) F; Ramezani, Hani. **Field Evaluation of Smart Sensor Vehicle Detectors at Intersections—Volume 1: Normal Weather Conditions.** Civil Engineering Studies, Illinois Center for Transportation Series, Illinois Department of Transportation; Federal Highway Administration, Issue 12-016, 2012, 32p
https://trid.trb.org/view/1223701

Abstract: Microwave-based vehicle detection products from two manufacturers were selected for field testing and evaluation: Wavetronix and Intersector. The two systems were installed by the manufacturer/distributor at a signalized intersection. Initial evaluation was performed and the results were shared with the companies. They were given an opportunity to change or fine-tune the system’s setup, if they wanted, resulting in a modified setup. Results are presented in this report in terms of four types of errors (false, missed, stuck-on, and dropped calls). At the stop bar, at least 94% of detections for Wavetronix and 96% for Intersector were correct. At stop bar zones, the overall occurrence of false calls for Wavetronix ranged from 0.56% to 1.62%. Missed calls were low for Zones 1 and 2 (0.13% and 0.43%) but significantly higher in Zone 3 (6.05%). Also, stuck-on calls were only observed in Zone 3 (0.58%), and a few dropped calls were found almost exclusively in Zone 3 (0.16%). For Intersector, false calls ranged from 1.4% to 3.56% and missed calls ranged between 0.05% and 0.27%. Stuck-on calls ranged from 0.92% for 2.83% and dropped calls were very low (0% and 0.19%). At the advance zones, at least 91% of detections for Wavetronix and 99% for Intersector were correct. For the advance zone, a direct comparison of the two systems was not performed because Wavetronix covered all three lanes combined, but Intersector had one zone covering only the center lane. Wavetronix did not have any stuck-on or dropped calls, missed calls were 1.07%, and false calls were 8.29% for the summer and fall datasets combined. Intersector had no dropped calls, 0.04% stuck-on calls (only one call), 0.8% missed calls, and 0.7% false calls. Additional testing is under way to evaluate the performance of the two systems under inclement weather conditions.

https://trid.trb.org/view/1135967

Abstract: The dilemma zone is the area where drivers must decide whether to stop or go when presented with a yellow traffic signal. An incorrect decision, leading to either stopping too suddenly or running a red light, can cause accidents. Advanced vehicle detection systems could help mitigate these dilemma zone conflicts. This paper presents a field test that modeled and evaluated the impacts associated with both point (fixed) and space (continuous) advanced detection systems. A radar-based space sensor was installed at a high-speed signalized intersection approach and evaluated in comparison with a typical signal timing plan and advance vehicle detection provided by an in-pavement inductive loop. The results showed that the rate of drivers exposed to the yellow indication within the dilemma zone was reduced by 20% with the space sensor. Far fewer drivers passed through the intersection on yellow or ran the red light with the space sensor. These findings provide preliminary evidence that radar-based space sensors could potentially improve dilemma zone safety at high-speed signalized intersections. Directions for future research are discussed.
Santiago-Chaparro, Kelvin R; Chitturi, Madhav; Bill, Andrea R; Noyce, David A. Real Time Performance Measures from Radar-based Vehicle Detection Systems. 19th ITS World Congress, ITS America, 2012, 10p https://trid.trb.org/view/1280339

Abstract: Real time monitoring of a transportation system provide agencies with crucial data for fine-tuning their systems. In the case of intersections having real time measures such as delay, queue length, safety indicators can help in planning, designing, and operating the transportation system better. Previous research has focused on computing real time performance measures from point data, mostly the result of monitoring loop detector data, through the use of models and approximations. However, if the individual trajectories of vehicles are known the quality of the values will improve significantly even when the complexity of the models required to obtain the measures is reduced. Technological advances are resulting in vehicle detection devices that not only act as a substitute for loop detectors but provide information that can be used to obtain vehicle trajectories. This paper focuses on presenting the logic behind a software-based methodology used to generate real time performance measures from vehicle trajectories as well as broadcasting those measurements to stakeholders over the internet without significant capital investments. From a practical purpose point of view the methodology, with the appropriate modifications, is used to monitor and broadcast average stopped delay at a signalized intersection approach using a radar-based vehicle detection device.


Abstract: This issue contains 20 papers concerned with the following aspects of urban and traffic data systems: data mining to study patterns of use of transport modes; using household travel data to measure regional traffic congestion; link covering and node covering formulations of the detection layout problem; multisensor data integration and fusion in traffic operations and management; sensitivity of commuters’ demographic characteristics to license plate data collection specifications; average travel time estimates for urban routes with exit turning movements; short-term travel time prediction considering weather effects; vehicle reidentification and travel time estimation using video image data; travel time reliability in New York City; using Bluetooth technology to generate route-specific origin-destination tables; hypothesis test for travel time data quality; comparison of reported speeds from corresponding fixed-point and probe-based detection systems; estimating multiclass and multilane counts from aggregate loop detector data; traffic ground truth estimation; imputation of video detection data in intelligent transportation systems; uncertainty treatment in FHWA procedure for estimating annual average daily traffic volume; estimating traffic speed with single inductive loop event data; Bluetooth sensor data and ground truth testing of reported travel times; lidar-based vehicle classification; and thermal image video sensors for stop bar detection at signalized intersections.


Abstract: Existing economic constraints require developing solutions that can solve the problems of the future in a cost-effective way. Therefore, relying on acquisition of new hardware-based systems which typically involve significant capital investment is probably not an economically-feasible alternative. Instead, for improving the operations of our transportation system through the use of technologies such as adaptive traffic control and those that allow real time monitoring needs to be achieved by managing existing systems more intelligently and by extending the capabilities of existing devices using a software-based approach. Through the use of an existing radar-based vehicle detection system real time delay per vehicle measurements were obtained for a signalized intersection approach. Software was developed to interpret the datastream produced by the device on real time and monitor the trajectory of vehicles approaching the intersection. Delay was computed from the vehicle trajectories by treating vehicles as individual particles that move through the intersection therefore allowing the application of fundamental dynamics models to compute delay. Delay measurements are broadcast in realtime thus allowing monitoring and control from a traffic control center. The accuracy of the procedures was validated by comparing trajectories obtained using the vehicle detection with those obtained using an instrumented vehicle. Data from the validation shows that data from the existing devices can be processed to produce trajectories that accurately match those of vehicles approaching the intersection. The methods and the software presented by the authors show the feasibility of adding value to existing vehicle detection systems by adding functions that are far beyond the device design capabilities.
https://trid.trb.org/view/1128982
Abstract: Thermal image sensors for stop bar presence detection have recently been introduced to the traffic industry as an alternative to cameras sensitive only to the visual spectrum. This new detection technology, from two manufacturers, was evaluated side by side with a video detection system. Inductive loops were used for a comparison to identify discrepancies that warranted the manual establishment of ground truth of the video images. The video camera and two thermal sensors operated simultaneously over a 24-h period, and discrepancies in the loop versus thermal or video detection calls were validated from recorded video. No missed call events longer than 10 s were observed, and only a modest number of false calls were made by the test systems. The bias in activation and termination times was also evaluated during day and night operation for each system. The study found that the median time difference in activating a detection zone was about 1 s when the day and night operations of the detection system were compared with a video camera. This finding is consistent with past studies that reported nighttime detection challenges related to headlight projections. However, the thermal cameras had virtually no change in median activation times when day and nighttime operations were compared. This encouraging finding suggests that integrating cameras sensitive to the infrared spectrum holds considerable promise for improving the quality of nighttime video detection.

Sharma, Anuj; Schmitz, Jacob. The Effects of Pedestrian Countdown Timers on Safety and Efficiency of Operations at Signalized Intersections. University of Nebraska, Lincoln; Nebraska Department of Roads, 2011, 86p
https://trid.trb.org/view/1239510
Abstract: Pedestrian countdown timers are becoming common at urban and suburban intersections. The added information that pedestrian countdown timers provide to pedestrians can also be used by approaching drivers. A before-and-after case study on the effects that pedestrian countdown timers have on safety and efficiency of operations was performed at two signalized intersections in Lincoln, Nebraska. The effects on both drivers and pedestrians were analyzed. Performance measures for pedestrian analysis include pedestrian compliance and average pedestrian walking speed. Performance measures for the driver analysis include probability of stopping and speed gain of vehicles at the stop bar during the yellow phase (vehicles passing through the intersection during the yellow phase) and queue discharge headway. Data was collected using a Wide Area Detector (WAD), point detector at the stop bar and a Pan-Tilt-Zoom (PTZ) video camera. Data was collected using state-of-the-art data collection software, Wonderware, which displayed all traffic and pedestrian signal information, vehicle detections, individual vehicle speeds, vehicle distances from stop bar, and the video from the PTZ camera all on one computer screen. Statistical models were estimated to understand the effects that pedestrian countdown timers have on the performance measures. The resulting models identified statistically significant factors that affected the performance measures. Pedestrian countdown timers were found to increase pedestrian walking speed by 0.2 ft/sec, and decrease the probability of pedestrian violations. Impact of PCT on driver safety and efficiency was not found to be statistically significant at 95% level of confidence. There was however some evidence, although not statistically significant of improvement of driver safety due the presence of PCT. The trend was more pronounced at the intersection of 17th and G (smaller intersection with less visual clutter) where the authors observed reduction in the percentage of red light runners and some reduction of dilemma zone boundaries.

https://trid.trb.org/view/1103171
Abstract: The performance of the Sensys wireless vehicle detection system was evaluated under adverse weather conditions (winter and rain) at a signalized intersection and in close proximity to the railroad tracks at a grade crossing. At the intersection stop bar zones, the overall frequency of false calls due to vehicles in the adjacent lanes ranged from 7.7% to 15.4% per lane in the winter data and between 2.6% and 6.2% in the rain data. In addition, the frequency of multiple activations due to a single vehicle (flickering false calls) ranged from 4.2% to 7.2% in the winter data and from 5% to 7.7% in the rain data. There were only seven stuck-on calls, two missed calls, and no dropped calls. At the intersection advance zones, frequency of missed vehicles traveling between the lanes ranged between 0.4% and 5.4% in the winter condition, and between 0.8% and 9.7% in the rain condition. A low percentage of vehicles traveling inside the marked lane (0%-1.2% per lane) were missed. False calls ranged on average from 1% to 4%. No stuck-on calls or dropped calls were found at the advance zones. At the railroad grade crossing, the trains generated multiple activations in the Sensys
detectors as they passed the crossing. After they departed, the sensors terminated the activations except in a few cases, where the calls remained stuck-on for periods of time. In addition, false calls were the most common type of detection error, which represented 56% to 60% of the total number of calls in the left-turn lane, and 13% to 14% in the through lane. Most of the false calls in the left-turn lane were caused by vehicles traveling in the opposing direction.

https://trid.trb.org/view/1109444

Abstract: Wireless magnetometers for vehicle detection were evaluated at a signalized intersection at both stop bar and advance locations. The studied approach had three lanes, and for each lane one sensor was installed at the stop bar and one more at the advance zones. Loop detectors were installed at the same location of the magnetometers and were used as a pointer to identify potential detection errors. Initially, data was collected after the system was installed by the manufacturer. Then, the system setup was adjusted by the manufacturer based on the analysis of the initial data, and data was collected again. Results show that the most frequent error at the stop bar was false calls (5.6%-7.6% due to vehicles in adjacent lanes, and additional 7.8%-9.6% due to single vehicles placing multiple calls), and at the advanced zones it was missed calls (0.9% to 10% per zone). Stuck-on calls and dropped calls were very rare.

Medina, Juan C; Hajbabaie, Ali; Benekohal, Rahim F.. **Detection Performance of Wireless Magnetometers at Signalized Intersection and Railroad Grade Crossing Under Various Weather Conditions.** Transportation Research Record: Journal of the Transportation Research Board, Issue 2259, 2011, pp 233-241  
https://trid.trb.org/view/1093123

Abstract: The performance of wireless magnetometers for vehicle detection was evaluated under favorable and adverse weather conditions at two sites: (a) a signalized intersection with stop bar and advance detection zones and (b) a railroad grade crossing, as a potential backup system to control the operation of gates. Loop detectors and magnetometers were installed at the same locations, providing similar detection areas. Discrepancies between activations from loops and magnetometers provided pointers to potential errors in the systems, and video images were used to verify them visually. At the signalized intersection, the most common type of detection error by the magnetometers in the stop bar zones was a false call caused by vehicles in the adjacent lane, with 5.6% to 7.6% error per lane in favorable weather and 7.7% to 15.4% in winter conditions. At the advance zones the most frequent error in all weather conditions was a missed call caused by vehicles traveling between two lanes, ranging from 2.9% to 9.7% in the left-turn lanes. At the railroad grade crossing, however, most errors were false and stuck-on calls. On average, there was one stuck-on call per every 150 trains, and one per every 2,800 vehicles. False calls varied from 13.4% to 14.1% in the through lane and from 55.9% to 59.9% in the left-turn lane, caused mostly by vehicles traveling in the opposing direction (this was an atypical location with no median separating the two directions of traffic).

Middleton, Dan; Longmire, Ryan; Charara, Hassan; Bullock, Darcy; Bonneson, Jim. **Improving Stop Line Detection Using Video Imaging Detectors.** Texas Transportation Institute; Texas Department of Transportation; Federal Highway Administration, 2010, 94p  
https://trid.trb.org/view/1089516

Abstract: The Texas Department of Transportation and other state departments of transportation as well as cities nationwide are using video detection successfully at signalized intersections. However, operational issues with video imaging vehicle detection systems (VIVDS) products occur at some locations. The resulting issues vary but have included: camera contrast loss resulting in max-recall operation; failure to detect vehicles leading to excessive delay and red-light violations; and degraded detection accuracy during nighttime hours. This research resulted in the development of a formalized VIVDS test protocol and a set of performance measures that agencies can incorporate in future purchase orders and use to uniformly evaluate VIVDS products. It also resulted in the development of a VIVDS video library and conceptual plans for a field laboratory for future projects to deploy a range of VIVDS products at an operational signalized intersection. Researchers evaluated alternative VIVDS stop line detection designs and developed methods for enhancing the operation of VIVDS through adjustments in controller settings for day versus night versus transition periods, zone placement, and camera placement.

Abstract: This report documents the results of a study on evaluating three major video imaging vehicle detection systems (VIVDSs) currently deployed in Nevada’s urban areas. The report first provides a brief review of the features and functions of some major VIVDSs. The evaluation was based on videos collected at selected intersections in both Northern Nevada and Southern Nevada. The dataset included a total of 10 intersections consisting of 30 intersection approaches and about 48 hours of video for each approach. These videos were directly recorded with detection overlays from the VIVDSs at the sites. The detection accuracy was later verified manually by watching video playbacks in the lab. The performance of the VIVDS was assessed based on the accuracy level, taking into account the total missed and false detections. Missed and false detections were the two major sources of error considered in this study. Specific detection errors and possible causes were discussed for each site. Recommendations were provided for potentially reducing video detection errors. A set of guidelines was also provided for improving the VIVDS’s performance at existing intersections or future deployments.


Abstract: Reliable and robust detection systems are the cornerstone in the efficient and proper functioning of vehicle infrastructure integration. This paper presents the design and implementation of a testbed for evaluating vehicular detection systems. The development of the testbed involved design of the hardware setup required for real-time monitoring of the sensors, programming the devices for data capture, and development of algorithms to automate the analysis of the recorded data. The methodology used to calibrate and validate the algorithms to automate the analysis of the data is also presented. Although the testbed is presented in the context of evaluation of video detection systems at signalized intersections, it can be used for evaluating any vehicular detection systems.


Abstract: The flexibility and adaptability of video detection systems (VDS) make them attractive for vehicle detection at signalized intersections. However, the VDS performance could be affected by illumination and weather factors. This paper presents an evaluation of three commercial VDS under six adverse weather conditions including snow, fog, and rain, during daytime and/or nighttime. The systems were installed side-by-side at a signalized intersection, and evaluated at stop bar and advance zones based on four detection errors: false calls, missed calls, stuck-on calls (detections that are not terminated soon after vehicles depart), and dropped calls. Activation and deactivation timestamps were initially screened using a computer algorithm, and finally all errors were manually verified using video images. Results showed significant changes in the VDS performance under the different weather conditions. False activations increased in most scenarios but to a greater extent in snow conditions during both daytime and nighttime (typically to more than 50%, and up to 90%). Missed calls also increased in snow conditions and during dense fog (typically to more than 10%, and up to 50%) mostly at the advance zones. Stuck-on calls increased mostly in nighttime rain (less than 10%), while in general dropped calls were rare. Detailed quantification of the errors in each detection zone, and their potential causes are presented.


Abstract: This issue contains 18 papers concerned with traffic signal systems. Specific topics discussed include the following: simulation-based optimization of the maximum green setting; wireless magnetometer vehicle detectors at signalized intersections; management of signalized arterial capacity; arterial signal coordination; crosstalk detection in loop detectors at signalized intersections; railroad-preempted intersections; providing automated performance measures at signalized intersections with existing video detection equipment; signal priority near a major bus terminal; traffic signal transition in coordinated meshed networks; equitable traffic signal timing plans; decision tree model to prioritize signalized intersections near highway-railroad crossings; advance-detection designs for high-speed
intersection approaches; uncertainty and predictability of urban link travel time; cross-evaluation of optimized signal timing; robust signal timing for arterials under day-to-day demand variations; adaptive signal control; analytical models for protected/permitted left-turn capacity at signalized intersections with heavy traffic; and arterial performance measures with media access control readers.

Day, Christopher M; Premachandra, Hiromal; Brennan Jr, Thomas M; Sturdevant, James R; Bullock, Darcy M. Operational Evaluation of Wireless Magnetometer Vehicle Detectors at Signalized Intersection. Transportation Research Record: Journal of the Transportation Research Board, Issue 2192, 2010, pp 11-23  
https://trid.trb.org/view/909283

Abstract: Compact wireless magnetometers offer attractive vehicle detection ability at signalized intersections because their installation requires minimal pavement cutting and the detectors are less likely than saw-cut inductive loops to malfunction because of pavement failure. A study was done at an instrumented intersection to evaluate the performance of wireless magnetometers at operating signalized intersections. A test bed was constructed with colocated inductive loop and wireless magnetometer detection zones. A 5-day analysis period was conducted for each of two left-turn pockets at an actuated, coordinated signalized intersection. Discrepancies between the detection and nondetection states were quantified with high-resolution log data of traffic events, and 240 h of data collection that was ground-truthed by visual inspection of video recordings of the detection zones. Behavior of detector state changes was also characterized. Wireless magnetometers were found to perform similarly to loops in relation to missed calls and had a slightly higher tendency to generate false detection calls. Detection state changes in the wireless magnetometers had typical (85th percentile) reporting latencies of 0.2 s or less for activation and 0.5 s or less for state termination. The paper concludes by recommending 8-ft spacing of the sensors adjacent to the stop bar to minimize missed calls.

Least Relevant Results

TRID

Peng, Yun-long; Zhou, Zhu-ping; Li, Lei. Trajectories Prediction of Vehicles at the Intersection Based on LSTM Neural Network. 19th COTA International Conference of Transportation Professionals, American Society of Civil Engineers, 2019  
https://trid.trb.org/view/1634971

Abstract: More and more non-motorized vehicles (including bicycles and electric bicycles) are pouring into the intersections, making the intersections’ environment more complex. The traffic accidents related to the vehicles and non-motorized vehicles at the intersections are serious. In this paper, vehicle trajectory sets are extracted at the intersections by using the video detection technology. The trajectory prediction model of motor vehicles based on the long short term memory neural network training is obtained, which consider the influence of non-motorized vehicles. The trajectory prediction model based on LSTM is used to predict the trajectories of the vehicles passing through intersections. The overall approach was tested on real trajectories sets at specific intersections and results show that the model has a high success rate and the final trajectory prediction has a better accuracy.

https://trid.trb.org/view/1573073

Abstract: Queue length estimation is a crucial part of an Adaptive Traffic Control System (ATCS) to optimize control parameters. Most ATCS technologies depend on video camera based or video and detector-based fusion techniques to estimate signal queue lengths. These systems are costly considering the maintenance cost of operations. In this study, the authors developed a data-driven real-time queue length estimation technique using a deep learning approach. The authors consider a connected corridor where information from vehicle detectors (located at the intersection) will be shared in between consecutive intersections. The authors assume that the queue length for an intersection at the next cycle will depend on the queue length of the target intersection and previous two intersections at the current cycle. The authors used InSync ATCS data to train a Long Short-Term Memory Neural Network model to capture time dependent patterns of a queue in a signal. The experiment results show that the model performed very well to predict the queue length. Although the authors run the experiments predicting the queue length for a single movement, the proposed method is applicable for other movements as well.
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Evaluation of Non Intrusive Traffic Detection Technologies Phase III
https://pooledfund.org/Details/Study/398

National Vehicle Detector Test Center
https://pooledfund.org/Details/Study/78