Existing Research Topic 30

Adapting ODOT Radar Traffic Monitoring System to automatically track real-time traffic flow

RNS Database:

2018 Traffic Data Monitoring Partnerships with ITS Operations

State DOT highway travel monitoring programs are continually seeking consistent quality traffic data sources that can be integrated into their business model. There have been many new advances and a very rapid deployment of ITS systems which are being used to monitor and maintain a safe and operationally efficient transportation network in real-time. Since these systems are used for day-to-day operations, they are very well maintained and monitored. The objective of this study is to learn how technology integrations between the ITS community and the traffic monitoring community have removed barriers and how the partnerships have addressed data quality concerns. The study should provide the monitoring community a better understanding of how the partnerships are providing improved coordination and creating resource efficiencies while reducing their individual system program reach.

TRID/TRIS Database:

2021 A Control-Theoretic Approach for Scalable and Robust Traffic Density Estimation Using Convex Optimization

<http://dx.doi.org/10.1109/TITS.2019.2953023>

Monitoring and control of traffic networks represent alternative, inexpensive strategies to minimize traffic congestion. As the number of traffic sensors is naturally constrained by budgetary requirements, real-time estimation of traffic flow in road segments that are not equipped with sensors is of significant importance—thereby providing situational awareness and guiding real-time feedback control strategies. To that end, firstly the authors build a generalized traffic flow model for stretched highways with arbitrary number of ramp flows based on the Lighthill Whitham Richards (LWR) flow model. Secondly, they characterize the function set corresponding to the nonlinearities present in the LWR model, and use this characterization to design real-time and robust state estimators (SE) for stretched highway segments. Specifically, the authors show that the nonlinearities from the derived models are locally Lipschitz continuous by providing the analytical Lipschitz constants. Thirdly, the analytical derivation is then incorporated through a robust SE method given a limited number of traffic sensors, under the impact of process and measurement disturbances and unknown inputs. The estimator is based on deriving a convex semidefinite optimization problem. Finally, numerical tests are given showcasing the applicability, scalability, and robustness of the proposed estimator for large systems under high magnitude disturbances, parametric uncertainty, and unknown inputs.

2020 Improved Accuracy of Vehicle Counter for Real-Time Traffic Monitoring System

<http://dx.doi.org/10.2478/ttj-2020-0010>

This research proposes a background subtraction method with the truncate threshold to improve the accuracy of vehicle detection and tracking in real-time video streams. In previous research, vehicle detection accuracy still needs to be optimized, so it needed to be improved. In the vehicle detection method, there are several parts that greatly affect, one of which is the thresholding technique. Different thresholding methods can affect the results of the background and foreground separation. Based on the results of testing the proposed method can improve accuracy by more than 20% compared to the previous method. The thresholding method has a considerable influence on the final result of vehicle object detection. The results of the average accuracy of the three types of time, i.e. morning, daytime, and afternoon reached 96.01%. These results indicate that the vehicle counting accuracy is very satisfying, moreover, the method has also been implemented in a real way and can run smoothly.

2020 A spatiotemporal approach for traffic data imputation with complicated missing patterns

<https://doi.org/10.1016/j.trc.2020.102730>

With the advent of intelligent transportation systems (ITS), spatiotemporal traffic data has gained growing importance in real-time monitoring, prediction, and control of traffic. However, in practical implementations, data collection devices are often faced with malfunctions caused by various unpredictable disruptions, thereby resulting in the so-called “missing value problems.” In realistic cases, the disruptions to the data collection devices are often associated with some key events (e.g., power cut and natural disasters), in addition, along with other disruptions the missing value problem could be in a complicated manner with both randomly and completely missing patterns. To perform the imputation task with such complicated missing patterns, the authors propose a hybrid spatiotemporal method which utilizes the time series properties by “prophet” model and captures the spatial residuals information by iterative random forest model. The spatiotemporal method first applies the temporal part to fill the missing value and then adopts the spatial part to acquire the residual component of the missing values. The results of the two components are integrated into the final imputations. Based on the PeMS freeway dataset (PeMS, 2019) and an urban road dataset under extensive artificially designed scenarios like randomly, clustered non-completely and completely missing patterns, the authors test their proposed approach with some existing techniques such as K-Nearest Neighbor (KNN), Seasonal-Trend decomposition using Loess (STL), Bayesian tensor decomposition, Denoising AutoEncoder (DAE). The test results indicate that the hybrid method achieves the best imputation quality for most missing patterns, particularly for those with completely or hybrid missing patterns. Furthermore, the hybrid model still performs well under extreme missing rates as high as 0.9, which validates the robustness of the model in extreme situations.

2020 System Monitoring of Auto Traffic

<https://www.cutr.usf.edu/programs-1/nicr/year-one-projects/1-3-system-monitoring-of-auto-traffic/>

No matter where they form and why, queues are impactful to traffic, causing delay and increased accident potential. The overall goal of this effort is to explore methodologies for automatically detecting the development of queues in a street network. Additional objectives would be to determine the spread of the queue, the rate of spread, and identify their impact area. By automatically determining these parameters from real-time information, the next step of predictive management (not taken in this project) could be analyzed to proactively employ real-time strategies to minimize queue formation, spread, and impact. While any real-time analytics approach faces significant challenges, new research in big-data monitoring, assessment, and analysis techniques provide the premise for finding a practical real-time solution.

2020 (active) Real-Time Traffic Analytics at Intersections

<https://ppms.cit.cmu.edu/projects/detail/335>

Central to a smart transportation system is access to real-time data especially at points of planned conflict such as intersections. Unfortunately, visual data is too expensive in bandwidth for remote analysis. The proposed research focuses on performing analysis at the edge and only transmitting compact analysis results. Algorithms will be developed to detect and track vehicles, pedestrians, and bicyclists to summarize counts, travel direction, and notable events such as near collisions. Summary results will be submitted to a website for a real-time look of the road environment.

2017 CALTRANS Evaluating the Performance of Traffic Detection Devices - Continuation of Task 1559

<https://trid.trb.org/Results?txtKeywords=real%20time%20traffic%20flow%20radar%20video&txtTitle=&txtSerial=&ddlSubject=&txtReportNum=&ddlTrisfile=&txtIndex=&specificTerms=&txtAgency=&sourceagency=&txtAuthor=&ddlResultType=&chkFulltextOnly=&recordLanguage=&subjectLogic=or&dateStart=&dateEnd=&rangeType=emptyrange&sortBy=publisheddate&sortOrder=DESC&rpp=25#/View/1441787>

Efficiently managing and operating California’s highway system requires round-the-clock reliable and accurate information on traffic speed and flow. This information is derived from data collected throughout the state by vehicle detection devices, which California Department of Transportation (Caltrans) obtains from various vendors. However, the devices do not always perform exactly as advertised. Testing often reveals that vendors’ accuracy claims are overstated or based on ideal conditions measured during the middle of the day when the devices are easiest to check manually. Under less ideal conditions, such as twilight, fog, poor weather, and traffic congestion, they might have problems with accuracy. For example, the detector might “see” vehicles that are not actually present—false positives—or not see vehicles that are—false negatives. Caltrans designs traffic facilities based on 24/7 operations, so it needs the capability to evaluate the performance of roadside vehicle detection devices in all sorts of situations to ensure that they are accurate at all times and recalibrate them as needed. For the best results, this testing should take place in the field under real-world conditions for at least a 24-hour, 7-day period of time. The VideoSync system consists of both hardware and software, each of which can be used independently. The software syncs loop, radar, and other detector data with video and provides graphical and statistical tools for "ground truthing" the detector.The associated hardware aids in collecting field data and can be used as a stand-alone surveillance system C1 Reader is the hardware device that plugs into log 170 or 2070 controller and reads data, acting as a server to client software Videosync. Videosync is a data collection client, reporting tool and data validation tool. The deployment of this tool makes more sense on a large scale with a central or multiple large nodes serving a data collection points (mysql db servers) with multiple c1 reader devices. The main uses of the hardware and software package could be used like the portable emissions measurement system (PEMS) database but inside the cities like at intersections in support of connected vehicle or smart infrastructure. The other use is of course to help in troubleshooting and testing of current and future detecting technologies. This tool could be used in the field right when ready after the construction of intersections or troubleshooting intersections since when ready it can provide real time detections with reasonable small delays of a few seconds.

RiP Database:

2020 (related) Development of Cost-Effective Sensing Systems and Analytics (CeSSA) to Monitor Roadway Conditions and Mobility Safety

<https://rip.trb.org/Results?txtKeywords=traffic%20monitor&txtTitle=&txtSerial=&ddlSubject=1797&txtReportNum=&recordStatus=&projectStatus=&ddlTrisfile=&txtIndex=&states=&specificTerms=&txtAgency=&sourceagency=&txtAuthor=&ddlResultType=&chkFulltextOnly=0&subjectLogic=or&dateStart=&dateEnd=&rangeType=emptyrange&sortBy=publisheddate&sortOrder=DESC&rpp=50#/View/1683376>

This state-of-the-art Cost-Effective Sensing Systems and Analytics (CeSSA) project will provide an affordable method that will benefit state, city, county governments, as well as local communities who have an immediate need but with limited budgets to evaluate the road quality and prioritize repair needs. The project will specifically strengthen the following two major areas to advance our research competency: (1) advanced vehicle-based sensors using Bluetooth technology and (2) computing algorithms in analyzing vibration data. The sensors developed by the project will be attached on each control arm of a vehicle. The vehicle will travel on different roads to generate a variety of vibration signatures that will allow us to evaluate the efficiency and effectiveness of the sensors and algorithms in identifying road roughness. The analysis results will be used to determine where the potential hazards (cracks, potholes, bumps, etc) on roadways are located in Google maps. We will present four specific contributions in the proposal including: 1) Developing the CeSSA system that can immediately reflect the actual road conditions and transfer data to a mobile application and web server. 2) Assembling and programming a sensing network, integrating accelerometers, rotation sensors, and magnetometers, which can differentiate various road surface conditions from unexpected driver’s behavior due to traffic and weather conditions. 3) Unlike prior solutions, we are suggesting to develop the technology based on low cost componentry and commercially available for all highway agencies and institutions. We see the importance to lower the entry level, to deploy widely the scheme to developing countries, which need to improve their infrastructure. 4) Delivering a friendly user interface that will not require lengthy personnel training, and be easy to analyze. The project outcomes will effectively help the governments better prioritize road repairs and immediately inform drivers of potential hazard locations such that they can adjust their path prior to traveling so as to improve the highway condition monitoring, maintenance activities, as well as mobility safety.