Generating Traffic Information from Connected Vehicle V2V Basic Safety Messages: Literature Search
IdeaScale 80

June 20, 2017

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Prepared by: Sheila Hatchell

Resources searched: TRID, RIP, Library Catalog, Internet TRIS

Summary: I reviewed 199 records in Research in Progress and selected those that could have related information. Since I could find nothing directly related to the research idea, I looked for studies and reports related to receiving, combining and processing BSMs and traffic information.

Most Relevant Results

I was able to fine no most relevant results.

Least Relevant Results

Development and field demonstration of a DSRC-based V2I work zone traffic information system
Prepared by: Buddhika Maitipe, Umair Ibrahim, M. Imran Hayee. June 2012.

Abstract:
This report describes the architecture, functionality and the field demonstration results of a newly developed DSRC based V2I work zone traffic information system with V2V assistance. The developed system can automatically acquire important work zone travel information, e.g., the travel time (TT) and the starting location of congestion (SLoC), and relay them back to the drivers approaching the congestion site. Such information can help drivers in making informed decisions on route choice and/or preparing for upcoming congestion. Previously, we designed such a system using DSRC based V2I-only communication, which could not handle longer congestion lengths and the message broadcast range was also very limited. Our current system, on the other hand, can achieve much longer broadcast range (up to a few tens of kms), and can handle much longer congestion coverage length (up to a few kms) by incorporating DSRC based V2I communication with V2V assistance. The new system is also portable and uses only one RSU, which can acquire traffic data by engaging the vehicles traveling on the roadside whether within or outside of its direct wireless access range. From the traffic data, it estimates important traffic parameters, i.e., TT and SLoC, and periodically broadcasts them back to the vehicles approaching the congestion well before they enter the congested area. The results from the field demonstration have indicated that new system can adapt to dynamically changing work zone traffic environments and can handle much

longer congestion lengths as compared to the previous system using V2I-only communication without V2V assistance.

Development and field demonstration of DSRC-Based V2I traffic information system for the work zone / prepared by: Buddhika Maitipe and M. Imran Hayee.

Abstract:
This report describes the architecture, functionality and the field demonstration of a newly developed dedicated short range communication (DSRC)-based Vehicle to Infrastructure (V2I) communication system for improving traffic efficiency and safety in the work-zone related congestion buildup on US roadways. The goal was to develop a portable system that can be easily deployed at a work zone site to acquire and communicate important travel information, e.g., travel time (TT) and start of congestion (SoC) location to the driver. By providing this information, i.e., SoC location and TT, drivers can make informed decisions on route choice and be prepared for upcoming congestion. The system is composed of a portable road-side unit (RSU) that can engage the on board units (OBUs) of the traveling vehicles using DSRC technology to acquire necessary traffic data (speed, time, and location). From the acquired data, the RSU periodically estimates the SoC location and TT that are broadcast to all vehicles in its coverage range. An OBU receiving the broadcast message calculates the distance to the SoC location. The distance to the SoC location and TT are then relayed to the driver, who can make smart decisions regarding whether to seek an alternate route and when to expect a sudden speed reduction. Results from the field demonstration have shown that the developed system can adapt to changing work-zone environments smoothly under various congestion patterns on the road.

An Adaptive DSRC Message Transmission Rate Control Algorithm (Contact the library for the full report)
Aaron Weinfield, John B. Kenney, Gaurav Bansal
18th ITS World Congress
October 2011

Abstract:
The U.S. Government and the automotive industry have been developing prototype systems to evaluate the effectiveness of using Dedicated Short Range Communications (DSRC) to support vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) safety applications. Many V2V safety applications rely on each vehicle periodically broadcasting a Basic Safety Message (BSM) at a sufficient interval to provide an accurate representation to surrounding vehicles about the transmitter's current position, speed, heading, and other critical information. Unfortunately, as the number of vehicles in communication range increases, the ability for each vehicle to reliably receive messages decreases due to packet collisions on the wireless medium. This paper describes an algorithm to dynamically adapt the BSM message transmission rate based on the wireless congestion level. Simulation and test results using real DSRC radios are provided showing the benefits of the algorithm.

Methods to Reduce DSRC Channel Congestion and Improve V2V Communication Reliability (Contact the library for the full report)
Weinfield, Aaron
17th ITS World Congress
October 2010

Abstract:
The U.S. Government, automotive industry, and DENSO have been developing prototype systems to evaluate the effectiveness of using Dedicated Short Range Communications (DSRC) to support vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) safety applications. Many V2V safety applications rely on each vehicle periodically broadcasting a Basic Safety Message (BSM) at a sufficient interval to provide an accurate

representation to surrounding vehicles about the transmitter's current position, speed, heading, and other critical information. A vehicle may also transmit a BSM immediately if some critical event occurs that requires immediate attention by neighboring vehicles. However, as the number of vehicles in communication range increases, the ability for each vehicle to reliably receive messages decreases due to increased congestion and packet collisions on the wireless medium. This paper shows how the congestion level affects the Packet Error Rate (PER) and describes parameters that can reduce the wireless channel congestion level and transmission methods that can increase the likelihood of receiving critical safety messages. Methods to detect high congestion levels and dynamically adapt these parameters are also provided. Test results using DSRC radios show the benefits of changing these parameters in real world situations.

Vehicle Based Data and Availability / U.S. Department of Transportation

Abstract:
No abstract available, but it's still worth a look.

Research in Progress: Leveraging Connected Vehicles to Enhance Traffic Responsive Traffic Signal Control
Sponsors: US DOT, ECONorthwest, Marshall Univeristy at Huntington, Old Dominion University, Virginia Tech Transportation Institute, Office of the Assistant Secretary for Research and Technology.
Performing Organizations: Marshall University at Huntington, Old Dominion University, Virginia Tech Transportation Institute.
Expected Completion Date: October 31, 2017

Abstract: 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.

Research in Progress: Enhancing Safe Traffic Operations Using Connected Vehicles Data and Technologies
Sponsor Organizations: Pacific Northwest Transportation Consortium, Office of Assistant Secretary for Research and Technology.
Performing Organization: University of Washington, Seattle

Completion Date: June 15, 2016
Note: This record is listed in Research in Progress; however the research has apparently been completed, but no record exists in TRID for the final report/deliverable.

Abstract:
The ultimate goal of the proposed research is to use connected vehicles (CVs) data and technologies to improve traffic safety on mixed-use roadway networks (e.g., freeways and intersections). This goal is relevant to all three themes of Pacific Northwest Transportation Consortium (PacTrans), namely Technological Impacts on Safety, safe travel on mixed-use roads, and Performance Evaluation of Safety Projects. To achieve this goal, the research team has identified four objectives: (1) Develop a cost-effective communication note (CN) device that is capable of communicating with connected vehicles via Dedicated Short Range Communications (DSRC) and with pedestrians, bicyclists, and unconnected vehicle through cell phones and other mobile devices via Bluetooth, Wi-Fi, or other suitable communication protocols. Such CN devices can serve both as notes of the CV system and as data access and dissemination points for certified mobile devices, including cell phones, tablet personal computers, and laptop computers. These CN devices can set up ad hoc networks that extends the detection to desired locations as illustrated by Figure 1. By placing and properly using such CN devices in the collision-prone locations, traffic safety for all kinds of road users can be significantly improved. (2) Develop a mobile application (app) that allows pedestrians, bicyclists, and drivers of unconnected vehicles to communicate with the CN device and vice versa. Considering the popularity of Android phones and other mobile devices, the mobile app to be developed in this study will be based on the Android system. As a result, the app will allow collecting data on systems users' location, speed, etc. and sending them appropriate warning messages in response to a particular unsafe scenario. (3) Develop an algorithm to identify unsafe conditions and determine appropriate CV based safety countermeasures (a.k.a. CV safety application) to be presented to system users. In other words, the team will determine what kind of message to be shown to which system users under a specific hazardous scenario. (4) Develop a connected vehicle simulation test-bed to evaluate the safety benefits of the proposed methodology under various traffic and landscape conditions. The CN device system will be implemented in the CV test corridors for the Washington State Department of Transportation (WSDOT). Field observations offers the data needed to calibrate the simulation test-bed. The expected outcomes of the proposed research include an innovative technology to combine personal mobile devices to the CV system and a new mechanism with its mobile implementation to identify and inform different road users about unsafe conditions on a roadway network. Both are important in enhancing safe traffic operations and travel on mixed-use roadways. Additionally, successful completion of the project will add to the body of knowledge for future evaluation of CV technologies and applications.

Research in Progress: [Using Connected Vehicle Technology for Advanced Signal Control Strategies]
Sponsor Organization: Research and Innovative Technology Administration
Performing Organization: University of California, Riverside
Expected Completion Date: None listed

Abstract:
Today's conventional traffic control strategies typically rely on measurements from point detection, and estimate traffic states such as queue length based on very limited information. The introduction of Connected Vehicle (CV) technology can potentially address these limitations of point detection via wireless communications to assist signal phase and timing optimization. The authors propose to develop agent-based online adaptive signal control strategies based on real-time traffic information available from CV technology. The authors will evaluate various strategies in terms of travel delay and fuel consumption, relative to conventional techniques, e.g., Highway Capacity Manual based methods. It is expected that the proposed strategies will out-perform the conventional methods in both mobility measures (e.g., travel time on an arterial corridor) and in fuel consumption. The new strategies should also be very robust to traffic demand variations.

Research in Progress: **[Developing Short Range Vehicle-to-Infrastructure Communication Systems]**
Sponsor Organization: Research and Innovative Technology Administration
Performing Organization: Texas Southern University, Houston
Expected Completion Date: January 31, 2016 – but the project is listed as Still Active

Abstract:
The objective of this project is to develop dedicated short-range communication systems (DSCS) to connect vehicles with roadside infrastructures (traffic signs, work zone barrels, traffic signals…) so as to not only enhance the safety but also reduce emissions and fuel consumptions of vehicles. The field test beds will be selected in typical work zone and stop sign areas, and simulations in the driving simulator will be also conducted to understand the drivers' reactions due to this type of short range communication system.

Research in Progress: **[High-Resolution Micro Traffic Data from Roadside LiDAR Sensors for Connected-Vehicles and New Traffic Applications]**
Sponsor Organization: Office of the Assistant Secretary for Research and Technology
Performing Organization: None listed
Expected Completion Date: September 30, 2018

Abstract:
The connected-vehicle crash-avoidance applications rely on real-time (location, speed and direction) information of each vehicle, pedestrian and bicyclist at a frequency of at least 1 HZ. This traffic data is named as high-resolution micro traffic data in this proposed research, meaning high-frequency high-accuracy data of each individual. High-resolution micro traffic data can be collected by conventional probe vehicles with the global positioning system (GPS) logging function. However, probe vehicles provide only sample data of the traffic fleet on roads, while the connected vehicle system needs the data of all road users. The current connected-vehicle deployment only receives high-resolution micro traffic data from the limit number of connected-vehicles. The traditional traffic sensors such as loop detectors, video detectors, Bluetooth sensors and radar sensors mainly provide macro traffic data such as traffic flow rates, average speeds and occupancy, so the existing sensors cannot provide the micro traffic data needed by connected vehicles. Even the crowdsourced data, such as real-time travel time data from Wave, is still the macro level traffic information. A new method to collect high-resolution micro traffic data for the connected-vehicle system is needed to help the current connected-vehicle deployment and the future connected-vehicle applications. The high-resolution micro traffic data will also change existing traffic safety engineering and traffic operation. For example, the micro-level trajectories of vehicles and pedestrians at intersections can be used to analyze intersection traffic safety and signal performance with much more details than the traditional safety and performance analysis. The existing Rectangular Rapid Flash Beacon (RRFB) for midblock pedestrian crosswalks can be upgraded to an automatic pedestrian signal with the real-time high-resolution micro traffic data. Warning of wildlife crossing highways can be automatically triggered when the real-time micro traffic data shows wildlife crossing. The high-resolution micro traffic data can also support adaptive traffic signal control systems. Unconnected vehicles and pedestrians can all benefit from the high-resolution micro traffic data. The new laser radar (LIDAR) technology has the capability to detect the 360-degree surrounding objects with high accuracy (centimeter level) and long measuring distance (300 feet radius or longer). This proposed research project is to develop methodologies of extracting high-resolution micro traffic data from the roadside LIDAR sensor data. The key objectives for the research are listed in the following: 1. Development of a method to extract location and speed trajectories of vehicles from the roadside LiDAR data. 2. Development of a method to extract location and speed trajectories of pedestrians from the roadside LiDAR data. 3. Development of a method to extract location and speed trajectories of bicyclists from the roadside LiDAR data. 4. Investigate possible applications of the high-resolution micro traffic data in traffic safety engineering, traffic operation and the connected-vehicle system with sample data generated by the developed methods.

Research in Progress: **Internet of Moving Things using Full Duplex Mesh Networks**
Sponsor Organization: Office of the Assistant Secretary for Research and Technology
Performing Organization: Data-Supported Transportation Operations and Planning Center
Expected Completion Date: December 31, 2018

Abstract:
Through years of research, true full duplex communication systems (transmission and reception in the same band at the same time) have been developed using novel off the shelf components. Such radios are unique in their ability to listen while transmitting at the same frequency at the same time. Although other full duplex technologies exist (from work conducted at Stanford, Rice and Columbia), these technologies are typically antenna or custom-chip based. The project team's solution is unique in that it is based on off-the-shelf discrete components together with software. This ability to build a software-centric full duplex solution has many advantages, including low-cost, rapid reconfigurability, and agility. Full duplex radios are able to listen and talk simultaneously, making them ideally suited for mesh networking applications. Conventional mesh networking is highly prone to poor performance due to massive overheads and rigidity. Full duplex radios are much more flexible and adaptable, and can perform tasks such as handoff and scheduling in a low-overhead, rapid manner. This makes them ideally suited to be the basis for the Internet of Moving Things (IoMT). IoMT aims to connect all moving (and static) objects with one another—buses, cars, people, even their pets—without using a cellular or satellite backbone. It enables vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) connectivity in a much more seamless fashion than currently thought possible. Full duplex based IoMT will provide low-cost connectivity between people, while helping us understand how people and vehicles move.

Research in Progress: **Identifying Potential Workzone Countermeasures Using Connected Vehicle and Driving Data**
Sponsor Organizations: Michigan Dept. of Transportation, Office of the Assistant Secretary for Research and Technology
Performing Organization: University of Michigan Transportation Research Institute
Expected Completion Date: April 20, 2018

Abstract:
Work zones present an ongoing safety challenge to the road safety community. Traffic management in a work zone is done through movable, temporary elements, and the novelty and complexity of the situation can challenge even attentive drivers. In the United States, (U.S.) 576 (2%) fatalities occurred in work zones in 2010 (Federal Highway Administration) FHWA 2015. For example, speed management and lane shifts can be challenging and can introduce safety issues in work zones. The advent of vehicle communication affords a new opportunity to develop countermeasures for work zones. Infrastructure can monitor work-zone driving behavior and potentially provide adaptive or even targeted interventions to help drivers manage work-zone driving more appropriately. This proposal seeks to identify workzone countermeasures that might be implemented using Vehicle-to-Infrastructure (V2I) and Infrastructure-to-Vehicle (I2V) communication. This work extends current data explorations taking place at University of Michigan Transportation Research Institute (UMTRI) to use driving data to understand workzone behavior. While that project focuses on driver behavior from a naturalistic driving study, this one will focus on connect-vehicle data available in UMTRI’s Safety Pilot Model Deployment study. Additional data from the Ann Arbor Connected Vehicle Test Environment may also be used.

Research in Progress: Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies. Task 12. Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations

Task 12. Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations

Abstract:
Connected vehicle (CV) technology will be essential to support the operation of automated vehicles in ways that will generate societal benefits rather than disbenefits. Different jurisdictions will have varying levels of interest in deploying CV infrastructure, based on varying perceptions of the benefits that they will gain from CV systems. Limited availability of CV infrastructure will seriously impede the ability of autonomous vehicles (AVs) to operate everywhere and is likely to deter growth of the market for AVs. How should this problem be addressed, to provide policy frameworks and/or business models that can facilitate widespread deployment of the needed CV infrastructure? The objective of the research is to provide guidance for agency decision-makers to use in evaluating possible business models for their CV investment and policy decisions. The project needs to start from a basis of solid analysis showing the importance of CV technology to enable AV systems to produce societal benefits, and then explore how to deploy the needed CV infrastructure. Task 1. Review and summarize existing authoritative research results to show the differences in traffic flow dynamics (and hence congestion, energy use, and pollutant emissions) associated with AV versus CV automation systems at various levels of automation. Based on these results, estimate the net difference in societal benefits of AV implementation with and without CV capabilities for a variety of representative deployment environments (large and small metropolitan regions, intercity corridors with different traffic volumes, etc.). Assess these separately for infrastructure-to-vehicle (I2V) and vehicle-to-vehicle (V2V) cooperative automation (for which the infrastructure requirements are likely to be substantially different). For cases in which the existing literature does not provide sufficient information about the differences, perform additional modeling studies to produce refined estimates. Note: The U.S. DOT is developing a benefits assessment tool that could be foundational to this effort. Task 2. Define how the requirements for CV systems to support AV operations could potentially be more stringent than they would be for other intelligent transportation systems (ITS) applications, in ways such as: (a) limited tolerance of holes in communication coverage when driving from one jurisdiction to the next; (b) greater availability requirements based on safety and productivity implications of the loss of communications by the AV applications; (c) need for additional data elements beyond the minimum required basic safety message (BSM) Part I data elements that will be required for cooperative collision warnings under National Highway Traffic Safety Administration (NHTSA) regulations; and (d) enhanced cyber security needs. Based on considerations such as these, identify the extent to which AV usage could impact the costs of deploying and/or operating the infrastructure elements of both I2V and V2V cooperative systems. Task 3. Define potential business models for deployment of the CV infrastructure needed to support AV use of CV technology, accounting for public agencies sensitivity about providing others with access to their traffic signaling infrastructure. These could include: (a) combinations of designing, building, owning, operating, and maintaining the CV systems by the public agencies themselves; (b) franchising or contracting out to third parties; (c) offering right-of-way access to third parties in exchange for them providing the CV infrastructure; (d) other forms of public-private partnerships in which the AV industry or AV operators would finance the CV infrastructure costs based on their own direct benefits; (e) relying on cellular infrastructure as available rather than deploying dedicated short range communications (DSRC), considering the potential differences in communication capabilities and system performance as well as costs and responsibilities for the public agencies. Task 4. Based on the findings from the previous tasks, develop recommendations for what actions states should take regarding implementation of both I2V and V2V connectivity infrastructure to support AV operations, addressing topics such as: (a) criteria states should use to prioritize locations for I2V and V2V CV infrastructure deployment and (b) how the CV deployments should be financed (what business models for what operating environments) based on the levels of implementation costs and of societal benefits relative to direct private user benefits.

Intelligent Transportation Systems – Connected Vehicle Safety Pilot
USDOT ITS Joint Program Office - New Data Sets are Available in the Research Data Exchange (RDE): MMITSS, BSM Emulator and Leesburg VA Vehicle Awareness Device

Abstract: No abstract available.

Vehicle to Vehicle Communitation for Crash Avoidance Systems: a WhitePaper by eInfochips
2016.

Abstract: No abstract available

5.9 GHz Dedicated Short Range Communication Vehicle-based Road and Weather Condition Application: Messaging Requirements
Final, Version 2, August 2013

Abstract/Introduction:
Prepared for Cooperative Transportation Systems Pooled Fund Study by Synesis Partners LLC. Significant effort has been expended in the Federal Highway Administration's (FHWA) Road Weather Management Program and in various federal and state connected vehicle programs to identify opportunities to acquire data from vehicles acting as mobile sensor platforms. It is also well-recognized that weather has a significant impact on the year round operations of the nation's roadway system. This 5.9 GHz Dedicated Short Range Communication (DSRC) Vehicle-based Road and Weather Condition Application project is the synergistic result of those converging opportunities.

Accurate, timely and route-specific weather information allows traffic and maintenance managers to better operate and maintain roads under adverse conditions. The research system developed by this project will collect weather observation data from mobile sensors on transportation agency vehicles; transmit the data by way of DSRC roadside equipment (RSE) to one or more collection systems; and ultimately make the data available to other information systems such as the New York State DOT INFORM system and the U.S. DOT's Weather Data Environment. In this way, the additional weather information from mobile platforms will eventually enable traffic managers and maintenance personnel to implement operational strategies that optimize the performance of the transportation system by mitigating the effects of weather on the road ways.

This document will define the mobile data messaging requirements against which the research application will be designed and implemented. The desired data elements will first be identified, and then be compared against the data elements that are available.

The comparison exposes the gaps between the intent and the implementation and illustrates that not all desired data elements may be captured in practice. Following the identification of data elements, applicable connected vehicle communication and messaging standards are reviewed. These in turn, drive the message formats and the subsequently documented messaging requirements.

DSRC: Deployment and Beyond
WINLAB Research Review
John B. Kenney, Toyota Info Technology Center
May 14, 2015

Abstract: No abstract available.