DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

MMITSS Phase III Extension for Additional Enhancements

A research project by UC Berkeley PATH program to add traffic adaptive and multimodal aspect enhancements to Multi-Modal Intelligent Traffic Signal System (MMITSS) for improved mobility and safety.

Advanced Research

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Project Title:
Connected and Automated Vehicle (CAV) Application Development

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WHAT IS THE NEED?

The Multi-Modal Intelligent Traffic Signal System (MMITSS) is the next generation of traffic signal systems that seeks to provide a comprehensive traffic information framework to service all modes of transportation, including general vehicles, transit, emergency vehicles, freight fleets, and pedestrians and bicyclists in a connected vehicle environment. Under the sponsorship of the Connected Vehicle Pooled Fund Study (CV PFS) and FHWA, MMITSS has been deployed in the California CV Test Bed. Caltrans statewide Traffic Signal Control Program (TSCP) has been enhanced to support MMITSS operations, including SPaT broadcasts, CV-based vehicular service calls and actuations, pedestrian service calls, CV-based signal priority, and dynamic force-off to adapt signal timing to the prevailing traffic conditions. However, due to the low market penetration of connected vehicles and the lack of multimodal road user detection and classification data, the effectiveness of traffic adaptive features cannot be tested and evaluated in real-world condition.

The current coordinated traffic control systems utilize a few time-of-day timing plans (cycle length, green split, and offset) for time-based coordination and utilize loop detectors for phase service calls and vehicle actuations. The time-of-day timing plans are preset based on traffic data collected through site surveys. Inductive loops are usually installed near the intersection stop-line and cannot detect and measure the fluctuation of traffic demand in real-time so that the traffic control systems are not well informed about the state of the traffic and are unable to select the appropriate timing plan that adapts to the prevailing traffic conditions. Furthermore, in the current systems, pedestrian service requests are detected by pedestrian pushbuttons, the systems are not necessarily aware of how many pedestrians and their location on the crosswalk.

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In a CV environment where equipped vehicles and pedestrians communicate their state (type, location, speed, heading, etc.) to the roadside infrastructure via Basic Safety Messages (BSM – vehicle) and Personal Safety Messages (PSM – pedestrian), this rich data set allows the traffic control systems to measure the fluctuation of traffic demand in real-time, adapt timing plan to the prevailing traffic conditions, and provide cooperative services to each mode.

Although the anticipated benefits of CV technologies on improving safety and mobility are promising, due to the low market penetration rate of connected vehicles, the benefits of CV technologies are difficult to assess in a real-world condition.

WHAT ARE WE DOING?

The objectives of this project are:

1. Enhance Traffic Control Features: Utilize multimodal road user detection and classification data (e.g., vehicles, pedestrians, and bicyclists) of NoTraffic Smart Sensors and adaptive signal timing features of the existing TSCP to add additional enhancements to MMITSS for improved mobility and safety;
2. Enhance the Deployability of MMITSS Vehicle-Resident Applications: Modularize the existing vehicle-resident CV application software and develop an application programming interface (API) to support a hardware-agnostic solution, that the vehicle-resident CV applications run on a separate computer and interface with an OBU (either a DSRC or a Cellular-V2X device) via the API for transmitting and receiving over-the-air messages. The API will support the use of OBUs from multiple vendors.
3. Conduct Field Testing with Augmented Market Penetration: Field testing will comprise both equipped VTA buses and PATH testing vehicles. PATH testing vehicles will collect the ground-truth travel time and delay data, which provide inputs to the before-and-after analysis on impacts of market penetration.

WHAT IS OUR GOAL?

The goal of this project is to add traffic adaptive and multimodal aspect enhancements to MMITSS for improved mobility and safety.

WHAT IS THE BENEFIT?

The State would be able to better assess the effectiveness of traffic adaptive features that support multimodal transport and impacts of market penetration of CVs and providing better safety and mobility for all modes of travel.

WHAT IS THE PROGRESS TO DATE?

During the last quarter PATH developed algorithms to aggregate event-based signal phase data into cycle-based. Huge efforts were devoted to building the Arterial Performance Measurement System. The components of Data Aggregation, Data Filtering, and Detector Health Analysis have been implemented. Currently, the Data Aggregation component is triggered every 5 mins to aggregate the raw detector and signal phase data. The Data Filtering and Detector Health Analysis components are triggered every day to check the quality of the aggregated data. All aggregated/filtered data and quality analysis results are stored in the PATH MySQL server. Currently, the Arterial Traffic Estimation component is being integrated into the Arterial Performance Measurement System. In addition, some updates are being made in the Aimsun microsimulation model for the California CV testbed to match the field settings.

To enhance intersection safety and TSP performance, the following features were incorporated:

(i) NoTraffic pedestrian detection data in SPaT broadcasts;
(ii) MAP and SPaT broadcasts at HAWK (High-Intensive Activated CrossWalK) signals;
(iii) Look-forward TSP requests (particularly crossing

HWAK signals).

Also, the MAP Engine Library was enhanced with the following functions:

(i) Identify the current approaching and downstream intersections.
(ii) Determine lane-of-travel for vehicles (BSM) and vulnerable road users (VRU, PSM).
(iii) Estimate distance and travel time to stop-bar of downstream intersections.
(iv) Track of road user (particularly VRU) movement at intersection conflict area. Since the SAE J2735 MAP doesn't specify travel path inside conflict area, PATH uses Bezier Curve to model connection path inside intersection conflict area.

Use of Universal Transverse Mercator (UTM) coordinate system to link adjacent intersections.