DRISI

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Research Notes

Advanced Research

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

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Support Deployment of RTCM Broadcasts

A research project by UC Berkeley PATH program to provide a one-stop source for the deployment of Radio Technical Commission for Maritime Services (RTCM) broadcasts in California by utilizing California Real Time Network (CRTN) and integrating Virtual Reference Station (VRS) with CRTN.

WHAT IS THE NEED?

Lane-level vehicle positioning is fundamental for many Connected Vehicle (CV) applications. At connected signalized intersections, the intersection broadcasts MAP messages which convey lane-level geometry of the intersection, including motor vehicular lanes, pedestrian crosswalks, and bike lanes, and Signal Phase and Timing (SPaT) messages that describe the current state of signals.

Lane-level positioning is critical for connected vehicles to determine their lane of travel, allowed movement(s) and connecting lane(s) at the stop line, conflicts with other motor vehicular lanes, pedestrian crosswalks, and/or bike lanes, and to associate lane of travel with SPaT messages to determine the state of the signal that controls vehicle's movement and the state of signals that control the movements on conflicting lanes.

Lane-level vehicle positioning is also important for freeway CV applications, such as adaptive ramp metering, work zone speed management, variable speed limit control, work zone and reduced speed zone warning, end-of-queue warning, and curve speed warning, etc.

Real-Time Kinematic (RTK) is a different positioning technique than Wide Area Augmentation System (WAAS) to achieve more accurate global Positioning System (GPS) solutions, typically on the order of centimeters. RTK uses carrier-based ranging for its underlining position information and provides range values (therefore positions) that are orders of magnitude more precise than code-based positioning technique which is used by more traditional GPS receivers.

The base station of an RTK system compares its position as computed from satellite data with its known position to find the difference and transmits the correction data to RTK-enabled GPS receivers in the vicinity of the base station via Radio Technical Commission for Maritime Services (RTCM) standard format . The RTK-enabled GPS receiver uses the RTCM correction data to adjust position estimation to get a more accurate geo-location.

To support RTK operations in a connected vehicle environment, the SAE J2735 standard defines a wrapper (MSG_RTCMcorrections) for transmitting RTCM differential corrections for GPS over Dedicated Short range Communication (DSRC), where a roadside unit (RSU) collects RTCM correction data from a nearby base station, encapsulates the correction data in MSG_RTCMcorrections, and broadcasts it over-the-air; an OBU receives MSG_RTCMcorrections over-the-air, reconstructs back the RTCM correction data, and forwards the correction data to an RTK-enabled GPS receiver; and the RTK-GPS receiver uses the correction data to increase the accuracy of position estimates produced. The OBU can utilize the improved position data to support vehicle-resident CV applications and broadcasts BSMs which contain centimeter precise position to RSUs to support infrastructure-based CV applications.

The California Real-Time Network (CRTN) is a multiple statewide GNSS (Global Navigation Satellite System – an umbrella term that encompasses all global satellite positioning systems including GPS and other similar systems) network to provide a public utility in supporting RTK positioning and to support research into earthquake early warning and response systems. The CRTN provides real-time RTCM version 3.0 (RTCMv3) correction data in NTRIP protocol (Networked Transport of RTCM via Internet Protocol) from 584 base stations throughout the California. However, the CRTN does not offer a VRS network solution but a single base solution.

WHAT ARE WE DOING?

The objectives of this project are:

1. Establish a NTRIP Caster on a cloud server which collects RTCMv3 correction data from CRTN base stations.
2. Automatically select the appropriate base station or establish a VRS for an RSU and provide real-time RTCMv3 data streams to the RSU for broadcast over DSRC.
3. Monitor the quality of the data streams and establish a VRS in case that the base station is down.
4. Provide a monitoring website for the status of RTCM broadcasts at connected RSUs.
5. Provide the option of RTCMv3 data streaming over cellular to Connected Fleet vehicles so the vehicle will have position corrections both within and outside the DSRC communication range with an RSU.

WHAT IS OUR GOAL?

The goal of this project is to provide a one-stop source for the deployment of RTCM broadcasts in California by utilizing CRTN and integrating VRS with CRTN. On-Board Units are required to embed a WAAS-enabled GPS receiver and to support the use of an external RTK-enabled GPS receiver as port of its positioning subsystem.

WHAT IS THE BENEFIT?

RTCM broadcasts have the potential to deliver free lane-level vehicle positioning solution for connected vehicles therefore improving the effectiveness of CV applications and providing better safety and mobility for all modes of travel.

WHAT IS THE PROGRESS TO DATE?

The draft RTCM Broadcasts User Guide was submitted on October 8, 2021 and the final version was released on October 18, 2021.

PATH completed RTCM data collection in the California CV Test Bed and is working on data analysis to evaluate the benefits of utilizing RTCM broadcasts on improving the accuracy in determining lane-of-travel. Project documentation is underway, and PATH is working on updating the Home and About web pages on the RTCM website to close-out this project.

IMAGES

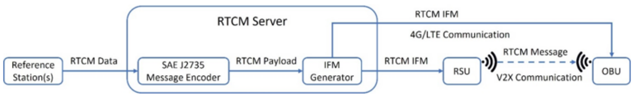

Image 1: Flow of RTCM Messages

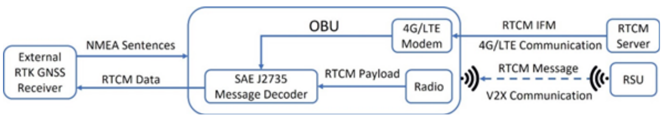

Image 2: OBU utilizes RTCM Messages