Use of Trucks' On-board Data for Real-Time Emission Modeling

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Project Overview

Heavy-duty trucks (HDTs) play a significant role in the freight transportation sector, but also consume a vast amount of fuel and are a significant source of both greenhouse gas and criteria pollutant emissions. In order to properly design strategies to reduce energy and environmental impacts of HDTs, accurate data of their fuel consumption and emissions are required, preferably in real-time.

This project investigated how data from a vehicle's data bus might be collected and what value these data types might have in a connected vehicle environment. An emphasis was placed on investigating methodologies for integrating the University of California at Riverside's (UCR's) Comprehensive Modal Emissions Model (CMEM) with electronic control unit (ECU) data of heavy vehicles to result in a real-time emissions modeling and reporting system.

Heavy-Duty Truck ECU Data Availability

The ECU data of HDTs can be accessed through the industry-standard SAE J1939 data bus. Many fleet owners have equipped their truck fleets with on-board devices that couple ECU with telematics capabilities where vehicle and engine operating parameters as well as positioning information are wirelessly transmitted to a computer server on a periodic basis. Through partnership with these fleet owners, the research team gathered and aggregated ECU data that can be used for real-time applications to evaluate and improve the performance of transportation systems, especially those related to freight movement.

Real-time Modeling and Reporting

UCR's CMEM has primarily been used to evaluate energy and emission impacts of traffic flow improvement projects such as those with intelligent transportation system (ITS) implementations. With the advancement in wireless communication in the last several years, it is now possible to perform real-time calculation of vehicle emissions with CMEM. This will allow for transportation systems to be actively managed so that their energy and environmental impacts are minimized. It has been shown that the truck ECU is an important data source for real-time emission modeling and reporting within the framework of CMEM. The ECU data has potential to even improve the accuracy of emissions estimated by CMEM. In the connected vehicle world, this real-time emission modeling capability can enable a variety of applications that improve the environmental performance of the transportation system.

Recommendations

The project team recommended the establishment of research programs under the AERIS umbrella to advance the science of vehicle emissions modeling. There are variables in the ECU that have not been previously explored that may be able to improve the accuracy of emission estimates by CMEM. Future research questions are listed below:

- How do environmental conditions (e.g., ambient air temperature) affect truck fuel economy and emissions on-road?
- How does an aged engine or degraded components affect truck fuel economy and emissions?
- How do various exhaust after-treatment technologies affect truck fuel economy and emissions?
- How can the model be adjusted or improved to accommodate new data items from the ECU (e.g., air-conditioning and wiper status)?