DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

A Cooperative V2V Alert System to Mitigate Vehicular Traffic Shock Waves

Developed a novel distributed communication protocol that enables us to eliminate upstream shock wave formation and uniformly distributes traffic across multiple lanes

Advanced Research

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Project Title:
UTC - A Cooperative V2V Alert System to Mitigate Vehicular Traffic Shock Waves

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Task Manager:
Asfand Siddiqui,
Senior Transportation Engineer (Electrical)
asiddiqui@dot.ca.gov

WHAT WAS THE NEED?

The past few decades have given rise to an increase in the number of vehicles along roadways. However, the existing traffic infrastructure is unable to support the increased volume of traffic efficiently in its current state. Expanding the current infrastructure with additional highways or extending existing highways with additional lanes is very costly, and will not solve the problem of traffic congestion. In uncoordinated traffic the highway capacity is not fully exploited.

The proposed alert system relies on vehicle-to-vehicle (V2V) communication to inform vehicles of changes in traffic state downstream, and provides vehicles the ability to adapt speeds (DRIVE) or perform lane change maneuvers (DRIVE-EX) to mitigate the impact of traffic shock waves.

WHAT WAS OUR GOAL?

The main goal of this research was to evaluate and extend a protocol that relies on V2V communication to share recent and relevant downstream traffic information with vehicles beyond line of sight in order to improve the overall traffic efficiency by mitigating traffic shock waves, and thus enabling safe driving on heavy traffic highways. The aim of the protocol is to redistribute traffic in order to more efficiently utilize highway capacity.

WHAT DID WE DO?

In this task, the research team 1) validated the efficacy of DRIVE on realistic traffic traces from congested highways in Los Angeles using Caltrans' PeMS traffic measurements; 2) extended our protocol (DRIVE-EX) to use multiple lanes to address the shock wave phenomenon, and efficiently distribute traffic across multiple lanes; 3) experimented with different potential causes of shock waves such as on ramps and a reduction of lanes, which can be caused from events such as accidents or road-work; and 4) evaluated a mix of autonomous and human driven cars to study the shockwave behavior as a function of the mix. All of the evaluations were carried out in Vehicles in Network Simulation (Veins). Veins couples two well-established simulators, OMNeT++ for vehicle communication and SUMO for road traffic simulation.

WHAT WAS THE OUTCOME?

The DRIVE protocol was extended to DRIVE-EX to redistribute traffic not only within a single lane, but across multiple lanes as well. Experiments were conducted with various causes of congestions. An evaluation was also performed with a varying the mix of autonomous and human driven vehicles to evaluate the overall traffic performance in the presences of different shock wave scenarios.

WHAT IS THE BENEFIT?

The proposed protocol, DRIVE-EX, provides vehicles with the ability to exchange recent and relevant traffic information with vehicles upstream about traffic disturbances in advance of being directly impacted by a disturbance with beyond line of sight information. The protocol redistributes traffic within a lane and across multiple lanes to mitigate shock waves. The results show that information from downstream vehicles increases vehicles' reaction time, and leads to reduce overall travel time and increased average velocity. The protocol also eliminates the need for vehicles to preform hard braking maneuvers followed by accelerations as is common in shock wave scenarios, which avoids the waste of energy and reduces vehicle emissions.