Shortening the Age of Information: Connecting Vehicles to Infrastructure in Real Time

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Now that we are decades into the Age of Information, it's increasingly important to minimize the *age* of information: that is, to make sure the information we have is the very latest. In the world of connected vehicle technology, Age of Information (AoI) is a concept that was introduced in 2012 to quantify the "freshness" of knowledge about the status of remote systems.

The latest NITC report from the University of Utah (UU) offers an innovative way of developing a comprehensive traffic signal control system for connected vehicles (CV) that optimizes AoI and reduces communication delay. This signal control system, when used in a mixed environment of autonomous and human-driven connected vehicles, stands to improve safety and operational efficiency. It accomplishes four main goals:

1. Reduce the CV communication delay when the network is dealing with a large number of CVs;
2. Coordinate the CV flows along multiple critical paths by optimizing the intersection offsets;
3. Improve both mobility and safety at intersections concurrently with optimal traffic signal timings;
4. Accommodate the operation of connected buses under a multimodal control environment.

DATA COLLECTION AND COMMUNICATION

According to a 2017 survey, it is predicted that more than 20% of vehicles in transportation networks will be CVs by 2025. Hence, there is an urgent need to develop a reliable and efficient communication network to support CV-based traffic signal control.

A multidisciplinary research team, led by UU's Xianfeng Yang and including researchers from transportation engineering and electrical engineering, worked to prioritize the data needs of different types of CVs, and to optimize the communication network.

HOW DOES THIS SYSTEM ADDRESS SAFETY AND MOBILITY?

Vehicles approaching an intersection, whether they are driven by a human or a machine, will receive a speed advisory (in the form of advice: either "Stop" or "Go") from the system, which will facilitate their smooth progression through the intersection. This system aims to achieve three primary objectives:

1. Proactively preventing rear-end collisions,
2. Reactively protecting side-street traffic from red-light-running vehicles, and
3. Effectively facilitating speed harmonization along local arterials.

HOW DOES IT SUPPORT MULTIMODAL TRAVEL?

To support a multimodal environment, the system introduces a control function to accommodate connected buses. The real-time signal control system dynamically integrates transit signal priority.

When median-island bus stations are located beside intersections, high bus volumes may cause queue spillbacks and consequently block nearby intersections. Traditional transit signal priority (TSP) control systems may exacerbate such situations when signal priorities are granted to approaching buses. With a new operational logic, the UU signal control system supports the operational efficiency and safety of traffic signals while integrating transit signal priority control strategies.

IMPACTS OF THIS RESEARCH

This research has several important impacts to advance innovation and CV technology:

1. The communication and networking protocols developed in this project will maximize the freshness of information in CV networks.
2. The research offers an innovative way of developing a traffic signal control system that can concurrently improve safety and operational efficiency.
3. The system developed in this project can provide dynamic signal progression control to facilitate the movement of connected vehicles along various critical paths.

ABOUT THE AUTHORS

The research team consisted of Xianfeng (Terry) Yang, Mingyue Ji and Qinzheng Wang of the University of Utah.

ABOUT THE FUNDERS

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THE FULL REPORT and ONLINE RESOURCES

For more details about the study, download the full report **Connected Vehicle System Design for Signalized Arterials** at nitc.trec.pdx.edu/research/project/1235

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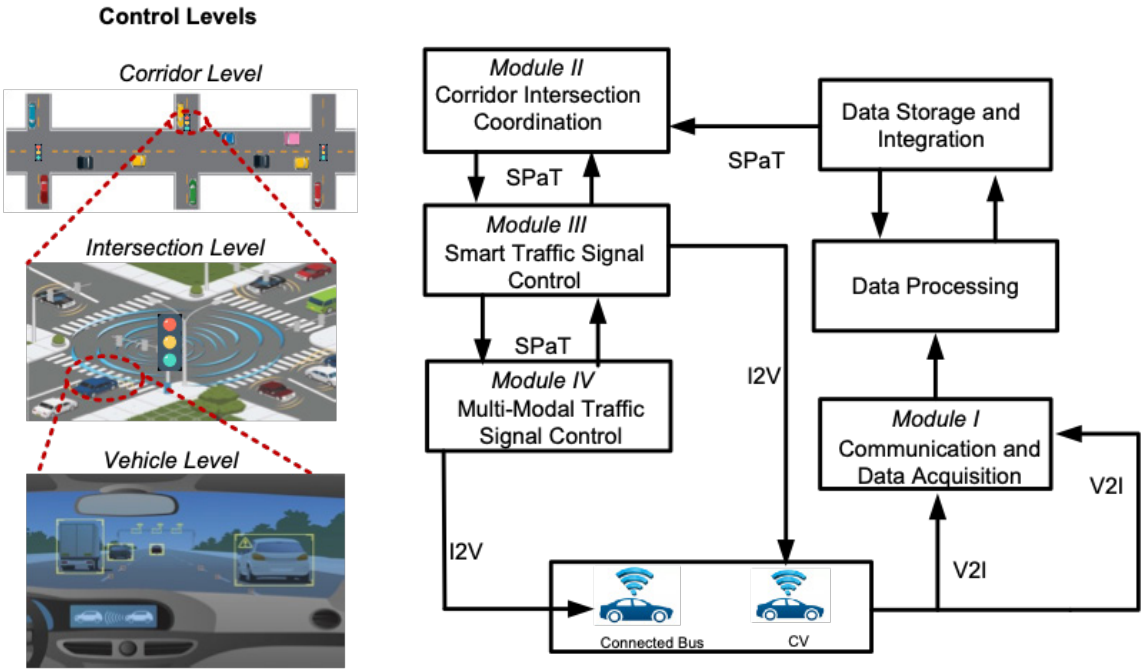

As shown in this figure, the system presents a communication and data acquisition protocol built off the concept of Age of Information (AoI) as a function of overall system latency and communication load, which measures the "freshness" of information. It has been well recognized that "freshness" is essential for sensor systems, especially for vehicular applications. The system is designed to minimize AoI for all CVs to ensure optimal control of status updates received at roadside units.

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