

**Proactive Doppler Shift Compensation in Vehicular Cyber-Physical Systems**

**Abstract:**

In vehicular cyber-physical systems (CPS), safety information, including vehicular speed and location information, is shared among vehicles via wireless waves at specific frequency. This helps control vehicle to alleviate traffic congestion and road accidents. However, Doppler shift existing between vehicles with high relative speed causes an apparent frequency shift for the received wireless wave, which consequently decreases the reliability of the recovered safety information and jeopardizes the safety of vehicular CPS. Passive confrontation of Doppler shift at the receiver side is not applicable due to multiple Doppler shifts at each receiver. In this paper, we provide a proactive Doppler shift compensation algorithm based on the probabilistic graphical model. Each vehicle pre-compensates its carrier frequency individually, so that there is no frequency shift from the desired carrier frequency between each pair of transceiver. The precompensated offset for each vehicle is computed in a distributed fashion in order to be adaptive to the distributed and dynamic topology of vehicular CPS. Besides, the updating procedure is designed in a broadcasting fashion to reduce communication burden. It is rigorously proved that the proposed algorithm is convergence guaranteed even for systems with packet drops and random communication delays. Simulations based on real map and transportation data verify the accuracy and convergence property of the proposed algorithm. It is shown that this method achieves almost the optimal frequency compensation accuracy with an error approaching the Cramér-Rao lower bound.

**Existing System:**

Doppler shift, which is the perceived change in frequency of wave emitted by a source which is moving relative to an observer, exists among vehicles due to their mobility. Since safety information is shared via wireless waves at specific frequency, the received waves would be moved from the desired frequency due

to Doppler shift, which consequently decreases the reliability of the recovered safety information and thus jeopardizes the safety of vehicular CPS.

**Proposed System:**

We propose proactive Doppler shift compensation algorithm based on the probabilistic graphical model. We assume data are transmitted frame by frame. Each time, when the transmitter sends a data frame out, it is reasonable to assume that Doppler shift for this data frame is a fixed constant due to the fact that the time duration for each data frame is much smaller than the vehicle speed change. The proposed algorithm compensates Doppler shift for each data fame in a distributed fashion. We study this algoirthm from both algorithm design and theoretical analysis perspectives.