AUTOMATED VEHICLES SYMPOSIUM 2018

Poster 18

Inter-vehicular Communication to Safely Mitigate Emergency Braking in Vehicle Platoons

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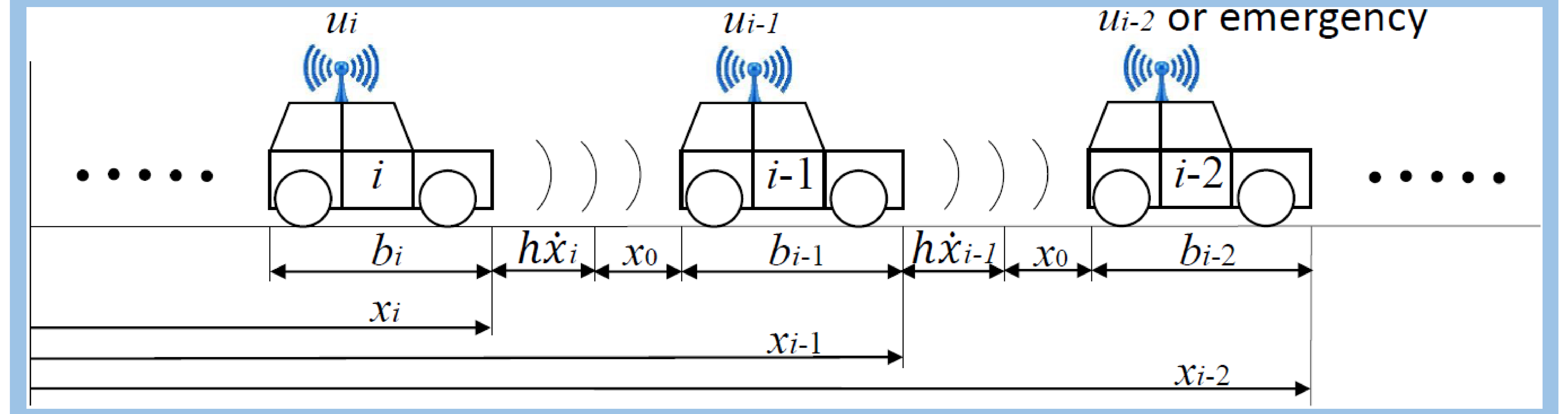
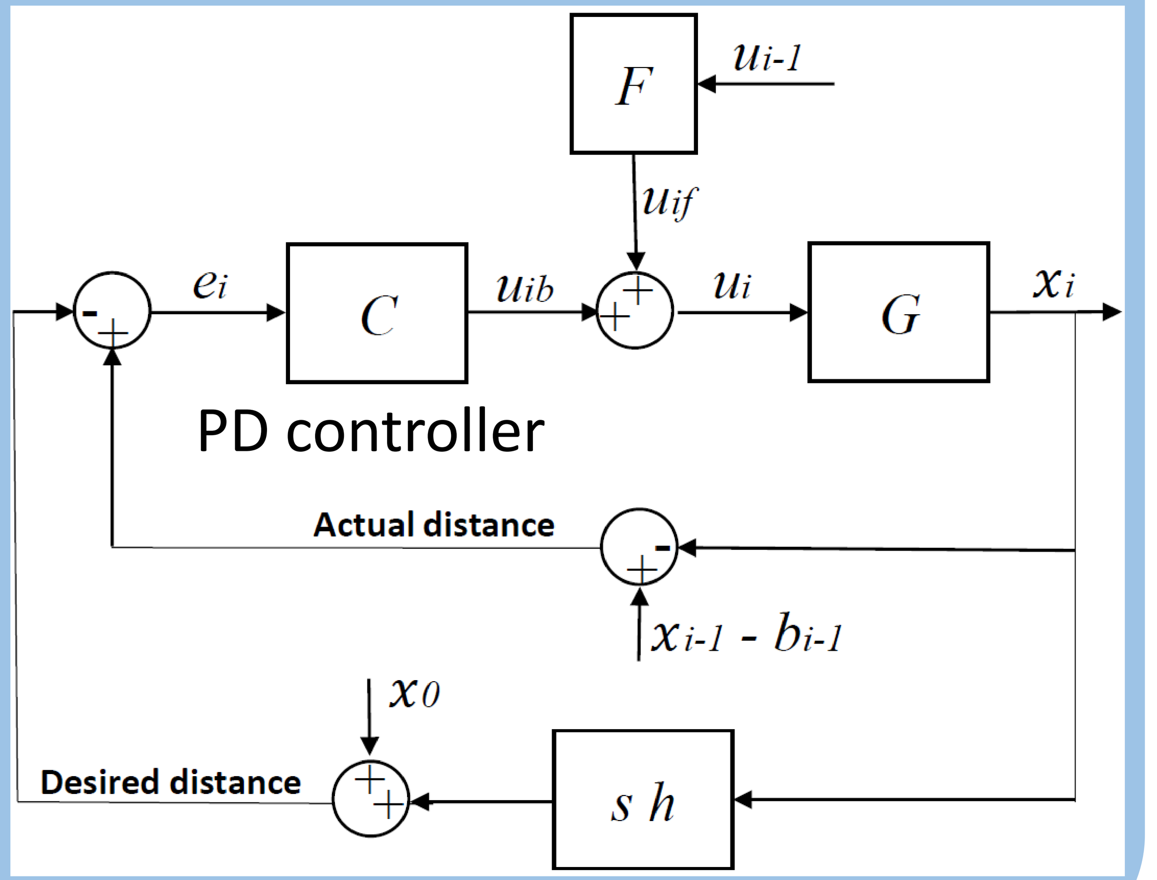
Abstract

Cooperative Adaptive Cruise Control (**CACC**) systems enable platoon formation as vehicles follow one another closely. Emergency braking in vehicle platoons results in collision risk. This work proposes a strategy that utilizes inter-vehicular wireless communication to mitigate the collision risk due to emergency braking in vehicle platoons.

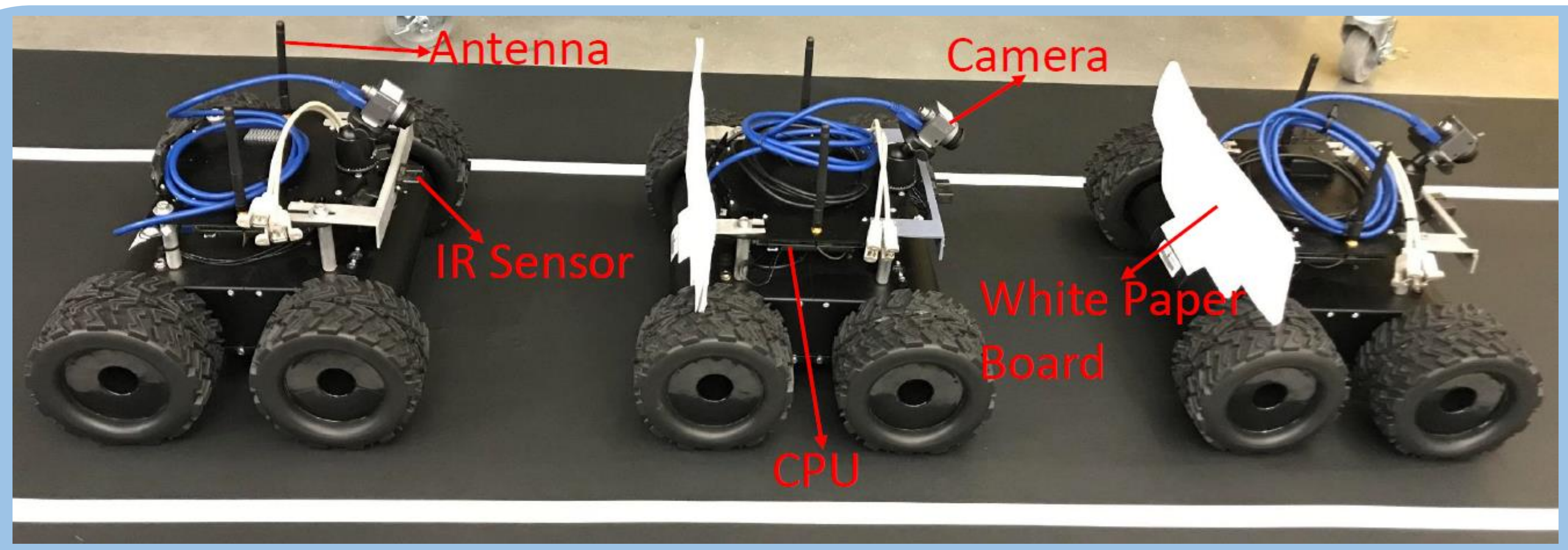
CACC Problem Formulation



CACC Block Diagram



- The desired inter-vehicular distance is $x_0 + h\dot{x}_i$ where x_0 is the standstill safety distance and h is the constant time gap.
- The control system minimizes the error between the actual and desired distances.



Mobile Robot Experiments

- Three-robot platoon on a straight lane
- Lane keeping with lane detection and path following control
- User Datagram Protocol for wireless communication
- C++ with OpenCV in Linux
- Infrared (IR) sensor for inter-vehicular distance measurement

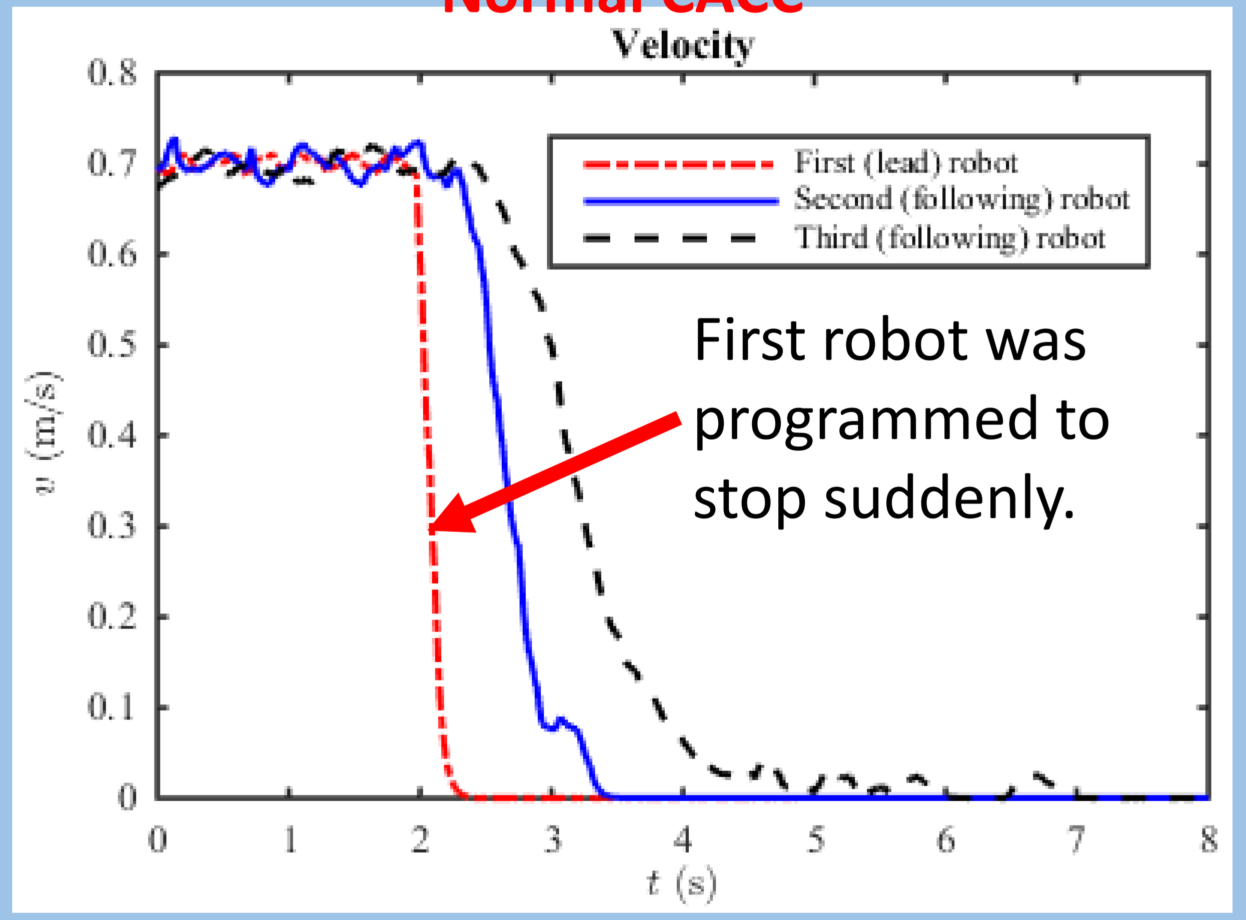
Normal CACC

- No emergency braking signal broadcasted.
- No additional emergency response strategy.
- Only the second robot had front-end collision risk for the test speed.

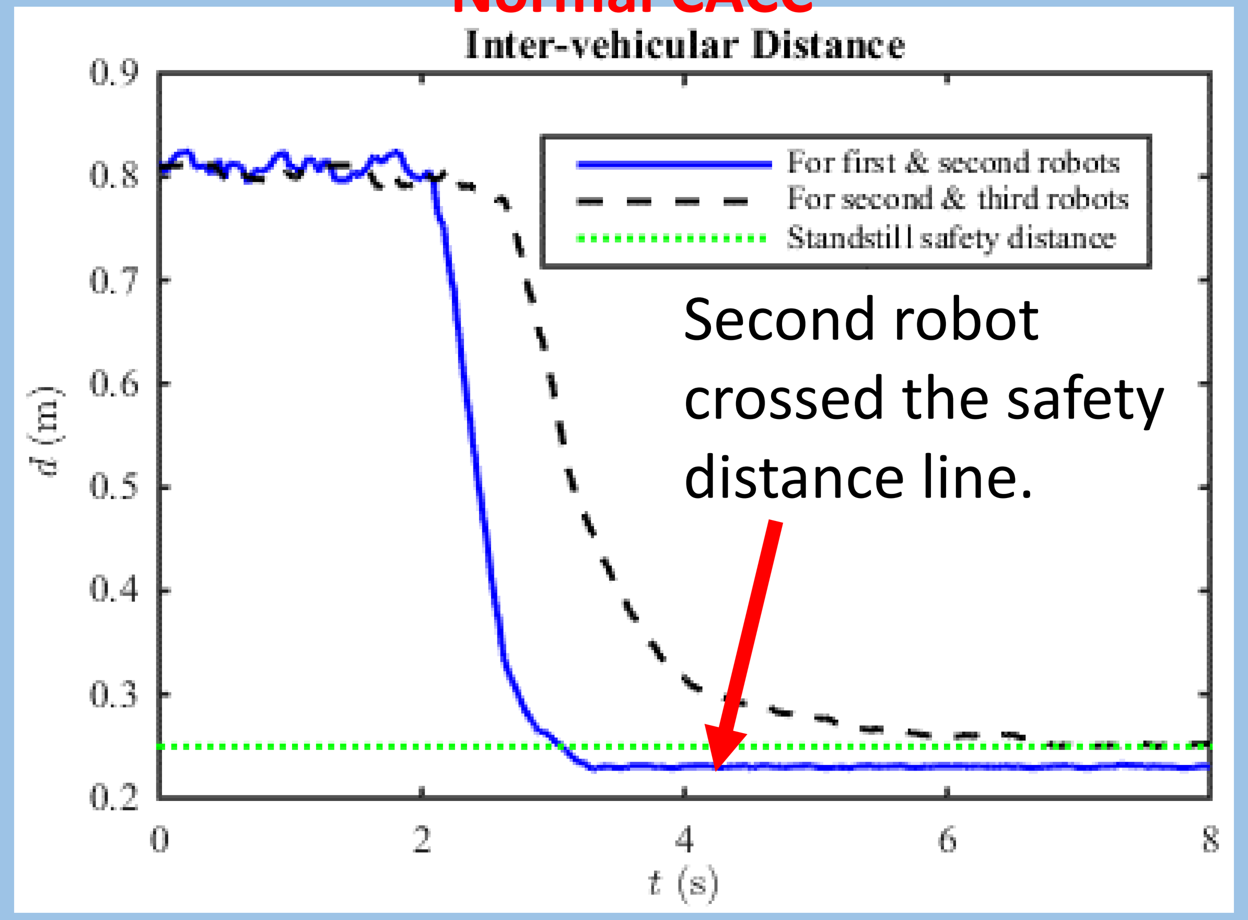
CACC with Additional Emergency Response

- **The goal is to stop behind the safety distance line (green line in the plots).**
- Second robot received the emergency braking signal from the first one.
- **Second robot *i*-1 then decelerated with a constant deceleration a_e determined by** $\dot{x}_{i-1}^2 = 2a_e(d_{i-1} - \tau_d \dot{x}_{i-1} - x_0)$ **where τ_d is the time delay in wireless communication and actuation, and d_{i-1} is the actual inter-vehicular distance.**
- Velocity results are similar to those of normal CACC.

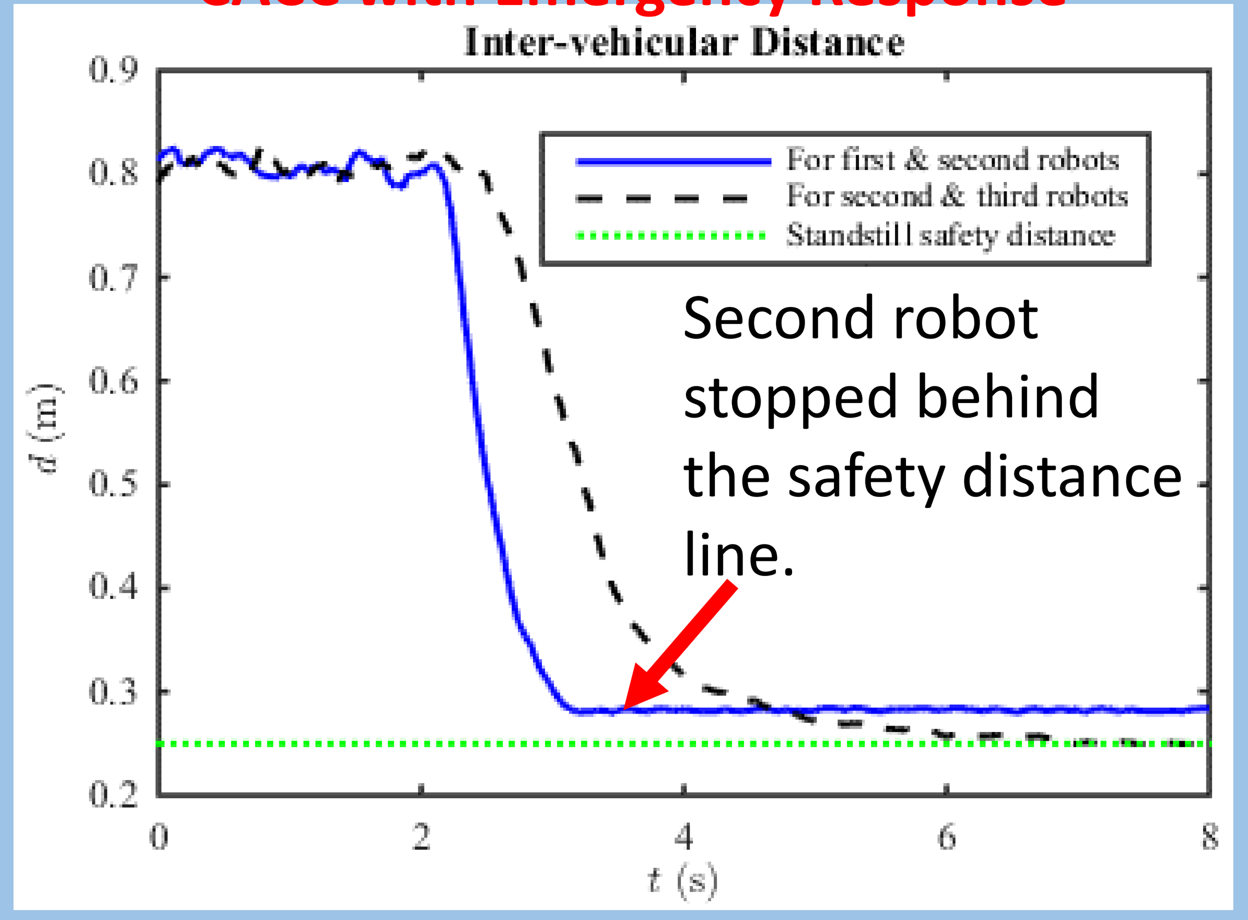
Normal CACC



Normal CACC



CACC with Emergency Response



Conclusions

- In emergency braking scenarios, inter-vehicular communication provides additional emergency signal to following vehicles to initiate braking.
- Collision risk is mitigated as the following vehicles stop earlier to maintain headways larger than the minimum required standstill safety distance.