Cooperative Adaptive Cruise Control Simulation Test Bed

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Abstract

Authors present a simulation test bed for evaluating Cooperative Adaptive Cruise Control (CACC) systems. The test bed integrates a vehicular simulation environment built in Unity to model vehicle dynamics and control, a Matlab communication simulation to model the IEEE 802.11p protocol, and a route generation process that utilizes Keyhole Markup Language (KML) files. This combination enables the analysis of CACC in complex scenarios, considering both vehicle behavior and wireless communication effects.

Motivation

- Evaluate CACC systems and control algorithms.
- Analyze platoon dynamics.
- Study the effects of wireless communication on automated vehicle behavior.

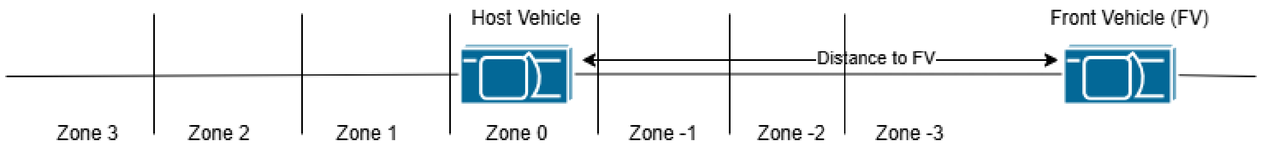
Methodology

The methodology employs a simulation environment combining several key elements. Vehicular movement, including ACC and CACC, is simulated using Unity to model vehicle dynamics and control in dynamic scenarios. Matlab is used to simulate the IEEE 802.11p wireless communication protocol, which encompasses data encoding, modulation, signal transmission, channel modeling, and signal reception/decoding. Simulation routes are generated from Keyhole Markup Language (KML) files, and the coordinate data are processed to create a detailed road representation.

Conclusion and Future Works

The simulation test bed effectively models CACC scenarios by integrating vehicular movement, communication protocols, and route generation. The simulation replicates CACC behavior, demonstrating how vehicles adjust speed and distance. The collected data supports further CACC analysis.

Control Algorithms



Data Collection

Group	Name	Description
	TimeSpan	Time stamp since the start of simulation
	CarName	Car name of the record
Speed	Speed	Speed
	Acceleration	Acceleration applying
Location	Index	Current location of the vehicle (meters)
	Latitude	Latitude location
	Longitude	Longitude location
	Heading	Driving direction of current location
Controls	ExpectedDistance	Expected distance to front vehicle (based on current speed min set: 50m)
	DistanceBuffer	+/- distance buffer to maintain a range on expected distance
	SafeHeadway	Safe time distance to maintain on ACC
Kinematics (FV)	Distance	Measured distance to front vehicle
	Speed	Measured speed of front vehicle
Platoon	Speed	Speed platoon is maintaining (proposing to current vehicle)
	VehicleIndex	Current vehicle's position within platoon
CACC (FV)	Name	Front vehicle's name (based on CACC msg received)
	LocationIndex	Front vehicle's location (meters)
	Latitude	Front vehicle's latitude location
	Longitude	Front vehicle's longitude location
	Heading	Front vehicle's driving direction
	Speed	Front vehicle's speed
CACC (Leader)	Name	Platoon leader's name (based on CACC msg received)
	LocationIndex	Platoon leader's location (meters)
	Latitude	Platoon leader's latitude location
	Longitude	Platoon leader's longitude location
	Heading	Platoon leader's driving direction
	Speed	Platoon leader's speed

Results