An Extended Cooperative Adaptive Cruise Control (CACC) Algorithm for Efficient Energy Consumption & Traffic Density Formulation

Bilgehan Bayar[1,], S. Amin Sajadi-Alamdari[2], Francesco Viti[1], Holger Voos[1]*

[1] Faculty of Science, Technology and Communication, University of Luxembourg,
Luxembourg-City, L-1359 Luxembourg
[2] Interdisciplinary Centre for Security, Reliability and Trust (SnT), University of Luxembourg,
6 rue Coudenhove-Kalergi, L-1359 Luxembourg, Luxembourg

[*]Corresponding author: bilgehan.bayar.001@student.uni.lu

Abstract submitted for presentation at the
Symposium on Innovations in Traffic Flow Theory and Characteristics and TFT Midyear Meeting
Sydney, Australia, 2-3 July 2016

Electric transportation, one of the most promising technologies of the century, can contribute to a greener environment as it is emission-free and sustainable. Although this technology promises a clean transportation style, it also has some drawbacks. One of the most significant one is cruising range, which needs to be addressed sustainably. The most eco-friendly solution is decreasing energy consumption by addressing driving behaviour. This can be achieved by taking the advantage of implementing an advancing vehicle automation technology which controls vehicles using a driver-assistance system such as Eco-Cruise Control (Eco-CC). Variety of systems already exist in the literature and a little known advanced version Eco-Adaptive Cruise Control (Eco-ACC) systems are developed as well. The next step of the vehicle automation is vehicle cooperation and information sharing, so-called Cooperative Adaptive Cruise Control (CACC). It is already developed and tested by various researcher. However, the largest deal of existing studies focus on assessing the performance in terms of safety, possible contributions to the energy consumption is not taken into account. This study covers the extension of Cooperative Adaptive Cruise Control systems while aiming to provide an energy efficient extended control algorithm to increase the energy efficiency and battery usage for electric vehicles. An energy efficient control algorithm is aimed to be derived to decrease the consumption of the vehicle. Cruising velocities and vehicle positions are received from the leading vehicles and accordingly traction force is adjusted to achieve efficient energy consumption.

By providing vehicle to vehicle (V2V) communication tighter spacing gaps, lower time headway, are aimed to obtain while traffic disturbances are damped, whereas in the cases ACC applications amplify the disturbance. Traffic density formula is introduced by using V2V communication which might be useful for ADAS and ITS framework. As a result, increase in traffic stability, density, and reduction in the total energy consumption is expected. Moreover, possible reductions in air drag with tighter spacing gaps may lead reduction in energy consumption.

For the energy calculations and the validation of the proposed method, vehicle dynamics and energy consumption of an electric car is formulated, which has completely different characteristics and limitations than combustion engine cars. Hence the study aims to provide additional understanding of behaviour of a fleet of CACC-equipped electric vehicles. Even though the proposed control algorithm is developed for Electric Vehicles, it can be extended to other vehicle types based on their energy consumption characteristics and vehicle dynamics.