VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Simin Hesami**

The public defense will take place on **Monday 30th June 2025 at 4pm** in room **D.2.01** (Building D, VUB Main Campus)

To join the digital defense, please click here

ENERGY-EFFICIENT ECO-DRIVING CONTROL FOR CONNECTED AUTOMATED ELECTRIC VEHICLES

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Abstract of the PhD research

The transportation sector accounts for more than one fourth of energy consumption and Greenhouse Gas (GHG) emissions of the world. The advancement of Automated Vehicles (AVs) has recently paved the path toward its introduction into the transportation system. In this regard, a important question is raised: in a transportation system, how can we leverage this technology to control vehicles in an energy-efficient manner and enhance ecological gains?

This PhD research focuses on various levels of energy-efficient eco-driving Connected Automated Electric Vehicles (CAEVs) including single CAEVs and platoons of CAEVs in the vicinity of signalized intersections. A novel framework backboned by optimal control and Model Predictive Control (MPC) is developed. Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communication are assumed, and their information is used in the framework to get the signal timing information and the state of the surrounding vehicles. The developed approach consists of three main parts: a free-flow-based eco-driving model, a predictive cruise control eco-driving model, and a multi module eco-driving model designed for platoons.

The free-flow-based eco-driving model provides energy-optimal trajectories in both up- and downstream of the signalized intersections. The application of this model is in situations in which the CAEV is far enough from its preceding vehicle to be considered as driving on a free-flow road.

The predictive cruise control eco-driving model has two main types: reactive, and proactive. In the reactive model, a second layer is added to the free-flow-based model to track the speed profile of the free-flow-based eco-driving model as close as possible, by considering a collision-avoidance constraint. In the proactive model, the first and the second layer of the problem are merged, aiming to have reduced speed fluctuations and improved energy consumption.

The eco-driving framework is then extended to address platoons of vehicles in a heterogeneous traffic environment in presence of Human-driven Vehicles (HVs). Based on the situation, either the free-flow-based or the predictive cruise control eco-driving model is implemented for the platoon leaders. For the follower vehicles in the platoons, an enhancement to the conventional Intelligent Drivel Model (IDM), capable of car-following in signalized roads, is designed and implemented.

The results show significant reductions in energy consumption by using the proposed frameworks at each level. The outcome of the proposed PhD work provides insights on CAEVs single and platoon control levels from different aspects through the realized frameworks.