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From May to August 2017, IFPEN's Mechatronics, Computer Science and Applied Mathematics Division hosted **Ardalan Vahidi**, Associate Professor in the Faculty of Mechanical Engineering (Clemson University - South Carolina, USA) as a scientific visitor.

During his visit, **Ardalan Vahidi worked on driving control in connected and/or driverless vehicles with a view to achieving greater energy efficiency**.

Professor Vahidi spent much of his time working with Antonio Sciarretta, an expert in this field within IFPEN's Control, Signal and Systems department, as well as Jihun Han, who has been with IFPEN as a post-doctoral researcher since 2016. The collaborative work focused on two priority areas:

- **A review of the existing literature**, examining the potential avenues for reducing the energy consumption of connected and/or driverless vehicles.

The analysis conducted provided an illustration of the impact on consumption of the **predictive knowledge** of several factors: **road characteristics (topography, number of lanes, speed limits, etc.), traffic light status, movement of vehicles close by and the lane changes they make**.

- The second part of the study was dedicated to measuring the opportunities provided by **collaborative driving**, once the penetration rate of connected and/or driverless vehicles is sufficient. Techniques such as platooning and cooperative cruise control, cooperative lane changing and cooperative control of intersections (see box below) were analyzed.

The second aspect of the research concerned the **theoretical fundamentals of energy-efficient driving**, with the definition of simple models to separate and characterize the influence of factors specific to vehicles and the available predictive information. Potential improvements examined included the minimization of losses through the wheels and powertrain, and covered both IC engine and electric vehicles.

For conventional vehicles, a characterization of the optimum conditions for the pulse-and-glide driving technique (see box below) was studied.

For electric vehicles, three scenarios were considered: the presence of speed limits, a traffic light or a vehicle in front.

The research led to **publications in specialist scientific journals**.

- ***Platooning:*** *grouping vehicles together in a convoy (or platoon) in order to reduce the distances between vehicles through communication and electronic control; this concept increases fuel efficiency thanks to reduced air resistance.*
- ***Cooperative cruise control:*** *speed regulation system that overlays communication between vehicles and adaptive control via radar of the separation distance.*
- ***Cooperative lane changing and intersection control:*** *systems in which the controllers of different vehicles cooperate not only by exchanging their decisions but also by including the impact of the decisions of other vehicles in their own decision-making criteria.*
- ***Pulse-and-glide:*** *an eco-driving technique, notably employed in North America to reduce fuel consumption, which consists in accelerating (pulse) up to a defined maximum speed and then allowing the vehicle to "free wheel" (glide) with minimal loss and friction down to a defined minimum speed. This cycle is repeated as often as possible throughout the journey.*

Connected and driverless vehicles: IFPEN welcomes Professor Ardalan Vahidi
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