FICHA BECA DOCTORAL 2018

Business Division Business Area	Industria & Transporte Automoción
Technology Platform	Automated Driving
Scholarship location	Bizkaia Derio, edificio 700

DESCRIPTION OF THE SCHOLARSHIP

Title: Cooperative manoeuvres for urban environments with automated vehicles.

Urban environments are becoming more and more complex for drivers due to several factors as consecutive crossroads or lanes changes. The complexity of these scenarios demands specific infrastructures–i.e. roundabouts, for improving traffic flow compared with traditional intersections. A roundabout removes timeouts associated with traffic lights at crossroads and, for that reason, it is a challenging scenario for human drivers and automated vehicles.

This work will be focused on the coordinated control for automated in roundabouts for smart cities. Main contributions are focused on real time trajectories generation and high level decision-making systems for cooperative manoeuvre with Automated Vehicles. The information from the different on-board sensors and communications to achieve a realtime trajectory generation will be considered, which should be smooth and with a continuous curvature in the path.

Description of the scholarship:

Roundabouts are relatively recent on urban environments, making difficult for some drivers–i.e. elderly people–to know how to deal with them. Figure 1 shows the proper circulation in function of the exit according to the European Road Circulation Code at roundabouts.

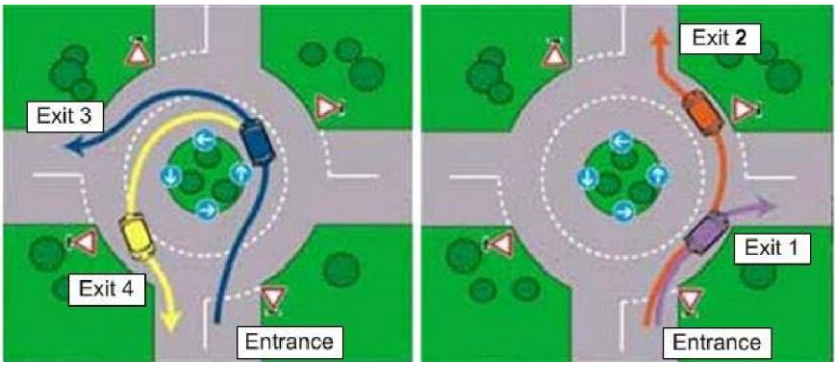

Figure 1. Roundabout behaviour taking different exits

So far, fully automated capabilities at roundabout have been only tackled in a few single vehicles demonstrations worldwide. All these demonstrations show several capabilities for automated vehicles in complex scenarios. However, most of them consider prerecorded paths–i.e. previously hand-driven data, and are based on steering wheel angle error tracking algorithms. Roundabouts were considered on these routes but they were modelled as standard intersections, without dedicated analysis in this scenario. A coordinated control in roundabouts, considering other automated, semi-automated and not-automated vehicles, remains an open challenge in nowadays.

This PhD Thesis proposes a path planning generation and decision-making methods for automated vehicle driving at roundabouts. These methods will attend a real-time trajectory generation, in a first step for single vehicles, and then for more complex scenarios with others agents. The trajectory through a roundabout is divided the driving process in three stages: entrance manoeuvre, driving within the roundabout and exit manoeuvre. The proposed thesis will be firstly tested on simulations, assuming different scenarios (lanes and exits). Then, a prototype platform–Electric Twizy– will be used for the system validation on real urban environments.

This work will be developed in the framework of Tecnalia, in the Automation area. The team has large experience in the development of perception, control and communication techniques for ITS systems in urban environments.

Intelligent control techniques, such as: Fuzzy logic and neuro-fuzzy system can be used to translate the human knowledge into the driving process. Different strategies will be used for the decision making of automated vehicles in urban roundabouts. For the trajectory generation, different mathematical models and parametric equations and elastic bands will be tested. The Bezier curves are an example of simple parametric equations, which have a computational advantage and its easy implementation in the control algorithm saves resources that can be reallocated to other computation tasks.

In brief, this PhD work proposal is oriented to work in the development and execution of complex manoeuvres in urban environments, particularly roundabouts. The specific objectives are:

- To redefine the control architecture of the vehicle in Tecnalia for real time path planning.

- To test single vehicles manoeuvres in urban roundabouts.

- To follow a pre-defined path, defined as a reference trajectory, based on stable control techniques.

- To perform specific trajectories in function of specific geometry configurations. As example: roundabouts, intersections and so on.

- Dynamic planning trajectory implementations – reactive planning – in order to perform unexpected avoidance maneuverers.

- To integrate on-board sensor and communication information in order to consider other vehicle in the different stages of the automated driving in roundabouts.

- To design a decision making based on human natural driving for automated vehicles in roundabouts, based on:

  o Information from other drivers.

  O Pedestrian on the crosswalk.

  O Merging on the roundabout (stop, give way, …).

  O Exits the roundabout.

  O Lane change, if necessary, in each stage of the roundabout.

This thesis will be tested on TECNALIA demonstrator vehicles.

REQUIREMENTS:

We look for a profile that meets the following requirements:

• Qualification and Specialty: Higher engineering in electronic, computer, telecommunications or similar.

• Languages: High knowledge of English, written and spoken.
• Computing: program well the object-oriented language, C ++, Matlab / Simulink.
• It will be valued: Having knowledge of vehicle models, control, simulation of real-time systems, and mobile robotics in general.

Further information and applications: http://bit.ly/2J23kWr