IFAC
INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

9th IFAC International Symposium on Advances in Automotive Control
Orléans, France
24 - 27 June 2019

AAC Orléans 2019

Workshop Information Form

Workshop Title

New advances on autonomous vehicle

Workshop Manager

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Summary of the WorkShop and General Schedule

New challenges undeniably occur while building next-generation autonomous vehicles. New solutions and technologies are continuously developed and designed toward a truly autonomous vehicle, that is to say, a machine behaving like a human.

Five levels have been defined in the evolution of autonomous driving, each level describing the extent to which a car takes over tasks and responsibilities from its driver, and how the car and driver interact:
1 - ***Driver assistance***: driver assistance systems support the driver, but do not take control;
2 - ***Partly automated driving***: one driver assistance system of steering and acceleration/ deceleration is automated, but the driver remains responsible for operating the vehicle;
3 - ***Highly automated driving***: under certain traffic or environmental conditions, the driver can disengage from the driving for extended periods of time;
4 - ***Fully automated driving***: the vehicle drives independently most of the time to perform all safety-critical driving functions and monitor roadway conditions, the driver being able to drive;
5 - ***Full automation***: the vehicle assumes all driving functions in every driving scenario, the people in the vehicle being only passengers.

The autonomous vehicle is a combination of sensors and actuators, sophisticated algorithms, and powerful processor systems that execute advanced software. Three parts emerge from the sensory system:
- ***navigation and guidance*** part that determines where you are, where you want to go, and how you get there;
- ***driving and safety*** that directs the vehicle, making sure that vehicle acts properly under all circumstances and follow the road legislation;
- ***performance*** that manages car’s internal systems (power control and management, consumtion and thermal dissipation)

Lots of challenges are still open such as road conditions, weather conditions, traffic conditions, accident liability, radar interference,…

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Lecturer #1 :

Name: AIOUN François – PSA Group
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Schedule: 28 June morning

Brief biography:

François Aioun received an engineering degree in electronics, computer science and Automatic control in 1988 from ESIEA high school, France. He obtained a Master of Science degree in Automatic control and Signal processing in 1989. From 1989 to 1993, he was recruited by Electricité de France to study active vibration control in a structure. He obtained a Ph.D. degree in Automatic Control in 1993. After post-doctoral research at Ecole Normale Supérieure of Cachan and in different companies, he joined PSA Group company, a car manufacturer, in 1997. His research interest in automatic control covers active vibration, power plant , powertrain, actuators and more recently Autonomous and Intelligent vehicles.

Summary of the contribution #1

Autonomous and connected vehicle challenges for the automotive industry

The autonomous vehicle seems to become a reality in the near future for many car manufacturers, academic laboratories that are in the field of intelligent vehicles, as well as technology companies such as Google or Uber.

Indeed, development of autonomous driving functions will enhance significantly security, comfort, capability of the driver, giving him more time to perform other tasks, relieving of tedious driving ones and reducing fuel consumption and traffic jam.

However, if full autonomous prototype vehicles already exist and are tested on highways or on urban roads, many issues and scientific challenges still remain to produce these autonomous cars on an industrial scale.

Some of these issues are due to complexity of interactions between the autonomous vehicle and human road users (human drivers, passengers, cyclists, pedestrians): Driver monitoring for take over management and driving safety, acceptability of autonomous driving by passengers and other road users, driving ethical rules, protection against electromagnetic attacks or inappropriate behaviors of pedestrians, …

Other issues are due to complexity of the Cyber Physical System to be controlled by driving algorithms: information exchange through connectivity and cooperative driving, scenery interpretation, decision and path planning and high-level of safety validation.

The aim of the conference is to exchange on challenges and issues that autonomous vehicle represents for the automotive industry.



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Lecturer #2 :

Name: GIRALT Alain – Continental Engineering Service
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Schedule: 28 June morning
Brief biography:

Alain GIRALT is a Vision System Expert in Advanced Driving Assistance System within Continental Automotive. Alain GIRALT was born in Toulouse in 1959. In 1992 in obtained his Ph.D. degree in Electronic Engineering from the” Institut Polytechnique de Toulouse” and joined the Advanced Development team of Siemens Automotive in 1993. In 2003 he was nominated Senior Expert in Vision Systems. In 2008 he joined the Continental Automotive where since he continues his activities of vision expertise supporting the algorithmic development of camera based systems for internal and external perception. Alain GIRALT has got a strong experience in partnership projects: SAVE, AWAKE, SENSATION, HAVE IT, ACROSS and Automate EU founded project.
www.conti-engineering.com

Summary of the contribution #2

This presentation is about the systems Continental is developing for the perception and modelling of the driver and the situation in which the vehicle is involved. The systems include both internal perception for modelling the driver’s state (physiological, behavior, etc.) and external perception for situation modelling (obstacle, lane marking, etc.) aiming both and combined to improve driver’s safety and comfort toward the autonomous vehicle. Different perception technologies (camera, radar, flash-lidar.), trends and challenges will be presented.

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Lecturer #3 :

Name: VICTOR Stéphane & MELCHIOR Pierre – IMS
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UMR 5218
Schedule: 28 June afternoon
Brief biography:

Stéphane Victor was born in Germany in 1983. He graduated from the INP/ENSEIRB-MATMECA and Ecole Polytechnique de Montréal engineering schools in 2006, and obtained his M.Sc. and Ph.D. degrees in Automatic control from Université de Bordeaux in 2006 and 2010. He is currently Associate Professor and has joined the CRONE team of IMS laboratory at Université de Bordeaux in 2006. His research interests are in the area of fractional differentiation and its applications in automatic control, system identification, thermal systems and motion planning with flatness.

Pierre Melchior was born in France on 1961. He graduated from the University of Bordeaux, Talence, France, and received the Ph.D. degree in control engineering from Paul Sabatier University, Toulouse, France, in 1989 and the Accreditation to supervise research (HDR) from the University of Bordeaux, in 2014. He is currently an Full Professor of control theory and a Researcher with Laboratory IMS, University of Bordeaux, Talence. He is head of the CRONE team of IMS Automatic Control Group. His research interests include systems, control theory, robotics, and biomechatronics (e.g., fractional systems, fractional path planning, fractional motion planning, and muscle modeling).

Summary of the contribution #3

Reference control generation and multi-criteria optimization

A method in reference generation, or trajectory planning is proposed. An energy criteria is defined and studied in detail, as one of the motivations of this study concerns energy consumption optimization of autonopous vehicles in relation to the trajectory. The proposed method follows Pontryagin maximum principle as proposed By Petit and Sciaretta [2011] and improvements are provided for position reference generation under several conditions such as time, road slope, waypoints or trajectory control constraints.

First, study developments are provided under Matlab/Simulink practical work and strategies are provided for multi-criteria optimization.

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Lecturer #4 :

Name: JACOB Bernard
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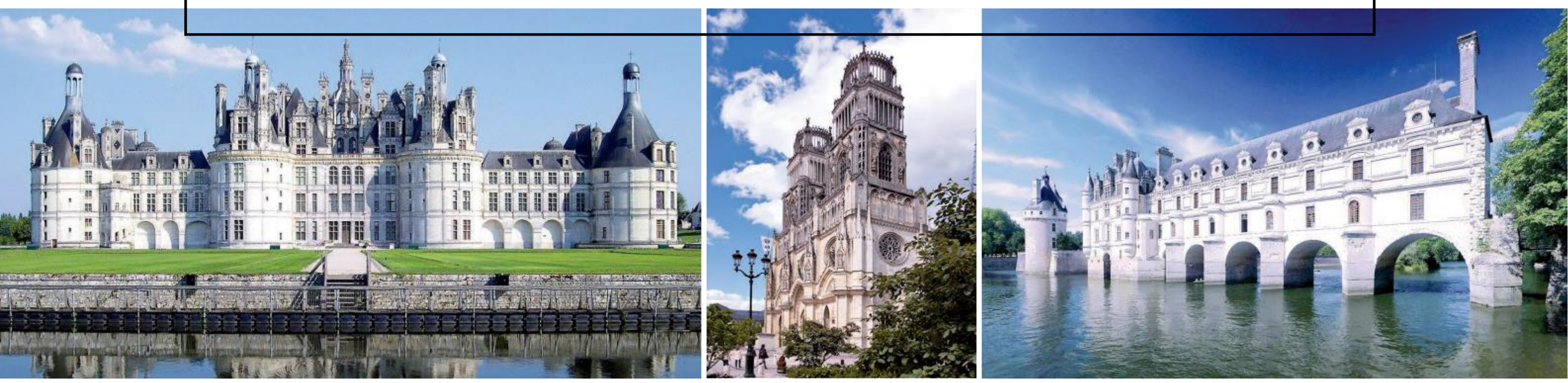
Schedule: 29 June morning
Brief biography:

Bernard Jacob is graduated from Ecole Polytechnique and Ecole Nationale des Ponts et Chaussées. He is a bridge and road engineer. He is Deputy Scientific Director with IFSTTAR and co-leader of the Infrastructure research axis. He has a 30 year experience on bridge durability, fatigue and safety, on traffic loads on infrastructures, on heavy vehicle technology and operation, weigh-in-motion and applications, trucks/infrastructure interaction, truck and road safety and freight transport. He is an international expert in Weigh-In-Motion and on heavy vehicles (weights and dimensions, interaction with infrastructures, safety, platooning).
He had lead positions in several National, European and International projects and expert groups. He is member of two TRB standing committees: AB055 on Heavy vehicle weights and dimensions and ABJ35 on Traffic Monitoring and WIM. He is the French secretary of the PIARC technical committee B4 on freight transport.
Bernard Jacob is professor in probabilistic structural reliability at ENTPE and ESIEE.

Summary of the contribution #4

Autonomous heavy vehicles and platooning

In most parts of the World, and in the EU, 75% or more of the freight transport is done by road. There is a continuous increase of the freight transport demand, and thus of the heavy vehicle flow on the existing infrastructure. The new challenges are to reduce the GNG emissions, the fossil fuel consumption, the road congestion and unsafety, and to increase the efficiency of the freight transport. For long distance freight transport, there are three main approaches to fulfil these objectives. Massification consists of using longer and heavier vehicles, i.e. high capacity vehicles (HCV), reducing the energy consumption per unit of load.km, and the number of vehicles to carry a given amount of goods. Electrification of heavy vehicles on long distance corridors, i.e. the electric road system (ERS), with several technologies supplying the vehicles in motion with electricity, such as catenaries, ground electricity supply or induction, may dramatically reduce the CO2 emission along the roads. The origin of the electricity remains an issue and the business model is still to assess because of the huge investments on the infrastructure. Truck platooning consists of operating series of trucks (e.g. 2 to 6 or 7) at short distances, such as 5, 10 or 15 m, and some level of automation (from SAE 1 to 4). Higher the automation level and shorter the safe spacing, thus higher the energy and CO2 savings by aerodynamic drag forces reduction. However, the main benefit at level 4 is a significant increase of the driver and vehicle productivity, with a potential range extension of 30%. Some additional benefit are achievable on the logistics organization. Platoons may be safely operated on motorways with connected and automated vehicles, may be formed and dismantled “on the fly” (in motion) and checked by a service provider. Several projects were conducted on platooning, in the US, in Japan and in Europe since 2 decades. A large EU funded project (ENSEMBLE) is currently running in Europe on multi-brand truck platooning, to pave the way to a future harmonized platooning system in Europe.



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Lecturer #5 :

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Brief biography:

Stéphane Victor was born in Germany in 1983. He graduated from the INP/ENSEIRB-MATMECA and Ecole Polytechnique de Montréal engineering schools in 2006, and obtained his M.Sc. and Ph.D. degrees in Automatic control from Université de Bordeaux in 2006 and 2010. He is currently Associate Professor and has joined the CRONE team of IMS laboratory at Université de Bordeaux in 2006. His research interests are in the area of fractional differentiation and its applications in automatic control, system identification, thermal systems and motion planning with flatness.

Summary of the contribution #5

Multi-criteria trajectory optimization for autonomous vehicles

In the last few years much effort has been made towards more autonomous vehicles and fuel consumption reduction. This article deals with the issue trajectory optimization of unmanned terrestrial vehicles so as to reduce consumption, travel time or to improve comfort. Main focuses are set on testing different criteria and the possibility of using a genetic algorithm to improve the potential field methods (Ge and Cui (2002) and Melchior et al. (2003)). The main idea of this article is that potential field methods could be improved by smartly placing intermediate attractive points in the field. It brings two improvements to the potential field method: the generation of an optimal path in the environment, and the generation of a correlated optimal motion. In the first two parts of this article the issue at stake is briefly described along with the different criteria and methods used, then simulations will be presented of the potential field method and its combination with a genetic algorithm.

Keywords: Autonomous vehicles, Path planning, Artificial Potential fields, Optimal trajectory, Optimization, Genetic algorithms