ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Press release – Monday 30 January 2017

With or without a driver, vehicles are able to cooperate

EPFL researchers have developed an algorithm for automated vehicles to operate in traffic alongside manually-driven vehicles. This is a key step in the shift towards autonomous driving expected to be achieved by 2030.

One thing is certain: one day our cars will drive themselves. But how will we make the transition from a handful of autonomous and connected cars today to a true smart system offering enhanced safety, comfort and seamless and robust operation, in just 15 years' time? Researchers who worked on the European AutoNet2030 project believe it can be achieved by combining driving assistance technologies and inter-vehicle communications. They have recently shown that it is possible for vehicles with or without drivers to operate in high-speed, multi-lane traffic autonomously under real-life conditions. This is a key step in the ongoing shift towards autonomous driving. EPFL's contribution to this project came in the form of a cooperative maneuvering control algorithm.

Thanks to a communication protocol based on Wi-Fi, vehicles can now share information among each other. This, combined with an array of driving-assistance devices – GPS, lasers, video cameras and other sensors – gives vehicles the ability to drive completely on their own. That said, it will be another 15 years before most vehicles are equipped with these devices, heralding a true driverless future.

Cooperation and autonomy

In the next few years, how will these cutting-edge vehicles rolling off the assembly lines fit into the traffic system alongside legacy vehicles? One option under study is to have automated vehicles travel in convoys. For example, a manually-driven truck could lead a platoon of autonomous tractor trailers moving at a constant speed and at an equal distance from each other. This approach has been successfully tested over hundreds of kilometers in Australia. The only problem is that this type of convoy behaves as a discrete block which, above a given number of vehicles, becomes increasingly difficult to manage.

The AutoNet2030 researchers came up with another solution: a cooperative and distributed system. Out goes the leader, as each connected vehicle communicates directly with other vehicles in the immediate vicinity. They then adjust their speed and position independently of each other. The convoy has no trouble driving on one or more lanes on a highway or reconfiguring when another vehicle joins the group. Each vehicle also benefits from its neighbors' 'eyes', effectively enjoying 360 degree perception. What's more, there's no upper limit to the size of the convoy in theory, since each member positions itself independently.

Simple units, complex behavior

Convoys are managed using control software based on an algorithm developed by EPFL's Distributed Intelligent Systems and Algorithms Laboratory (DISAL). "We have been working on this type of distributed control algorithm for around ten years. Simply put, the idea is to find a way for agents that are not particularly clever – robots or cars – to work together and achieve complex group behavior," said Alcherio Martinoli, the head of DISAL. In mathematical terms, this means that the algorithm uses information that it receives from the agents' sensors to guide the convoy's movements in real time. The convoy automatically and constantly reorganizes when, for example, another vehicle joins or leaves it, it changes lanes, or it adapts to target speeds. The DISAL researchers began by managing robots on simulators before moving on to real miniature robots and then to cars on simulators. Finally, as part of the AutoNet2030 project, they managed to get to real vehicles on the road.

The final demonstration took place at the end of October 2016 in Sweden, on the AstaZero test track. Three vehicles were used: an automated truck and car and – a key aspect of the project – a networked though manually-driven car. The researchers equipped the non-automated car with GPS and laser sensors and a human-machine interface allowing the driver to follow instructions on joining the convoy.

Initial demonstration

"It may not seem so impressive with only three cars, but for the first time we were able to validate what we had achieved in the simulation. And the number of vehicles in the convoy has no impact on the complexity of the control mechanism," said Martinoli. What's next? "This is a proof of concept," said Guillaume Jornod, the EPFL scientist who ran the trials. "We are hoping that, with a rise in demand, carmakers will come up with ever cheaper solutions for converting legacy vehicles, that they will coordinate their efforts with the community working on the Internet of things, and that we will be able to deploy and improve this multi-lane convoy system for heterogeneous vehicles."

In addition to EPFL, the AutoNet2030 project involved: Institute of Communications and Computer Systems (Greece, coordinator), Broadbit (Hungary), Baselabs (Germany), Centro Ricerche Fiat (Italy), ARMINES – Mines ParisTech – INRIA (France), Scania (Sweden), Hitachi Europe and the Technische Universitaet Dresden (Germany). This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 610542.

Press Kit
Video: https://youtu.be/SMOk3LZIZR0
Photo: go.epfl.ch/AutoNet2030
AutoNet2030 website: autonet2030.eu

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