Cooperative cybercars, a question of priorities

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(PhysOrg.com) -- European researchers have developed new control systems that let driverless vehicles communicate and cooperate with each other. Could fleets of high throughput rapid transit systems soon be cruising our cities?

Many metro and tram systems effectively run automatically nowadays. Still, it is reassuring to see the driver in the cab, knowing someone is there to take over in an emergency or to override the computer's controls if necessary. But European researchers in the CyberCars2 project have now demonstrated that vehicles can be left to themselves much more. If allowed to 'talk' to each other, automated vehicles can organise themselves well enough to get around efficiently and safely.

Two earlier EU-funded projects, CyberCars and CyberMove, developed the sense and control systems by which unmanned road-based vehicles, called cybercars, could safely navigate the streets.

Now the follow-on CyberCars2 project, has added a communication layer to the system and data analysis software so that vehicles can exchange data and coordinate their movements.

These results from this latest project will drive forward the development of high-throughput, efficient automated transportation systems (as opposed to single vehicles) that could be deployed in traffic-free zones.

Coming through!

A number of the consortium's partners have been involved in basic research to develop the rules by which the flow of traffic is governed. What happens, for instance, when two automated vehicles arrive at an intersection at the same time? Who takes priority and who decides to go first? Should a car stop at the junction and give way, or just slow down until the other car has passed, then speed up again?

The early days of the project saw researchers creating software to simulate all the possible manoeuvres and scenarios that a fleet of automated vehicles might encounter. The scientists then used the simulator to explore a wide range of situations. They looked at the behaviour of vehicles and tested different rules and prioritisation strategies that vehicles could follow to negotiate complicated situations.

The simulator software allowed the researchers to test millions of negotiations and draw up mathematical rules, known as algorithms, that would control how the cybercars negotiated and navigated junctions, traffic lights, merges and emergency situations in utmost safety.

The project also developed new techniques to handle the enormous volume of data that cybercars might have available to analyse - imagine how much information would fill the airwaves at a city centre terminus where a hundred automated vehicles might be moving around in close proximity.

The researchers adopted a technique called data mining, which uses complex mathematical analyses of data to find patterns and trends. In a typical data search you have to know what you are looking for, then a computer can rapidly churn through the data to find what you want. For example, it might reveal that vehicles are always late when it rains on Mondays and Fridays, but not mid week - something that you would probably never have thought to look for.

The CyberCars2 data mining allows the cybercar control systems to cope with the enormous volume of transient data and identify which elements are the most important or critical to its safe manoeuvring.

Close cooperation

One of the biggest breakthroughs in CyberCars2 is the replacement of the traditional "block system" to control traffic flows with techniques that let vehicles follow each other at extremely close quarters.

"The software developed by the predecessor CyberCars project was for moving vehicles independently at fairly large distances," explains Michel Parent of INRIA, coordinator of CyberCars2. "We used the same block system as railways, where a vehicle cannot proceed until the one in front has cleared a section.

"But block technology only allows a low throughput. The communication and decision-making modules we have developed help to increase the efficiency of an automated service through coordination which will adjust the speed of vehicles as they approach junctions so they can cross without having to stop."

If the stunt-like four-way crossings don't impress you (which they might not at the current speeds of about 5km/h), then perhaps the "platooning capabilities" of the CyberCars2 test vehicles might at least raise an eyebrow.

Platooning lets cars drive close behind one another, almost as if they are coupled together. As they are communicating and cooperating with each other, if the car at the front has to stop, the one behind also applies its brakes in an instant. Safe stopping distances for cooperative cybercars could be less than a metre, depending on the speed.

The CyberCars2 research has developed real-time controls that bring the distance between vehicles down to 0.3 seconds. Imagine travelling at 40km/h, but only 3m behind the vehicle in front!

“This is an order of magnitude better than what exists for existing automated systems,” says Parent, who remarks that the automated transit system being installed at Heathrow Airport has a spacing of six seconds.

Safety first

But could you trust a ride in such a dare-devil machine? Safety is evidently the ultimate limiting factor to the uptake of automated transport systems, and these cybercars are developed with safety first. For example, the software is designed to handle a loss in communication between vehicles. If the communication network breaks down, the vehicles revert to “line of sight” procedures; they will not cross intersections, for example, unless they visually detect that the coast is clear.

Indeed, the first applications of CyberCars2 technology could well be found in somewhat normal looking cars. Part of the CyberCars2 project involved the building of several “dual-mode” vehicles that could be switched between fully automatic and manual driver modes.

But while a car is under manual operation, the automated systems continue to work, providing the driver with useful information about the road and other vehicles in the vicinity. The Advanced Driver Assistance Systems (ADAS) are being developed in a number of EU-funded projects and manufacturers have started to install them in cars.

Meanwhile, the CyberCars2 project continues to push cooperative, automated transport systems as the answer to many of the transport issues facing European cities, especially through the EU-funded CityNETMobil project which will explore the possibilities for such systems in five demonstration cities.

"All the basics are there for a functioning, efficient and safe system," Parent asserts.

This is the second of a two-part special feature on CyberCars2. Part 1: www.physorg.com/news169913192.html

More information: www-c.inria.fr/cybercars2

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