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AUTONOMOUS TRAMS

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In January the Government published a report on The Future of Mobility. Within the section looking at future transport systems was a section on automation and autonomous vehicles. While the focus was on self driving cars and autonomous buses, there was only a brief reference to self-driving trains and no reference to any such technology for trams. However, in the German city of Potsdam, an experiment began in September last year with the local transport company, ViP, working with tram manufacturer Siemens to look at the potential for autonomous trams.

Autonomous Trains

When London Underground's Victoria line was opened in 1968, it had automatic train operation (ATO) and did not require the use of drivers, although they were carried in case the ATO system failed. London's Docklands Light Railway is also an automated system, where there are no drivers, but there are staff members on the trains who are able to take control of the vehicles if their ATO system fails. In each case, the normal operation is controlled by a computer which can set signals and points, open and close doors and start and stop the trains in accordance with a set programme.

However, they are not autonomous. They effectively take orders from a third party (the computer controlling them) and have very little input from the world that is surrounding them. The closest thing to autonomy is the detection system which realises that a door cannot close due to an obstruction and opens the door again, expecting the obstruction to be removed by someone. As a result, the trains run on closed systems, which are designed to severely restrict the opportunity for any person or thing to get into the way of the vehicle. The trains are not designed to detect obstructions and will not change their movement if an obstacle appears in their path.

Metro automation onto the streets

Taking automation onto the streets and installing it into a tram creates a whole new series of challenges. Objects are no longer restricted from the path of the vehicles and there are a myriad of potential interactions that the vehicle needs to take account of. ATO is not designed to deal with these interactions and "green means go" is no longer an option. This is why tram systems have generally been operated on the basis of there being a driver who will run on "line of sight", rather than simply drive to a set of signals. The driver looks out for potential interferences or blockages of the tram's route and reacts to them, whether they are actually occurring or could occur, much as a car driver would do.

Once you start to look at a tram from the point of view of a metal box running on a street, then the autonomous technology being developed for the automotive industry starts to become much more appealing. The presence of the tram tracks also provides an indicator to pedestrians and other street users of the existence of the tram line, hopefully making them more aware of the potential arrival of a tram near to them. However, in the world of autonomous vehicles, the systems need to work on the basis that no-one has noticed the vehicle.

Tram automation v car automation – benefits and issues

Trams have the advantage that they will only be travelling in a limited number of directions (forwards or backwards or left / right when at a set of points) rather than the greater number of options for an autonomous car. However, in both cases, the detection systems will primarily need to focus on an area forward of the path the vehicle is intending to take. Both will need to be aware of actions occurring immediately in front as well as in a defined arc on either side of it.

While the tram has the advantage of having a defined path to run on, and hopefully people being more aware of its expected arrival, this can also be a major disadvantage. If there is a blockage in the road ahead, an autonomous car can manoeuvre around it, while the tram needs to stop and wait for the blockage to be removed. In a full automation scenario there would be no-one from the tram company to deal with the blockage and the tram would remain stationary until a third party removed the blockage. For this reason it would seem logical to always have a member of staff travelling on the tram and be able to override. Indeed, in the Potsdam experiment, there is a driver in place in case there is need to override the autonomous system and to ensure that it is safe to restart the tram when it has stopped through movement detection. The future intention, as the technology improves, is to move the driver away from the cab and deploy them in a different role, possibly in providing passenger assistance within the tram itself.

One benefit of the automation which has been observed, even though there is a driver available, is the speed within which potential interactions between the tram and other users of the road can be detected and the brakes applied. The detection system is able to process the information about movements ahead and make the decision to apply the brakes faster than a human can. Even if an impact cannot be prevented, the faster reaction can have a significant effect on the speed of impact and any damage caused.

Detection systems – which movements are ones to look out for?

The tram in Potsdam is fitted with camera sensors, multiple radar and lidar (light from a laser). These create a digital world around the tram and allows a digital picture to be created, which can decide whether a potential interaction with the tram is likely and to take action to avoid the interaction.

It is important for the system to be able to distinguish between a set of movements which might mean that a person or object is going to move into the path of the tram and a set of movements which will simply see an action taking place in a plane parallel to the tram. The detection system will also need to allow for a movement which changes as, for example, the pedestrian finally notices the tram and either speeds up to get across the tram track before the tram arrives, or stops and retreats from the tram's pathway.

Given the number of potential movements alongside a tram track in a busy town centre where, maybe, the tram is the only large vehicle to be able to cross a town square but there are hundreds of people moving in many directions, detecting the right movements will be very important. Arguably there will be more conflicting movements than for most autonomous vehicles, so the technology will need to be particularly sophisticated. Having a stop-start process simply because of a person's movement to one side of the tram would not benefit the tram operation!

Risks and liabilities (as we are lawyers after all!)

The Potsdam experiment uses a short (6km) part of the city's tram system and has a driver in the cab in case the system does not perform as well as expected and they need to intervene. The citizens of Potsdam treat the autonomous tram as any other and therefore expect it to act in the way other trams would. The digital eyes and algorithm-based brain need to work as well as that of a fully trained driver and the tram operator would be responsible for any accident caused by the tram, in the same way as if the tram was fully under the control of a human driver. However, because of the amount of data being captured during its journey, where there is, say, a collision with a car, there is likely to be a considerable amount of evidence to show who was at fault. The extent to which such data is admissible in court could be quite important.

As autonomous technology continues to improve, even if autonomous trams are not coming to a street near you soon, there is a fair possibility that some of the technology will. Where there are detection systems which react faster than a human driver, there is likely to be an amount of pressure to fit such technology on the basis that it may reduce the possibility of accidents and incidents. How easily it can be retrofitted to existing trams could be a factor in its use, but this would need to be weighed up against the risk mitigation provided.

Where do we go from here?

While the Potsdam experiment is providing a significant amount of data for Siemens, it is not designed for commercial use. However, understanding and identifying the technological challenges of autonomous driving under real-life conditions is crucial to the continued development of autonomous trams. Given the high carrying capacity of trams, where there are many people wishing to use a similar route, using a single autonomous tram rather than many autonomous cars may become part of a city's congestion strategy in the years ahead.

Just because the UK Government aren't thinking too much about trams at the moment, it is not to say that autonomous trams and digital technology will not form part of the transport strategy in an automated future. The latest Future of Mobility Urban Strategy sees automated vehicles being an integrated part of our transport system in the not-too-distant future so watch this space!

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