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Driverless sweepers

While driverless vehicles may seem a long way off, trials of autonomous electric road sweepers have been successfully conducted. Lucy Radley takes a look at how they work, as well as their actual capabilities

Finnish firm Trombia Technologies, now majority-owned by RCV manufacturer Faun Group, offers the Trombia Free, which was seen launching for series production at last year's IFAT waste management show in Munich. This was said to have come at the end of an 18-month global pilot programme using "challenging" locations in both the US and Europe.

Municipal sweeper specialist Bucher Municipal, meanwhile, has deployed software and robotics by AI start-up Enway on its existing Bucher CityCat 2020ev. Enway, now owned by Bucher Municipal, is based in Berlin and Singapore, and it was in the latter location that trials were carried out on public roads within a defined perimeter.

Both vehicles navigate in broadly the same way – using a combination of GNSS (Global Navigation Satellite System) navigation and LiDAR. For those who haven't seen it before, GNSS is an overarching term which includes multiple international positioning systems based on constellations of satellites, the best-known example being the North American system GPS.

LiDAR is a composite word made up of "light" and "radar". It uses ultraviolet, visible and/or near-infrared light to construct a 3D model of a given environment, created by bouncing that light off of objects and measuring the time it takes to return to the scanning unit. It is the same technology used in many now-familiar advanced driver assistance systems (ADAS) such as lane return assist (LRA) and advanced emergency braking systems (AEBS), so is very much tried and proven. It is LiDAR which gives these vehicles vision, and enables them to detect obstacles.

Use of LiDAR-GNSS "fusion" enables these vehicles to navigate over a small area, and allows them to deliver high-precision cleaning to within a couple of centimetres, which in most cases is far more accurate than can be achieved by a human driver. Quite apart from anything else, it can't be distracted by the radio, a phone, or by having its eye caught by something irrelevant through the windscreen. It also gives these vehicles predictable and reliable reaction times, again unlike its human counterpart. It could be argued that GNSS/LiDAR-controlled vehicles like this are actually safer than traditional ones for this reason.

MAPPING

When it comes to larger range navigation, however, both are reliant on using what Enway describes as "previously determined and mapped outdoor areas and routes". Trombia says its Free sweeper also operates within

"predefined routes or zones", and said that it meets the two ISO standards for such applications.

The most relevant of these is ISO22737:2021. This covers low speed automated driving (LSAD) systems for predefined routes, specifying performance requirements, system requirements and performance test procedures. These systems class as Level 4 driving automation, according to the internationally recognised guidelines established by SAE (Society of Automotive Engineers). This refers to vehicles that can perform all driving tasks, but require specific circumstances and geofencing, hence the predefinition of routes. Importantly, the option must still be there for human override. Vehicles which are truly fully automated and need no human intervention qualify as Level 5 automation.

The other ISO standard Trombia references is ISO3691-4:2020, which is essentially the same thing, but for driverless industrial trucks. This is important, because it reveals a lot about how advanced this technology really is – or rather, isn't. Trombia may be in series production, but at the moment it is only really ready to deploy inside private industrial sites or estates.

The Bucher Municipal/Enway machine is at a similar stage – and has been since it first started operating in such places in 2017. The video it has released (*www.is.gd/ekisus*) showing a Singapore case study actually shows a driver present behind the wheel, presumably to take control should anything go wrong.

A smaller version, Enway's own B2 self-driving cleaner, looks more like the kind of industrial cleaner seen being push-steered by an operator, and is designed to work alongside a human cleaning crew. This was tested in a shopping precinct in Darmstadt, Germany, where the engineers involved admit to having found "the interaction between the human cleaner and the automated sweeper was a challenge."

But perhaps the most telling aspect of both these machines is the solution which has been found for when problems arise and human guidance is required, or when the vehicles need to be "taught" new routes. They are both capable of being remotely-driven from a central control point, manned by a single operator who can oversee multiple machines. This needs Industrial WiFi at a minimum to enable remote monitoring and observation, the planning of new routes and waypoints, and the scheduling of sweeping duties. For full manual intervention, a stable 4G network is required. TE

IFAT HIGHLIGHT

Shown at the Munich, Germany trade fair for water, sewage, waste and raw materials management, which returns 13-17 May 2024, was an autonomous version of the articulated, fully electric 2m³ Boschung Urban-Sweeper S2.0, in cooperation with WIBOT. It is said to be equipped with LiDARs, cameras, radars and GPS antennas, providing a 360° coverage of its surroundings. "The accurate and efficient recognition algorithm allows the sweeper to track all objects in sight simultaneously," said the developers. They continued: "The Urban-Sweeper S2.0 driven by WIBOT can not only be used in closed areas, it can safely sweep the public streets with a Level 5 certification."

ANALYSIS

There is no doubt that a great deal of the knowledge gathered at the research and development stage of these machines could prove useful for those seeking to automate larger vehicles. But it is also clear that there is still a lot more work to be done before they can be truly autonomous – Level 5 on the SAE scale requires vehicles to be able to self-drive under all conditions.

The sensor fusion approach is already in use in road-going commercial vehicles. Which specific types of sensors are used depends on the application, but the principle is always the same, with each component making up for the blind spots in the other. For example, Mercedes-Benz Trucks offers Level 2 automation on some long-distance heavy tractors in the form of its proprietary Active Drive Assist, which adds self-steering to the usual ADAS package. In that instance, the sensor fusion is between radar on the front bumper, combined with a camera in the windscreen and GPS-guided predictive cruise.

As to whether remote supervision or even driving of larger vehicles is a possibility, the latter potentially raises a lot more challenges. Having a central control suite for several vehicles is likely to be a necessity, in the author's opinion, but there is a huge difference between remotely driving a sweeper compared to a cargo-carrying van or truck. Looking at the heaviest end of the spectrum, a six-axle articulated tractor and semi-trailer can vary in weight by around 28t from load to load, and behaves very differently as a result. The distribution of the load affects vehicle handling as well, and that's before looking at environmental variables such as wind and road camber. All of these things are currently judged by how the vehicle physically feels to the driver, something which would require an immense leap forward in sensor capability to replicate for a remote operator. Smaller, lighter vehicles, however, such as those used for urban parcel deliveries, could potentially be operated in this way.
-Lucy Radley