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“Connectivity is essential for assistance functions”

A variety of different factors will play a role in the development of assistance systems for fully autonomous driving. In addition to electrified actuators, a multi-dimensional sensor concept consisting of radar, lidar, cameras and ultrasound is needed. In this interview Udo Wehner, Executive Vice President of Vehicle Integrated Functions at IAV, explains to ATZ what an adaptive cruise control (ACC) system will look like in 20 years because it will not be possible to transfer all IT solutions directly into cars without modification.

Dipl.-Ing. Udo Wehner (born in 1965) has been Executive Vice President of Vehicle Integrated Functions at IAV GmbH in Chemnitz since 2011. After successfully completing his electrical engineering degree, during which he specialised in automation and control systems, he began his career in 1995 at the engineering service provider IAV in Chemnitz in what was then the relatively new field of driver assistance systems. He was soon promoted and in 1999 took over responsibility for developing electric/electronic vehicle systems. As Executive Vice President he now heads the vehicle integrated functions business unit, including energy management, driver assistance, active safety, autonomous driving and complete vehicle integration, at IAV’s 13 sites worldwide.

ATZ _ Udo Wehner, you have been developing assistance systems such as adaptive cruise control (ACC) for 20 years. What have been the outstanding technological advances during that time?

WEHNER _ When I become involved at the end of the 1990s, the most important considerations were integrating the functions into the car and obtaining the first feedback from users. At the time drivers had no experience of using assistance systems. No major technological advances were made, at least as far as cruise control was concerned. We introduced technical changes in the braking system and, most importantly, we were constantly developing the human-machine interface or HMI.

And looking beyond ACC?

The advances in assistance systems in recent years have primarily related to vehicle electronics, in other words, the so-called electronification of sensors and actuators, which has opened up a whole range of new functions. First we had drive-by-wire for the accelerator pedal and that helped to make ACC possible. Then came brake-by-wire which activates the vehicle’s brakes at the same time as the driver. This was followed by shift-by-wire or electronic gear shifting. Later came steer-by-wire which helps the driver with steering. We have been making gradual progress in the field of connectivity by networking all the necessary components, and this is, of course, essential for assistance functions.

But you did have to wait for technical advances to be made in the field of compact radar sensors before they could be integrated into cars.

Initially we relied on lidar systems, but for various reasons, including the package and visibility, they proved not to be suitable. Today we want the sensors to be visible to demonstrate our technical expertise and the availability of the functionality. At that time this was not the case. All the sensors had to be hidden. However, radar had other important advantages over lidar. These included the ability to measure distance and speed using the Doppler effect, even in poor weather conditions. Radar in cars has constantly been improved and enhanced. Different radar sensors have been integrated with transmission frequencies of 77, then 24 and now 79 GHz. The development process has been evolutionary. There have also been considerable improvements in the evaluation functions and the computing power. Around the year 2000, these radar systems were the first to be equipped with a digital signal processor or DSP.

“Autonomous driving will only be possible with the help of data fusion”

Could radar sensors be replaced with more cost-effective cameras?

Some cruise control systems are based on a camera. This is quite common and these systems are used in standard production vehicles. Cameras are not the conventional sensors for ACC systems, but they are a possible alternative. By the way, stereo cameras do not offer any real advantages for measuring and calculating distance. The key area for stereo cameras is in the immediate vicinity of the car, while radar is more often used to monitor the car’s more distant surroundings. However, cameras were very quickly integrated into production vehicles because they made it possible to provide road sign recognition and lane departure warning systems.

And we must not forget ultrasonic sensors when it comes to vehicle positioning …

… and they are often forgotten, but they now play a major role in monitoring the car’s immediate surroundings. Initially, they had range of only two or three metres. But today when you park your car, you do it with the help of high-performance ultrasonic sensors with a longer range. When driver assistance systems were first introduced, ultrasonic sensors were known rather dismissively as “beepers”. Nowadays, they form the basis for many automated parking functions.

It appears that all the sensors, including radar, lidar, cameras and ultrasound, will be functioning in parallel.

Groups have formed in support of the various sensor systems that are rather like political parties – it’s almost a question of faith. But we believe that the right sensor set-up is needed for each function. It is the function that determines the arrangement of sensors and if the function involves an automation level higher than two, in other words, three, four or even five, then a certain amount of redundancy or diversity is required in order to provide this function with a specific level of safety in relation to the data fusion. This is the only way of achieving the safety needed for automated or autonomous driving on the public roads. Everything is pointing towards a multi-dimensional sensor concept.

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Around the year 2000, these radar systems were the first to be equipped with a digital signal processor says Udo Wehner (right) in conversation with Michael Reichenbach, Deputy Editor-in-chief of ATZ

What will an ACC system look like in 20 years?
By that time there are unlikely to be any separate ACC systems. The driving functions will be performed by one or more central computers which will guide the car both longitudinally and laterally. The car will then move forward and sideways in the traffic accordingly. There will be a system consisting of many networked functions, rather than a lot of individual functions that have been brought together. No major changes will be made to the actuators. Steering, brakes and acceleration will still be available, but we won't be putting our foot on the accelerator pedal any more.

So will everything stay as it is now? Can we assume that we have done all the development work?
No, there will be major changes to the sensors and their evaluation functions. Over the next 20 years we will see a lot of new developments. In addition, the car's environment will become a sensor. The information may come via a WLAN based on 802.11p, in other words, using car-to-x ITS communication, or it may come from the Internet via a mobile phone network. But even in 20 years' time, autonomous cars must ultimately be able to drive without the communication functions and digital maps. They may have a limited range of functions, but they must still operate. This is because in some places there will not be the necessary network coverage or the availability and security of data. We must still be able to guide a vehicle safely through the traffic, even if it cannot communicate with the outside world.

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Wehner emphasises that in 20 years' time cars must still be able to drive without maps and communication functions; they may have a limited range of functions, but they must still operate

"Reliable external information would be helpful"

What role do maps play as the new sensors in the context of autonomous driving?
The additional factor here is communication and this is what makes maps dynamic. One example is road sign recognition. Of course, we need to think about how this can be validated. At the moment it is just a function that is nice to have, but in future we will need reliable information about the speed limit on a certain stretch of road, from the perspective not only of road safety, but also of potential fines for the driver. If you were caught by a speed camera travelling at 100 km/h in autonomous mode where the limit is 80 km/h, you would not be pleased. We must ensure that sensor data is secure and this includes data from the map, car-to-x communication and possibly from other external sources. It would be helpful to know how reliable the external information is. This would make it easier to link it with internal vehicle data. It would then be possible to create a highly dynamic representation of the vehicle's environment using maps.

Will the automotive industry retain its traditional closed structure or will it adopt the open architecture of the IT sector?
I think there will be a mix of the two. Some functions and systems will be closely linked to IT, while others, such as steering, braking and driving, will keep the traditional structure for some time. Over-the-air updates for all control units will definitely be introduced. It will be important for the automotive industry to monitor how IT has resolved the problem. However, it will not be possible to transfer all IT solutions directly into cars without modification. At the CES 2017 in Las Vegas, IAV presented demo vehicles together with Microsoft and HPE, our partners from the IT industry, which communicate with other road users via the cloud. This shows that we are working together rather than competing with one another.

So this means that the IT experts can also learn from the carmakers?
Yes, they will learn to understand the car. In our initial discussions more than two years ago, I spoke about there being 60 computers in a car. I did not refer to them as one individual device as the IT specialists do. Of course, this is a question of aggregation. If you look at the situation from a certain viewpoint there is one computer. However, if you take a more in-depth and technical perspective, then there are 60. All of this will come together, when we begin cooperating with one another and developing a mutual understanding. It is time for us to get started. There are a lot of areas where the automotive industry needs to change.

Udo Wehner, thank you for this interesting discussion.

INTERVIEW: Michael Reichenbach