Sensors: Powerful, Cheaper and Multipurpose

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Susan Kuchinskas reports on how a new generation of sensors will make driving safer while making advanced safety systems more prevalent.

A human being doesn't have 360-degree visibility when she's driving a car. She relies on her judgment to tell her whether to look at her side mirror, the backup camera, the road 200 meters out, or at the car right in front of her. Then her brain discards irrelevant or non-essential information as she decides whether to hit the gas pedal or the brake.

As carmakers release ever-more-advanced safety features on the road to autonomy, they're taking the opposite approach: Look everywhere at once and then integrate all the data to make the decision. Luckily, new generations of sensors are getting more powerful and cheaper, allowing OEMs to make cars safer, cheaper and still affordable.

There are three strategies for implementing advanced safety features: add still more sensors; reduce the number of sensors by combining functions; use advanced processing to make use of sensor data.

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More is better

OEMs continue piling on the sensors to move toward more autonomous driving. GM recently demonstrated an Opel Insignia that could drive itself in low-speed, stop-and-go traffic, as well as at highway speeds. That was thanks to six LiDARs in the Insignia's bumpers, as well as a forward-pointing camera on top of the car to read lane markings and detect objects.

All that equipment is pricey; suppliers are working hard to bring costs down. For example, Velodyne has gradually offered lower-price LiDAR sensors, from $80,000 in 2007 to $8,000 for its Puck VLP-16.

There are two reasons Velodyne has been able to lower the cost, according to Wolfgang Juchmann, director of sales and marketing for the LiDAR division of Velodyne Acoustics. The first is strategic.

"We want to ensure that everyone knows that Velodyne will not be the pricing bottleneck in getting this into the automotive market," Juchmann says.

The other is that, with lower costs, Velodyne has increased the sales volume for the 16-channel Puck. It's aiming to sell 10,000 units, the point at which it makes sense for the company to automate its manufacture. "If you do a couple of thousand, it's not worth buying robots. Getting into the 10,000 units-per-year-range, it makes sense to invest in automation," he says.

Unfortunately, he's the first to admit, OEMs want LiDARs that cost from $100 to $200. Getting to that price point is more of a business challenge than a technological hurdle. If Velodyne could sell several million LiDARs a year, it could make the pricing work. But it's not as simple as filling orders, according to Juchmann. Velodyne could make prototypes, and then automakers would need to design them into vehicle models, integrating the LiDAR with all the other sensors and the car's architecture. He thinks this might take three to five years.

Meanwhile, Velodyne needs to move from mechanical building blocks to miniaturized components on semiconductor chips. "You can't go to [a chip supplier] and say, 'I want this tomorrow.' It might take a year to put it on a

chip," he says. It could take the chip manufacturer a year and a half to build a prototype, but longer to make it rugged enough to be embedded in a car. The whole thing is a sort of dance in which development among partners and the OEM happens simultaneously but with multiple

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Doubling up

Another strategy that's putting advanced driving features into more cars is the ability to let one sensor or one array of them perform more than one task.

Jeremy Carlson, senior analyst, ADAS/automotive technology at IHS, notes that he's seeing ADAS systems combining a couple of sensors into one platform. For example, detection of vehicles in the blind spot and cross-traffic detection were usually built on 24GHz radar sensors. Now, 77GHz radars combine both these applications to create lane-change assistance.

For example, Delphi says that its 76GHz electronically scanning radar (ESR) makes it possible to precisely detect objects in two coverage areas with one radar unit. Its newest generation of ESRs can scan 200 meters forward for long range and 60 meters for short range. These capabilities enable autonomous emergency braking for vehicles, pedestrians and animals, as well as adaptive cruise control.

Robert Bosch's ultrasonic sensors are multipurpose. While they were originally used to provide an acoustic warning if the driver was approaching an object, the same type can now be used for other advanced safety and assistance functions, for example, Bosch's Park Assist, which can identify open parking spaces, determine if the space is big enough for the car and, if it is, park it automatically.

Bosch's fifth generation of ultrasonic sensors have a longer range of up to five meters, enabling a Side View Assist feature that can warn drivers of traffic in parallel lanes before a lane change.

Bosch's new generation of radars is also multipurpose; for example, in addition to adaptive cruise control, they can automatically apply the brakes in case of an imminent crash, while detecting pedestrians, bicycles and other cars. Its forward-looking, stereovision video cameras are another example of eking more functionality from the same sensor.

"We're expanding, with this new generation, the range of possible functionalities you can implement in a vehicle, not only from the

convenience perspective but also from the safety perspective," says Kay Stepper, head of the regional business unit for driver assistance and automated driving at Robert Bosch.

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New materials, including a switch from gallium arsenide to silicon-germanium for radar diodes, have made production of Bosch sensors less expensive. Bosch also is benefitting from economies of scale, as cheaper sensors allow them to be embedded into less-expensive car models, thereby driving up total production, according to Stepper.

Bosch is working closely with automotive manufacturers to help them differentiate not by the amount of sensors on the car, but by the systems they enable. "The proliferation of sensors is helping this," Stepper says. "You can use some of these already existing sensors for things like adaptive cruise control or sign recognition to provide even more functionality in the future."

Sensor fusion

Already, advanced safety systems such as traffic jam assistance and pedestrian detection rely on data from multiple sensors. This data must be amalgamated and analyzed in order to get an accurate view of conditions, in the process known as sensor fusion. Sensor fusion becomes even more important as a vehicle moves toward highly autonomous driving, according to Vijitha Chekuri, director of delivery and operations for IoT solutions at Lochbridge. She notes, "A true autonomous vehicle will have to incorporate intelligent sensor fusion algorithms to amalgamate the data for a complete picture of the surroundings for a vehicle in most weather and road conditions."

Everyone acknowledges that sensors still are not where they need to be in order to provide true autonomy in all conditions. Each of the current sensor technologies in use today – radar, LiDAR, ultrasonic sensors, cameras and GPS – has shortcomings. In current implementations, "What is lacking in one is complemented by another technology, making sensor fusion a necessity," Chekuri says. "All of these sensor technologies, combined with machine and vision learning, still are not quite mature enough to replace human perception and intuition." To get to true autonomy, she adds, cars will need very mature, human-like "brains" to process sensor data.

Stepper says, "We are firm believes in the power of sensor data fusion." That said, he notes that the fusion of data from multiple inputs requires a large microprocessor. While at this point, most of the processing is done

in Bosch sensors themselves, he says, Bosch's thinking is that a central processor is needed to house sensor fusion and to make decisions. Stepper adds, "The tricky part is the industrialization. We need to bring software onto an embedded target that needs to be cost efficient for the

rollout of a vehicle."

For the latest on sensor tech. in automotive and autonomous cars, check out TU-Automotive Detroit 2015 - the no.1 event dedicated to auto technology.