Cool Vendors in Perception Solutions for Autonomous Vehicles

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Initiatives: Technology Market Essentials

Perception solution sensors and software are one of the most fundamental and critical components of autonomous vehicles. Technology and service providers require strong collaboration partnerships with their customers to enable the exploitation of these innovative technologies.

Overview

Key Findings

- Lidar, radar and cameras are the three primary sensors that will effectively replace human eyes for autonomous vehicles. While a lot of progress has been made in these solutions, they remain a work in progress with innovative and disruptive solutions entering the market regularly.

- No single sensor will be sufficient to cover all driving scenarios, like bad weather and night conditions, making a diverse set of sensors and sensor fusion a prerequisite for autonomous vehicles to offer a complete, holistic and unified view and/or redundancy.

Recommendations

Technology and service providers developing autonomous vehicle systems should:

- Continue to monitor the progress of complementary sensor solutions, and establish a comprehensive understanding of the competitive landscape. This would be critical in projecting winning combinations for autonomous vehicles to be used as a guide for establishing partnerships and/or leveraging gaps for business opportunity.

- Evaluate needs and support for deployment of sensor fusion to maximize the advantage of each sensor, such as fusion algorithms and compute, power and memory resources to analyze multidimensional and multisource data.

Strategic Planning Assumption

By 2025, autonomous vehicle robotaxis will have expanded to 100 cities, signaling the end of personal car ownership in metropolitan areas.

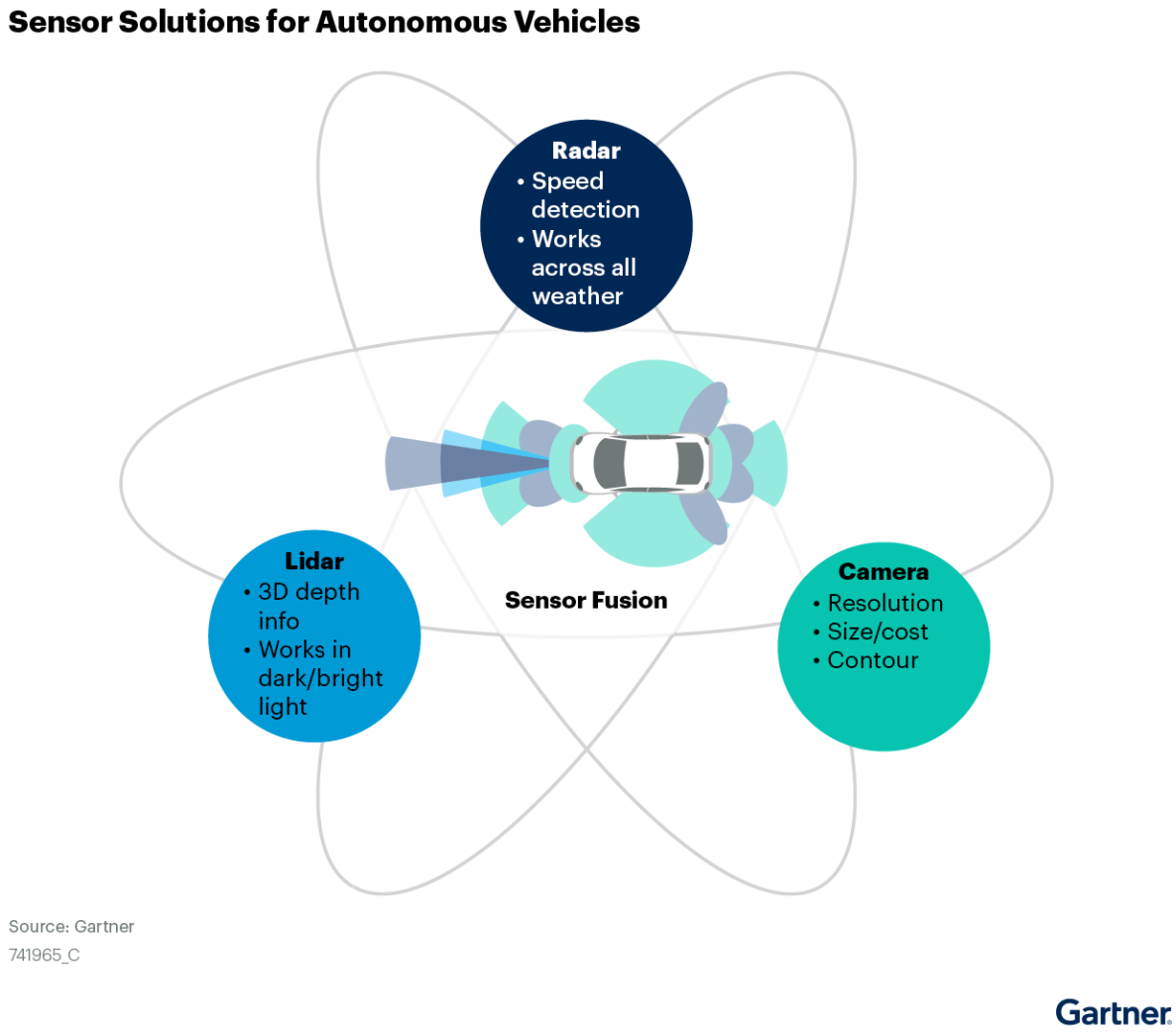
Analysis

This research does not constitute an exhaustive list of vendors in any given technology area, but rather is designed to highlight interesting, new and innovative vendors, products and services. Gartner disclaims all warranties, express or implied, with respect to this research, including any warranties of merchantability or fitness for a particular purpose.

What You Need to Know

One of the critical components for enabling current and future success of advanced driver assistance systems (ADASs) and autonomous vehicles at L4 and beyond is sensing solutions (see Figure 1) to understand the environment and create a safe driving solution. Safety is one of the primary motivating factors for moving toward autonomous vehicles. While a lot of progress has been made over the last few years in the primary sensors, such as cameras, radars and lidars, there is still a lot of ground to cover before we have mature and robust solutions. Some of the challenges include cost, reliability, scalability, performance in adverse conditions, and form factor. Gartner's Hype Cycle for Automotive Technologies, 2020 puts various lidar solutions and sensor fusion as being at least two to five years from reaching the Plateau of Productivity.

Figure 1: Sensor Solutions for Autonomous Vehicles



These sensor solutions require integration into the vehicle architecture and must be extremely reliable and robust. Other factors that these sensors are judged on include range, resolution, cost, performance across diverse conditions, form factor, and manufacturability. One critical aspect often ignored is credibility of players providing these solutions, since most of them are startups with limited long-term future plans and/or funding. Also, since no single sensor can offer a complete solution, sensor fusion will be the critical enabling factor. Absence of established players with optimum or leading technology for these sensor solutions has created a new opportunity for various startups focusing on one specific technology and solution.

Technology and service providers (TSPs) serving the automotive ecosystem with products or services for ADAS applications or self-driving vehicles must keep themselves updated with innovations in this area. These updates will ensure integration with their solutions and maximize the business opportunity by filling in gaps/needs to implement these sensor solutions. Additionally, what is extremely important is to develop a sense of the combination of sensors that will be the winning solution across various platforms. Data analytics, perception algorithms, compute/power/hardware to support sensor fusion, and wired/wireless connectivity are some of the opportunities that must be sensor-aware and vice versa. Also, these sensor solutions might have been initially developed for automotive as an application, but there are various other areas of applications, such as smart infrastructure, industrial and robotics. TSPs in these areas must also keep themselves updated.

So what are some of the cool startups developing these sensor solutions for autonomous vehicles? In this research document, we highlight three vendors that are providing sensor solutions for autonomous vehicles. These startups are being written about not just for their cool technology and business best practices, but also the challenges that these companies are facing in this space.

Almotive

Budapest, Hungary (aimotive.com)

Analysis by Gaurav Gupta

Why Cool: Almotive is solving an underlying problem with sensor fusion due to compute resource and data transfer requirements by leveraging object fusion at a basic level. Almotive leverages parallelism in hardware as each sensor performs object detection locally. A key advantage of object fusion is that the data sent to the central perception engine is orders of magnitude smaller than sending all the raw sensor data; indeed, it is also significantly smaller than the fused data. Since the transmission of large amounts of data in a vehicle is a major challenge — for reliability as well as cost and power reasons — this is an area of considerable interest in the emerging area of sensor fusion. Almotive is able to achieve this with its unique neural network processor, provided as hardware intellectual property (IP) that is optimized for automotive inference.

Almotive offers a complete solution under one umbrella with its software (aiDrive) and hardware (aiWare), which are offered independently:

- AImotive has a modular software architecture, called aiDrive, that can be deployed as the core of automated driving solutions. aiDrive offers robust perception technologies for mono, stereo and fisheye camera setups and enables the fusion of sensor data across cameras, radars, lidars and other common sensors in automated driving. aiDrive is also hardware-, middleware- and OS-agnostic, supporting easy integration into existing concepts and solutions. aiDrive is based on open system architecture, reducing time to market and validation effort for customers.

- The aiWare neural network accelerator (NNA), provided as hardware IP, is a highly autonomous engine that places minimum demands on the host CPU and can be integrated either within an SoC or as the primary computation unit of a stand-alone NNA chip. Core performance, on-chip memory, floorplan, external memory bandwidth and other parameters are all configurable to optimize performance for a wide range of customer requirements. AImotive's dedicated NNAs can be used in multiple places in a vehicle, including domain controller, sensor controller or central processing cluster. The aiWare solution is optimized for convolution and deep neural networks with low latency and low power to provide a cost-effective solution and is particularly efficient for large sensor data such as multiple HD cameras or early sensor fusion.

Challenges: While building complementary hardware and software is a cost-effective, scalable and flexible strategy, establishing partners that will leverage the company's IP to get silicon and convincing customers to sample their solutions adds another complex step in generating revenue. Further, they would always be dependent on a third party ready to take their IP into the market. Automotive players will also look for end-to-end platforms for autonomous vehicle development and validation, requiring AImotive to scale operations and capabilities. AImotive does offer multiple solutions under one umbrella, like a simulation engine, software stack and hardware IP, but it would need to ensure that the company resources are not spread too thin.

Though the company has established partnerships with other firms like Sony to enhance ADAS solutions, it would need major OEM/Tier 1 relationships to scale. Additionally, AImotive has advertised that its NNA is primarily camera-centric, though in principle it can handle data from any sensor, providing real-time inference. As lidar adoption picks up, a camera-centric strategy might not be the best one, though next-generation lidars and radars generating larger output datasets might also suit its NNA. Additionally, as new entrant EV companies join the autonomous vehicle space, TSPs in the ecosystem will need to be more agile.

Who Should Care: TSPs developing self-driving systems of all types should consider the aiDrive and aiWare solutions from Almotive for autonomous driving capabilities at a foreseeable lower cost than competitors. Almotive's expertise in optimizing usage of software through a parallel neural-network-based hardware offering provides flexibility and scalability. The company is focused on automotive applications, but the technology has applications for broader autonomous things, too. Companies developing autonomous mobile robots, drones, consumer appliances and industrial equipment should also look at its object fusion methodology to improve perception.

SOSLAB

Seoul, South Korea (soslab.co)

Analysis by Jonathan Davenport

Why Cool: SOSLAB has designed a solid-state lidar that overcomes many issues associated with the system complexity and high unit cost that plagues conventional lidar. Its lidar invention is made up of mass-producible components:

- A vertical-cavity surface-emitting laser (VCSEL) array to produce laser light beams — a technology already mass-produced in the iPhone 12
- Custom optics to steer the beam and create the 3D point cloud scanning pattern
- A single-photon avalanche diode (SPAD) array with 19,200 pixels to capture the time-of-flight information for each of the returning beams

To complement its hardware, SOSLAB has also developed a perception software algorithm to help its customers classify objects.

Most lidar companies have focused on developing only long-range lidar for front area detection. Instead, SOSLAB has specifically designed its solid-state lidar to enable autonomous vehicles to understand their immediate surroundings by capturing point cloud data around the periphery of the vehicle. SOSLAB's short-range lidar can be programmed to eliminate blind spots while maximizing resolution for a given range or field of view. For example, dense point clouds can be created that enable highly accurate object detection on the side and rear of vehicles. This high-quality field of view and image resolution is vital to provide autonomous vehicles with the situational awareness they need to safely operate in complex traffic scenarios like traffic jams and merging into lanes.

Current mechanical lidars have been too expensive to install on mainstream production vehicles. SOSLAB's simple design and low cost allows as many as six devices to be installed around the vehicle. The small form factor also allows vehicle design to be optimized both for aerodynamics and aesthetic purposes. This makes the type of solid-state lidar that SOSLAB is working on very suited to SAE Level 3 driving use cases, such as automated lane keeping systems (ALKS). As regulation for ALKS may come into force in countries such as Japan, the U.K. and Germany in 2021, it could become an attractive market opportunity in terms of unit sales for companies with this sort of lidar solution.

Challenges: Competitors are working on alternative solutions, such as using lidar on-a-chip and frequency-modulated continuous wave technology. Plus, SOSLABs will face competition from traditional Tier 1 companies such as Valeo, [1] ZF [2] and Continental, [3] which are also working on solid-state lidar. These companies have the benefit of strong existing relationships with automotive manufacturers.

Manufacturing the lidar hardware is challenging, and in particular, ensuring that the lens and the optics are aligned is difficult. As a result, the company is still developing its production partners to ensure the mass production of high-quality units. In addition, as a startup, it needs to gain market credibility with automakers, especially outside South Korea.

Who Should Care: TSPs developing self-driving systems of all types should consider the lidar modules from SOSLAB, as they can support autonomous driving capabilities at a lower cost than high-profile lidar competitors. Companies developing vehicles, Tier 1 providers and mobility operators will also want to think about how to leverage short-range lidar for safety use cases. The company is focused on automotive applications, but the technology has applications for broader autonomous things, too. Companies developing autonomous mobile robots, drones, consumer appliances and industrial equipment should also look at SOSLAB's solution.

TriEye

Tel Aviv, Israel (trieye.tech)

Analysis by Gaurav Gupta

Why Cool: TriEye is solving one of the most fundamental issues in autonomous driving — detection in low light and adverse weather conditions — with its camera solution. Its short-wave infrared (SWIR) camera is based on the breakthrough complementary metal-oxide semiconductor (CMOS)-based image sensor, which enables SWIR capabilities. Its image data enables seamless integration with existing ADAS and autonomous vehicle architecture and can use existing computer vision algorithms. Its full-stack solution also encompasses the software layer and remote sensing based on AI capabilities.

Multiple industries have been harnessing SWIR's technological capabilities for decades using a compound of exotic materials, indium gallium arsenide (InGaAs). However, InGaAs has a low production yield, and its fabrication involves multiple, complex steps, making the technology prohibitively expensive.

Due to its high price and long lead time, InGaAs-based cameras are not suitable for mass-market applications. Additionally, the cameras can be large and cumbersome, which is also an entry barrier to mass market automotive adoption. Conversely, CMOS-based cameras can be manufactured with far greater ease and at a cost much lower than that of InGaAs-based cameras. They are more reliable, scalable and energy-efficient, provide much higher resolution, and can be miniaturized and integrated into a mobile phone camera. However, standard CMOS-based cameras today are not able to sense the SWIR spectrum, because their sensitivity is extremely low after 1 micron. Based on advanced nanophotonics research, TriEye's cutting-edge nanophotonics strategy enables SWIR sensing on a CMOS-based sensor for mass production. This unique combination enables vision in adverse weather and nighttime conditions and allows for better visualization of potential hazards on the road, a significant technological breakthrough in the automotive sensor industry.

Short-wave infrared (SWIR) is a specific wavelength range from 1,000 nm to 1,600 nm. In contrast to cameras on the visible spectrum, a SWIR camera has a lower refractive coefficient, meaning that it is significantly less scattered and hence has an increased detection range. This enables it to perceive what standard cameras in the visible spectrum are not able to see. Another significant advantage of SWIR is that it is a useful tool for remote material sensing. By comparing the relative intensities of carefully chosen spectral bands, the differences between spectral signatures are revealed. This allows differentiation between target materials, such as ice- or water-covered areas on an asphalt surface. SWIR detects the material of the object, not its color. So cotton material will appear as the same bright white in the SWIR spectrum, enabling pedestrian detection at night with dark clothes.

A SWIR camera can see through fog because of its high penetration coefficient. A SWIR camera can achieve over 300-meter visibility in the dark, offering effective night vision capabilities and greatly lowering the risk of collision. SWIR technology is able to see through glass. Unlike lidar and radar sensors that require visible exterior mounting on the car roof or bumper, SWIR cameras can be mounted behind the windshield or in the car headlight. This is the preferred location for car manufacturers since it allows for maximum image clarity and doesn't require design modifications. Moreover, windshield positioning offers an optimal view of the road and it means that the manufacturer does not need to be concerned with implementing a cleaning system.

Challenges: TriEye's current sales cycle is not just "press to buy" on the website. Its sensor integrates into the product of its customers, which takes time. With a full pipeline, lead time for new customers to get their sensors is about six to eight months. A big roadblock to its business is scaling operations as per demand. TriEye has collaborated with leading CMOS foundries to fabricate its sensors, adhering to automotive grade qualifications, but assembling a camera would need additional manufacturing partnerships.

Another challenge is the high cost with SWIR technology. With its patent-pending technology that is compatible with CMOS-based sensors, TriEye has reduced exorbitant manufacturing costs. The company has streamlined integration of mechanical, optical and hardware interfaces while establishing active engagements with partners, such as Porsche.

Who Should Care: Product managers developing self-driving systems of all types should consider the camera modules from TriEye, as it can support autonomous driving capabilities by offering a high-resolution and cost-effective solution. Its product solves the low-visibility challenge in severe weather and night conditions, which has been a big barrier in terms of sensor capabilities. Its solutions fill a gap and readdress the capabilities between a radar and a lidar. The company is focused on automotive applications, like ADAS and autonomous driving, but the technology clearly has a wider appeal, and companies looking at robotics, smart city, industrial, drones, agriculture and maritime should also consider TriEye's products. In some of these applications, TriEye has already established partnerships that will build products on top of its technology.

Evidence

[1] Valeo Scala, Valeo

[2] Solid State LiDAR (in Development), ZF

[3] High Resolution 3D Flash LiDAR, Continental

Recommended by the Authors

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