Making Sense Out of Autonomous Vehicles

The Role of Lidar Technology in the Automotive Industry Today

Matthew Jaster, Senior Editor

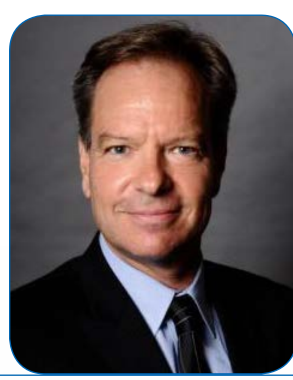
An argument can be made that the sensor has had one of the greatest impacts in manufacturing in recent years. Need proof? You can't have a discussion about Industry 4.0 or the Industrial Internet of Things (IIoT) without mentioning how sensors placed inside components or machinery are changing the way shop floors operate today.

It's happening everywhere—from automation technology to aircraft production to even keeping tabs on the health of human beings. Sensors are working in conjunction with cameras, analysis software and robotics to provide real-time monitoring in a wide variety of industries. Autonomous vehicles (AVs), in particular, are set to utilize sensors for a multiple array of new technologies. In fact, lidar sensors may be the key to unlocking the potential of driverless cars in the future.

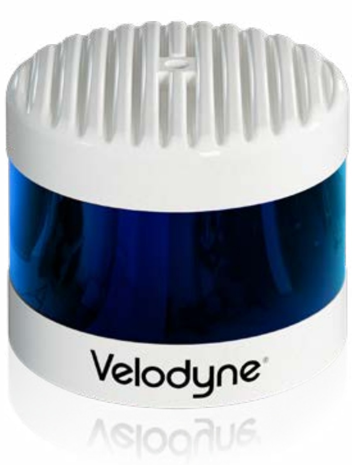
According to Dr. Mircea Gradu, vice president quality and validation at Velodyne Lidar, Inc. both the AV and lidar sensor industries are very young and extremely competitive.

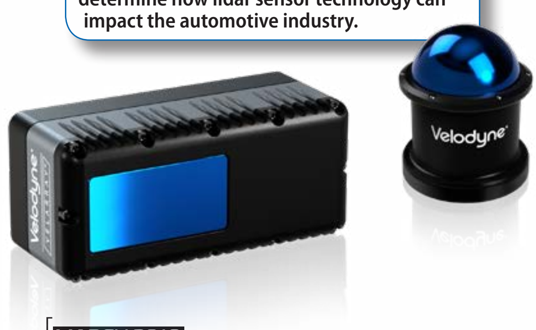
"Time to market is extremely important, and given the historically longer duration required to develop standards for testing and validation along with a meaningful regulatory frame, these steps take a lower priority for some of the players," Gradu said "Velodyne is a strong voice within the industry promoting the safe deployment of AVs, including their comprehensive testing and validation based on a common set of real world scenarios and relevant corner cases."

Velodyne Lidar is currently working with industry representatives, academia and lawmakers to determine how lidar sensor technology can impact the automotive industry of the future. The end game is a self-driving automobile ride that will take passengers to their required destinations safely, comfortably and efficiently. While the secret to the AV industry's success may rest on many factors, sensor technology continues to play a key role in its development.



Velodyne Lidar is working with industry representatives, lawmakers and academia to determine how lidar sensor technology can impact the automotive industry.





An Overview of Lidar Sensors

The term lidar was originally created by combining the words "light" and "radar." Later, the interpretation of lidar became an acronym for (light detection and ranging), a surveying method that measures distance to a target with pulsed laser light and then measures those reflected pulses with a sensor.

The technology is commonly used to make high-resolution maps, conduct atmospheric research and meteorology, and is being utilized by agricultural robots for seeding and fertilization. It was identified by NASA as a key technology to enable the safe landing of future robotic and crewed lunar-landing vehicles (it's the same technology used today when a cop is pointing a lidar gun toward your vehicle to see how fast you were going).

The concept of lidar technology dates back to the 1930s. The technology was developed further in the early 1960s, closely following the invention of the laser. Lidar gained public notice in 1971 when the Apollo 15 mission used the technology to map the moon's surface. Since then, this technology has been deployed in applications such as self-driving cars, unmanned aerial vehicles, robotics, security, and more.

Developing High-Performance Sensor Solutions for the AV Industry

You may have heard a news story or two in recent years about self-driving cars. They're coming. Frankly, the technology is already here. In 2019, it's really more about examining and testing these autonomous transportation methods in order to ensure vehicle and passenger safety and to develop electronic systems that deliver driver assistance.

Lidar systems play a crucial role in in areas like Adaptive Cruise Control (ACC), Automatic Emergency Braking (AEB) and Lane Keep Assist (LKA). These functions depend on the detection of a vehicle's environment to act autonomously or semi-autonomously. Lidar mapping and estimation achieve this.

Velodyne Lidar provides smart, powerful lidar solutions for autonomy and driver assistance. Founded in 1983 and headquartered in San Jose, California, Velodyne is known worldwide for its portfolio of lidar sensor technologies. In 2005, Velodyne's founder and CEO, David Hall, invented real-time surround view lidar systems, providing perception and autonomy for automotive, new mobility, mapping, robotics, and security applications.

This technology was developed as part of the Defense Advanced Research Projects Agency (DARPA) Grand Challenge, a prize competition for American autonomous vehicles funded by DARPA to sponsor research that bridges the gap between fundamental discoveries and military use. Hall first developed vehicle software and hardware in 2004 as part of the competition. For the last 15 years, the company has continued to move this sensor technology forward adding intelligence and enabling customers to detect more objects and offer cars a more detailed view of their surroundings.

According to Gradu, Velodyne organizes The World Safety Summit annually, a forum for bringing together the industry representatives, OEMs and Tier suppliers, law makers and academia to work toward a non-competitive, shared information approach on safety topics, similarly to the one embraced by the aircraft industry decades ago. It's these shared experiences and collaborations that will help AV fleets become the norm in the coming years.

"To achieve the necessary safety requirements in the AV industry, we're going to need sensor development that is done in conjunction with a universal standard. This includes testing, validation, calibration, simulation, and software/hardware that work together seamlessly," Gradu added.

Technology Update in Munich

Gradu recently spoke about the technology during the 2019 International VDI Conference – Automotive Sensor Systems in Munich, Germany. During the event, attendees heard an overview on advanced lidar solutions, along with a look at market segmentation and specific requirements for lidar.

Gradu addressed key considerations in lidar component testing and system validation. He also examined safety and standardization implications for lidar in providing advanced driver assistance capabilities, such as Lane Keeping Assist (LKA), Automatic Emergency Braking (AEB), and Adaptive Cruise Control (ACC).

To help conference attendees learn about driver assistance systems, Velodyne and the International VDI Conference have posted a white

In order to achieve the necessary safety requirements in the AV industry, sensor development must be done in conjunction with a universal standard.

paper on driver assistance technology on the conference website. The paper discusses the levels of vehicular automation defined by the Society of Automotive Engineers (SAE) International, the advantages of lidar sensors, and how lidar enables a safety-first approach that provides significant advances in driver assistance.

Download the white paper here: (*www.vdi-wissensforum.de/en/event/automotive-sensor-systems-2019/*)

Gradu's session at the VDI Conference was called "Advanced Safety Lidar Solutions and Opportunities in their Testing and Validation."

He received extremely positive feedback on the presentation with several of the participants (OEMs and Tier 1s) enlisting their teams to join the efforts toward the standardization of the test and validation protocols for AVs at the complete vehicle system level, as well as sub-system and component level.

In addition, SAE International sponsored an Edge Report on "Unsettled Topics Concerning Sensors for Automated Road Vehicles," that included Velodyne CTO's Anand Gopalan's direct input, summarizing how the AV community plans to address these issues in a timely manner.

The SAE Edge Research Report identifies key unsettled issues of interest to the automotive industry regarding the new generation of sensors designed for vehicles capable of automated driving. Four main issues are outlined that merit interest:

First, specifying a standardized terminology and taxonomy to be used for discussing the sensors required by automated vehicles.

Second, generating standardized tests and procedures for verifying, simulating, and calibrating automated driving sensors.

Third, creating a standardized set of tools and methods to ensure the security, robustness, and integrity of data collected by such sensors.

The fourth issue examines the ownership and privacy of data collected by automated vehicle sensors.

All of these issues must be examined and addressed in the coming months to move AV technology forward.

A Growing Market

Velodyne is working with a growing number of companies on sensor technology including Ford, Mercedes Benz, Volvo, TomTom, Here, Bing and others.

"Velodyne has over 100 customers representing traditional automotive OEMs, AV technology companies, commercial and off-highway vehicle manufacturers, as well as a wide variety of players from the aircraft, aerospace, drone, naval and security industries," Gradu said. "Velodyne's experience on all early AV prototypes allowed us to gather invaluable knowledge related to real world operating conditions and representative scenarios for the sensor validation."

Gradu said there is unanimous agreement that lidar is, and will remain, a vital component of the AV system in particular for Level 4–5. The leading edge technology advancements introduced by Velodyne within the new Alpha Puck, Velarray, and VelaDome products are focused on the highest range and resolution performance, enhanced near field capability, power consumption reduction, weight, volume and cost optimization will position the lidar technology even stronger in the AV space.

"Companies in the autonomous space need to work together – just as companies in the aerospace industry cooperate on safety issues – in order to ensure the safe launch of AVs," said Gradu. "Velodyne is committed to fostering this industry learning experience to apply rigor into sensor validation, especially in addressing corner cases that present high safety risk."

While sensor technology will be crucial to the success of the AV industry, Gradu believes lidar technology is merely scratching the surface and will be able to offer self-driving vehicles further advancements in the coming years. Both *Gear Technology* and *Power Transmission Engineering* will report on these developments in future issues.

"How will a driverless car decide the optimal path for the vehicle to take in the future?" asks Gradu. "And what can we do to optimize areas like performance, comfort and the powertrain by utilizing unique sensor technology in these vehicles? These are the types of questions we're asking."

For more information:

Velodyne LIDAR
Phone: (408) 465-2800
www.velodynelidar.com

Velodyne's product portfolio offers an entire range of lidar solutions for AVs and advanced driver-assistance systems (ADAS), providing the real-time perception data that enables safe and reliable operation. The company produces both directional and surround-view sensors. The computer perception data provided by these sensors allows immediate object and free space detection for safe navigation. In recent months the blog on the Velodyne website has examined how many of the features of lidar sensors can impact a driverless car in terms of resolution, range and field of view.

Resolution

High-resolution lidar is critical for object detection and collision avoidance at all speeds. Finer resolution allows a sensor to more accurately determine the size, shape, and location of objects, with the most advanced lidar sensors being able to detect objects within three centimeters and some moving closer to two centimeters. This finer resolution outperforms even high resolution radar and provides the vehicle with the clearest possible vision of the roadway.

To examine the importance of resolution, consider the example of a tire fragment in the road. The lidar system needs to be able to not only detect the object but also recognize what it is. This is not an inconsequential task given that it requires detecting a dark object on a dark surface, so a sensor with finer resolution increases the vehicle's ability to accurately detect and classify the object. To aid the process of responding to roadway events, unlike cameras, lidar provides 3D images of the surroundings with precise measurements of how far away objects are from the vehicle.

For Related Articles Search
sensors
at www.powertransmission.com

Range

Lidar range is a topic that creates significant buzz in the auto industry. Autonomous vehicles need to see as far ahead as possible to optimize safety. At highway speeds, a minimum range of 200 meters allows the vehicle the time it needs to react to changing road conditions and surroundings. Slower, non-highway speeds allow for sensors with shorter range, but vehicles still need to react quickly to unexpected events on the roadway such as a person focused on a cellphone stepping onto the street from between two cars, an animal crossing the road, an object falling from a truck, and debris ahead in the road. In each of these situations, onboard sensors need sufficient range to give the vehicle adequate time to detect the person or object, classify what it is, determine whether and how it is moving, and then take steps to avoid it while not hitting another car or object.

Another factor connected to range is reflectivity. Reflectivity refers to an object's propensity to reflect light back to the sensor. Lighter colored objects reflect more light than darker objects. While many sensors are able to detect objects with high reflectivity at long range, far fewer are able to detect low reflectivity objects at range.

Field of View

It is widely accepted that a 360° horizontal field of view – something not possible for a human driver – is optimal for safe operation of autonomous vehicles. Having a wide horizontal field of view is particularly important in navigating the situations that occur in everyday driving.

For instance, consider the scenario of performing a high-speed merge onto a highway. The maneuver requires a view diagonally behind the autonomous vehicle to see if another car is coming in the adjacent lane. This also requires a view roughly perpendicular to where the vehicle is currently traveling to assess cars in the adjacent lane and confirm there is room to merge. Throughout this process, the vehicle must look forward so it can negotiate traffic ahead of it. For these reasons, a narrow field of view would be insufficient for the vehicle to safely execute the merge maneuver.

Therefore, lidar sensors that rotate are optimal for these applications because one sensor is capable of capturing a full 360 degree view. In contrast, if an autonomous vehicle employs sensors with a more limited horizontal field of view, then more sensors are required and the vehicle's computer system must then stitch together the data collected by these various sensors. (*www.velodynelidar.com/newsroom/category/blog/*)