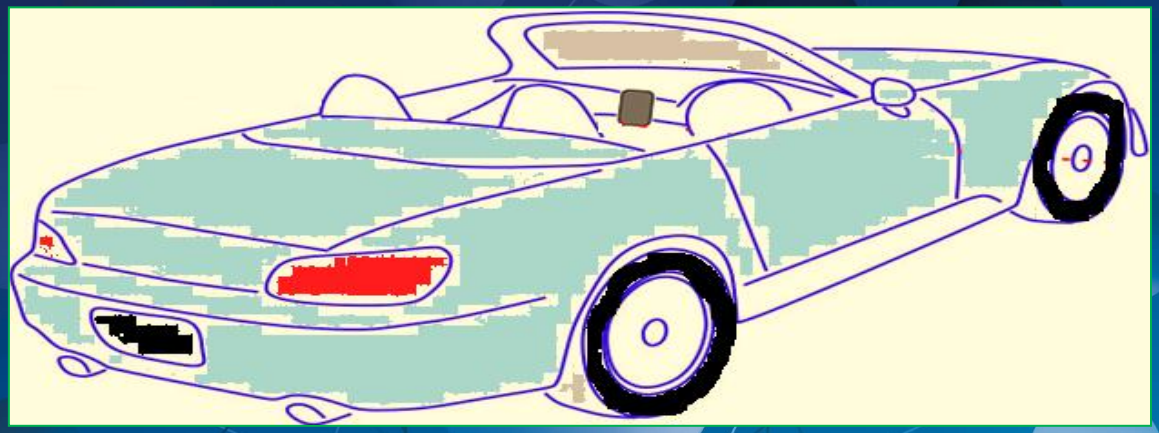
Sensor Technology (TechVision)



Sensors in Automotive Applications

LIDAR sensors poised to impact autonomous vehicles

D727-TV

February 19, 2016

FROST & SULLIVAN

Contents

Sensor Technology Innovations in Automotive

Automotive ADAS (Advanced Driver Assistance System) Sensor

Velodyne–16 channel architecture for LIDAR sensors

Tech. Profile

Velodyne offers a 16-channel architecture for its LiDAR (light detection and ranging) sensors. Known as VLP-16, this solution tracks a number of key data points and is a smaller, lower-priced version than the the 64-channel system (which provides a 360 degree azimuth field of view and uses 64 laser diodes). The VLP-16 measures 100mm in diameter and 65mm in height and weighs about 600 grams. It was developed with the purpose of catering to mass-market consumers, boasting essential features such as real-time, 360 degree perspective, 3D distance, and calibrated reflectivity measurements.

Growth Potential

The VLP-16 offers tremendous growth potential in the future with sales potential to cross several thousands of units when autonomous vehicles expand and gain adoption.

Market Opportunity

Despite the current autonomous vehicle market being in a nascent stage, 9 out of 10 OEMs (original equipment manufacturers) use a Velodyne sensor, giving clear evidence of the company's excellent reputation in the industry. As vehicles become more and more autonomous, companies that can bridge the gap between cost and quality will become the industry's 'preferred vendors'.

Competing Aspects

Velodyne's system can provide higher resolution by providing a rich point cloud populated at a rate of 300,000 points per second.

Technology Convergence

LiDAR technology can be used with other automotive navigation technologies, such as radar, cameras, GPS (global positioning system), and so on, for enhanced navigation or object detection in vehicles.

Innovation Attributes

Smallest product in Velodyne's 3D LiDAR portfolio. Able to fit in a car's sideview mirror Range of up to 100 meters, capturing close to 300,000 data points every second. It offers a 360 degrees horizontal field of view and up to 30 degrees vertical field of view with ± 15 degrees data capture in both directions. Later versions are expected to have a more sensitive mode of operation that allows for a range of 150 to 200 meters.

Market Entry Strategies

In autonomous or semi-autonomous vehicles, there is a requirement for sensors that can capture an abundance of data points, and though these sensors are highly accurate with their data collection making them very reliable, their cost has deterred wide-spread deployment. The VLP-16 is aimed at a more cost-effective, compact yet high-resolution sensor for autonomous/semi-autonomous vehicles.

Biosensor for Alcohol Detection

Sober Steering–Biosensor for steering

Tech. Profile

The sensor is embedded in the horn pad, thereby allowing the driver to test and retest alcohol level through touch without taking his/her eyes off the road. A remote message is sent via GPS and a fleet management system to the fleet manager if alcohol is detected in the driver's body.

Year of Impact

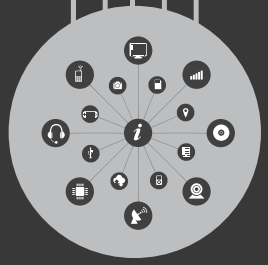
The sensor has already been commercialized. Sober steering is available for fleet vehicles, such school buses with the potential to incorporate other commercial vehicles such as coach buses, construction vehicles, hazmat vehicles and various other trucks It also has potential fo ruse in passenger cars..

Competing Aspects

Sober Steering has been ingenious with its alcohol detection system offering not only on-the-go driver BAC (blood alcohol content) monitoring, but also in creating an effective immobilizer if alcohol is detected above a pre-set limit.

Market Opportunity

Sober Steering's BAC touch sensor has realistic potential, initially in fleet vehicles, and in passenger vehicles (initially as optional equipment) to provide a fast, reliable, and passive means to detect drunk drivers and immobilize the vehicle.



Add on Service

Sober Steering does not allow the driver to circumvent the test by wearing gloves as the system registers a failed test, thereby acting as a near fail-proof system hence acting as a deterrent for driving under the influence of alcohol.

Innovation Attributes

The touch-based biosensor is able to accurately determine if the driver is under the influence of alcohol by detecting alcohol in gases emitted from the palm. It can swiftly detect alcohol at the palm in less than 5 minutes after ingestion. Unlike traditional breath analyzers, the touch-based sensor continuously monitors BAC and does not require the driver to pullover for use. Touch-based BAC sensors for automotive have used infrared light to measure alcohol content in blood vessels in the palm or finger.

Market Entry Strategies

With strong capabilities in research and development, the possibility of partnering with an OEM or Tier-1 supplier exists, which will further boost the customer base for Sober Steering.

Technology Readiness Level 1 2 3 4 5 6 7 8 9

Programmable Logic Device for ADAS

Xilinx–Zynq UltraSCALE+ multiprocessor System-on-Chip (MPSoC)

Tech Profile

Xilinx's Zynq UltraSCALE+ multiprocessor System-on-Chip (MPSoC), is an integrated hardened ARM (Advanced RISC Machines) processor. The MPSoC also has lock-step cores on the processor side, along with a Platform Management Unit and Security Management Unit, each with separate triple redundant processor cores and voter logic designed to ensure a functionally safe and secure silicon system.

Competing Aspects

Xilinx's unique functional safety architecture is a key factor that makes Xilinx devices preferred for current and future ADAS modules among a number of global OEMs. MPSoC provides user-programmable processors and maximized throughput along with reduced latency.

Innovation Attributes

Flexible high bandwidth FPGA (field programmable gate array) fabric, improved power management system, and processing performance provides leading price/watt and price/performance ratings. The MPSoC also integrates numerous ADAS applications to provide ASIL C/(D)-level functional capabilities.

Market Entry Strategies

The growing customer demand for ADAS applications for vehicle safety has led to a key market opportunity for SoC (system on chip) suppliers.

Impact & Opportunities

Wide Scale Adoption

✓Xilinx's strong multi-faceted automotive partner ecosystem which provides IP, design tools and services has helped the company position its offerings across a wide range of clients at extremely competitive prices.

Market Opportunity

✓The Zynq UltraSCALE+ MPSoC is best positioned to cater to the growing ADAS market for multiple reasons. For instance, the processing system is capable of system control and application level processing, while the FPGA fabric on-board can also parallel process video inputs from multiple cameras and other sensors simultaneously.

Technology Readiness Level 1 2 3 4 5 6 7 8 9

Fuel Quality in line Sensor

SP3H–Fuel quality sensor to decrease pollutant emission and increase fuel efficiency

Tech. Profile

The fuel quality sensor is based on near-infrared (NIR) spectroscopy; and is integrated in a vehicle's fuel chamber to classify the molecular structure of fuel. LED (ligh-emitting diode) light is transmitted at different wavelengths through the fuel. The fuel molecules absorb part of the LED energy at certain wavelengths; the remaining energy is received by the NIR detector. The fuel's NIR absorbency spectrum is determined by comparing, for each wavelength, the emitted energy to the transmitted energy. Fuel DNA fingerprint information is extracted and sent to the electronic control unit (ECU).

Innovation Attributes

SP3H's FQIS is the standard component that can be retrofitted into any vehicle. The technology is robust and works with ease across a wide range of operating temperatures. It also manages to reduce carbon emissions by approximately 5% and to increase engine efficiency by approximately 20%.

Technology Readiness Level

1 2 3
4 5 6
7 8 9

Competing Aspects

SP3H has a competitive advantage because of its HCP™ (HydroCarbon Profilers) technology that enables it to determine the molecular structure and content of fuel accurately and efficiently using advanced algorithms.

Market Entry Strategies

SP3H has designed a valuable product which will add value to its customers in the automotive industry. It has also developed a Fuel Quality Diagnostic Tool that workers can use in garages and workshops to deliver high-quality services.The FQIS provides a miniaturized optical sensor for information mapping in seconds and works with different types of fuels.

Impact & Otunities

Wide-scale Adoption

✓It is expected to be commercialized in circa one years' time

✓In one or two years, bus and truck operators and stationary power systems based in Europe and the US are expected to primarily account for SP3H's market revenue

Market Opportunity

The technology will be driven by applications in:

✓On road automobiles

✓Off road automobiles

✓Stationary power structures

Product Portfolio

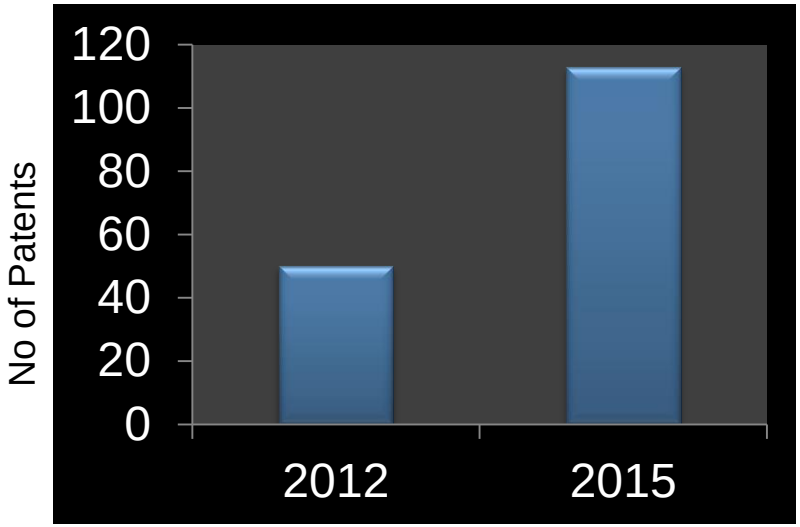
SP3H is developing an NIR-based gas sensor for use in the transportation sector where compressed natural gas (CNG) and liquefied natural gas (LNG) kits are installed to identify the quality of gaseous fuel. SP3H is also planning to develop a bunker fuel sensor to determine the quality of bunker fuel, which is thick and highly polluting.

Strategic Insights

Strategic Insights

Companies to Watch in 2016

Intellectual Property (IP)



- Original equipment manufacturers (OEMs) for applications such as autonomous vehicles have used expensive sensor suites with best-in-class LIDAR sensors that can cost OEMs six-figure sums or four-figures at best. This cost factor makes it impractical for LIDAR sensors to be part of a sensor suite from a volume-production perspective.
- R&D activities are increasing with an aim to reduce the cost and improve the imaging efficiency.
- The US has filed the highest number of patents for sensing in automotive followed by China and Europe.

Source: WIPO/Frost & Sullivan

Strategic Insights

Drivers

- ✓ Design flexibility
- ✓ New product development
- ✓ Strong R&D efforts
- ✓ Technology advancements
- ✓ Greater demand for enhanced user experience
- ✓ Advanced sensor platforms, sensor fusion software, and algorithms

Restraints

- Ẋ Technological barriers such as limitations under certain environmental conditions, processing limitations
- Ẋ System Reliability
- Ẋ High Cost
- Ẋ Size (need for miniaturization)

Government Initiative

There are several sources of greenhouse gas emissions, and automobiles feature prominently among these. Governments consistently work towards imposing new regulations to further reduce greenhouse gas emissions from vehicles and aiding companies to devise a solution that effectively addresses the issue. The automotive industry is also working towards developing cost-efficient and reliable technology to deal with this problem.

Focus Areas

- 3D mapping, navigation, object detection
- ADAS
- Autonomous vehicles
- Programmable logic device
- Sensor fusion
- V2V communication
- Complementary object detection technologies for vehicles (LIDAR, radar, cameras)

The 2020 Scenario

- With the advent of technologically improved LIDAR, more features pertaining to automated driving and active safety can be incorporated into future vehicles. In ADAS in autonomous vehicles, at least in the foreseeable future, LIDAR, which can be impaired by heavy fog or dense forest canopies, will tend to work in tandem with other sensors (such as radar and cameras) to produce best-in-class sensor fusion.
- Sensor fusion is common in already existing applications, such as navigation/orientation in mobile electronics. The trend is now changing from sensor fusion to data fusion for situational and context awareness.

Key Patents and Industry Interactions

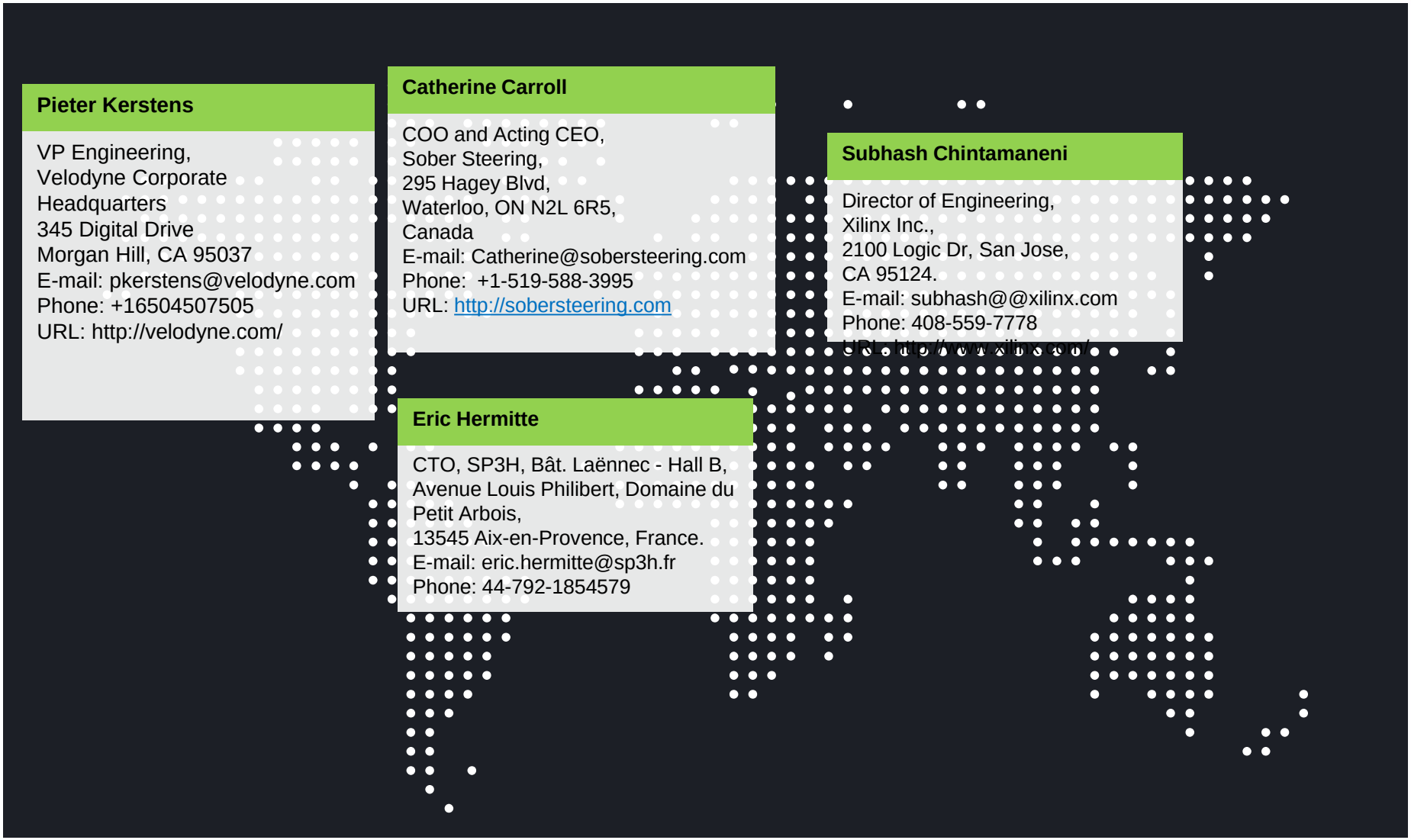
Key Patents

No.	Patent No.	Publication Date	Title	Assignee
1	**US20160041452**	11.02.2016	Optical device, lidar device and imaging device	Mitsubishi Electric Corporation
	An optical device includes: a casing having a waterproof structure; a light transmission part provided in the casing; an air blow port for blowing air onto the light transmission part; a flow path for causing the air to flow to the air blow port, the flow path being provided to maintain the waterproof structure of the casing; an air intake port through which the air flows into the flow path; a blower part generating the flow of the air from the air intake port to the air blow port; and an observation unit accommodated in the casing to receive light from the outside via the light transmission part.			
2	**US 20160026184**	28.01.2016	Curb detection using lidar with sparse measurements	GM Global Technology Operations LLC
	A method of detecting curb-like barriers along a route of travel using a lidar sensing system. Sparse measurement per each ray tracing is captured from a sensor using the lidar sensing system. Each ray tracing is analyzed separately by a processor. Curb candidates are identified for each respective beam. Curb candidates are combined to generate multiple curb representative hypotheses. A weighting factor is applied to each curb hypothesis. Curb hypothesis that represents the curb is selected. The curb detection is applied to an autonomous guidance system related to guiding a vehicle along the route of travel.			

Key Patents (continued)

No.	Patent No.	Publication Date	Title	Assignee
3	**US20160018523**	21.01.2016	Lidar measurement device for vehicular traffic surveillance and method for use of same	Applied Concepts Inc.
	A Lidar measurement device for vehicular traffic surveillance and method for use of same are disclosed. In one embodiment, video circuitry acquires video of a field of view having a target therein. A steerable laser progressively transmits laser range-finding signals to the field of view in a horizontal and vertical step-wise manner and receives reflected laser range-finding signals from the target. A processing circuit portion determines target data of the target based upon range and time measurements associated with the reflected laser range-finding signals. The processing circuit then integrates the target data into the video such that the video may displayed with an image of the target and speed measurement associated therewith.			
4	**EP2972555**	20.01.2016	System and method for increasing coherence length in lidar systems	Digital Signal Corp
	Various implementations of the invention compensate for "phase wandering" in tunable laser sources. Phase wandering may negatively impact a performance of a lidar system that employ such laser sources, typically by reducing a coherence length/range of the lidar system, an effective bandwidth of the lidar system, a sensitivity of the lidar system, etc. Some implementations of the invention compensate for phase wandering near the laser source and before the output of the laser is directed toward a target. Some implementations of the invention compensate for phase wandering in the target signal (i.e., the output of the laser that is incident on and reflected back from the target). Some implementations of the invention compensate for phase wandering at the laser source and in the target signal.			

Industry Interactions



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