DVN
Lidar

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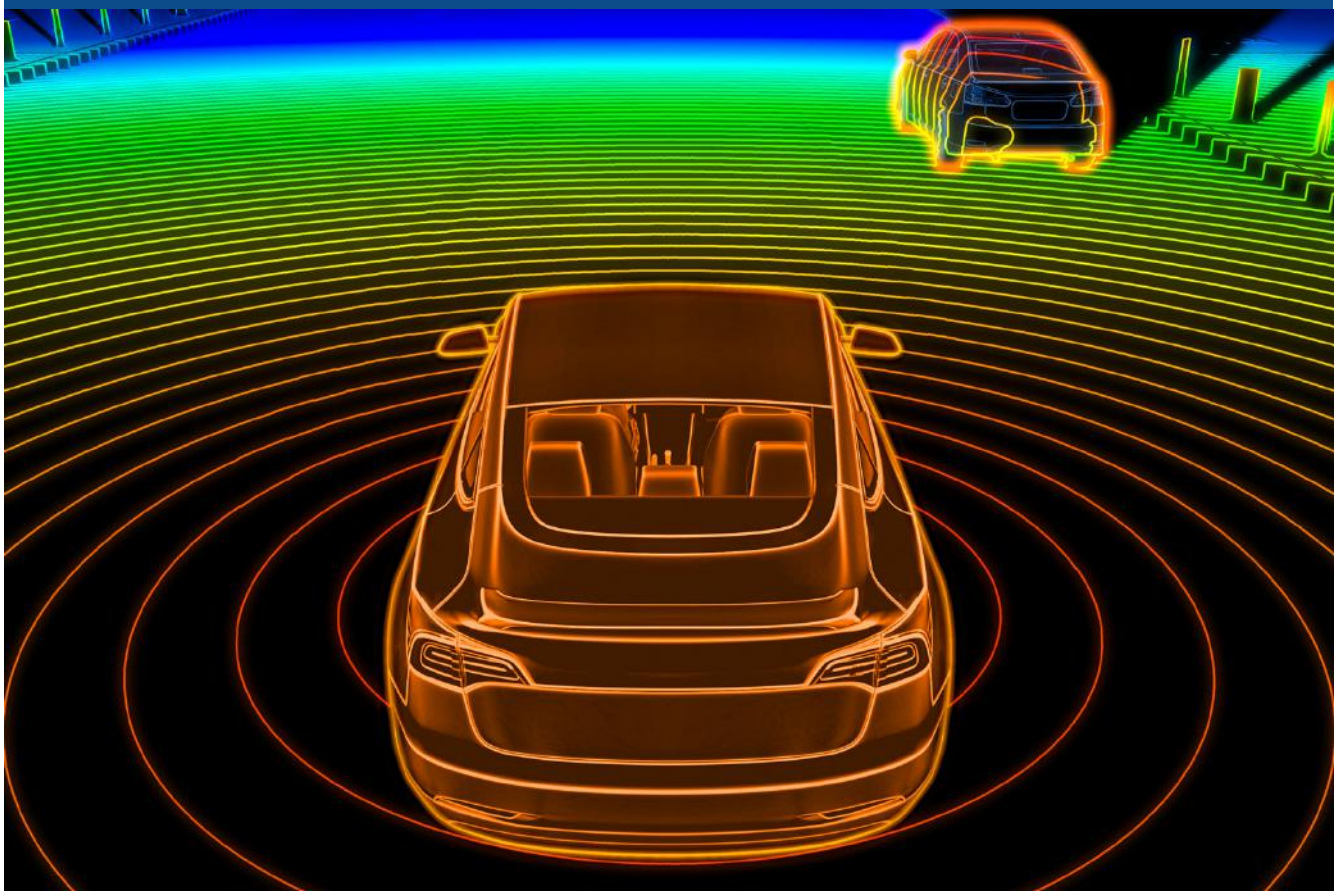


EU, UN Regulations Pave the Way for Greater Vehicle Automation

Editorial · August 2022

In our last newsletter we had significant news about the adoption of UN Regulation № 157, which is highly relevant for the introduction and proliferation of L^3 vehicles. In the meantime, the EU has finished some other important legislation under the GSR (general safety regulation) umbrella, which introduces a range of mandatory ADAS to improve road safety. It establishes a legal framework for the approval of automated and fully driverless vehicles in the EU. This is in line with WP.29's activities under its committee for Automated/Autonomous and Connected Vehicles (GRVA).

In today's DVN-Lidar Newsletter you'll find our description and analysis of these direction-setting regulatory and legislative decisions with respect to the regulatory situation in Europe concerning driving automation—the first in a series; watch in future Newsletters for comparable evaluations of the situation in North America and in Asia.

Today you'll also find news about achievements from within the lidar ecosystem; not just market and technology aspects, but also financial news and interesting results from a university study covering lidar testing results in realistic adverse weather conditions.

And we've also got updates for you on the DVN-Lidar Workshop coming up on 12-13 September, and the DVN-Lidar Conference on 30 November-1 December.

We're glad you're here with us! Enjoy this August newsletter, and—as always—we welcome your feedback and suggestions; please feel free to **drop us a line** and share your thoughts.

Alain Servel

DVN LIDAR ADVISOR
FORMERLY WITH PSA GROUP

DVN-L Analysis: EU Legislation, UN Regulations on Driving Automation

Most of OEMs admit that lidars are mandatory in AD L3/L4 embedded sensing architectures and represent an efficient solution for ADAS applications. OEMs will integrate lidar technology in their

Virtually all automakers agree: lidar is an indispensably crucial component of any vehicle-embedded sensor suite for safe, performant L^3 and L^4 automation. That being so, lidar technology is increasingly being integrated into ADAS and AD developments planned for L^3 vehicles with market introduction in the next two years. Examples include Audi; Mercedes; Volvo; Great Wall, Stellantis and more. The lone exception is Tesla, whose notoriously contrarian CEO Elon Musk has said lidar is "a fool's errand" and that anyone relying on it is "doomed", even as Tesla cars are under steadily-increasing regulatory scrutiny for dangerous misbehaviour by their so-called "Autopilot" and "Full Self-Driving" L^2 systems. For the overwhelming majority of car manufacturers who share the more realistic view, lidar integration is driven by the intent to offer new and interesting features to the end consumer. For the time being, sales volumes are still limited and costs are high, but innovations are increasing the affordability of lidar components and systems.

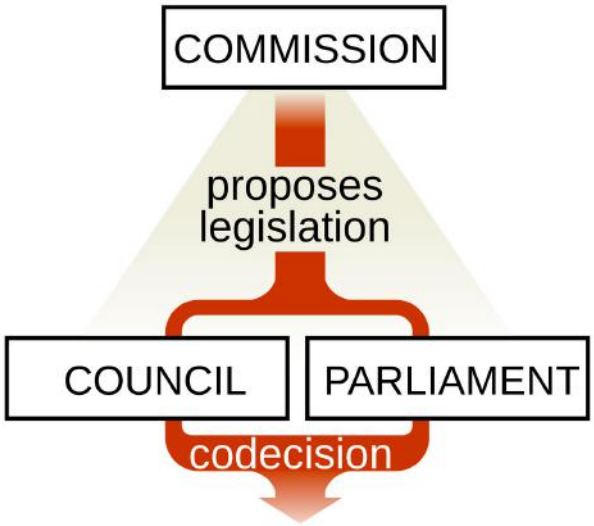
Conversely, the application of any regulation on new vehicles can have a significant effect on sales volumes enabling industry to reduce the piece price of lidar sensors. In history, this was the case when the European legislation COM 2010/542 obliged automakers to integrate ABS (antilock brakes) into almost all kinds of motor vehicles.

In this context, the application of the GSR (general safety regulation) in Europe, in coherence with the recent release of UN GRVA we reported on last month, brings substantial opportunities for the lidar sensor market by boosting lidar deployment rates.

In general, regulatory activities on automated driving are picking up speed worldwide. Today we provide the DVN view on these developments in EU legislation and UN Regulations.

Principle of Legislation in the EU

This diagram depicts the path of legislation within the 27-member European Union. The initiative for rulemaking is with the European Commission. The proposals of the commission are assessed by the European Council and the European Parliament.



The European Council consists of the governors of the 27 member states. The European Parliament comprises about 700 delegates, who are directly elected in their countries. If the Council and the Parliament pass a legislative proposal of the Commission in consent, the Commission gets back the task to implement the new legislation.

For implementation, two procedures are available:

• **Implementing acts**

Implementing acts are legally-binding acts that enable the Commission, under supervision of committees consisting of EU countries' representatives, to set conditions to ensure that EU laws are applied uniformly.

• **Delegated acts**

Delegated acts are legally-binding acts that enable the Commission to supplement or amend non-essential parts of EU legislative acts; for example, to define detailed measures. The Commission adopts the delegated act, and if Parliament and Council have no objections, it enters into force.

Next, let's look at how these legislative principles have been applied to road safety and automated driving.

New regulations concerning road safety and driving automation

In 2018, the Commission presented the revised GSR (general safety regulation) that replaced both the previous GSR (EC № 661/2009) and the PSR (Pedestrian Safety Regulation, EC № 78/2009). The new regulation addresses the need for improving vehicle and road safety, as studies have shown human error is a causal element in an estimated 95 per cent of crashes. The European Parliament and the Council adopted the regulation in November 2019.

In the subsequent legislative step, the Commission has taken following measures:

Two implementing acts

- Implementing Regulation (EU) **2021/535** on the construction and safety of vehicles and their systems; components, and separate technical units, and
- Implementing Regulation (EU) **2021/646** on emergency lane-keeping systems in motor vehicles

Four delegated acts

- Delegated Regulation (EU) **2021/1243** with detailed rules concerning motor vehicle alcohol interlocks;
- Delegated Regulation (EU) **2021/1341** with detailed rules concerning driver drowsiness and attention warning systems;
- Delegated Regulation (EU) **2021/1958** supplementing Regulation (EU) 2019/2144 with detailed rules on intelligent speed assistance systems and their type-approval as separate technical units, and
- Delegated Regulation (EU) **2022/545** supplementing Regulation (EU) 2019/2144 with detailed rules on event data recorders and their type-approval as separate technical units.

This regulation introduces a range of mandatory advanced driver assistant systems to improve road safety, and establishes the legal framework for approval of automated and fully driverless vehicles in the EU. The new safety measures will help to better protect passengers; pedestrians, and cyclists across the EU, expectedly saving over 25,000 lives and avoiding at least 140,000 serious injuries by 2038.

The GSR empowers the Commission to complete the legal framework for automated and connected vehicles. It is the Commission's intent to deliver technical rules this summer for the approval of fully driverless vehicles, making the EU a pioneer on that front. This will help to increase public trust; boost innovation, and improve the competitiveness of Europe's car industry.

The new rules require safety features to assist the driver, including:

- For all road vehicles—cars; vans; trucks, and buses—intelligent speed assistance; reversing detection with camera or sensors; attention warning in case of driver drowsiness or distraction; event data recorders, and emergency stop signal.
- For cars and vans, additional features such as lanekeeping systems and automated braking.
- For buses and trucks, technologies for better recognising possible blind spots; warnings to prevent collisions with pedestrians and cyclists, and tire pressure monitoring systems.

The Connection to UN Regulations

As described in last month's DVN-L Newsletter, new amendments to UN Regulation № 157 extend the velocity range for certain automated vehicle functions from 60 to 130 km/h, and that is a major step forward. It will also effectively require the use of lidar sensors.

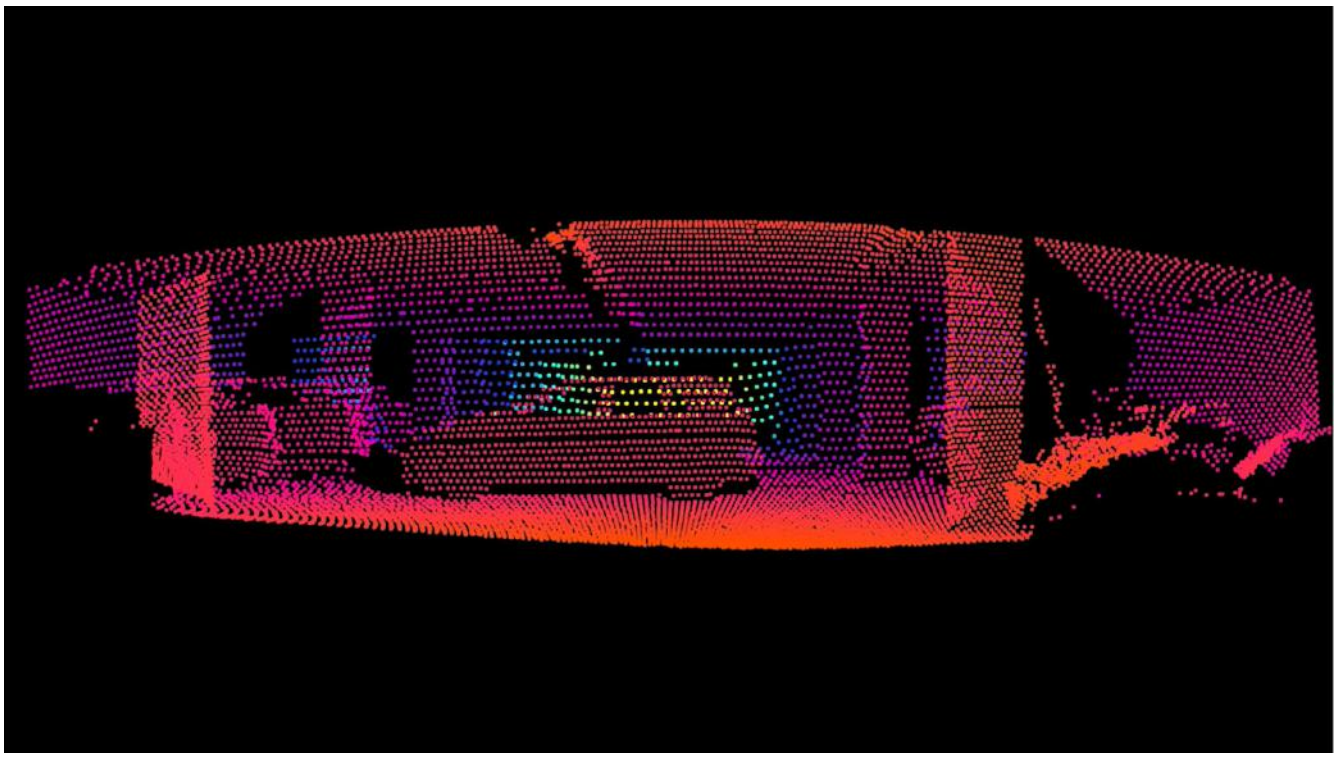
The new EU rules will align EU legislation with the UN R157 on L^3 automation, and adopt new EU technical legislation for fully driverless vehicles—the first international rules of this kind. The technical rules set out via a delegated and implementing act cover testing procedures; cybersecurity requirements; data recording, and monitoring of safety performance and incident reporting requirements by manufacturers of fully driverless vehicles, all to establish a comprehensive assessment of the safety and readiness of fully automated vehicles before they are placed on the EU market. This table gives an overview of the relation of the nine specific topics of the new EU regulation with other regulatory acts.

ANNEX II ofRegulation (EU) 2019/2144: DRIVER AND SYSTEM BEHAVIOUR

E1	Alcohol interlock installation facilitation	Regulation (EU) 2021/1243
E2	Driver drowsiness and attention warning	Regulation (EU) 2021/1341
E3	Advanced driver distraction warning	No requirements yet
E4	**Driver availability monitoring system**	**UN Regulation No 157**
E5	Event data recorder	UN Regulation No 160
E6	**Systems to replace driver's control**	**UN Regulation No 157**
E7	**Systems to provide the vehicle with information on state of vehicle and surrounding area**	**UN Regulation No 157**
E8	Platooning	No requirements yet
E9	Systems to provide safety information to other road users	No requirements yet

Currently, the primarily-important items for automated driving and thus also for lidar applications are E4; E6, and E7. These are fully in line with UN Regulation № 157. Additionally, we expect that in future also items E3 and E8 will become significant areas for lidar applications.

European Investment Bank Backs Blickfeld at €15m



The European Investment Bank (EIB) is now financing Blickfeld at a level of €15m. The funding is provided under the EIB's venture debt program, tailored to the specific financing needs of high-growth innovative companies. This funding is guaranteed by the European Fund for Strategic Investments (EFSI), also known as the Juncker Plan.

Blickfeld's lidar sensors use ToF measurements of laser pulses transmitted via MEMs on a 70°H × 30°V field of view, to generate precise three-dimensional information about the shape and surface properties of surrounding objects. Blickfeld intend to deploy this technology for automotive ADAS and L^3 autonomous driving, as well as other application areas. The technology is already used in data protection-compliant collection of vehicle and people flow in the retail space and public places:

It is also used to sense traffic flows for urban traffic management context in smart cities, and to reduce false alarms in building security systems. Its detailed three-dimensional capture of the environment can also help to measure materials quantities in docks, such as fertilisers or recycled materials that are known to be difficult and expensive to quantify.

Blickfeld will use the additional capital to accelerate the development of their lidar solutions for autonomous driving and a variety of industrial applications. Another field for expansion is the position of the company in key international markets. In line with this strategy, Blickfeld are opening regional offices in the US and in China. Blickfeld CEO Mathias Müller says "The EIB's support is testimony to Blickfeld's maturity as a company and the confidence that those responsible have in the potential of our lidar technology. The capital provided by the EIB is the ideal financial instrument for us to expand even faster. We are convinced that our lidar solutions will make a real difference for many industries, and we are very pleased that the EIB has recognised an important innovative technology that will strengthen Europe's position as a key centre of industry and business".

DVN comment

Blickfeld's approach is to address four different sectors of the industry: automotive; security; smart cities, and industrial & farming. Their Vision Mini and Vision Plus lidars, dedicated respectively to short/medium- and to long-range AD and ADAS applications, have been designed to conform to automotive requirements. Additional EIB funding will help Blickfeld adapt their sensors to the exigencies of their chosen market sectors and thereby expand their reach. One risk of this approach for a relatively small company, of course, is the splitting of resources which, if not carefully managed, can lead to losing focus and dedication.

Microvision Test Car Shows Mavin Lidar, Sensor Fusion Prowess

MicroVision have announced the completion of their European test vehicle. The retrofitted Jeep Grand Cherokee is registered in Germany, and has been configured and built to demonstrate Microvision's Mavin range of sensors, notably their new Mavin DR lidar.

The Jeep is scheduled to demonstrate the capabilities of Mavin DR in meetings with multiple automakers over the next several weeks, and MicroVision have successfully completed their second highway test track session focused on high speed testing of its sensor fusion features and Mavin DR; MicroVision CEO Sumit Sharma says "As we close out this week's second highway track testing session, we can report that we're very pleased with the outcomes and we look forward to sharing select data in the coming weeks".

Mavin DR is MicroVision's fourth lidar hardware variant, and the first to offer a dynamic range, combining short-; medium-, and long-range sensing with respectively varying fields of view in one box. According to MicroVision, the new sensor produces an ultra-high-resolution point cloud showing road surface and non-drivable limits of the road ahead. With its low-latency, 30-Hz point cloud, the Mavin product range allows ADAS and AD systems to significantly decrease their global reaction time at higher speeds. In addition, the newly refined form factor of enables even more flexible deployment options for automakers.

DVN comment

MicroVision are expanding their activities from the U.S. to the European market, as clearly indicated by their foundation of a branch office at Nuremberg, Germany. Under the guidance of this office, the test Jeep with Mavin DR is set up to test the newest lidar sensors in real-world conditions, and to demonstrate capabilities to the European automotive industry. DVN will be keeping very interested eyes on MicroVision's approach here.

Livox Car Lidar Now Up For Ordering

Livox, a subsidiary of DJI, recently announced the retail launch of their second-generation semi-solid-state HAP lidar. It offers a 150-metre detection distance; 144 lines equivalent, and a 120° × 25° field of view, for the equivalent of between USD $1,400 and $1,600 (not counting automaker volume discounts). It does not use a one-dimensional rotating mirror; instead it has a double-wedge prism structure, which makes the assembly structure simpler and smaller.

The HAP product is also the core component for Xpeng's Navigation Guided Pilot autonomous-drive system, already in production.

Livox are known to develop high-performance 3D lidars for mass production, especially on the Asian market for various industries. The company claim to benefit from their flexible, automated production lines:

Chinese automaker Xpeng have installed Livox lidar sensors on their new P5 model, which is being launched also in Europe. The P5 offers what's called CNGP—City Navigation Guided Pilot—made possible by the HAP lidar. Livox are also promoting the adoption of lidar in non-automotive sectors, to spur constant industry growth around spatial intelligence.

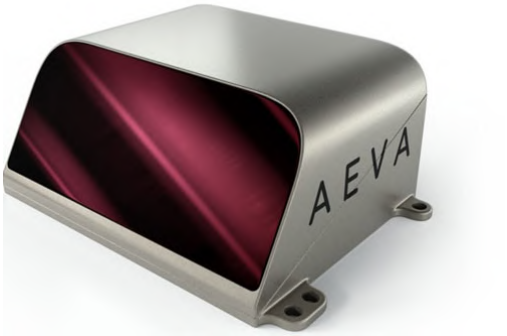
According to the company, the Livox automotive lidar offers long-range detection; excellent resolution; low influence from ambient light, and direct acquisition of object distance information, which can significantly improve the reliability and user experience of the intelligent driving system. Livox say the HAP's detection range for objects with low (~10 per cent) reflectivity is up to 150 metres, and that it offers a horizontal FoV of 120°; an angular resolution of up to 0.18°H × 0.23°V, and a point cloud density equivalent to 144 lines. Supported by HAP lidar, the traditional ADAS system will be more effective in dealing with scenarios such as HWP (Highway Pilot); close cut-in vehicles in urban traffic jams; night driving; adaptive cruise on curves, and park-by-memory, so users can enjoy a better functional experience with ease and security.

DVN comment

Livox offer a wide portfolio of lidar sensor products dedicated to various industrial sectors like automotive; robotics; smart cities, and academics. The HAP is their first automotive-grade sensor for driving automation applications installed in a series vehicle. The coöperation between Livox and Xpeng could pave the way for more model launches for Livox. On the other hand, Xpeng are not bound to just the one supplier; they also use (for example) Robosense lidar sensors on their SUV, as previously described in DVN-L. A very interesting new approach is that Livox are promoting a technically delicate product like a lidar sensor through online ordering. DVN-L will be keeping tabs on how this distribution channel works out as it ramps up.

Aeva 4D Lidar Ships to Strategic Customers

Aeva have secured quite a lot of collaborations with automakers and tier-1 suppliers including Plus Trucks (photo); Audi; Denso, and ZF. Now, they're announcing that their first Aeries II 4D lidar sensors have been produced and shipped to strategic customers, marking a major milestone on the company's path toward mass production.



Aeries II is based on a lidar-on-chip technology which eliminates all internal optical connections (e.g., fibres) and places all key components—transmitters; optics, and receivers— onto one silicon photonics chip. This architectural simplification allows to integrate the lidar in a more compact module. By consequence, the whole manufacturing process has been entirely automated, bringing better reliability during the production cycle. This technical solution allows Aeva to price their products lower, with the goal to rapidly meet automakers' needs within their cost constraints.

Aeries II integrates FMCW principles to measure the relative velocity (doppler effect) of each reflected point with an accuracy of a few centimetres per second, in addition to a precise 3D position. The sensor delivers four million raw points per second, a maximum field of view of 120°h × 30°V, and a maximum detection range of up to 500 metres. It is 75 per cent smaller than the previous generation, while achieving the strict environmental and operational standards required by automakers and industrial customers.

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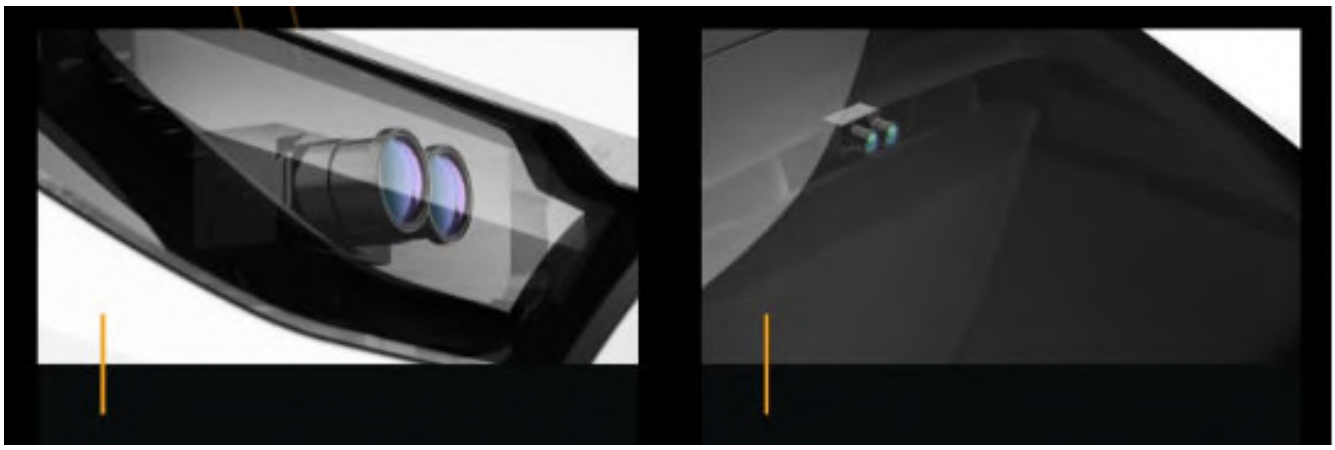
Aeries II integrates FMCW principles to measure the relative velocity (doppler effect) of each reflected point with an accuracy of a few centimetres per second, in addition to a precise 3D position. The sensor delivers four million raw points per second, a maximum field of view of 120 degrees by 30 degrees, and a maximum detection range of up to 500 meters. Its compact design is 75% smaller than the previous generation while achieving the strict environmental and operational standards expected by OEMs and industrial customers.

DVN comment

FMCW principles allow lidar systems to reach the same performance as radars in terms of relative speed measurements. This capability is known to accelerate clustering of reflecting points, in road scenarios where standard TOF lidars could aggregate, in a first step, the reflecting points associated with different objects. As a positive consequence, this 4th dimension (Doppler) gives a shorter response time to recognise separate objects. An open question is the status of the industrialisation: is it a prototype...? A product in pilot manufacturing...? Or is it really in volume mass production? We're watching to see.

AGC Glass Sensor Cover Sees First Adoption



AGC have developed a cover glass for automotive lidar sensors, and it has been chosen by a lidar maker through Belgium AGC Automotive Europe, a European automotive glass subsidiary.

AGC are aiming for mass production within this year, and recently presented the concept at the Automotive Engineering Exposition in Nagoya, Japan. The cover on an automotive lidar is required to protect the optics inside the lidar housing and to avoid obstruction or absorption of the laser beams which must pass through. AGC say their cover glasses outperform resin covers by being harder than current general-purpose products. A standard resin cover can be easily scratched by a gravel, where a cover glass will not be scratched at all. This aspect is one critical requirement of lidar manufacturers. Glass is also highly transparent to laser light, while plastic covers absorb a part of the laser beam.

In addition, the cover glass has excellent heat resistance, so it is possible to install a heater for melting snow and defrosting. Sensors used in ADAS and AD systems, including lidar, have to carry on working in any and all weather conditions. It is difficult to install heaters on a plastic cover, which can be deformed or otherwise degraded by the heat.

The remaining challenge for cover glass is the cost; plastic covers are cheaper. Glass is more difficult to work with, which is a factor in its higher cost. AGC are working to provide their cover glass at an competitively affordable price.

DVN comment

The protection of lidar optics is crucial, particularly against gravel and other normal road projectiles, as well as water; insects, and dust. Any obstruction or attenuation of the laser beam could cause a non-detection of some important object on the road ahead. Technical solutions are known for water management and dust removal, but against gravel the only solution is the hardness of the protecting material. Glass is therefore one of the solutions. The heater-compatibility of the glass cover is particularly attractive; newly-developed transparent heaters available for plastic covers suggest themselves, but an open question is their applicability to glass covers.

TUD Study: Lidar Detection in Bad Weather

A research team at the Technical University of Darmstadt in Germany have conducted a long-term study about the influence of adverse weather conditions on the detection performance of commercially-available lidar sensors. Lidar sensors from three suppliers were analysed; data were recorded over the six months from October 2021 to March 2022 on the August-Euler Airfield close to Darmstadt. This diagram shows the distribution of weather conditions during the measurement times in the recording period:

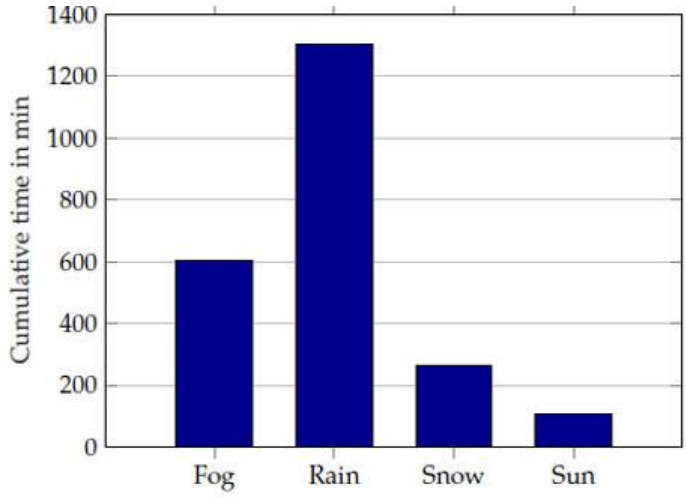
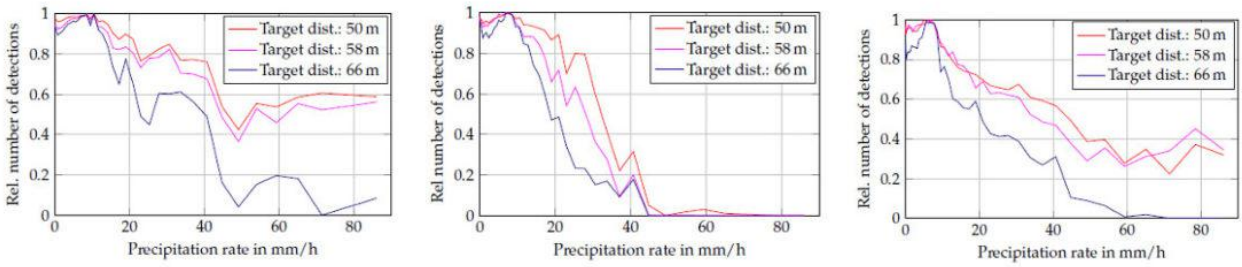


Figure 1. Time coverage of weather categories in the data set.

The experimental setup consisted of a test station with lidar sensors and reference sensors for environmental conditions as well as reference targets placed in front of the test station:

The targets were plywood boards painted with RAL7047 (Telegrey 4) lacquer. The reflectivity of the target boards was 50 per cent, and the boards were placed at of 50; 58, and 66 metres' distance. The study revealed results for detection rates under the four weather conditions. As an example, these diagrams depict the results of the three sensors under rainy conditions:



Detection probability of the targets starts to drop around a precipitation level of 10 mm/h for all three lidar sensors. At greater rainfall, the behaviour of the three sensors is quite different and no uniformity can be observed. To assess these results it should be noted that average European rain fall rates are around 5mm/h , very strong rain fall around 30 mm/h and rainfall during thunderstorms around 50 mm/h. Also interesting results for the other weather conditions can be found in the study.

DVN comment

The TUD research team conducted a well-designed study on the influence of weather conditions on lidar sensor performance. The results quantify weather-related detoriation of detection rates, as well as significant differences in behaviour among different lidar sensors under adverse weather conditions. An aspect not yet covered in the study is the comparison with other sensors types like camera or radar. Also interesting would be the investigation of a system with sensor fusion of camera, radar and lidar. More independent research like this should be encouraged and executed to map this crucial topic of influences of surrounding conditions on detection rates—then those study results can shape and guide further research and development to address the relevant needs and issues. DVN is approaching the authors of this study for a presentation at our next lidar conference on November 31st/December1st in Wiesbaden.

DVN LiDAR EVENTS

The fifth DVN Lidar Conference will take place on 30 November and 1 December this year in a new location: the Dorint Pallas Hotel in Wiesbaden. This hotel can be easily reached from Frankfurt Airport and Frankfurt Main Railway Station by train or taxi within about 30 minutes.

The change of venue responds to the increasing number of participants and exhibitors wanting more spacious and comfortable conference facilities. The pictures here show the conference room, which can accommodate up to 400 participants. The same room after the first conference day will be converted to a ballroom setting with round tables for the conference dinner in the evening.

The exhibition area is directly adjacent to the conference room, with space for 20 expo booths—these, as usual, have different sizes to suit the range of exhibitors' needs. The planned layout of the exhibition area is shown in the exhibition floor plan:

The DVN team are hard at work to make this 5th DVN Lidar Conference a grand event exceeding all past conferences and responding in excellent fashion to the needs, wants, and intrigues of exhibitors, speakers, and attendees alike. We will keep you informed as the event and its docket take shape; watch for updates here in the DVN-L Newsletter as well as by email.