ROADVIEW

Robust Automated Driving in Extreme Weather

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Welcome to the ROADVIEW Newsletter, Issue 3

Dear Reader,

Welcome to the third edition of our newsletter!

In this issue, we are excited to share the latest updates from the ROADVIEW project. We start with an introduction to 'REHEARSE', a key dataset developed by our ROADVIEW partners to support the testing and validation of ROADVIEW technology.

Next, we present a summary of the first demonstration's results, showcasing critical advancements and validations. These outcomes highlight the potential of various system components to enhance the safety and efficiency of connected and automated vehicles.

Looking ahead, we offer a glimpse into the upcoming demonstrations scheduled for 2025, which will further illustrate the practicality and impact of ROADVIEW technology.

Finally, this edition features profiles of two of our key partners, the Swedish National Road and Transport Research Institute and Cerema, whose contributions have been instrumental to the project's success.

We hope you enjoy the read!
accelopment on behalf of the project consortium

REHEARSE Dataset: Reinforcing Autonomous Driving

On the road to the commercialisation of an Automated Vehicle (AV), its software needs to be deeply tested. Due to the system's automated nature, these tests are unique; however, if conducted on public roads and a system failure occurs, a catastrophic accident is highly likely. Therefore, to avoid such scenario, the system must be first tested in controlled environments, such as test tracks or simulated urban areas, where factors like traffic, weather, and pedestrian interactions are carefully managed. This kind of testing is quite demanding both in up and down time, and it cannot cover all the cases specified by the system constraint definitions, particularly those concerning actor safety. Simulation offers a solution to the limitations of a controlled environment.

Although simulated test environments require a significant initial setup, once they are running, tests can be executed automatically, and with significantly smaller downtimes. The compounding of errors forces the initial simulation setup to be done with a very high degree of accuracy, furthermore, additional details result in a smaller simulation-to-reality gap. This initial step counts with Digital Models from the test track, weather validation, and mainly sensor models and noise models development for the specific test cases.

Named after the action of practise a play or song for a later public performance, REHEARSE (adveRse wEatHEr datAset for sensoRy noiSe modEls) comes to help with the minimisation of this gap in the initial setup from the testing system. It consists of data collected in the CARISSMA Outdoor Track in Ingolstadt, Germany (See Fig.1), and

Figure 1. Data capture setup with REHEARSE sensors at the CARISSMA's Outdoor Track, featuring a layered arrangement of devices: a Rotative LiDAR (top), followed by MEMS, LiDAR, RGB and FLIR cameras, and a 4D RADAR.

in the Cerema's PAVIN fog and rain test chamber (See Figs. 2 & 3) in Clermont-Ferrand, France. The usage of outdoor and indoor test sites allows for a head-to-head sensor data comparison between different environments. Furthermore, the test sites are complementary in their test capabilities, further strengthening the dataset.

In each of the test tracks, data is collected from two different cameras, a 4D RADAR, and two different types of LiDAR. The sensors and target are static. The targets measured are EURONcap-validated targets in the shape of a car, pedestrian, and cyclist. To further improve the dataset robustness, validated

Figure 2. Cerema's PAVIN platform simulating fog

camera, RADAR, and LiDAR targets are also measured. With the focus on adverse weather, REHEARSE has data on rain, fog, snow, and clear weather conditions, in a wide intensity range, in day-and night-time. The adverse weather caused in the scene is validated using a broad selection of meteorological instruments, which allows a precise weather simulation. The dataset is also shipped to the end user using a standardised format to further facilitate its usage and make it more

Figure 3. Cerema's PAVIN platform simulating rain

widespread.

The ROADVIEW project has already utilised REHEARSE, for the development of sensor noise models, the development of a 4D RADAR and LiDAR model for simulation, and its usage has even been further amplified by the novel point cloud annotation method developed by ROADVIEW partners.

REHEARSE provides invaluable data that makes it possible for a sensor noise model under harsh weather conditions to be developed, as well as a broad range of algorithms in target detection under harsh weather. It also provides a visual comparison between different types of sensors, the usage of more than one type of camera and LiDARs allows for future projects to compare the efficacy of the selected sensors in

Useful link:

- **REHEARSE dataset:** Click here to access the dataset database and download its contents.

Demonstration 1: A reflection on ROADVIEW's First Demo

Demonstrations are a crucial step in enhancing the safety and functionality of Connected and Automated Vehicles (CAVs) under challenging environmental conditions. In the ROADVIEW project, these demos aim not only to test new technologies but also to showcase how they perform in real-world scenarios. Such trials are essential, as they enable project teams, stakeholders, and the general public to witness the practical impact of the project's innovations.

Led by ROADVIEW partner Ford Otomotiv Sanayi A.S. (FORD), Demo 1 was conducted over the summer and completed in late August 2024. The primary goal was to verify that the developed systems met the required specifications. Testing in real conditions allowed for the early identification and resolution of potential issues, supporting readiness for broader deployment. Additionally, this initial phase aimed to build trust among engineers, designers, end users, and investors by demonstrating tangible progress and clear benefits.

Outcomes of Demonstration 1

Demo 1 resulted in a wide range of technological advancements and validations, highlighting the capabilities and potential of various system components designed to improve the safety and efficiency of CAVs. The demonstration included the participation of several ROADVIEW partners demonstrating their results. Halmstad University (HH) successfully tested a novel AI-based filtering method, named 3DOutDet, on FORD and Technische Hochschule Ingolstadt (THI) data to detect and remove outliers such as raindrops and snowflakes in 3D LiDAR point clouds during different times of the day (See Fig. 4). This capability enhances the accuracy of environmental perception under adverse weather conditions, crucial for safe CAV operations.

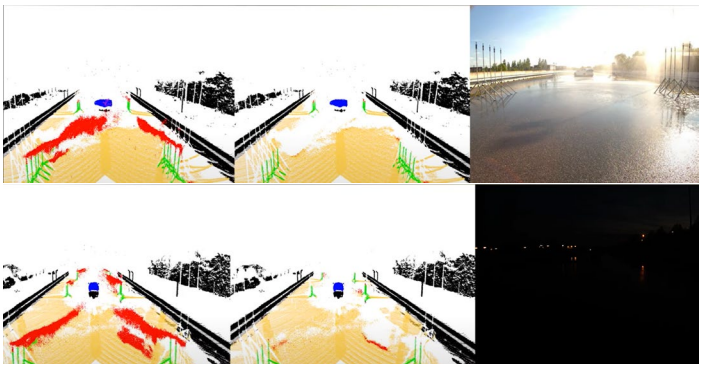


Figure 4. HH's Rain filtering on REHEARSE dataset in daytime (top) versus nighttime (bottom)

The Finnish Geospatial Research Institute (FGI) demonstrated the construction of high-resolution, environment-aware maps using LiDAR data collected with their Automated Research Vehicle Observatory (ARVO) (See Fig. 5). This includes creating high-definition (HD) maps that are essential for precise vehicle positioning and navigation on highways, enhancing both the accuracy and reliability of CAVs in real-world scenarios. FGI also showcased a system that predicts road grip in real-time at the front of the research vehicle using camera and LiDAR sensors. This system allows the vehicle to anticipate and adapt to changing road conditions before encountering slippery areas, significantly improving vehicle safety and performance. The method is being prepared for real-time applications and integration into vehicle systems.

Figure 5. FGI's testing vehicle, a Ford Fusion passenger vehicle

The Technical Research Centre of Finland Ltd (VTT) demonstrated a Visibility Detector that estimates the effective range of LiDAR sensors, which is essential for safe driving in low-visibility conditions. VTT also introduced a Weather Conditional Navigation System that integrates with the vehicle's existing systems to improve routing and safety based on real-time weather data. This technology leverages infrastructure-based communication systems to increase responsiveness to environmental changes. Additionally, VTT showcased a Minimal Risk Manoeuvre feature, which enables vehicles to safely move to the road shoulder in emergencies, enhancing the safety of CAVs. The demonstration included real-time data integration from multiple sources, such as road conditions and vehicle telemetry, highlighting the potential for complex system interactions and data sharing among CAVs.

Finally, Canon Research Centre France (CRF) validated the concept of using Vehicle-to-Everything (V2X) communication to exchange critical road and weather information between infrastructure and CAVs. This system aims to enhance the predictive capabilities of vehicle systems under varying weather conditions, particularly in harsh environments like the Finnish Lapland.

Figure 6. VTT's Demo vehicle, a Volkswagen Touareg.

Scientific Relevance of Demonstration 1

The improvements in perception and decision-making systems demonstrated in Demo 1 offer significant potential for enhancing the reliability and efficiency of CAVs under varied environmental conditions. The ability of these systems to accurately interpret complex scenarios and respond appropriately is crucial for the wider adoption of CAV technologies in public transportation and logistics. These advancements could lead to safer and more predictable vehicle behaviour, reducing accidents and improving road safety globally.

ROADVIEW's Demo 1 extends well beyond its initial automotive focus, offering potential benefits and insights for various sectors. As the project moves towards further integration and real-world testing, the continued refinement of these technologies promises to contribute to the fields of automation, data processing, and environmental resilience, heralding a new era of technological innovation that is interconnected and adaptive.

Useful links:

- **Demonstration 1 - Playlist:** Click here to watch all full videos from the ROADVIEW's first demo.
- **Demonstration 1 - Wrap-ups:** Click here to watch short wrap-up videos, explaining the ROADVIEW's demo 1 in layman's terms.

Looking ahead:
ROADVIEW Key Demos in 2025

As 2024 draws to a close, the ROADVIEW project looks forward to an exciting year in 2025. Three major demonstrations are scheduled in the new year, each designed to showcase the project's innovative capabilities across both real-world and controlled environments. These demonstrations will provide valuable insights into the effectiveness of ROADVIEW technology.

ROADVIEW's Robust Perception System

In this demo, the ROADVIEW project will showcase the viability of its system for robust perception in Muonio, Finnish Lapland. The system relies on three key innovations: collaborative perception, where vehicles exchange sensory data to gain a more complete understanding of their surroundings; an environmental and weather condition estimator, which uses vehicle sensor data to assess real-time weather and environmental factors, enabling vehicles to adapt accordingly; and improved localisation through high-density mapping, enhancing positioning accuracy by referencing detailed, up-to-date maps for precise navigation, even in challenging environments. Hosted by VTT in collaboration with FGI, CRF, and Cerema, the event will use an autonomous Volkswagen Touareg (See Fig. 7) to test a range of new technologies. The overarching goal of the demo will be to demonstrate that the ROADVIEW system can efficiently help the car detect nearby objects, predict road slipperiness, and adjust navigation based on weather conditions.

Figure 7. VTT's Demo vehicle in Muonio

ROADVIEW's X-in-the-Loop Environment

Another important demo for 2025 will be the ROADVIEW x-in-the-loop system led by THI with the support of KO, HH, and FGI. The X-in-the-loop system consists of a testing simulation framework where real components (like hardware and software) interact with virtual models to validate their performance and functionality under realistic conditions. The overarching goal of the demonstration is to showcase the ROADVIEW integrated perception system under challenging weather conditions. The demonstration will be divided into two phases. The first phase, known as

Figure 8. THI's Demo vehicle, a BMW M8.

Figure 9. THI's demo vehicle on the outdoor test track.

hardware-in-the-loop test systems, will focus on testing the effectiveness of all ROADVIEW integrated perception systems. This includes noise models, sensor models, vehicle dynamic models, and digital twins developed for the project. These tests will be conducted within a virtual environment that replicates the outdoor test track from the CARISSMA Institute of Automated Driving. In the second phase, called the vehicle-in-the-loop test system, THI's BMW M8 (See Figs. 8 & 9) integrating the ROADVIEW systems will be tested and evaluated in a controlled environment with various simulated weather conditions to ensure effectiveness before proceeding to real-world environments.

ROADVIEW's SAE Level 4 trailer-mounted truck

Finally, under the leadership of FORD, with support from HH, FGI, VTT, and CFR, the project will demonstrate the effectiveness of its systems in an SAE Level 4 autonomous trailer-mounted truck (See Fig. 10). Beginning in a parking lot, the truck will drive autonomously on a Turkish highway, navigating extreme weather conditions. During the demonstration, various use cases will be tested, including lane-keeping, following, overtaking, merging, and exiting. Key findings from the ROADVIEW project will be integrated, enabling the truck to drive independently in challenging conditions such as rain, snow, and fog.

Figure 10. FORD's truck at the SUMMITS'24 in Turkey

CCAM Cluster Event: Driving Knowledge Exchange across Europe

The recent ROADVIEW CCAM Cluster Event, held on 24 September 2024, successfully brought together key stakeholders in the field of Connected, Cooperative, and Automated Mobility (CCAM). Organised by the ROADVIEW project in collaboration with the CCAM Association, this event featured presentations from prominent EU-funded projects, including AI-SEE, AWARD, EVENTS, IN2CAMM, PoDIUM, and ROADVIEW itself. Representatives from industry, the scientific community, and policymakers joined to foster invaluable discussions on the future of CCAM, underscoring the importance of European efforts in advancing sustainable mobility solutions.

The agenda, structured to promote both in-depth discussion and practical demonstrations, opened with a welcome session by Prof Eren Erdal Aksoy from ROADVIEW and Marzena Jougounoux from the CCAM Association. They set the stage for a day focused on knowledge sharing, collaboration, and addressing challenges in the CCAM landscape. Following this, Christian Merkt, chair of the CCAM Association, provided insights into the partnership's vision, highlighting achievements and collaborative efforts across Europe.

A highlight of the event was the project pitch session, where each featured project presented its ambitions and ongoing research. These presentations offered a platform for sharing the latest technological advancements, fostering a productive exchange of ideas on how these projects contribute to addressing critical barriers in CCAM development.

Click on the image to watch the recording of the event.

The panel discussion further enhanced the day's value, as participants delved into the current barriers and success factors in CCAM. This interactive session provided a clear examination of the technological and regulatory challenges in the sector, with valuable contributions from project representatives who discussed strategies to drive forward the EU's regulatory and research agendas.

The event concluded with an engaging showcase of video demonstrations from several projects, allowing participants to witness practical applications and innovations up close. This visual display of results not only celebrated the achievements of the projects but also stimulated future collaborations among stakeholders.

Overall, ROADVIEW's CCAM Cluster Event was a successful hub for networking and knowledge exchange, drawing together a community dedicated to the advancement of CCAM in Europe. By addressing challenges, exploring solutions, and emphasising the importance of EU-funded research and collaboration.

Meet the Partners:
VTI

The Swedish National Road and Transport Research Institute (VTI), is an independent and internationally prominent research institute in the transport sector. The institute's principal task is to conduct research and development related to infrastructure, traffic, and transport. VTI is dedicated to the continuous development of knowledge pertaining to the transport sector, and in this way contribute actively to the attainment of the goals of Swedish transport policy.

Figure 11. VTI's Facility in Gothenburg, Sweden.

Click on the image to hear from Sogol Kharrazi talking about the VTI and its role within the project.

VTI's operations cover all modes of transport, and the subjects of pavement technology, infrastructure maintenance, vehicle technology, traffic safety, traffic analysis, users of the transport system, the environment, the planning, decision making processes, transport economics, and transport systems. The knowledge that the institute develops provides a basis for decisions made by stakeholders in the transport sector. In many cases the institute's findings lead to direct applications in both national and international transport policies. VTI is an assignment-based authority under The Swidish Ministry of Infrastructure, employing 200 people across Sweden in Linköping (head office), Stockholm, Gothenburg, and Lund.

Meet the team

Maytheewat Aramrattana
Senior Researcher at VTI

Sogol Kharrazi
Senior Researcher at VTI

Mattias Hjort
Researcher at VTI

Meet the Partners:
Cerema

Cerema is France's leading public institution for developing and leveraging public expertise in regional cohesion and ecological and energy transitions. With specialised skills across mobility, transport infrastructure, urban planning, construction, resource conservation, risk prevention, and road and maritime safety, Cerema integrates these competencies to support and guide regional development projects.

Cerema's Intelligent Transport Systems (ITS) research team is dedicated to advancing mobility and safety in challenging weather conditions, including fog and rain. The team explores the impact of reduced visibility on driving, using both technical analysis and sensor perception. Key research is conducted at Cerema's PAVIN Fog and Rain platform, a state-of-the-art facility open to both research institutions and private companies. This platform supports the evaluation of smart transport systems and scientific activities such as validating perception models for harsh weather or conducting perception tests. The platform can simulate metrologically controlled fog and rain conditions, offering a unique environment for such studies.

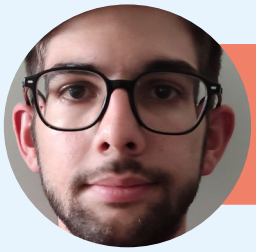
In recent years, many vehicle manufacturers and Original Equipment Manufacturers (OEMs) have tested their sensors and vehicles at this facility. The platform has also hosted numerous test campaigns, including some for the EU-funded DENSE and AWARD projects.

Click on the image to hear from Pierre Duthon talking about Cerema and its role within the project.

The ITS team at Cerema has extensive experience with surveillance sensors, both passive (e.g., video cameras and audio sensors) and active (e.g., LiDAR and radar). These sensors are used in either homogeneous configurations (multiple sensors of the same type) or heterogeneous combinations (e.g., video and LiDAR). The team is also skilled in processing high-value data from these sensors, particularly in image processing, to extract meaningful insights and enhance overall sensor performance.

Meet the team

Frédéric Bernardin
ITS Research Group Lead at Cerema



Mickaël Fernandes
Photometry and ITS Research Officer at Cerema

Pierre Duthon
ITS Research Deputy Manager at Cerema

Louahdi Khoudour
Director of Research at Cerema

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