



Virtual Validation in the Automotive Industry

A Cost-Effective and Scalable Solution Driving Innovation
and Safety in Automotive Development

Virtual validation in the automotive industry is reshaping the design, testing, and market launch of vehicles. This is especially true for driver assistance systems, autonomous driving, and software development. As vehicles become increasingly complex and software-driven, virtual validation offers a robust framework for ensuring safety, reliability, and performance - all while cutting costs and time compared to traditional physical testing.

Optimizing Driver Assistance Systems Through Virtual Validation

Driver assistance systems, such as adaptive cruise control, lane-keeping assistance, and automated emergency braking, rely heavily on sophisticated software and sensor integration. Virtual validation plays a crucial role in the development and testing of these systems by simulating real-world driving scenarios and assessing system responses.

- 1 Simulation of Driving Scenarios:** Virtual validation allows engineers to create detailed simulations of various driving conditions, including urban environments, highways, and adverse weather conditions. We design and develop distributed virtual validation pipelines for our customers where a vehicle simulation is one of the most important parts of the architecture. Using state of the art simulations like Carla, CarMaker and others in our pipelines, helps test the effectiveness of driver assistance systems in detecting obstacles, maintaining lane position, and adjusting speed. We also develop custom vehicle simulation with e.g. Unity3D if current vehicle simulations can't fulfill all the requirements of our customers.
- 2 Sensor Fusion and Calibration:** Driver assistance systems depend on data from multiple sensors, including cameras, radar, and lidar. Virtual validation facilitates the fusion and calibration of these sensors, ensuring accurate data interpretation and system responsiveness. We develop custom sensor simulations and sensor models specified by our customers.
- 3 Human-Machine Interface (HMI) Testing:** The interaction between the driver and assistance systems is critical for safety and usability. We develop custom augmented- and virtual reality Applications in Unity3D and Unreal that enables

testing of HMI designs, ensuring that alerts, controls, and feedback are intuitive and effective. Furthermore, a dedicated and award winning UI/UX Team creates new user friendly HMI designs and helps our customer with subject studies while using state of the art attention analysis methods like eye tracking etc.

Advancing Autonomous Vehicle Safety with Virtual Validation

Autonomous driving represents one of the most complex challenges in the automotive industry, requiring advanced algorithms and extensive testing to ensure safety and reliability. Virtual validation is indispensable in the development of autonomous vehicles, providing a controlled environment to test and refine autonomous systems.

- 1 Complex Scenario Simulation:** Autonomous vehicles must navigate a wide array of scenarios, from busy city streets to rural roads. We develop virtual validation solutions that allows for the simulation of these complex environments, including interactions with pedestrians, cyclists, and other vehicles, to test decision-making algorithms and system robustness.
- 2 Algorithm Development and Testing:** Autonomous driving relies on machine learning and artificial intelligence to interpret sensor data and make driving decisions. Virtual validation supports the development and testing of these algorithms, enabling iterative improvements and ensuring they can handle unexpected situations. We support our customer to develop AI Pipelines and integrate these algorithms into virtual validation architectures.
- 3 Safety and Redundancy Checks:** Safety is paramount in autonomous driving. Virtual validation provides a platform to test system redundancies and fail-safes, ensuring that vehicles can safely handle system failures or unexpected events.

Enhancing Automotive Software Reliability with Virtual Validation

Software development in the automotive industry has become increasingly complex, with vehicles now featuring millions of lines of code to manage everything from infotainment systems to powertrain controls. Virtual validation is essential for ensuring software reliability and performance.

- 1 Software-in-the-Loop (SiL) Testing:** Virtual validation includes SiL testing, where software components are tested in a simulated environment. We integrate the software artefacts of our customers (e.g. vECU's) into the virtual environment. This approach allows developers to identify bugs and optimize performance before integrating software into physical hardware.
- 2 Continuous Integration and Deployment:** Virtual validation supports agile software development practices, including continuous integration and deployment. Developers can test their software artifacts in a virtual environment, ensuring compatibility and functionality before release. We provide services to combine the software development processes of our customer with a CI/CD and virtual validation pipeline, ensuring a seamless development approach for our customers.
- 3 Cybersecurity Testing:** As vehicles become more connected, cybersecurity is a critical concern. Virtual validation enables rigorous testing of software security measures, identifying vulnerabilities and ensuring robust protection against cyber threats.

What Are the Benefits of Virtual Validation?

Virtual validation in the automotive industry offers many advantages in terms of project efficiency, flexibility and safety:

- 1 Cost and Time Efficiency:** Virtual validation reduces the need for physical prototypes and extensive real-world testing, significantly lowering development costs and accelerating time-to-market.

- 2 **Scalability and Flexibility:** Virtual environments can be easily scaled and adapted to test a wide range of scenarios and configurations, providing flexibility in development and testing processes.
- 3 **Enhanced Safety and Reliability:** By identifying issues early in the development process, virtual validation enhances the safety and reliability of driver assistance systems, autonomous vehicles, and software components.

Ensuring Accuracy and Staying Competitive in Automotive Validation

In the automotive industry, the combination of virtual and physical validation is crucial for reliable test results and competitiveness. While virtual models provide an efficient way to simulate real-world conditions, integration with traditional test methods remains essential.

- 1 **Model Accuracy and Realism:** Ensuring that virtual models accurately represent real-world conditions is crucial for reliable validation results. We provide continuous refinement and validation against physical tests, that are necessary.
- 2 **Integration with Physical Testing:** While virtual validation can replace many physical tests, it is often used in conjunction with traditional methods to ensure comprehensive validation. Balancing virtual and physical testing requires careful planning and coordination. We provide virtual as well as physical testing for our customers, where both teams are working hand in hand to test and validate the software of our customers on different levels.
- 3 **Technological Advancements:** As technology evolves, manufacturers must continuously update their simulation tools and processes to stay competitive. This requires ongoing investment in software, hardware, and personnel training.

Future Trends in Virtual Validation: AI, IoT & Collaborative Platforms

The future of virtual validation in the automotive industry will be shaped by innovative technologies that make test processes more efficient and accurate:

- 1 AI and Machine Learning Integration:** The integration of AI and machine learning into virtual validation tools will enhance predictive capabilities and automate decision-making processes.
- 2 IoT and Real-Time Data Utilization:** The Internet of Things (IoT) will provide real-time data from connected vehicles, refining simulations and improving the accuracy of virtual validation.
- 3 Collaborative Development Platforms:** Collaborative platforms will facilitate virtual validation across different teams and locations, enabling seamless sharing of data and insights.

Virtual validation is revolutionizing the development of driver assistance systems, autonomous driving technologies, and automotive software. By providing a cost-effective, efficient, and scalable approach to testing and validation, it is paving the way for safer, more reliable, and innovative vehicles. As the industry continues to evolve, virtual validation will remain a cornerstone of automotive development, driving advancements in technology and design.

For many years, in-tech has been involved in agile projects for different OEM's and first Tiers, focusing on the development of innovative software solutions. This includes the conception and development of architectures, high-performance algorithms, frameworks, tools, and co-simulations in the areas of autonomous driving, ADAS, and virtual validation.

Contact

If you have any questions, please do not hesitate to contact us. Please contact us via
sales@in-tech.com

in-tech contact:

Oliver Trauer
Technical Head – ADAS/AD & Virtual Validation
E-Mail: oliver.trauer@in-tech.com