LeddarTech®

WHITE PAPER

AI-Based Low-Level Fusion and Perception for Advanced Safety Systems

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Abstract

Historically, road safety has been driven by innovations such as airbags, seat belts, increased robustness of the vehicle frame and improved vehicle stability. A new car assessment program (NCAP) tests new vehicles that enter the market on a variety of factors and awards a score or a rating to a vehicle based on how well it has performed against those assessment tests. The better the performance, the better the rating. NCAP testing involves not only the mechanical and structural integrity of vehicles upon impact but also their ability to avoid rollovers and crashes.

Structural integrity tests consist of side impact tests, rear-end crashes and head-on frontal crash tests among others. Rollover resistance tests measuring the ability of a vehicle to protect its occupants in the event of a vehicle rollover are another example of tests that vehicles must go through prior to release to the market. Such structural integrity and vehicle stability tests are a significant component of NCAP testing and will continue to remain so.

Moving From Accident Protection to Accident Avoidance

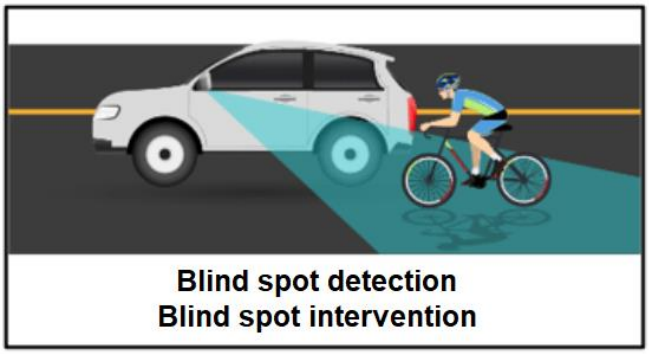
While structural integrity and vehicle stability are and will remain a critical part of NCAP, technology will lead the next advancements in road safety. ADAS features will power the next stage in enabling safer roads and reducing accidents, injuries and fatalities. This next leap in safety is marked by a shift from accident protection to an accident avoidance mindset, and the pillar of these technological changes is sensor fusion and perception technology that has enabled advanced driver assistance systems (ADAS) such as blind spot warning, lane departure warning and forward collision warning. Great leaps in fusion and perception technology have enabled the development and testing of ADAS in new car assessment programs across the world.

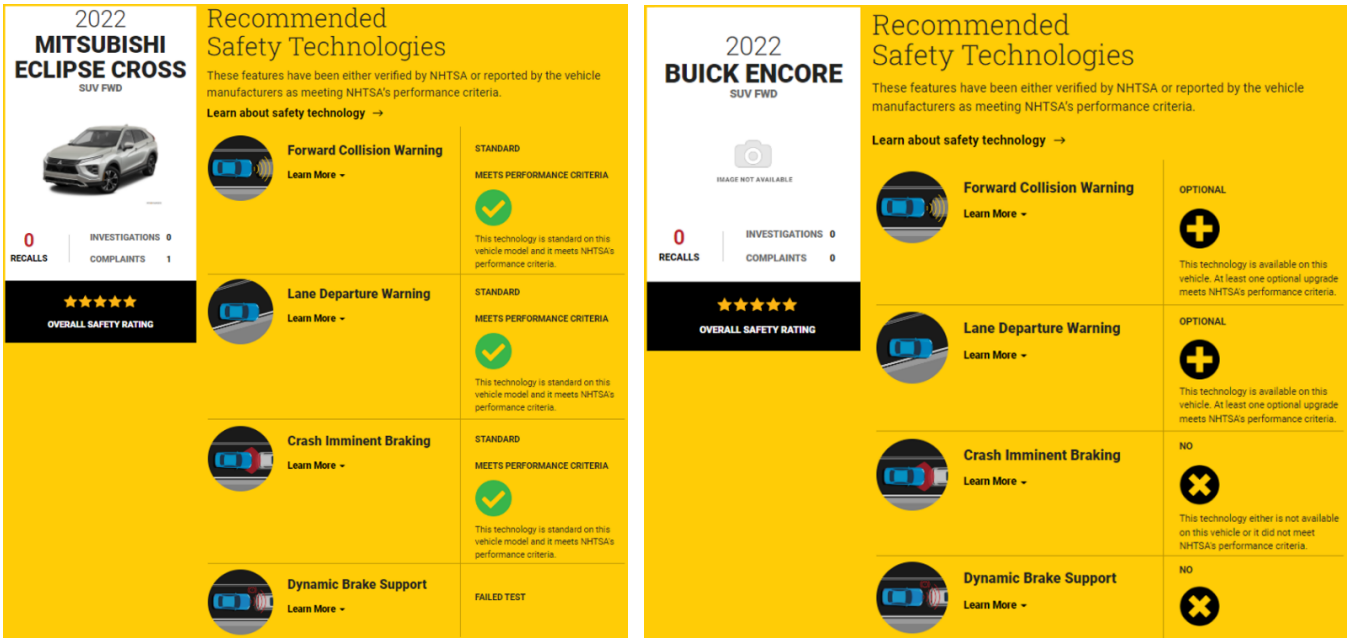
In total, there are 12 new car assessment programs across the world, each catering to its specific region and needs. NCAP programs across the world are at different levels of maturity regarding ADAS adoption. Leading ADAS adoptions are U.S. NCAP and Euro NCAP, with both regions bringing updates to their assessment programs. Europe is poised to witness new NCAP regulations coming in 2025 that cover even more ADAS features in addition to the ones already included in the program. Similarly, the U.S.A. is also poised to revamp its new car assessment program to widen ADAS testing.

ADAS in NCAP

Some of the ADAS technologies that are currently part of new car assessment programs are adaptive cruise control, lane support system and automated emergency braking system for Euro NCAP and forward collision warning, dynamic brake support, crash imminent braking and lane departure warning for U.S.A. NCAP.

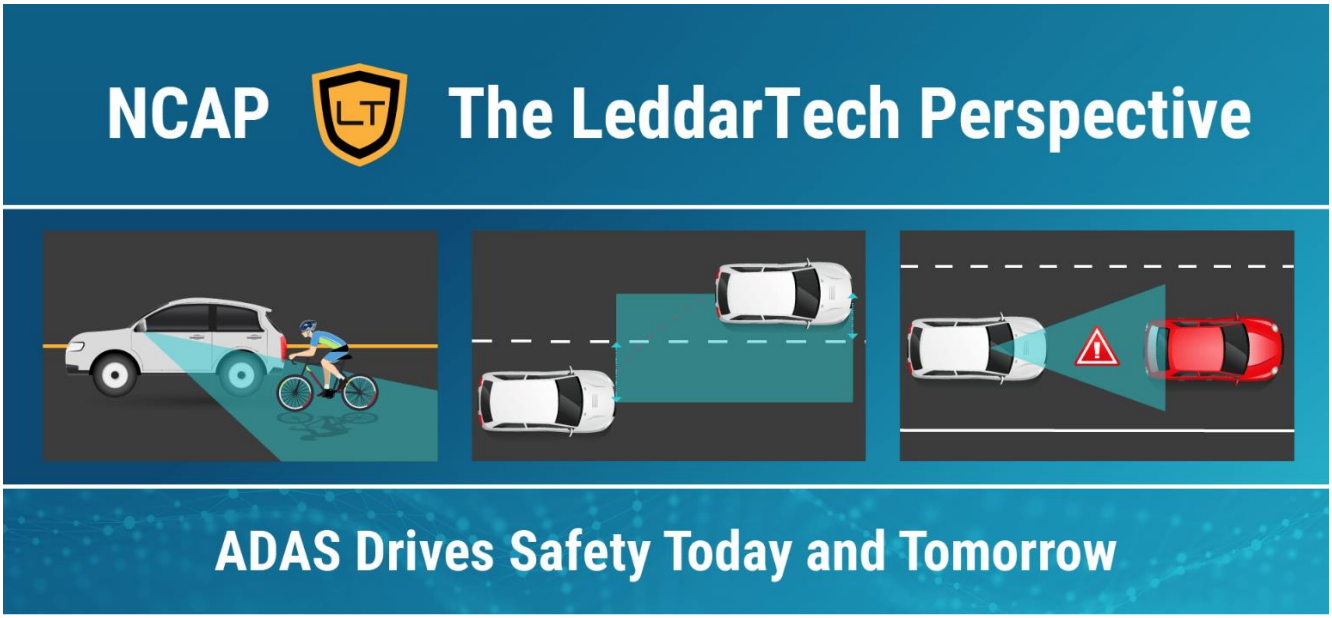
In early 2022, the National Highway Traffic Safety Administration (NHTSA) proposed updates to its new car assessment program. It provided the rationale behind these proposed updates, explaining how many lives and serious injuries could be avoided by engaging ADAS features on the vehicle and tightening testing criteria for ADAS features. This trend of increased ADAS adoption, testing criteria tightening and subjecting vehicles to more varied tests will accelerate putting more demands on sensor fusion and perception software stack. A perception software stack that is scalable (to enable future ADAS feature development), high-performing, sensor-agnostic (to incorporate radar, LiDAR, camera, ultrasonic) and cost-effective will be key to delivering strong results for OEMs and Tier 1s during NCAP testing.





Vehicles' ADAS performance under USA NCAP (source: nhtsa.gov)

With a view to enhancing safety and making roads safer, LeddarTech welcomes the proposed changes and goes as far as to recommend making vulnerable road users such as bicyclists, motorcycles and pedestrians a key element of its ADAS-driven NCAP changes. LeddarTech is excited to see the proposed inclusion of pedestrian AEB in U.S. NCAP and would welcome expanding the program to cover additional scenarios and use cases.



Testing Requirements of NCAP Today

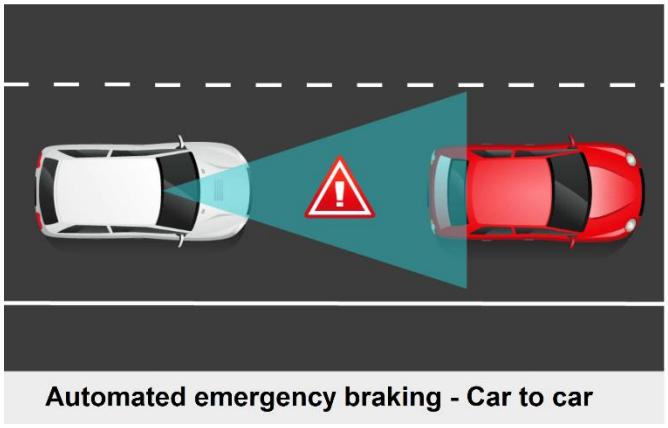
For a vehicle to rank well on NCAP ADAS tests, its fusion and perception system must perform well under a myriad of conditions and show strong performance on multiple criteria under multiple scenarios. For example, Euro NCAP introduced automated emergency braking (AEB) ADAS testing involving car-to-car crashes. Some of the scenarios in which the vehicle must be tested are car-to-car rear stationary (CCRs), car-to-car rear moving (CCRm) and car-to-car rear braking (CCRb). Testing is further complicated by the multitude of tests performed on the vehicle by changing one or more test conditions, such as test vehicle speed, object speed and angle of introduction.

The test protocol also specifies the weather conditions, brake warm-up procedure, tire conditions and many other requirements before testing. Euro NCAP AEB C2C Test Protocol v4.1.1 stipulates that ADAS tests be conducted in dry conditions with wind speeds below 10 m/s and homogeneous natural ambient illumination across the test area. Furthermore, it prescribes that tests not be performed driving towards or away from the sun when there is direct sunlight.

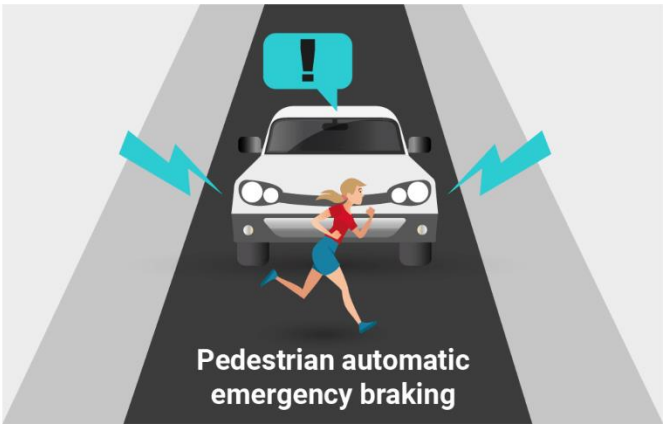
Future Testing Requirements of NCAP and the Challenges Therein

The future of ADAS testing under NCAP is marked by lower error margins, increased complexity and varied testing. Existing test protocols, while robust, test vehicles under best-weather conditions. Future testing of NCAP will incorporate night-time and inclement weather testing such as low light and/or heavy precipitation, fog or snow, and varying degrees of traction/reflectivity of the surface to simulate actual driving conditions faced by drivers.

Given the challenges that lie ahead, sensor fusion and perception solutions must perform well across varied environments, conditions and scenarios. Such systems must be scalable and sensor-agnostic so that future advancements in ADAS can be built on the same platform, reducing rework needs and incorporate everchanging sensor architecture. A scalable system reduces R&D time and cost for OEMs and Tier 1-2s, enabling them to go to market faster and deliver these life-saving technology to the masses. Most importantly, perception systems must remain cost-effective while delivering high performance.



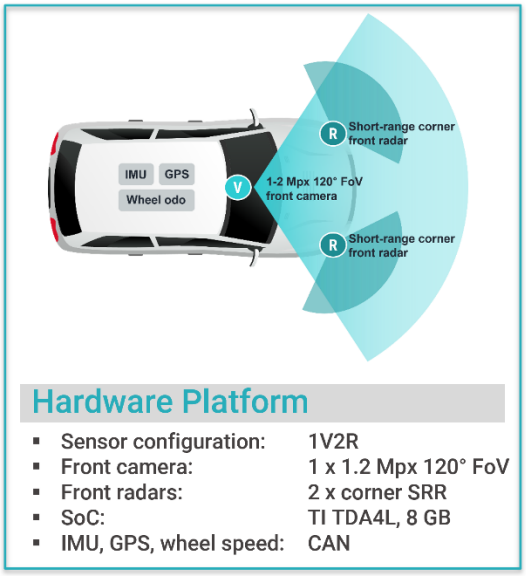
Automated emergency braking - Car to car



Low-Level Sensor Fusion to Enable 5-Star Safety Rating

High performance and cost-effectiveness are two key elements in democratizing safety. Today, LeddarTech enables OEMs and Tier 1-2s to unlock new levels of perception performance by leveraging proprietary low-level fusion and perception technology. LeddarTech has delivered two comprehensive front-view products, LVF-E (entry) and LVF-H (high), that cost-effectively provide the performance required to reach 5-star safety ratings.

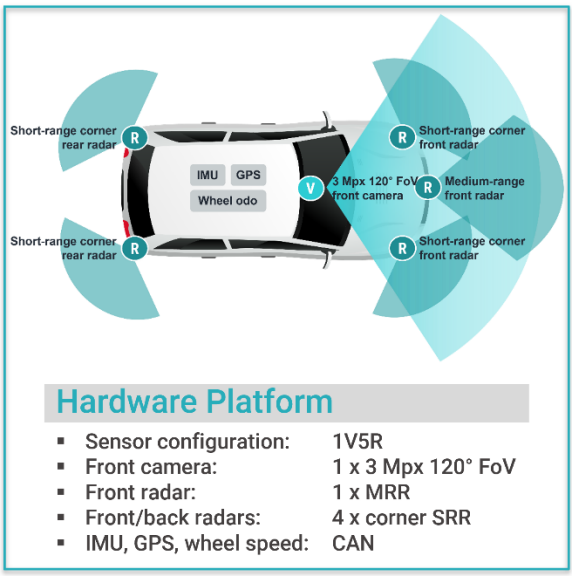
LVF-E



Hardware Platform

- Sensor configuration: 1V2R
- Front camera: 1 x 1.2 Mpx 120° FoV
- Front radars: 2 x corner SRR
- SoC: TI TDA4L, 8 GB
- IMU, GPS, wheel speed: CAN

LVF-H



Hardware Platform

- Sensor configuration: 1V5R
- Front camera: 1 x 3 Mpx 120° FoV
- Front radar: 1 x MRR
- Front/back radars: 4 x corner SRR
- IMU, GPS, wheel speed: CAN

LeddarVision™ perception stack extends safety features support with detected objects trajectory prediction, perception decomposition and ODD analysis, and extends the supported object detection range to over 200 m. LVF-H's superior object detection performance extends to occluded VRUs and vehicles, providing early warning in NCAP-tested scenarios (e.g., occluded cyclist tests). Its ability to detect and track objects under poor weather conditions such as fog, rain and snow and even when the camera is saturated against direct sunlight makes safe and reliable ADAS a reality. In addition, the system's capability to detect and track objects if the camera fails and to continue operation despite a dirty lens are examples of how LeddarVision outperforms legacy object-level fusion solutions and realizes strong NCAP performance. LeddarVision's demonstrated performance in reducing false alarms, small object detection, superior object separation and position measurement accuracy in highway scenarios form the basis of a perception system designed to deliver a 5-star safety rating.

Summary

Road safety has undergone and continues to go experience incremental changes. Vehicle safety solutions have traditionally revolved around mechanical innovations such as airbags, seatbelts and stronger frames. However, the future of road safety will be determined by a vehicle's ability to avoid or mitigate an accident and, to achieve this, robust performing fusion and perception software is required. The perception system must be scalable, offer high performance in a variety of scenarios, conditions and environments, and be cost-effective to accelerate adoption. LeddarTech's two front-view products (LVF-E and LVF-H) are two distinct comprehensive low-level fusion and perception software products that optimally combine sensor modalities for L2/L2+ ADAS applications to enable a 5-star NCAP 2025/GSR 2022 rating.

This White Paper does not constitute a reference design. The recommendations contained herein are provided "as is" and do not constitute a guarantee of completeness or correctness.

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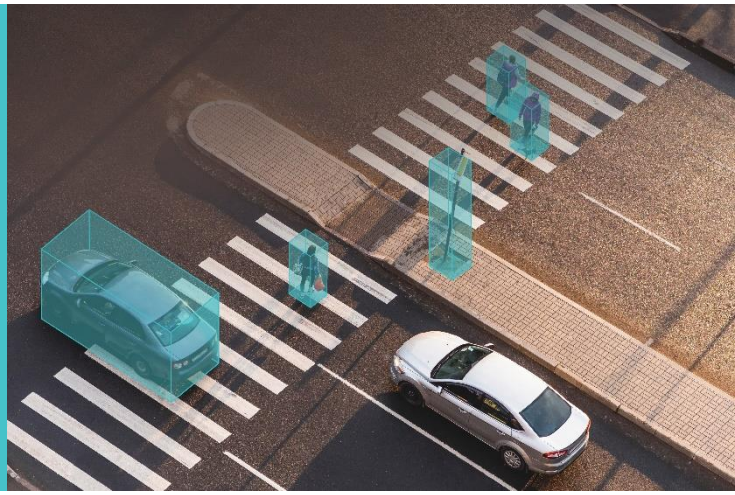
About LeddarTech
A global software company founded in 2007 and headquartered in Quebec City with additional R&D centers in Montreal and Tel Aviv, Israel, LeddarTech develops and provides comprehensive AI-based low-level sensor fusion and perception software solutions that enable the deployment of ADAS, autonomous driving (AD) and parking applications. LeddarTech's automotive-grade software applies advanced AI and computer vision algorithms to generate accurate 3D models of the environment to achieve better decision making and safer navigation. This high-performance, scalable, cost-effective technology is available to OEMs and Tier 1-2 suppliers to efficiently implement automotive and off-road vehicle ADAS solutions. LeddarTech is responsible for several remote-sensing innovations, with over 160 patent applications (87 granted) that enhance ADAS, AD and parking capabilities. Better awareness around the vehicle is critical in making global mobility safer, more efficient, sustainable and affordable: this is what drives LeddarTech to seek to become the most widely adopted sensor fusion and perception software solution.
For more information: sales@leddartech.com



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