cognata
Simulating Autonomy

MAGAL
TESTING THE LIMITS

REDUCING ADAS VALIDATION COSTS WITH HIGH ACCURACY SIMULATION

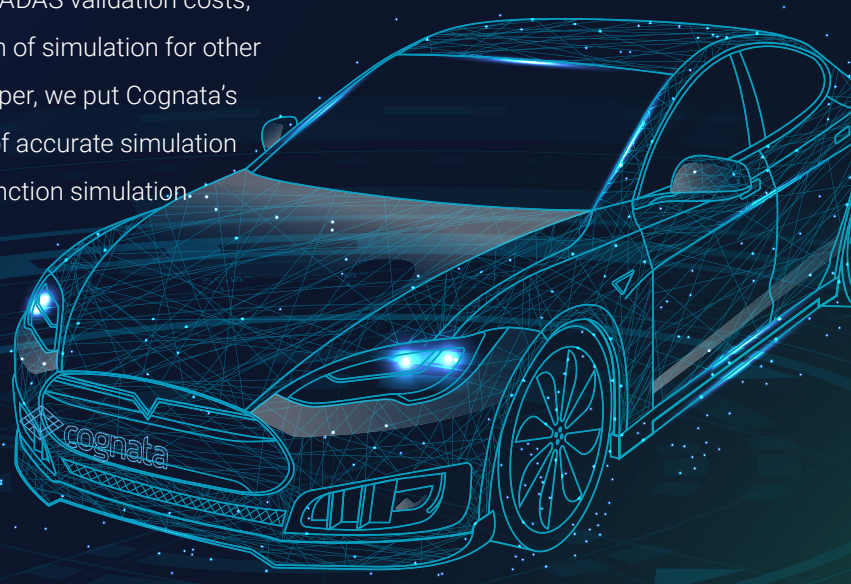
With 99% verified accuracy, Cognata's simulation significantly accelerates ADAS validation driving tests

BACKGROUND

The National Highway Traffic Safety Administration (NHTSA) newly Released estimates show traffic fatalities reached a 16-year high in 2021. Over the years, vehicle manufacturers have invested significantly in the development of Active Safety and Advanced Driver Assistance Systems (ADAS) features like Automatic Emergency Braking (AEB), Lane Keep Assist, and Adaptive Cruise Control, to name a few.

ADAS systems have the potential to greatly improve roadway safety. They work by alerting or assisting drivers to prevent or mitigate crashes. Each year, more and more vehicles are being equipped and sold along with these systems.

While Simulation has long held the promise of reducing ADAS validation costs, adoption of simulation in ADAS lags behind the adoption of simulation for other vehicle functions such as crashworthiness. With this paper, we put Cognata's system to the test - showing that the critical milestone of accurate simulation of vehicle dynamics can be combined with the ADAS function simulation to provide a complete and accurate simulation solution for replacing driving tests with simulation.



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The overall effect of ADAS technologies by comparing crash rates for vehicles with and without various ADAS technologies

Forward Collision Warning with Autobrake

- **50%** ▼ Front-to-rear crashes
- **56%** ▼ Front-to-rear crashes with injuries
- **14%** ▼ Claim rates for damage to other vehicles
- **24%** ▼ Claim rates for injuries to people in other vehicles
- **41%** ▼ Large truck front-to-rear crashes

Automatic Emergency Braking with Pedestrian Detection

- **27%** ▼ Pedestrain injury
- **30%** ▼ Pedestrain injury crashes

Lane Departure Warning

- **11%** ▼ Single-vehicle, sideswipe and head - on crashes
- **21%** ▼ Injury crashes of the same type

Blind Spot Detection

- **14%** ▼ Lane - change crashes
- **23%** ▼ Lane - change crashes with injuries
- **7%** ▼ Claim rate for injuries to other vehicles
- **9%** ▼ Claim rate for injuries to people in other vehicles

rear automatic braking

- **78%** ▼ Backing crashes (when combined with reaview camera and parkingsensors
- **28%** ▼ Claim rates for demage to other vehicles
- **10%** ▼ Claim rates for demage to insured vehicle

Source: Insurance Institute for Highway Safety,Highway Loss Data Institute, 2022

Analysis of the National Motor Vehicle Crash Causation Survey, conducted by the National Highway Traffic Safety Administration (NHTSA), shows that driver error is a factor in 94% of crashes. Although it is important to remember multiple factors contribute to all crashes, the largest portion of driver error issues involves the driver failing to recognize hazards, including distraction. Many of the most promising ADAS technologies are designed to identify and react to potential hazards faster than an average human driver.

The Highway Loss Data Institute and the Insurance Institute for Highway Safety study the overall effect of ADAS technologies by comparing police-reported crash rates for vehicles with and without various ADAS technologies. This infographic shows that each of the four ADAS technology groups studied (see the figure on the left) were associated with decreased crashes and insurance claim rates.

This study focuses on explaining the importance of adopting simulations for the large-scale testing of ADAS and AD systems. Cognata's simulation platform allows for coverage-based ADAS testing which offers ADAS developers an end-to-end solution, including structured test plans in one click, to verify the performance of their ADAS systems.

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TESTING ADAS SYSTEMS

ADAS systems need to be validated thoroughly for various on-road use-cases that a vehicle may encounter in everyday driving situations, if not for the legislative requirements, for the safety of the vehicle passengers and road users.

International standards like the Euro NCAP, Chinese-NCAP, and others have specified a series of test scenarios and protocols to validate ADAS functionalities for vehicle manufacturers to follow. These standards can provide homologation to vehicles and help assess the level of safety that the vehicle can achieve in pre-crash and collision avoidance situations.

Consumer demands for more safety and comfort while driving, along with the continued increase of government safety regulations have been the main growth drivers of ADAS in automobiles for the latter half of this decade. However, such growth also exacerbates and/or creates new challenges for the industry, ranging from pricing pressure and inflation to design complexity and great difficulty in testing these systems.

Physically testing each vehicle variant according to international standards, while important, can be time-consuming, expensive, and cumbersome. To hasten the process and help promote the autonomous transformation, simulations can be adopted to support large-scale testing of vehicle variants accurately which can, in turn, help vehicle manufacturers and their suppliers alike to develop highly efficient ADAS and AV systems to manufacture safer vehicles.

Various components of the ADAS systems can be thoroughly validated and tested for various combinations of sensors, and their corresponding parameters, for millions of edge cases that may not be covered during physical testing.

This is where various OEMs and Tier 1 and 2 manufacturers alike have leveraged Cognata's strengths, capabilities, and expertise in simulations to adopt widespread and large-scale simulations to speed up the development process and ensure the development of highly efficient and safe ADAS and AV systems.

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COGNATA: EURO NCAP CORRELATION

The traditional approaches for ADAS testing are the following:

Virtual environment simulation - modeling a complete driving scenario using the software. This includes the driver, sensors, traffic, and realistic vehicle dynamics. In contrast with real-world testing, virtual environment simulation is safe. Also, it allows the testing of self-driving cars in various scenarios. A virtual environment helps to validate many aspects of vehicles at a time, decreasing development costs where possible.

X-in-the-loop simulation methods - X-in-the-loop approaches usually combine both real-world and simulated elements for ADAS and autonomous car testing. Thanks to these methods, auto manufacturers can check the performance of specific car components early in development. These methods include software-, hardware-, and driver-in-the-loop.

Augmentation of measured data during ADAS system testing - Real video sequences from test drives, for example, can serve as a background in simulations. Along with different objects that appear on the screen, developers can add virtual ones. That's how real and virtual data come together to improve a car's perception. They both help to test and train an autonomous car's classification abilities.

We, at Cognata, simulated multiple Euro NCAP test scenarios and correlated them with physical test results from the test track to achieve very close results using Cognata's vehicle dynamics in Cognata Station.
The Euro NCAP scenarios which involve Vulnerable Road Users (VRU), such as pedestrians and cyclists, also consist of AEB VRU scenarios defined in the Chinese NCAP which are also extensively covered in Cognata's simulation platform.

The Uniqueness of Cognata's simulation platform in the field of ADAS testing is that it allows coverage-based testing which offers ADAS developers an end-to-end solution, including structured test plans in one click, to verify the performance of their ADAS systems. The simulation provides a realistic environment that can perfectly simulate the ADAS performance in an operational environment.

Simulation of Euro NCAP CBNA vs real-world testing (cyclist crossing the path of the vehicle)

Simulation of Euro NCAP CPNA vs real-world testing (pedestrian crossing the path of the vehicle)

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TESTING & METHODOLOGY

We, in Cognata, validated our simulation system, putting our emphasis on ADAS systems, against calibrated data received from Magal, a unique company based in Israel, specializing in tests and examinating according to standards, characterization of environmental conditions, ADAS, preparation of technical characterization of the problem, instructions and more.

In this experiment we tested test cases of CBNA (Car-to-Bicycle Nearside Adult) and CPNA (Car-to-Pedestrian Nearside Adult) as specified in the Euro NCAP AEB VRU v3.0.4.
We created simulations to correlate real-world testing data we received from Magal, a renowned Automotive Testing Agency in Israel, within Cognata's simulation platform. The simulations were run in a closed-loop between Cognata Station and Cognata SDK, which is a C++-based SDK where users can integrate their ADAS/AD Client. An AEB algorithm was added to the Cognata SDK.

Real-world testing	Simulated testing
Sensors Used: • Vbox 3i ADAS – 1 cm accuracy • Telemetry Module • GPS Dual antenna • DGPS or N trip • IMU – 0.01 Deg./sec • Vbox Video HD2	**Sensors Used:** • Cognata Dynamic Object Ground Truth • GPS **Vehicle Model Used:** • Cognata SUV **Cognata Scene Used:** • Test Track

SCENARIOS TESTED:

1. AEB – CBNA

Car-to-Bicyclist Nearside Adult (CBNA) – a collision in which a vehicle travels forwards toward a bicyclist crossing its path cycling from the nearside and the frontal structure of the vehicle strikes the bicyclist when no braking action is applied.

2. AEB – CPNA

Car-to-Pedestrian Nearside Adult 25% (CPNA-25) – a collision in which a vehicle travels forwards toward an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 25% of the vehicle's width when no braking action is applied.

The following data was analyzed:

• Braking Distance (Distance vehicle takes to stop/ slow down safely).
• The speed at the initiation of braking.
• Time of brake initiation.
• Lateral and Longitudinal distance from the Subject Vehicle to the Target.

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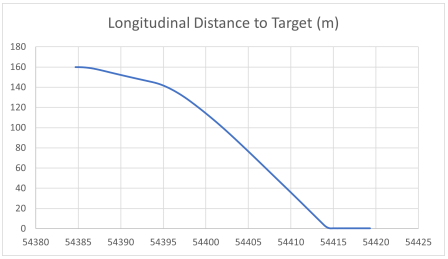
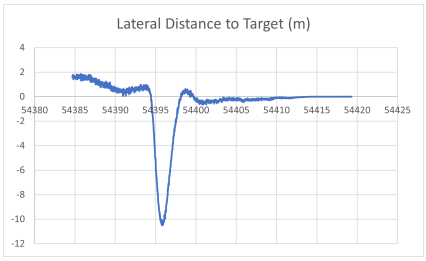
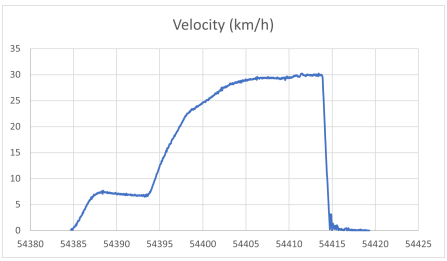
FINDINGS

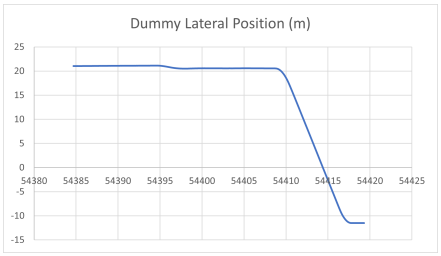
1. AEB – CBNA

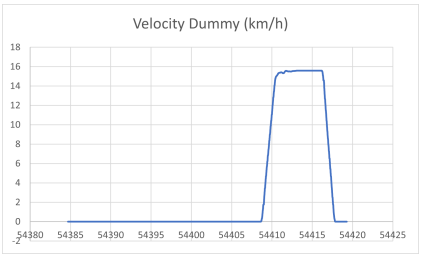
The results obtained from the physical tests are shown below:

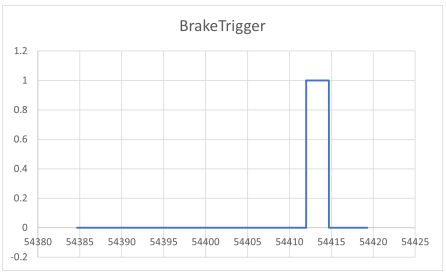












BRAKE INITIATION

4.699 m | Longitudinal Distance to target

0.003 m | Lateral Distance to Target

30.004 km/h | Speed

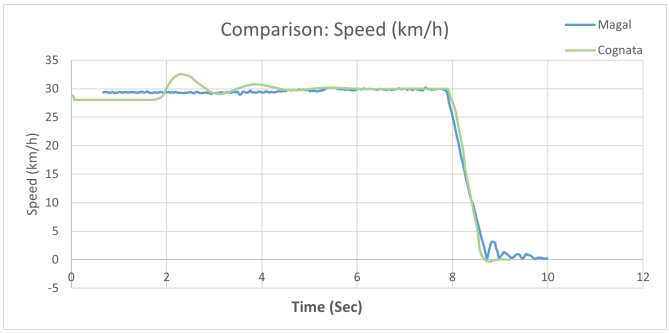
END OF BRAKING

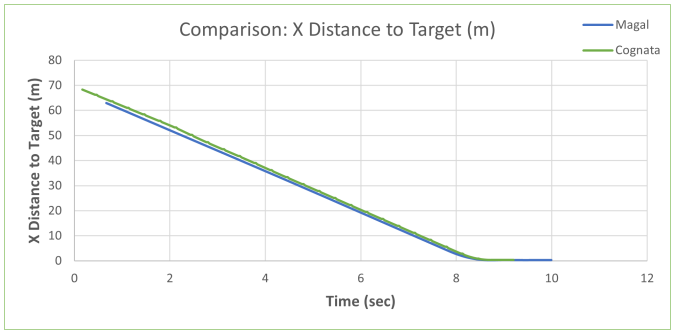
1.23 sec | Braking Duration

0.34 m | Longitudinal Distance to target

4.6 - 0.34 = 4.35 m | Braking Distance:

Here are the simulation results:





	Real[m]	Cognata[m]
Start (Braking distance from Object)	4.699	4.7
End (Breaking distance from Object)	0.34	0.33

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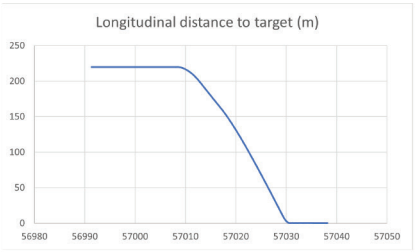
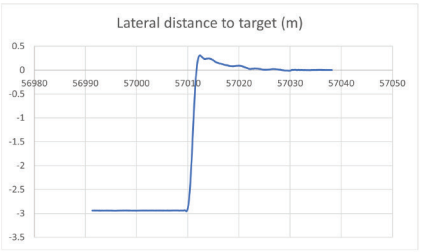
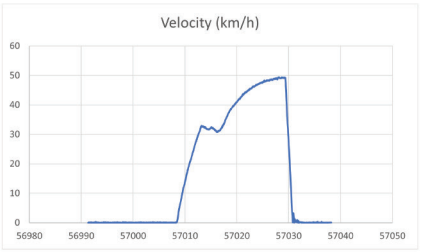
FINDINGS

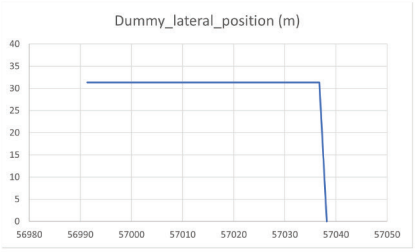
2. AEB – CPNA

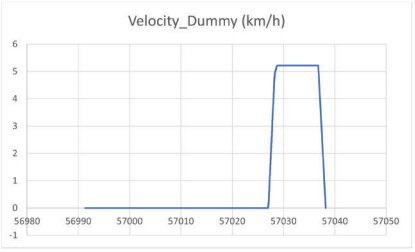
The results obtained from the physical tests are shown below:

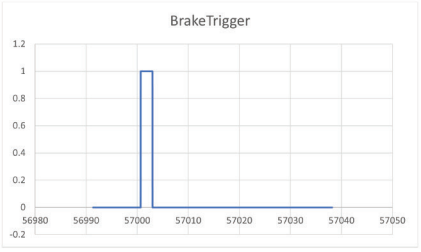












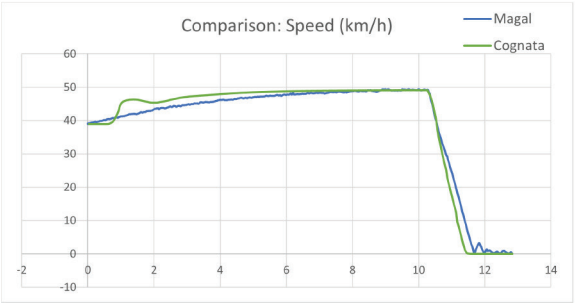
BRAKE INITIATION

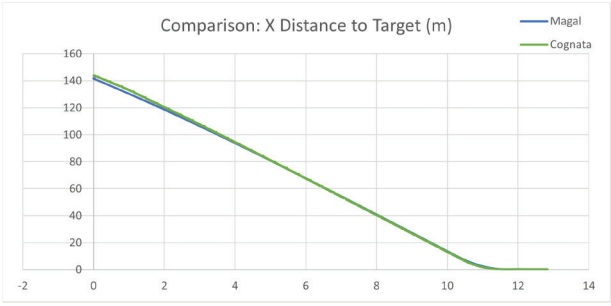
9.88 m	Longitudinal Distance to target	**0.008 m**	Lateral Distance to Target	**49.13 km/h**	Speed

END OF BRAKING

2.18 sec	Braking Duration	**0.36 m**	Longitudinal Distance to target	**9.8 - 0.36 = 9.51 m**	Braking Distance:

Here are the simulation results:





	Real[m]	Cognata[m]
Start (Braking distance from Object)	9.884	9.872
End (Breaking distance from Object)	0.369	0.371

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SUMMARY & CONCLUSION

Using Cognata's simulation platform, we were able to achieve 99% accuracy compared to the Real-World tests for CBNA and CPNA as specified by the Euro NCAP VRU tests. These results and accuracy rates can help Automotive Manufacturers and suppliers reduce their development time and accelerate the time to market by adopting simulations for various homologation to vehicles' testing standards for ADAS, AV, and Active Safety, as well as adopting ADAS function simulation as a complete and accurate simulation solution for replacing driving tests with simulation.

ABOUT MAGAL

Magal Automotive Engineering LTD. deals with all aspects of solutions for all types of vehicles, including ADAS and Sensor Testing, for a variety of companies. In addition to the ADAS activity, Magal deals with various systems such as suspension modifications, brakes, tires, wheels, etc. Magal provides a "bumper-to-bumper" service and solutions for all these cases, from maintenance and use specifications, to customer customization and end-user training at all required levels.

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ABOUT COGNATA

Cognata provides a realistic automotive simulation platform where virtual cars travel virtual roads in digital twins, from cities to unmarked terrain, all remarkably true to real-world weather and road conditions. Working with leading automotive technology companies around the world, our end-to-end platform accelerates time to market by delivering simulation solutions for the entire automated driving product lifecycle, from training to testing to deployment.

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