

## INTRODUCTION

The comfort and safety experienced while driving a vehicle relies heavily on how well the vehicle interacts with the road surface. Since the 1980s, road data has played a crucial role in designing and developing vehicles for safety, comfort, and durability tests.

Responding to a growing demand for digitized road data from both road authorities and the automotive sector, our technology partner XenomatiX introduced the pioneering road lidar, XenoTrack, as early as 2015, with the latest version launched in 2022.

XenoTrack is utilized in over 20 countries worldwide, spanning the automotive and road industries, to improve safety and comfort on the road and prolong the vehicle's lifespan.

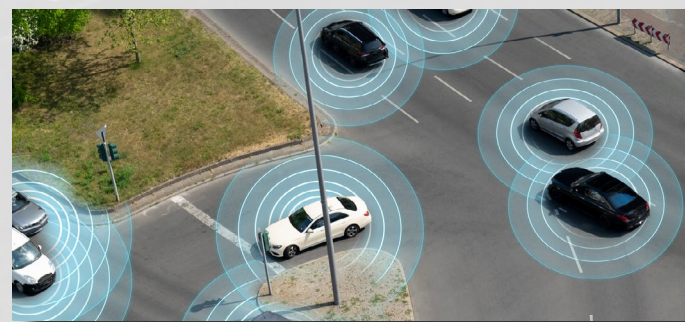
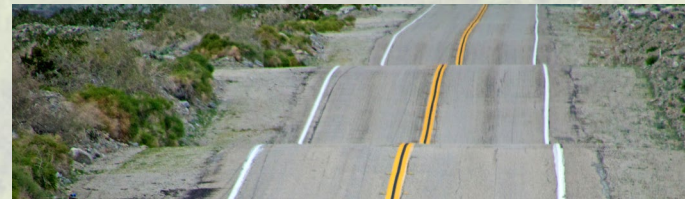
Its versatile applications include: Active Suspension, (Virtual) Proving Ground, ADAS and Autonomous Driving, Testing and Simulations, Mapping and SLAM and Road Quality Survey.

## APPLICATIONS

**ACTIVE SUSPENSION:** In pursuit of comfort and safety goals, numerous automotive brands and their suspension suppliers have been developing adaptive or active suspension systems. XenoTrack's digital representation of the road aids in anticipating the effects of road obstacles such as potholes, enabling the car's suspension to adjust accordingly for a smoother ride. This enhances stability for both the vehicle and the driver across various surfaces, including cobblestone, off-road terrain, highways, and more.

**(VIRTUAL) PROVING GROUND:** Test and proving grounds provide automotive manufacturers with the means to replicate the most challenging real-world scenarios that a vehicle might face. XenomatiX's road digitization allows for a comprehensive analysis of the pavement's geometry and road paths, pinpointing the factors that significantly affect vehicle loads. Tests conducted using digitized road data demonstrate a stronger correlation with real-world conditions, thereby enhancing the accuracy of the validation process and directly improving vehicle quality. This applies not only to traditional proving grounds but also extends to racetracks.

**ADAS AND AUTONOMOUS DRIVING:** As advanced driver assistance features become more prevalent and autonomous vehicles approach the market, the onus of safety shifts from the driver to the vehicle itself. Vehicles must now be vigilant of other vehicles, as well as vulnerable road users, and must detect objects on the road that could pose safety risks to both occupants inside and individuals outside the vehicle. The ability to perceive the road environment is a crucial aspect of a vehicle's performance. Road imperfections such as potholes are challenging for human drivers to avoid and notoriously difficult for automated vehicles to navigate. Utilizing digitized road data aids vehicles in avoiding situations that could cause discomfort or concern for passengers, enhancing overall safety.





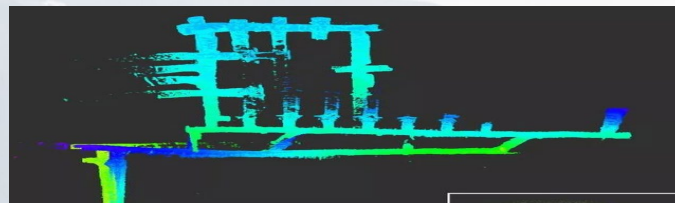
**TESTING AND SIMULATIONS:** The entire lifespan of a vehicle can be simulated in a fraction of the time by employing accelerated and augmented simulation tests. Various road profiles are utilized in scientifically validated worst-case scenarios to assess chassis and suspension virtual models. Stresses and displacements are computed in finite element models, and mean time between failures (MTBF) is determined. To ensure accuracy, the same road profiles used in real-life tests must be applied in full virtual simulations.

**MAPPING AND SLAM:** Within the realm of autonomous vehicles, mapping and SLAM (Simultaneous Localization And Mapping) are integral components. Vehicles possess detailed, high-definition digital maps, which are compared with their current environment to determine their precise position and chart a safe and comfortable route to their destination. The exceptionally detailed and accurate 6D road data provided by XenoTrack, the Road Lidar, is regarded as a significant advantage in achieving optimal performance in this regard.

**ROAD QUALITY SURVEY:** Currently, specialized vehicles are deployed for road inspections, but this task will increasingly be assumed by regular or autonomous vehicles utilized for transportation. Nonetheless, this transition does not imply that road surveying will become cost-free. Vehicle and sensor manufacturers are already establishing their presence in the market, poised to leverage this emerging “big data” road model for commercial purposes.

Road data has been fundamental in vehicle design for decades and is growing in significance for automotive manufacturers, particularly as consumers demand greater comfort and safety while traveling in vehicles. Our solutions play a crucial role in enhancing road safety and comfort by furnishing companies with a remarkably precise depiction of the road surface tailored to their automotive applications.

XenoTrack, the Road Lidar, revolutionizes road surface digitization, leading to improved road safety, comfort, and streamlined maintenance procedures. XenomatiX employs its advanced 6D road lidar technology to meticulously measure and gather high-precision, current data of road networks as per the customer’s specifications.



This state-of-the-art lidar, XenoTrack, boasts exceptional precision, resolution, short-range capabilities, and is entirely solid-state. With proven accuracy down to millimeters, it excels in high-performance road inspection tasks, capturing intricate details of 3D road geometry, including road markings.

The XenoTrack portfolio offers two versions: XenoTrack RearView (Single or Dual Lane) and XenoTrack FrontView, both equipped with XenoWare, the comprehensive 3D point cloud software. This integration empowers a wide array of high-fidelity road profile-based applications, ensuring unparalleled performance and efficiency.

TOYO continues to lead the industry with innovative solutions for road safety and maintenance, driven by cutting-edge technology and precision engineering.



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