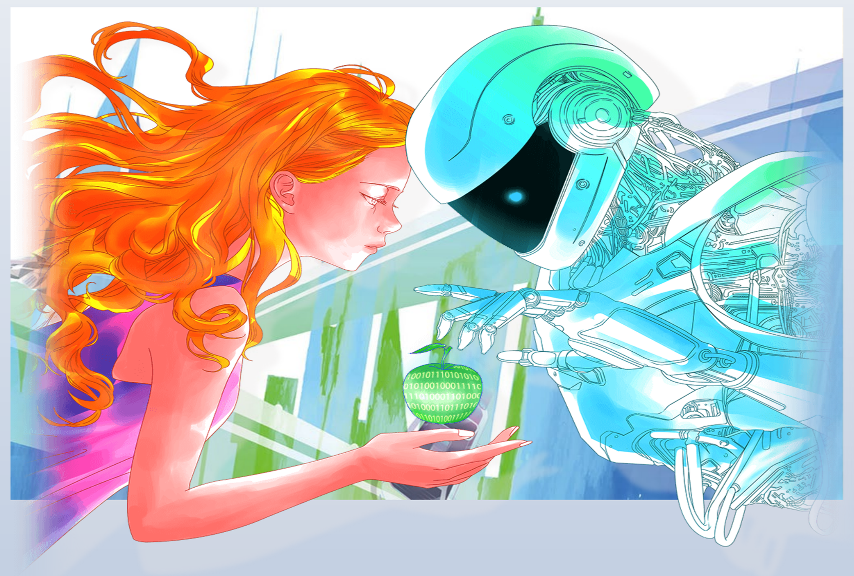


Speed Bump Response System for Autonomous Driving

FORUM8
13th CPWC
AutoBump

INTRODUCTION

The Automotive Shift to AVs and EVs
The automotive industry is rapidly transforming, driven by the dual megatrends of Autonomous Driving and Electric Vehicles. This evolution elevates the importance of accurately detecting and responding to road anomalies like speed bumps, potholes, and debris, making it a critical challenge for the next generation of mobility.

Limitation
There are two main limitations: Relying on HD maps that are not updated in real-time, and a perception focus biased towards dynamic hazards (like cars and pedestrians) over road surface details.

Problem
Failure to respond to road surface obstacles is not just about causing discomfort; it can lead to serious safety problems. The risk is especially critical for electric vehicles, where underbody impacts can cause catastrophic battery damage.

" Why Simulator-BasedBump Response System? "

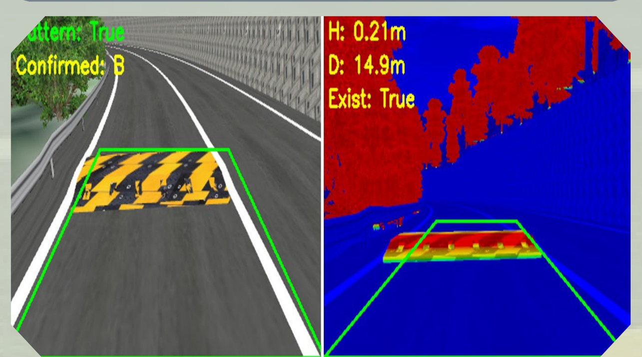
HD maps are not updated in real-time, they face challenges with real-world changes such as physical damage or visual degradation like peeling paint. Furthermore, acquiring a dataset specialized exclusively for speed bumps through real-world driving is difficult.

Overcoming Testing Limitations

Breaking Free from HD Map Dependency

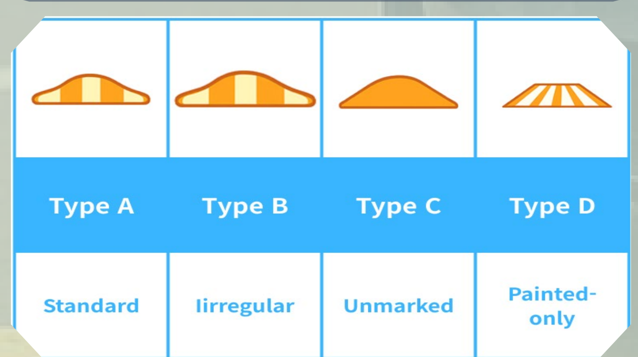
Test Environment for Speed Bumps

Detection



Based on the two views (front camera view, Dense Height Map), it determines the presence and geometry of a speed bump through pattern recognition and image analysis.

Classification

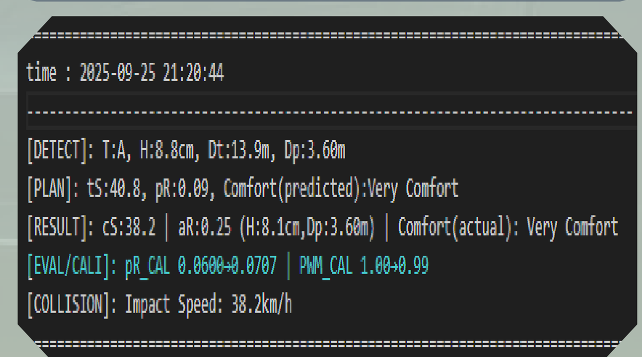


Classifies speed bumps into four types based on the presence of a pattern and the measured height. This enables a tailored response to different types of speed bumps.

Deceleration

Executes an optimal deceleration strategy. Not just for ride comfort, it sets an optimal target speed that satisfies both safety and driving efficiency based on the predicted ride comfort (RMS)

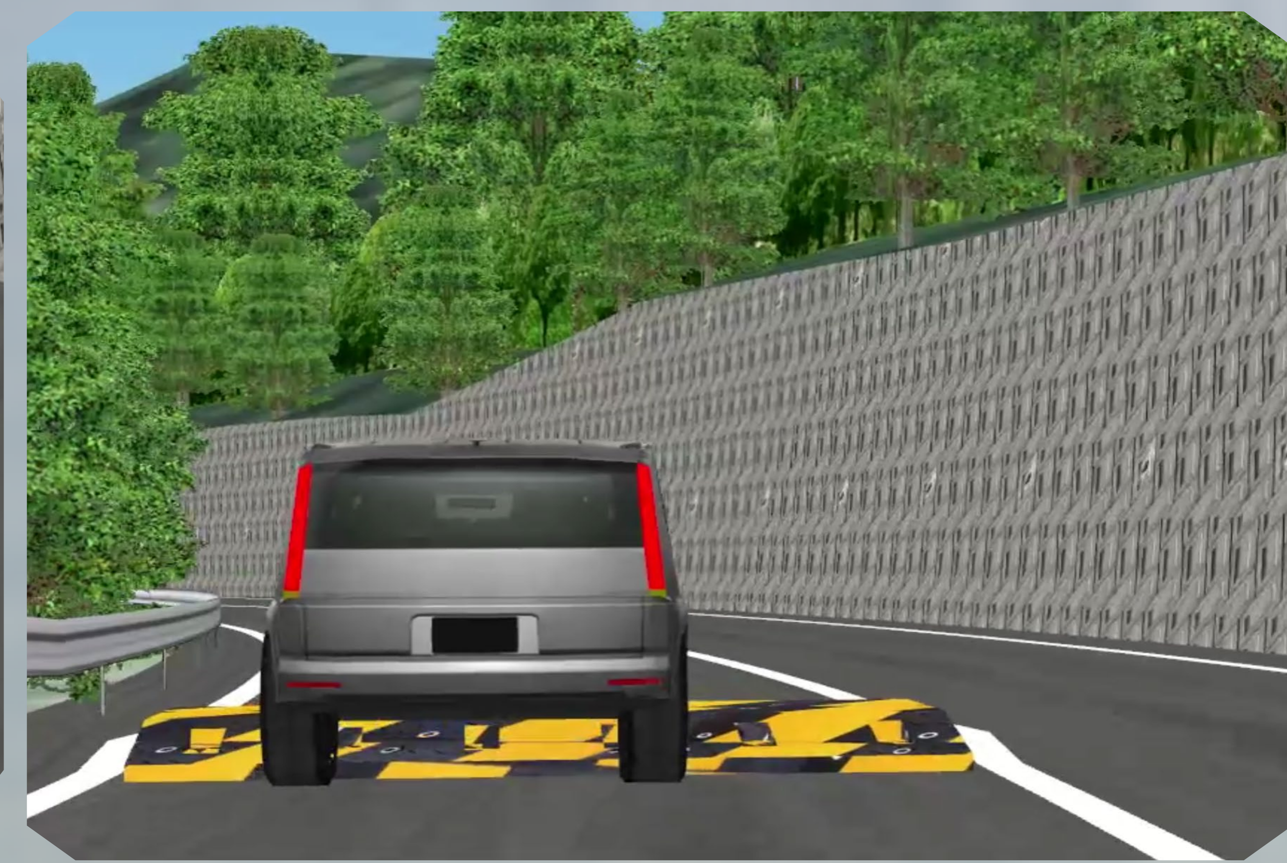
Evaluation/Calibration



After passing a speed bump, the system evaluates performance by comparing target vs. actual speeds and predicted vs. actual ride comfort (RMS). It then self-learns by updating calibration coefficients based on the results.

" What if the view ahead is obstructed? "

While driving closely behind another vehicle, sensor view can be blocked.
Our system uses V2V communication to solve this. The lead vehicle transmits real-time speed bump data to the following vehicle.
This allows the follower to recognize the hazard and plan for optimal deceleration, even without direct sensor detection.

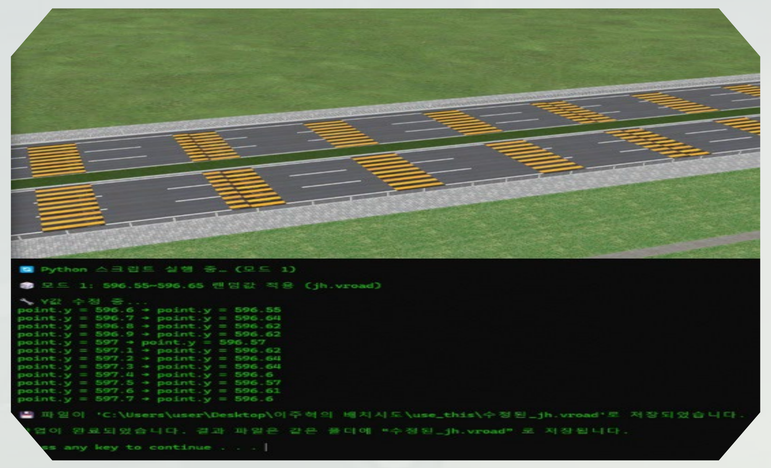


Future Development Plans

Improving System Resilience

We will shift our pattern recognition algorithm from a rule-based, color-centric method to a learning-based morphological analysis (e.g., YOLO) to ensure robust detection regardless of color, weather, or lighting. Separately, we will replace assumed sensor data with real-world measurements by using a plugin to process point cloud data. This will enable a deep-learning-based analysis to identify vehicles and precisely determine their geometry.

Map Auto-Generation Program & Dataset



map auto-generation program to enable testing across a wide variety of speed bumps under diverse climatic and environmental conditions. This program will then be used to build a highly specialized training dataset focused exclusively on speed bump responding.

Digital Twin Test nvironment

Ultimately, we will build a digital twin test environment to bridge simulation with the real world. This system will mirror the dynamic characteristics and movements of an actual vehicle in real-time. By integrating this with live data from real roads, we can superimpose virtual speed bumps and other obstacles, allowing us to test our system's real-time responses.