Collaborative Sciences Center for ROAD SAFETY

RESEARCH BRIEF

Advancing accelerated testing protocols for safe and reliable deployment of connected and automated vehicles through iterative deployment in physical and digital worlds

A key goal of this research was to expand and illuminate viable automated vehicle validation procedures by finding fringe case scenarios that push the boundaries of what these vehicles are capable of and discovering the most likely modes of failure. This goal was to be accomplished with a heavy use of vehicle simulation tools and virtual data, while ultimately transferring these tools to the physical domain with the use of testing tracks and more realistic hardware-in-the-loop simulation.

As a first step, the research team conducted a review and analysis of real-world automated vehicle crashes and harnessed the information in a simulation tool (CARLA) to recreate the crash and create fringe scenarios by altering crash circumstances, e.g., adding rain in a crash scenario. Specific efforts focused on refining and optimizing the simulation procedure as it relates to the efficacy of fringe case testing and vehicle validation. In this project period, the research team developed a testing procedure that can standardize how to test Level 2 and 3 automated vehicles systematically and safely regarding their functions and capabilities with considerations of the driver and environment settings.

The challenge at hand was formalized with a thorough analysis of the domain shift problem as it relates to 2D object detection: the foundation of vehicle perception system. More formal ways to define this domain shift problem as it relates to the perception system were also defined. A probabilistic model of the perception system was generated, and further work defining simulated procedure of fringe cases was completed. These procedures are designed to allow accelerated testing and identification of fringe cases and stress points, as reflected in AV crashes, where automated systems will be prone to failure.

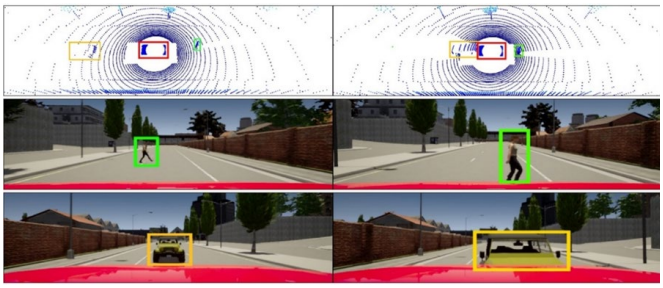

Figure 1 - Visualization of CARLA sensors in CARLA Simulation

Ultimately, the cumulative work done on this project in this and previous phases, further cements the simulated framework needed to make the virtual validation and exploratory process of fringe case detection possible in the future, as well as more easily transferable to the domain of physical hardware. Both software and hardware-in-the-loop testing has been carried out focusing development of combined metrics of performance and a formalized methodology for accelerated testing.

PRINCIPAL INVESTIGATOR

Subhadeep Chakraborty
University of Tennessee, Knoxville

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