Scenario-Based Testing and Driving Assessment Metrics Validation

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MOTIVATION

The technological shift towards Connected and Automated Vehicles (CAVs) is promising but concerns about safety and consumer trust persist. To build trust, we need credible test results demonstrating the reliability of AVs. Testing includes simulation, closed-course, on-road, functional and safety checks, and human-in-the-loop testing. These tests are crucial for the safe and dependable operation of CAVs and for gaining public trust and regulatory approval.

PROBLEM STATEMENT

Conventional methods of CAV safety assessment require extensive on-road testing, covering thousands of miles with a safety driver. However, it is expensive, and the chances of encountering a crash scenario are rare. This research presents a cost-effective, scenario-based simulation testing approach for comprehensive CAV safety evaluation, providing developers flexibility in scenario selection.

SIMULATOR

The simulator of choice for this research project is CARLA, an open-source and high-fidelity simulator for CAV research and development. It offers digital assets and a platform that is designed to have flexible specifications to enable the creation of useful data.

Figure 1: CARLA Logo

WORK AND RESULTS

This research project adds to a safety case framework that evaluates the driving safety of CAVs.

The simulations involved placing the digital twin of the research vehicle in multiple scenarios, which were based on NHTSA's 37 pre-crash scenarios and focused on ego vehicle collisions with other vehicles.

As prescribed by the DA methodology developed by our research group, each simulation of a scenario with the test vehicle model is scored based on the Complexity, Relevance, Fidelity, Metric, and Severity of the violation in the scenario.

Metrics that were calculated include Evasive Maneuver Incident, Collision Incident (CI), Minimum Distance Safety Envelope (MDSE), and OEDR Response Time.

Figure 2: Vehicle Model in CARLA

Figure 4: Vehicle Following Scenario

Figure 3: Vehicle Collision scenario

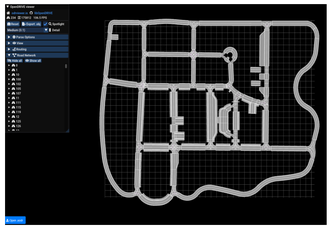

Figure 5: View of the map on Xodr viewer

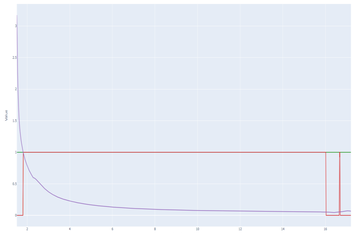

Figure 6: Comparing different MDSE Values

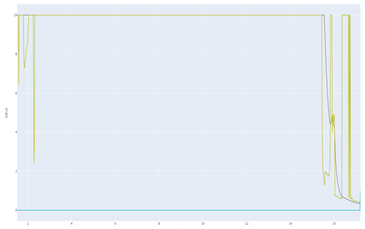

Figure 7: Comparing CI, TTC, MTTC

FUTURE RESEARCH

The future work for this research will include establishing the scenario-based pillar of the safety case along with the Safety Management System and Design Methods pillars.

CONCLUSION

The scenarios were simulated with the vehicle model and data were collected to perform metrics analysis and validation. The proposed scenario-based testing pillar will guarantee that CAV developers may create safe and dependable vehicles by offering an extensive safety testing and validation framework. The initiative will allow researchers to run simulations of a variety of scenarios by creating a digital twin of the car, which will provide them with important insights into how the vehicle performs under various driving circumstances.

ACKNOWLEDGEMENT

I would like to thank Dr. Jeffrey Wishart and Dr. Junfeng Zhao for their unwavering guidance, invaluable insights, and tireless support throughout this research project. Thank you to all the team members for their outstanding dedication and collaborative efforts.

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