

Master's Thesis of Fabian D' Cruz

Mentoring:

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Introduction

Traditional microscopic simulators often lack the native capabilities to model Automatic Emergency Braking (AEB) and Car-to-Everything (Car2X) sensors, as well as their communication within a realistic environment, which is essential for the development of Autonomous Vehicles (AV) and their associated systems. The open-source platform openPASS has emerged as a potential solution, specifically designed for assessing safety systems. However, a significant knowledge gap exists regarding its practical capabilities, limitations, and performance compared to established benchmarks, such as SUMO. Therefore, the primary goal of this thesis is to conduct a thorough exploratory and comparative evaluation of the openPASS platform.

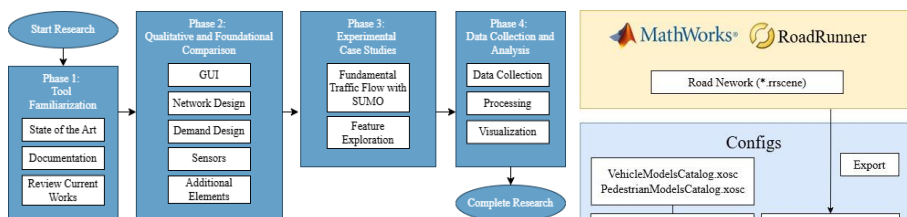


Fig 1: Methodology

Methodology

This thesis employs an exploratory-comparative study design, using a mixed-methods (qualitative-quantitative) case-study approach.) The primary objective is an investigation into its core capabilities, configuration workflows, and observable performance characteristics. The four phases in this methodology are tool familiarization, qualitative and foundational comparison, experimental case studies and data collection and analysis as shown in Fig 1.

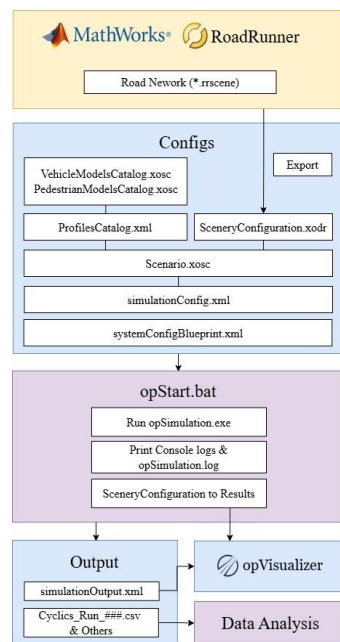


Fig 2: OpenPASS processes

Results

The openPASS misses out on functionalities required to do large-scale simulations and native GUI & live visualization features. On the other hand, it has agent-level control and sensor integration features. The traffic simulation metrics and the performance metrics point that openPASS is not meant for a city simulation but for agent-level assessment of safety systems (Fig 3).

OpenPASS currently lacks a full-fledged system with all necessary modules for real world calibration and comparison in terms of traffic flow. The agents in openPASS can be controlled through dynamic conditions defined in the OpenSCENARIO format. The AEB system sensor override the driver and successfully executed an emergency braking to avoid collision when the pedestrian came close enough to satisfy the TTC condition of the system.

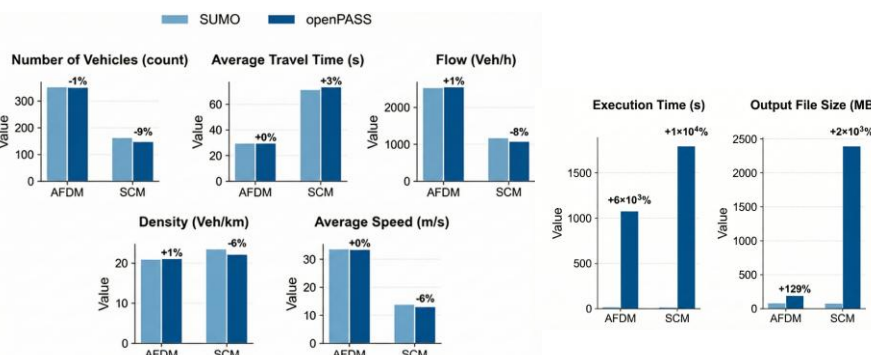


Fig 3: OpenPASS vs. SUMO



Fig 4: AEB system in work to avoid collision

The sensor accuracy was found to be linearly related to the failure probability of the sensor. The failure probability is a stochastic drop out of the sensor system and is evident from the proportional relation from the graph (Fig 5). The car2x sensor system allows sending and receiving of electronic messages between agents. The signal strength and receiver sensitivity are the two important parameters and are dependent to each other as shown in the Fig 6. The signals are received only when the received signal strength is more than the receiver sensitivity.

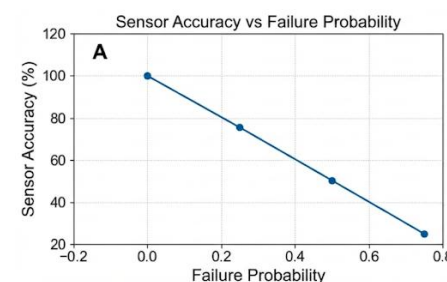


Fig 5: AEB sensor accuracy vs. Failure

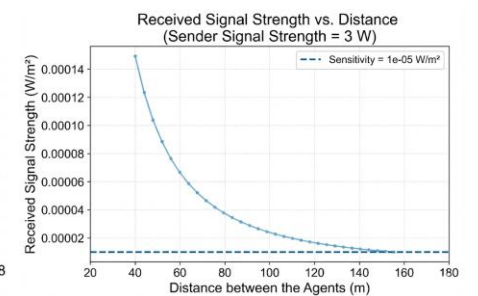


Fig 6: Car2x sensor detection & range

The logged sensor data was analyzed and found out that the loggings are with respect to the ego vehicle and its sensor coordinate. The acceleration, velocity and positional values were transformed into the world coordinates to compare with the ground truth values. The errors were found out to be negligible after coordinate transformation.

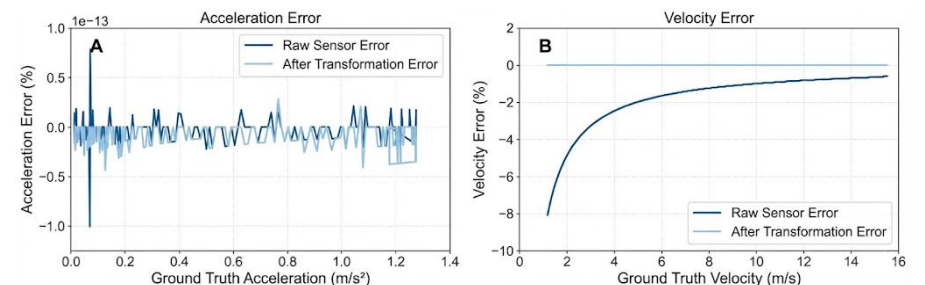


Fig 7: Sensor data errors

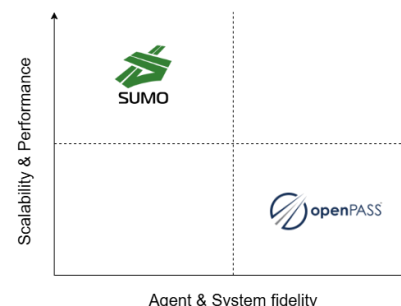


Fig 8: Positioning of openPASS

Conclusion

The final verdict is that the openPASS is not a replacement for traditional traffic simulators like SUMO, rather it is a powerful, specialized platform for a different class of problems. It is better to use SUMO for large-scale, network-level analysis of traffic flow, mobility patterns, and traffic management strategies. On the other hand, use openPASS for systems-level, component-by-component validation of ADAS and CAV functions in controlled, high-fidelity, and repeatable scenarios like testbeds or intersections.