Validation of the Perception Components of Autonomous Vehicles

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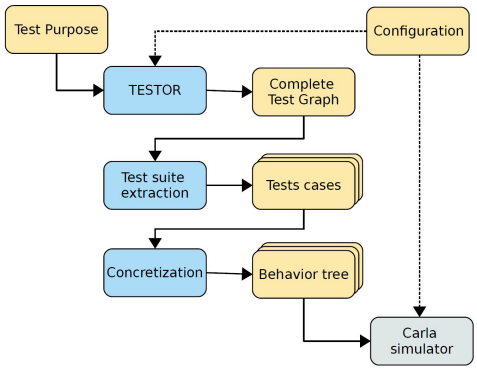
Context

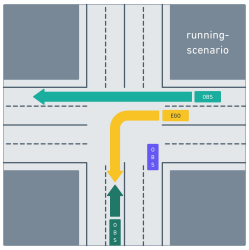
- Autonomous vehicles (AVs) must be thoroughly tested and validated for the evaluation of their performances during development and for their certification before release on public roads.
- The solution we investigate in the thesis is to evaluate the performance of autonomous vehicles by running test scenarios in a simulator and in a dedicated test facility.
- The thesis is funded by the Fonds pour l'innovation et l'industrie which aims at proposing a platform for the homologation of AVs and their validation in real and simulated environments.

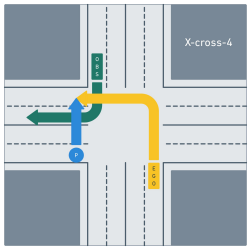
Automated Generation of Critical Scenarios[1]

- Automated generation of critical test scenarios (behavior of actors).
- The generated scenarios are focused on critical situations such as accidents or near-misses collision.
- Virtual testing of AVs: the test cases are executed on the realistic simulator Carla.
- Virtual testing is a complementary method to real world testing that is easier and safer to implement.



- Based on formal methods for concurrent systems:
  1. Formal model of the environment and actors
  2. Test purposes defining the desired critical situations
  3. Generation of test cases from the formal model and test purpose
  4. Transformation of test cases into behavior trees
  5. Execution of behavior trees on an simulator.



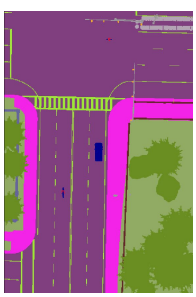


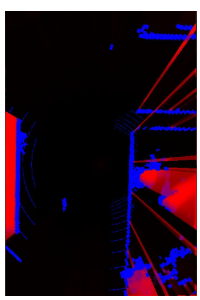
Real World Experiment

- Hybrid testing between ViL and SiL with integration of virtual obstacles in real LiDAR data[2].
- Real world execution of critical scenarios with virtual actors at Transpolis, a dedicated test center for AVs.
- Comparison of results between real world and simulation.

Perception Metrics

- Metrics on perception system output: occupancy grid, velocity grid and prediction.
- Comparison with semantic ground truth and observability map.
- The perception metric includes a criticality metric at the scenario and occupancy grid levels.





References

[1] J.-B. Horel, C. Laugier, L. Marsso, R. Mateescu, L. Muller, et al., “Using Formal Conformance Testing to Generate Scenarios for Autonomous Vehicles,” *2022 Design, Automation & Test in Europe Conference & Exhibition (DATE)*, 2022.
[2] T. Genevois, J. -B. Horel, A. Renzaglia and C. Laugier, “Augmented Reality on LiDAR data: Going beyond Vehicle-in-the-Loop for Automotive Software Validation," *2022 IEEE Intelligent Vehicles Symposium (IV)*, 2022.