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A Cognitive Digital Twin Architecture for Decision Making in Autonomous Driving

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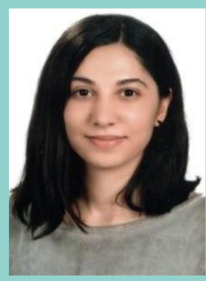

Background

Simulation platforms are preferred in autonomous driving research for safe, repeatable, and cost-effective testing of driving algorithms. In addition to this development, Digital Twin technology, which acts as a real-time virtual replica of a physical system, is maturing in manufacturing and IoT fields, as well as its integration with autonomous driving. The combination of simulation and digital twin approaches in the architecture discussed in this study has the potential to enhance the rapid development and enhancement of algorithms, continuous monitoring, and the secure verification of machine learning and control strategies. These benefits are significant for the development of intelligent transportation systems.

Project Goals

- Develop autonomous vehicle algorithms in a safe, repeatable, and cost-effective environment.
- Test and compare the performance of control and learning-based algorithms in a digital twin environment.
- Demonstrate the potential of digital twin technology for real-time monitoring and error analysis.

Experimental Approach

- Simulation Environment: Creating and controlling the vehicle and its dynamic environment in the open-source CARLA simulator for autonomous vehicle testing.
- Data Collection: Continuous data collection from sensors for analysis of environment.
- Digital Twin: Real-time sensor data transfer to the digital twin, reflecting vehicle behavior and environmental conditions in the virtual model.
- Test Scenarios and Algorithms: Obstacle detection, collision prevention, navigation, route tracking, balanced driving by using algorithms such as PID control, ML-based decision trees, Kalman filters for noise reduction.

Expected Outcomes

- Successful completion of algorithms' accuracy, time-to-schedule, route tracking, target acquisition, obstacle detection, and collision prevention functions.
- Real-time data flow minimizes delays, enabling the digital twin model to control the vehicle.
- Reducing local device processing load and the system's dependence on local devices by applying digital twin approach.
- Evaluation of model security by comparing simulation data with digital twin outputs.