Generative AI Driven City-Scale Digital Twin for Virtual Testing and Benchmarking of Autonomous Vehicles

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Objective

Automatic generation of city-scale digital twins via GenAI, validating AV safety in days and scaling across the entire city.

Problems

- On-road AV testing is costly and unsafe
- Manual HD-map creation is slow
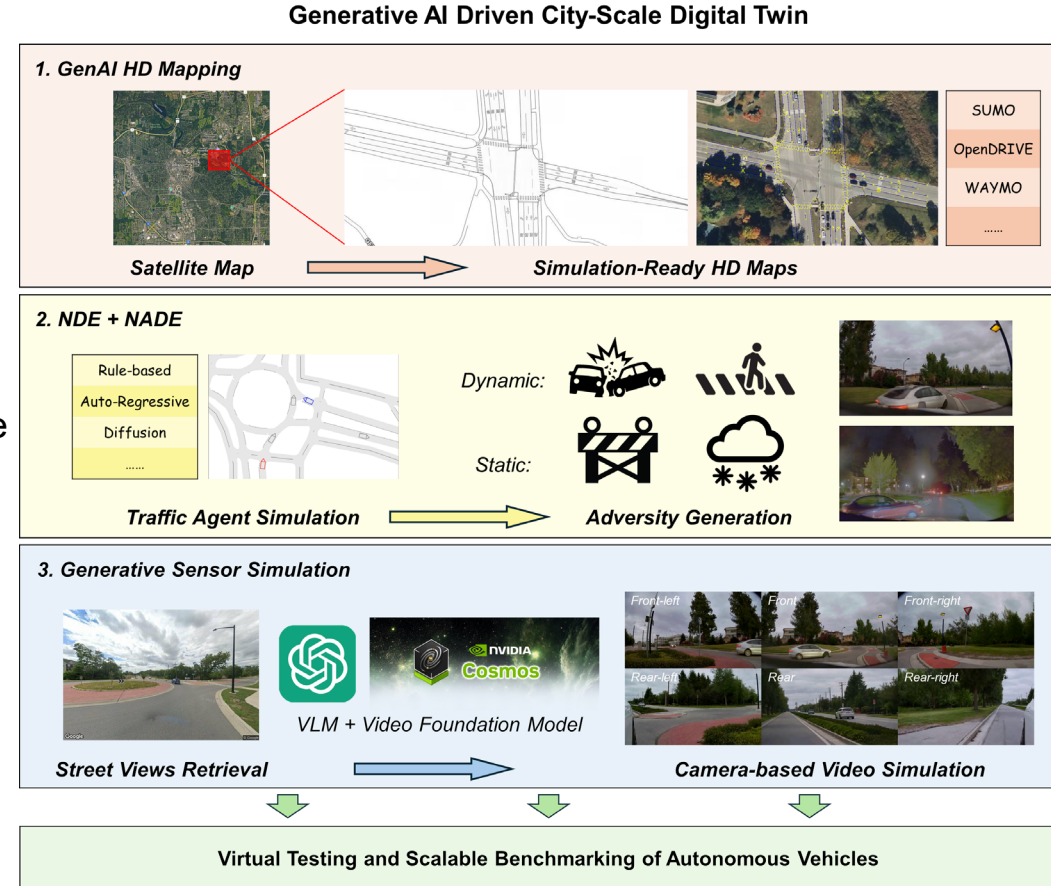- Simulators have sim-to-real gap

Metrics

- AV validation: from years to less than days.
- HD map generation: from months to hours.
- Safety-critical events generation: 100× more
- AV deployment evaluation: 10× reduction

Plan

- Year 1: Pilot city digital twin and validation.
- Year 2: Expand to more cities and align with USDOT/SAE/ISO standards for regulatory acceptance.

Potential Impact

- *For AV Developers & OEMs:*
  Validation cycles cut from years to days, reducing cost and accelerate safe deployment.
- *For Regulators & the Public:*
  Identify unknown safety risks, reveal performance gaps, and build public and regulatory confidence in AV safety.

Generative AI Driven City-Scale Digital Twin

1. GenAI HD Mapping — Satellite Map → Simulation-Ready HD Maps (SUMO, OpenDRIVE, WAYMO, ...)

2. NDE + NADE — Traffic Agent Simulation (Rule-based, Auto-Regressive, Diffusion, ...) → Adversity Generation (Dynamic, Static)

3. Generative Sensor Simulation — Street Views Retrieval → VLM + Video Foundation Model → Camera-based Video Simulation (Front-left, Front, Front-right, Rear-left, Rear, Rear-right)

Virtual Testing and Scalable Benchmarking of Autonomous Vehicles

Solution

GenAI HD Mapping
Generate city-scale HD maps in <24 hours with <10 cm positional error.

NDE + NADE
Convert real data into a scalable library of thousands of stress tests

GenAI Sensor simulation
Produce photorealistic sensor outputs including camera and lidar

SaferDrive AI

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