VISTA: An Open Data-driven Simulator for High-Fidelity Autonomous Driving

Alexander Amini

Massachusetts Institute of Technology (MIT)
Open Source, Technology Transfer, & Commercialization Spotlight Series
The promise of autonomy for sustainable mobility

Autonomous Vehicles

Interconnected Cities

Seamless Embedding Into Society

Fundamental Challenges

Unexpected Changes and Edge Cases

Dynamic Scenarios Harsh Environments

Complex Behaviors and Interactions
Building resilience through data

Real world

Slow, restrictive, expensive

Simulation

Realism, generalization, cost
Simulation for decision making

Model-based Simulation

Data-driven Simulation

Realism  Cost  Design  Modularity

Realism  Cost  Design  Modularity

Real-to-Sim: building \textbf{synthetic worlds} directly from \textbf{real-world data} to enable resilient, sustainable autonomy
THE VISTA SIMULATOR

World
A collection of agents, their sensors, and traces where they live

Agents
Observe and execute action in the world

Sensors
Attach to agents and sense data

Traces
Dataset logs from the real-world
Open-sourced for the research community

vista.csail.mit.edu

>> pip install vista

7,334 installations
412 installs/month
93 installs/week

Starred 190
Fork 28
Issues 10
Pull requests 2
VISTA builds synthetic worlds from real-world data

**VISTA**: Virtual Image Synthesis and Transformation for Autonomy

Photorealistic data-driven simulation for synthesizing novel edge-case scenarios and data

Original Data

![Original Data Image]

Novel Simulated Trajectory within VISTA

![Novel Simulated Trajectory Image]
Data-driven simulation for resilient mobility

Physical

Simulate different physical sensing modalities
(2D cameras, 3D LiDAR, events, etc)

Environmental

Environmental and geographic perturbations
(weather, lighting, road type, etc)

Behavioral

Human-like interaction simulation
(multi-agent decision making, etc)
Data-driven simulation for resilient mobility

Physical
- Simulate different physical sensing modalities
  (2D cameras, 3D LiDAR, events, etc)

Environmental
- Environmental and geographic perturbations
  (weather, lighting, road type, etc)

Behavioral
- Human-like interaction simulation
  (multi-agent decision making, etc)
Data-driven simulation for resilient mobility

Physical

Simulate different physical sensing modalities
(2D cameras, 3D LiDAR, events, etc)

Environmental

Environmental and geographic perturbations
(weather, lighting, road type, etc)

Behavioral

Human-like interaction simulation
(multi-agent decision making, etc)
Open source data-driven platforms

Data-driven approach leverages existing data to simulate thousands of new examples across a variety of conditions.
A flexible platform for high-fidelity, photorealistic mobility simulation

```python
# Initialize the VISTA simulator
world = vista.World(dataset)

# Create virtual agents in the world
for i in range(num_agents):
    agent = world.spawn_agent(location)

# Place sensors on the agent
agent.place_camera(pos_camera)
... agent.place_lidar(pos_lidar)

# Run!
while True:
    # Simulate the environment and data
    sensor_data = agent.observe()

    # Feed data through end-to-end controller
    action = agent.brain(sensor_data)

    # Step with the desired action
    state, reward = agent.step(action)
```

Data-driven Environment

Agent Library

Virtual Sensors

Vision

Depth

Lidar

Event

Rendering, Dynamics, and Control

Action

State

Controller

Reward
Summary

The VISTA Simulator

World
A collection of agents, their sensors, and traces where they live

Agents
Observe and execute action in the world

 Sensors
Attach to agents and sense data

Traces
Dataset logs from the real-world

Open-sourced for the community!

vista.csail.mit.edu

>> pip install vista

7,334 installations
412 installs/month
93 installs/week

Acknowledgements

I. Gilitschenski
S. Han
S. Karaman
Z. Liu
J. Moseyko
J. Phillips
W. Schwarting
A. Young

D. Rus
T. Wang

Data-driven Simulation for Resilient and Sustainable Mobility

mit.edu/~amini  amini@mit.edu