National Aeronautics and Space Administration

Learning from Demonstration: Autonomous Navigation in Unstructured Environment

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1. BACKGROUND AND APPROACH

Challenges Autonomous navigation in offroad/unstructured environments would require algorithms that can **reason beyond geometric notions of traversability.**

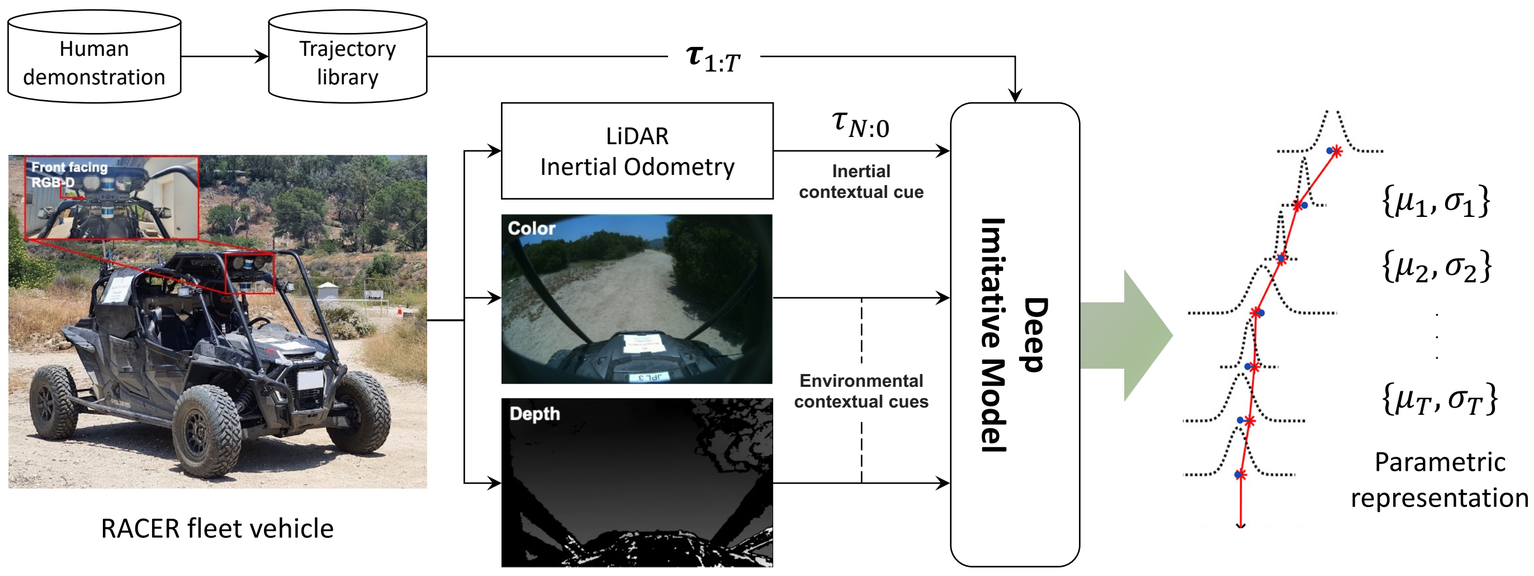
Benefits Addressing this class of problems has a **significant impact on various sectors** ranging from planetary exploration, to search and rescue, construction, and surveillance and many other field robotics domains.

Approach **Employing Imitation learning (IL) paradigm** which can enable the system to learn relevant cues directly from prior experience.

Project page: DARPA RACER

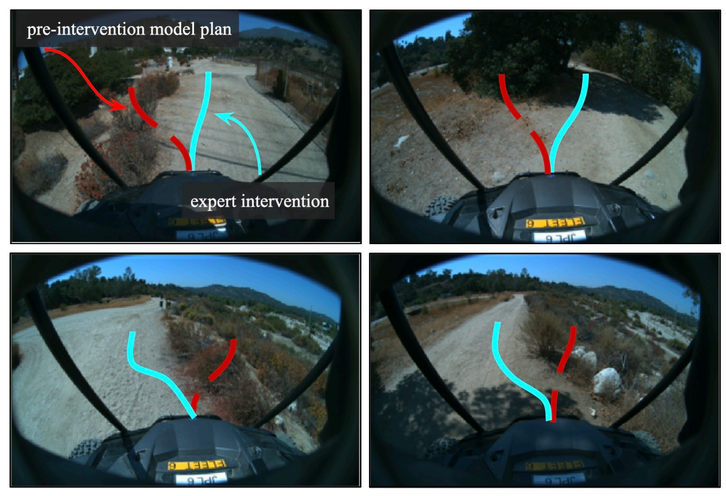
2. METHODOLOGY

Proposed Imitation learning pipeline



RACER fleet vehicle

Dagger implementation



Learning from demonstration
- Imitation-learning based spatial planning.
- Training a conditional density estimator of expert-like spatial trajectories.

Incorporating multiple contexts into planning
- Environmental contextual cues.
- Inertial contextual cues.

Resolving distribution shift
- A well-known issue with offline imitation learning.
- Employing DAgger to improve deployment performance.

3. EXPERIMENTAL RESULTS

Experimental setup

Data collection sites

Closed-loop evaluation site: N.Arroyo Seco Trails

Field testing results

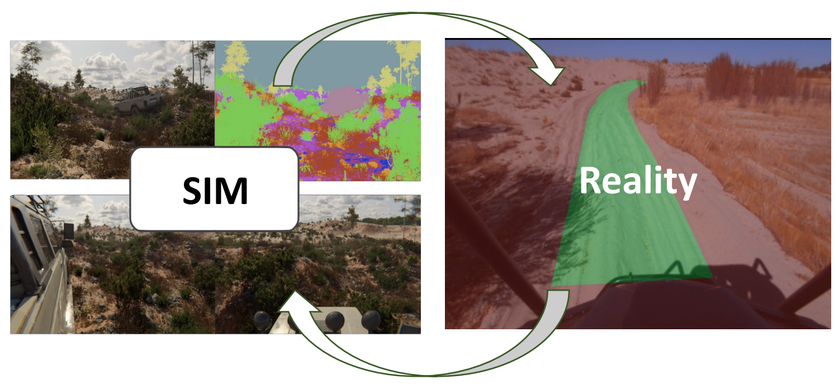
Observations from our evaluation. Planned future trajectory in green

Model	Interventions / Minute ↓	Interventions / 100m ↓
BC, pre-intervention data inclusion	—	—
Flow, pre-intervention data inclusion	5.179	5.561
BC, post-intervention data inclusion	2.479	2.833
Flow, post-intervention data inclusion	**2.004**	**2.197**

Quantitively evaluation result.
Compared to the generic BC method, our model(Flow) shows about 1.2 times higher performance in terms of human intervention.

4. FUTURE RESEARCH DIRECTION

Applying Sim-to-Real approach
- Collecting dataset from the high-fidelity simulator.
- Sim-to-Real policy transferring for motion planning.
- Connecting simulation and real-world using shared latent spaces.



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Publications:

Imitative Models for Passenger-Scale Autonomous Off-Road Driving (submitted to the IEEE ICRA 2023)

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