simula

Testing Autonomous Cars

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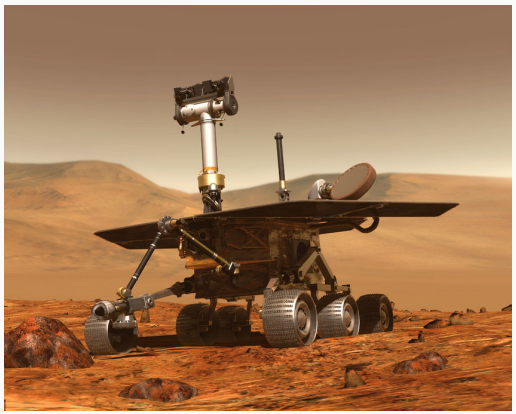
Introduction to Autonomous Systems

Introduction to Autonomous Systems

- Autonomous systems are emerging technologies that are becoming vital in many innovative domains.
- Example of autonomous systems include

(a) Autonomous Cars

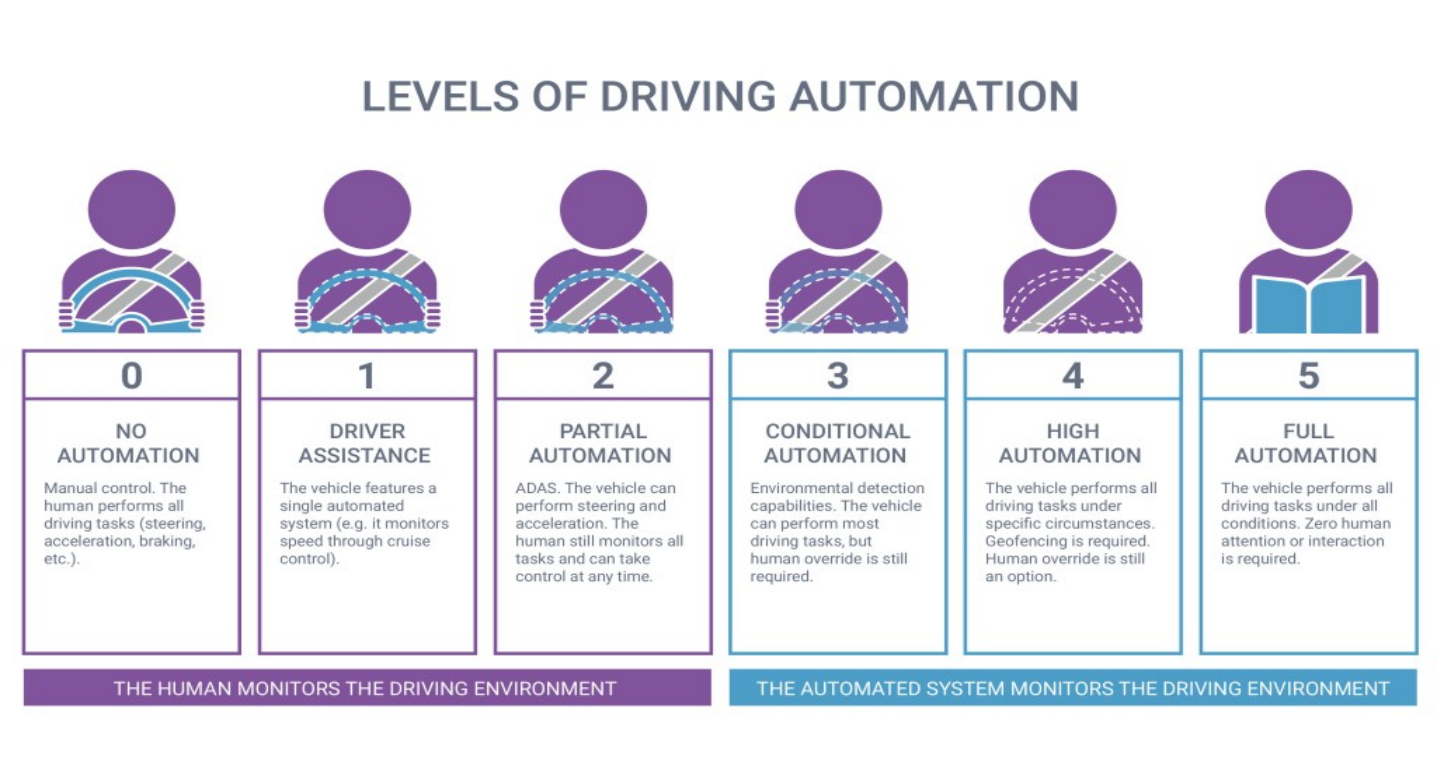


(b) Autonomous Robots

- The type of autonomous system we are focusing on is **autonomous cars**

Levels of Autonomy

An **autonomous car** is a system that can automatically perform a predefined set of tasks under real world conditions



Autonomous systems with high level of autonomy are using Artificial Intelligence (AI)

Challenges with Autonomous Systems in Real World

Problems related to Autonomous Systems in Real World

- Many of the AI based autonomous systems work in safety critical environments
- Such systems are difficult to test in real world
- They can be dangerous if they are not tested properly

Vulnerabilities of Autonomous Systems

Fatal vulnerabilities are recently exposed in autonomous systems

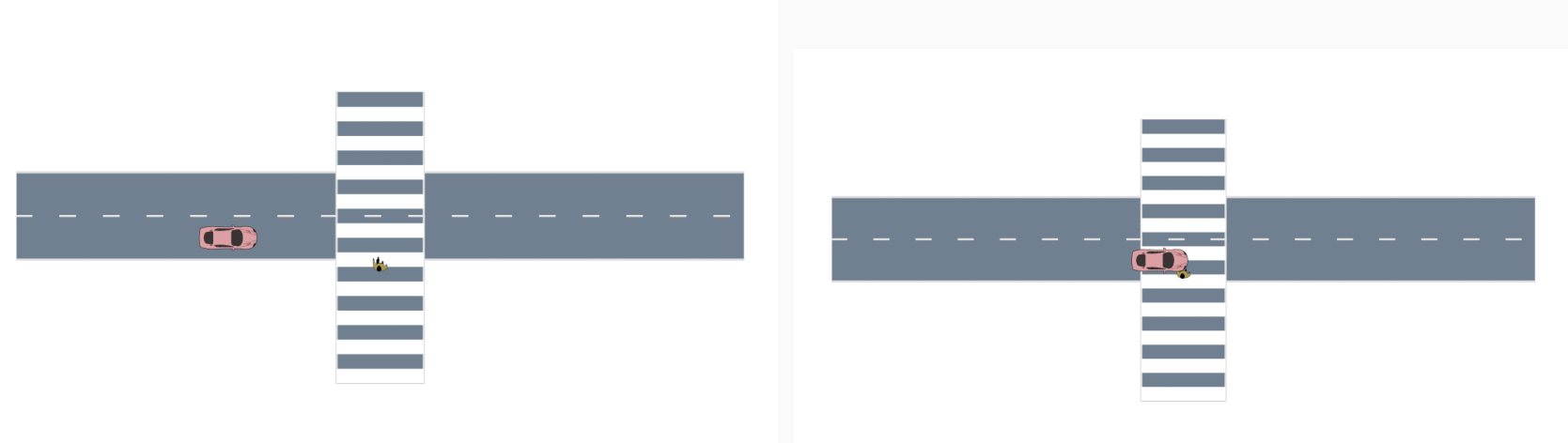


Figure 1: Pedestrian walking down the road (left) and Autonomous car failed to hit the brakes (right)[1]

[1] A. Corso, P. Du, K. Driggs-Campbell, *et al.*, "Adaptive stress testing with reward augmentation for autonomous vehicle validation," in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, 2019, pp. 163–168. DOI: 10.1109/ITSC.2019.8917242.

Safety Validation Approaches

Safety Validation Approaches

- Real-world testing
  - Expensive and risky
- **Simulation based testing** ✓
  - Simulate challenging scenarios
  - No risk to real world

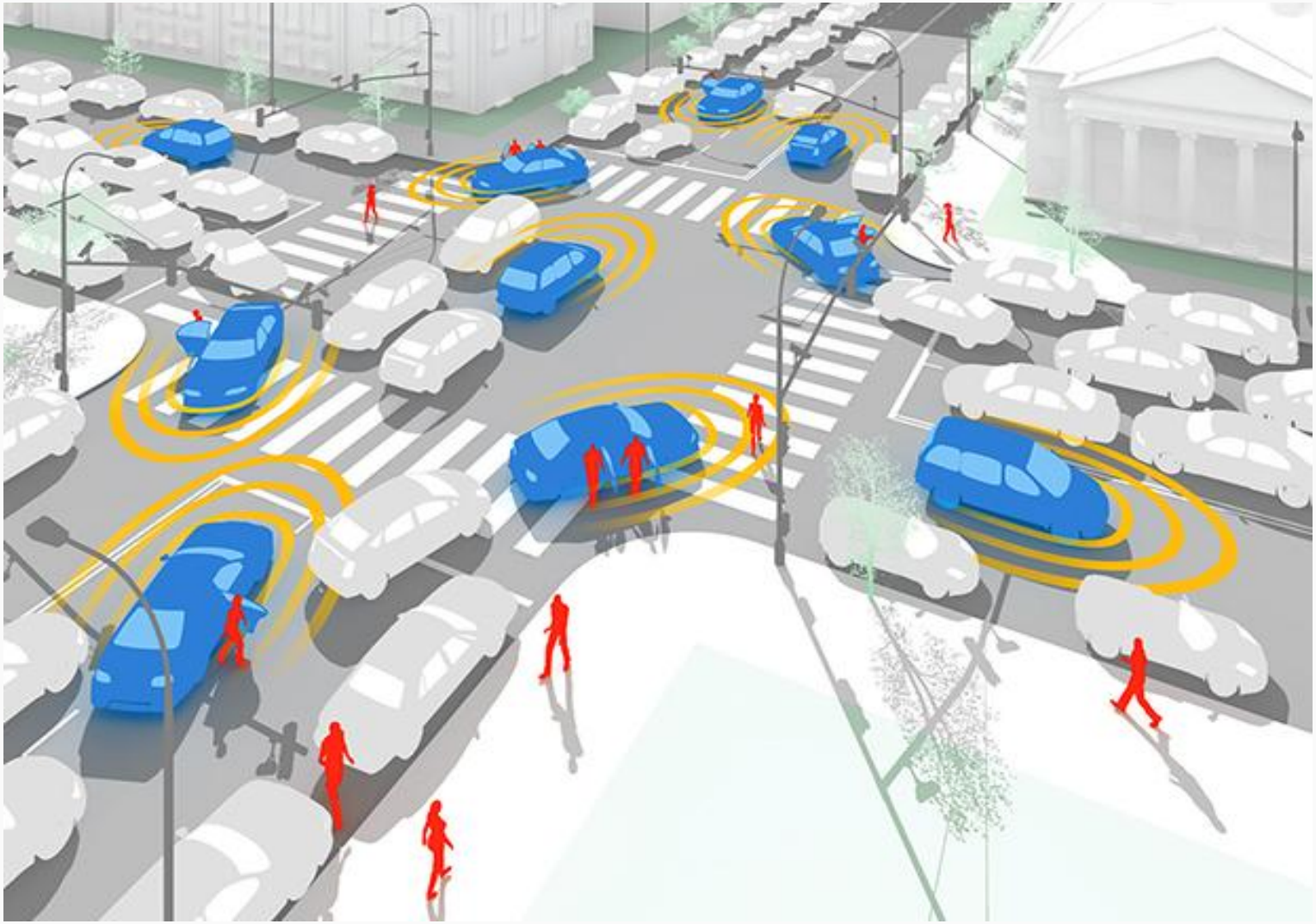
Research Motivation

Research Gap in Testing Autonomous Cars

- Lack of multi agent driving environments
- Lack of intelligent test cases
- Lack of realistic adversarial testing for self-driving environment

Research Motivation

Using **deep reinforcement learning** (Deep RL) to test autonomous cars within simulation environment.



Simulation Environments

Simulation Framework

- Flow [2]
- Highway-env [3]
- AdaptiveStressTesting [4]
- PGDrive [5]
- Comma ai [6]
- AirSim [8]
- Carla [9]

Ongoing Research Project

Ongoing Research Project

Using Deep RL as an adversarial agent to test self-driving car in a multi-agent environment.

Ongoing Research Directions

1. Testing multi agent driving environment scenarios
2. Generating intelligent test cases using Deep RL
3. Creating realistic adversarial testing for self-driving environment

Future Collaboration with VIAS

Resilient Autonomous Systems in the Digital and Physical World

Thank you!

References i

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[5] Q. Li, Z. Peng, Q. Zhang, C. Qiu, C. Liu, and B. Zhou, "Improving the generalization of end-to-end driving through procedural generation," *arXiv preprint arXiv:2012.13681*, 2020.

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