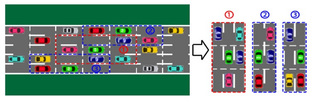
# Adaptive Intelligence for Cyber-Physical Automotive Active Safety System Design and Evaluation

Panagiotis Tsiotras (Georgia Tech), Karen Feigh (Georgia Tech), Laurent Itti (Univ. of Southern CA)
http://dcsl.gatech.edu/research-adapt-intell.html

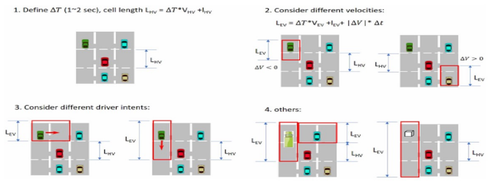
## Driver-Based Reinforcement Learning Traffic Navigation



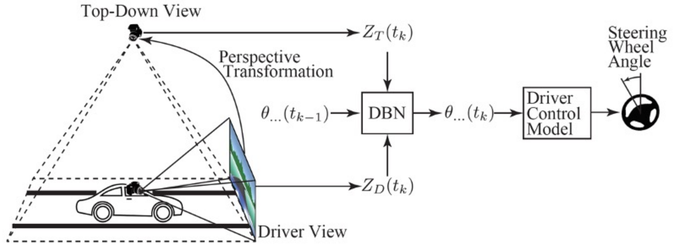
MDP State Decomposition

**Additions to Traffic System Modeling**
- ✓New driving scenarios with multi-cell state lane boundary constraints
- ✓Modelling road curvature affects

**Deep Reinforcement Learning Features**
- ✓Traffic Configuration
- ✓Overtaking Strategy
- ✓Action Features
- ✓Tailgating
- ✓Collisions



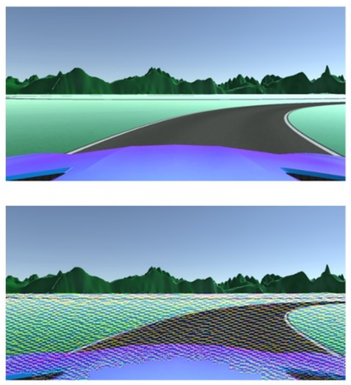

## Structured & Robust Transfer Learning for Driving




- Develop algorithm to naturally duplicate "human-like" driving behavior
- Provide more structure to overall processing pipeline compared to end-to-end approaches

- To reliably and robustly estimate the view-ahead angles we use:
  - Classical image processing
  - Convolutional NNs
  - Combine estimations using DBN
- Estimation error much more resilient to adversarial noise

**Robustness to Adversarial Noise**



## Objective

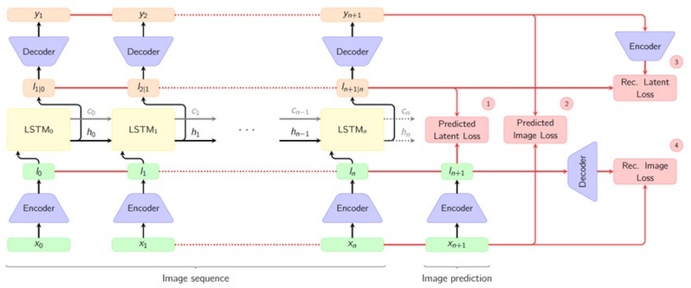
Improve capabilities of automotive advanced driver assistance systems (ADAS) by taking into account the physical and psychological interactions between the driver, the vehicle, ADAS, traffic, and the environment.

## Research Approach

- Putting the focus on human driving behaviors
- Better modeling of the human driver within control systems and for behavioral decision making
- Creating a simulation environment for validation and human-in-the-loop testing of ADAS systems

## Latent State Representations for Behavior Cloning

- Explore recurrent networks (RNNs) combined with autoencoders (AE) to properly compress, represent, and predict the latent representation of the state during driving




(a) Ford AV Dataset - Source (b) Ford AV Dataset - Reconstructed (c) Argoverse Dataset - Source Image (d) Argoverse Dataset - Reconstructed

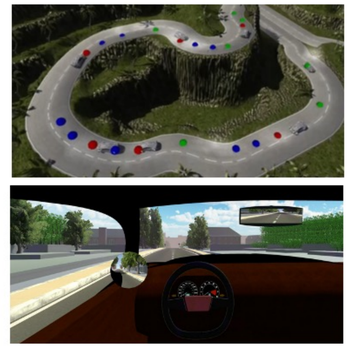
- Next step is to append raw sensor measurements, such as velocity and acceleration to the latent variable

## Human Driver Expectations of Autonomous Cars

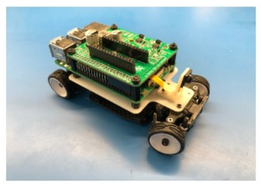
- 29 participants (ages 18-60, 25% female)
- Multiple interactions with human and autonomously driven cars
- Highly-realistic campus scenario
- Tested an instrument for validation of simulator
- Planned random failures of autonomous cars to test trust

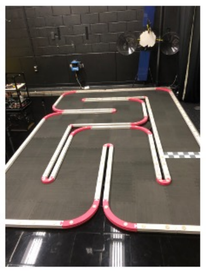
## VIP Team / REU Student Activities

**Development of the Driving Simulator**
- Multi-car traffic
- Realistic scenarios with terrain, weather, steering-column feedback torque, and smooth control, all built on satellite maps and CAD models of campus
- ADAS: Emergency Braking, Adaptive Cruise Control, Blind Spot Detection, Lane-Departure Detection, Crash Sensing



**Scaled Experimental Vehicles & Test Tracks**





- More than 25 students per year
- Three vehicle platform sizes

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