Deep Imitation Learning for Autonomous Driving

CSE472 Machine Learning Sessional

Prepared By:

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Problem Definition

- With minimum training data from humans the system learns to drive in traffic on local roads with or without lane markings and on highways.

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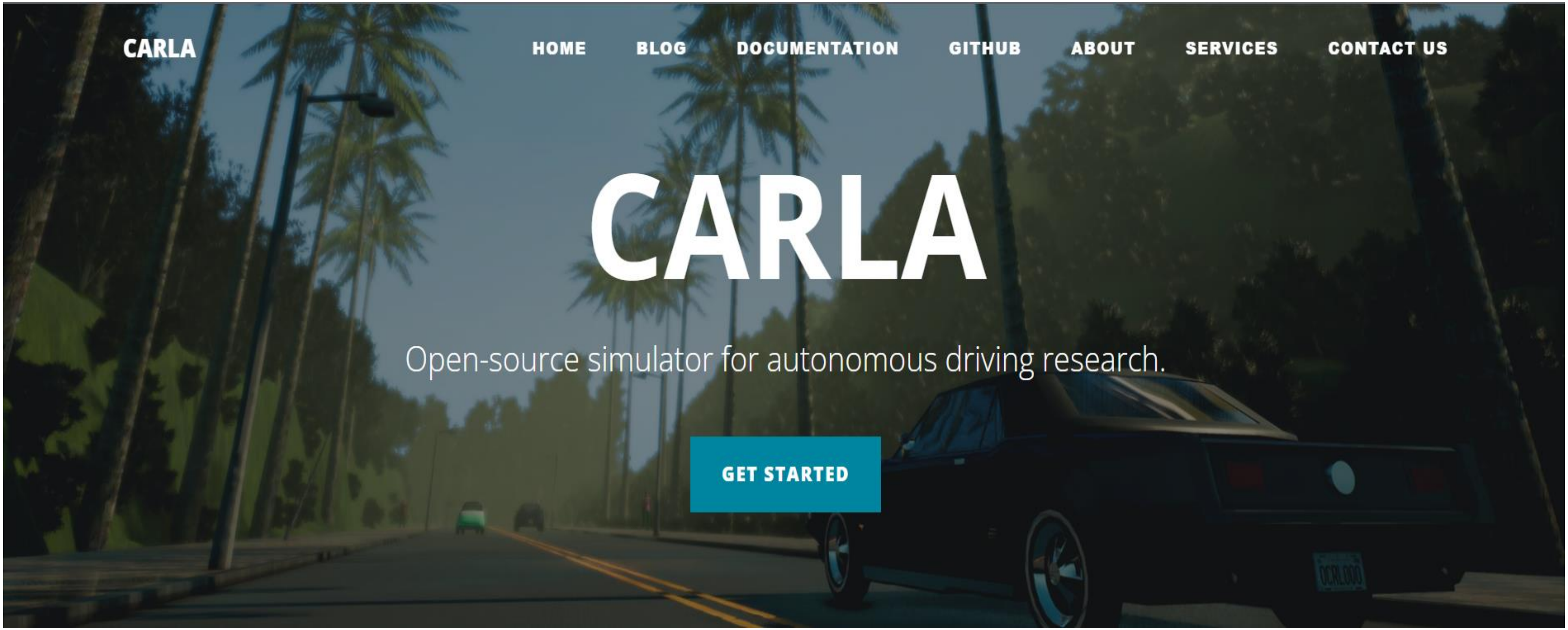
- It also operates in different weathers such as rainy, sunny, snowy etc. and different daylights.

Dataset and Its Analysis

- We used our own dataset which was collected using **CARLA** Simulator.

CARLA Simulator



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- We used CARLA 0.9.8 version for windows.

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- Among them we used **3.6k** images for training and **2k** images for validation.
- Our dataset has four action classes according to driving control command which are

  'w' --> acceleration

  'a' --> steer left

  'd' --> steer right

  's' --> break

Proposed Solution

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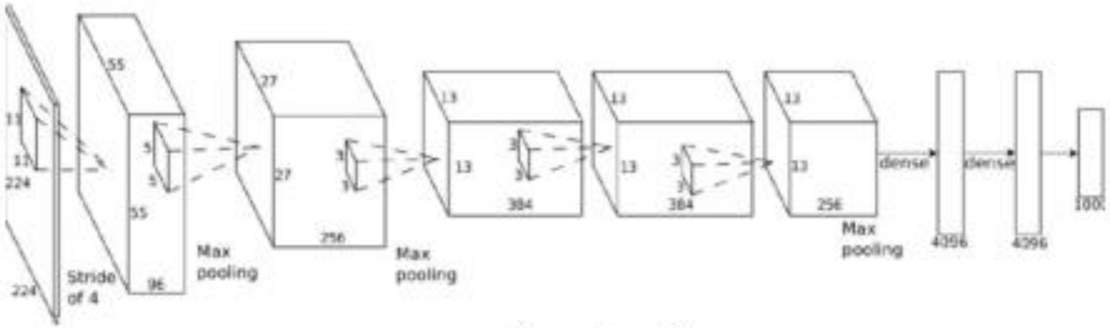
    - **Imitation Learning** is a framework for learning a behavior policy from demonstrations.
- Usually, demonstrations are presented in the form of state-action trajectories, with each pair indicating the action to take at the state being visited.

Imitation learning

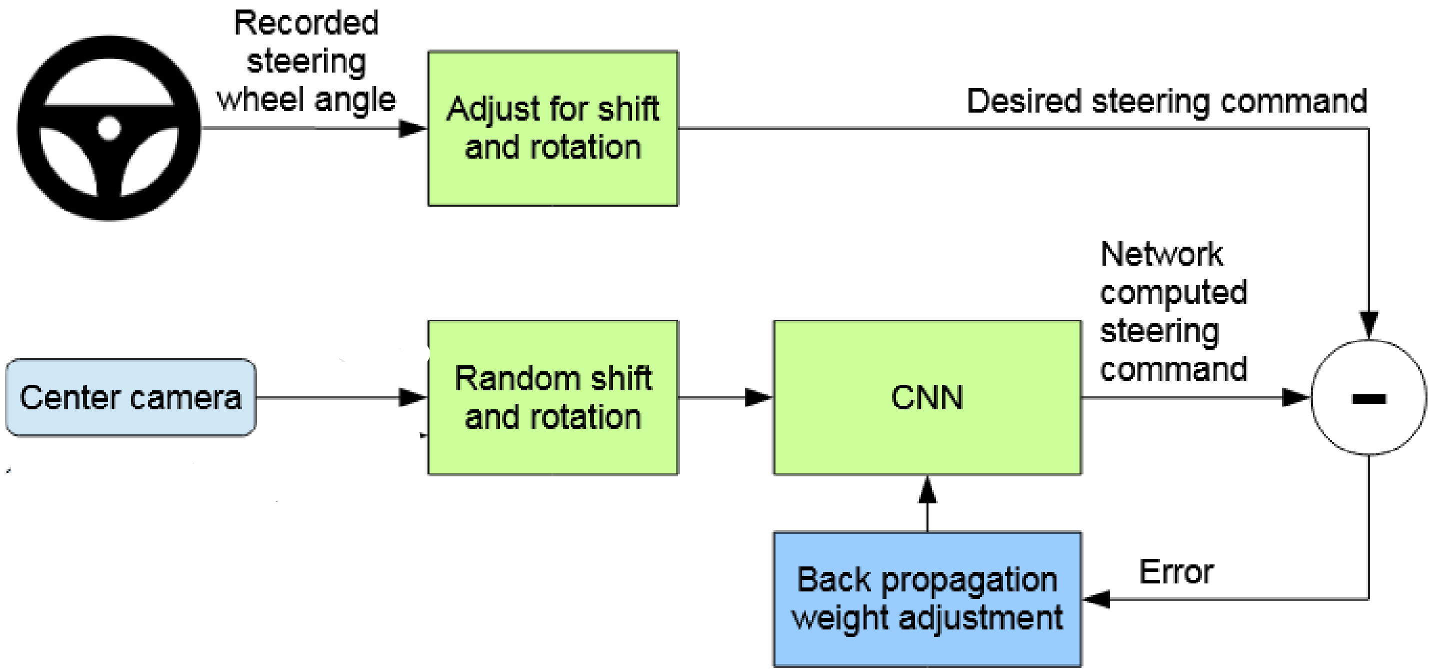
$\mathbf{o}_t$



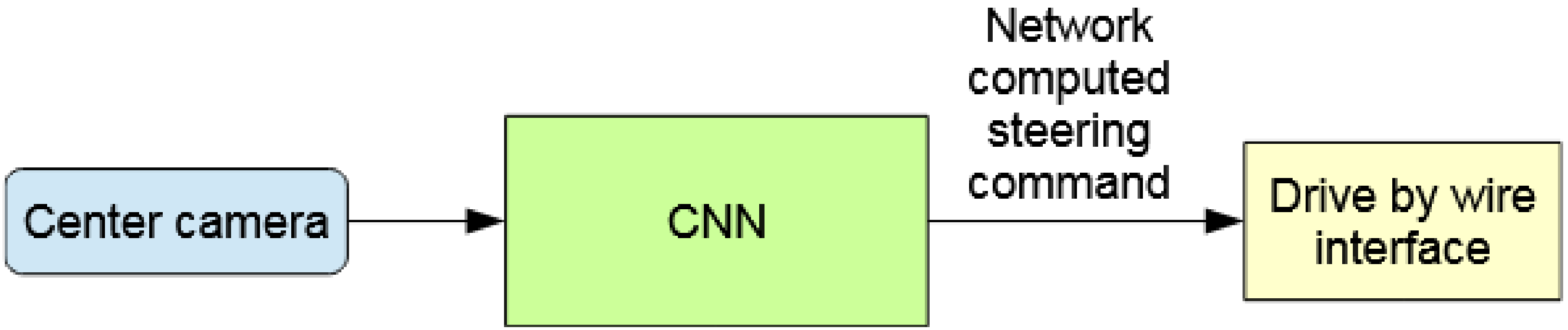
$\pi_\theta(\mathbf{a}_t|\mathbf{o}_t)$

$\mathbf{a}_t$

Architecture - Train

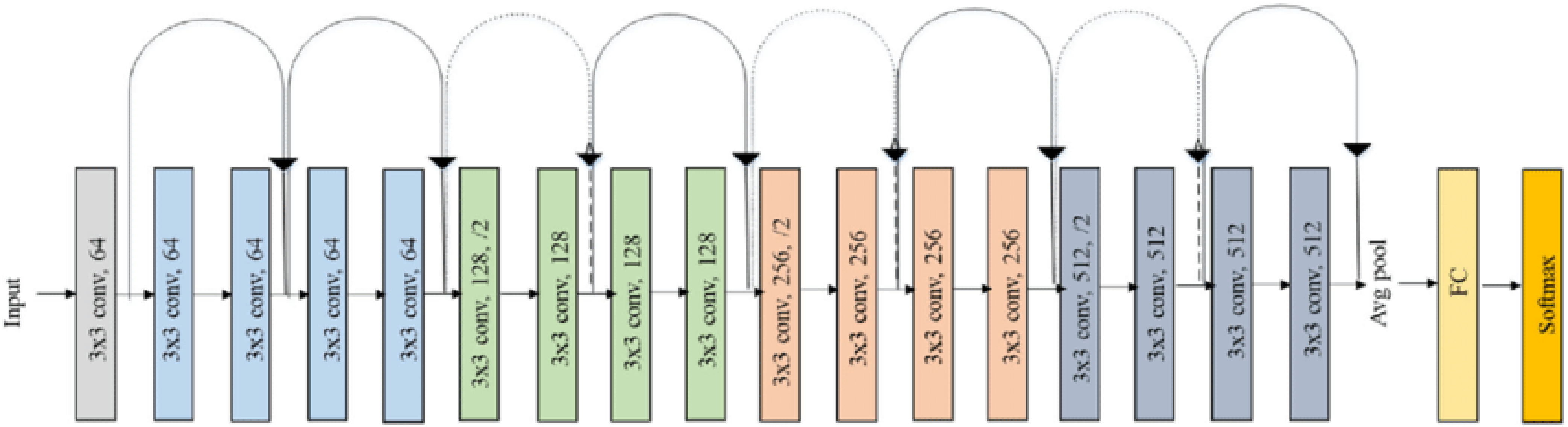


Architecture - Test



Architecture

- We used RESNET18 as our training model.



Loss Function and Its Intuition

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- We posed the problem as image classification in a modified way where every image does not denote a class but an action.

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- This interventions occurs when the simulated vehicle hit any obstacle.
- A human intervention approximately take 6 seconds to retake control, recenter it and restart the self-steering mode.

Performance Report

$$\text{autonomy} = \left(1 - \frac{(\text{number of interventions}) \cdot 6 \text{ seconds}}{\text{elapsed time [seconds]}}\right) \cdot 100$$

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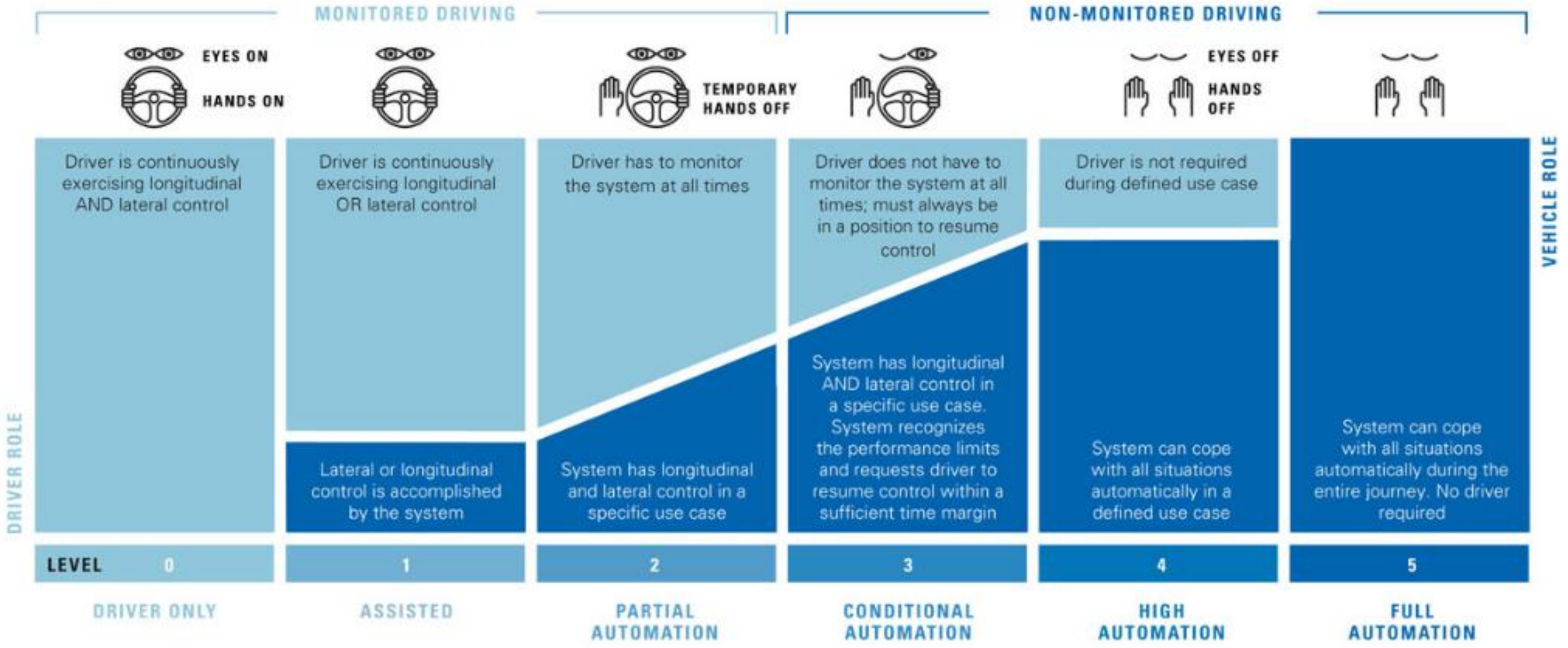
- We got 80% autonomy in normal weather
- But in dark weather, simulated vehicle is moving very slowly.

Comparison with state-of-the-art Method



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- State of the art automation is level 4 which is implemented in Google Waymo cars.
- Another fictional car that achieved level 5 autonomy is Batmobile used by batman.

Challenges/Discussion

- CARLA latest version aims for realistic simulations, so the server needs at least a **6 GB GPU** although **8 GB** is recommended. A dedicated GPU is highly recommended for machine learning. But we did not have this configuration. So, we used a lower version of CARLA.

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- And the number of images of 's' action (break) was small.
- We are also not experts controlling the car.

Future Works

- We can use conditional imitation learning to train the car to use external signal to make decision on intersection.

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- In this work, we used RGB camera to obtain perception of the environment for the car. We can incorporate other sensor data in our training data and make the decision making of the car more robust.

THANK YOU
Any questions?