# GEM Parking Wizard: HyperGemini

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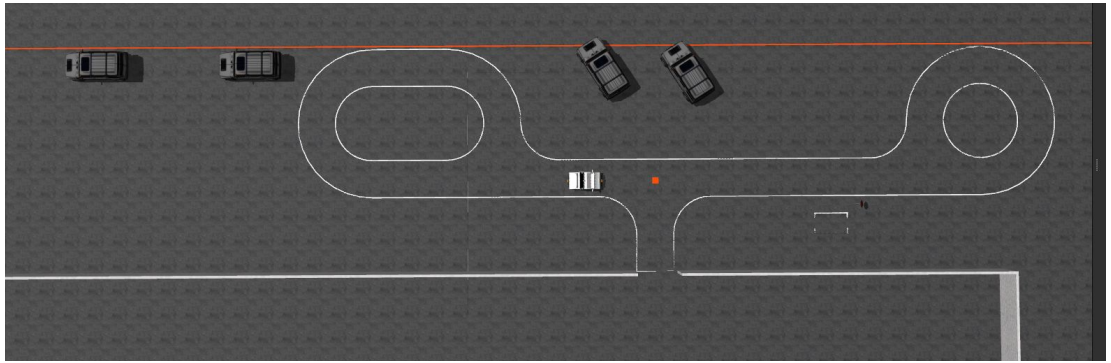
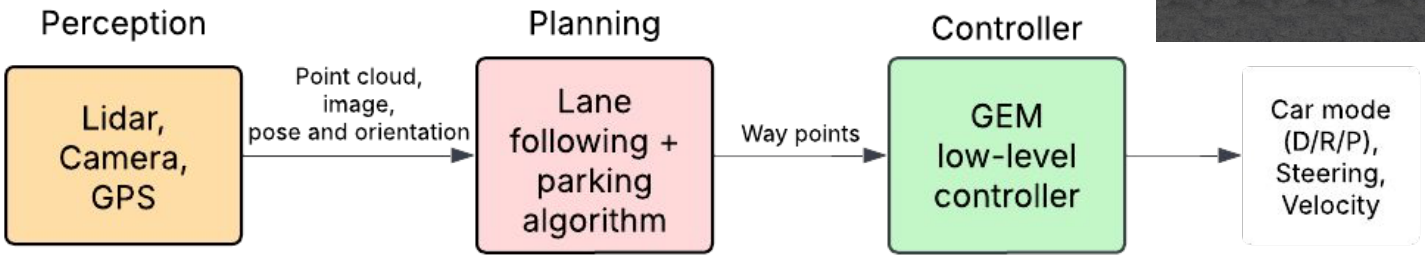
# What problem are we solving?

We aim to create an autonomous driving module capable of detecting and parking in both **diagonal and parallel parking** spots.

**Nonholonomic Control Constraints**: Limited steering curvature, making accurate path planning and motion control in tight spaces challenging.
**Complex Sensing and Perception**: Reliably detecting lane boundaries and parking slot orientation requires sensor fusion, especially hard under various environmental conditions.



# Plan and preliminary work




**Preliminary work:**

Simulator with Highbay environment [1];
Lane following from MP1
Segmented Parking Maneuver with Real-time Collision Checking[2]
Nonholonomic Controller Tuning (PID, Pure Pursuit, Fuzzy Logic)[3]

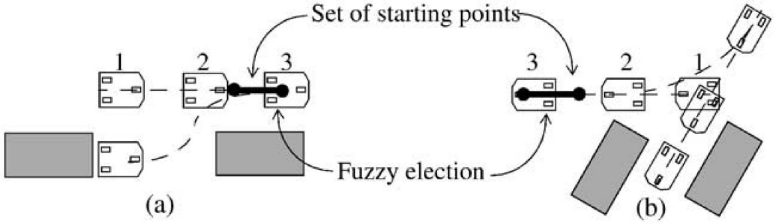



Fig. 2. (a) Parallel parking; (b) diagonal parking.

# Timeline, Task allocation, and Approach

Midpoint checkin

| Milestone | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 |
|---|---|---|---|---|---|---|---|---|
| Lane Detection | QH | | | | | | | |
| Lane Following | | YL | | | | | | |
| Diagonal Parking | | | YL | QH | XY | | | YL |
| Parallel Parking | | | | | XZ | XZ | XY | QH |

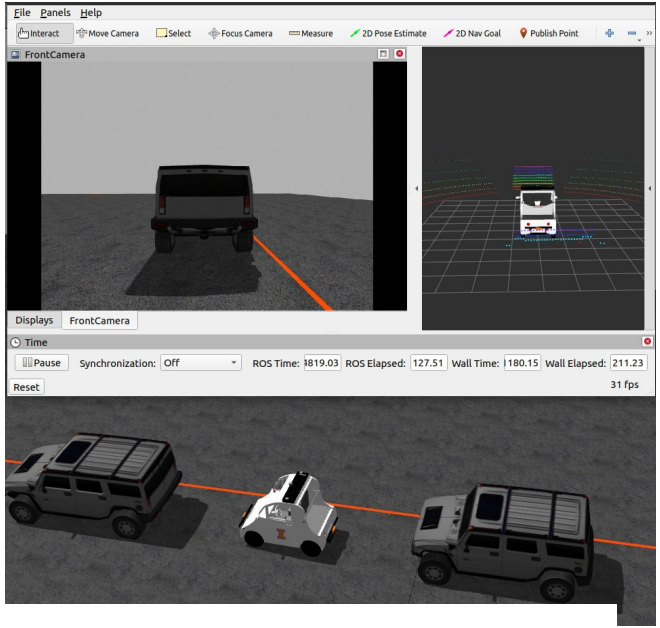
1. Implement **lane detection and lane following** using the provided code and prior mps
2. Identify key parking checkpoints and control strategies for both parking situations
3. Achieve a comprehensive automated driving and parking solution

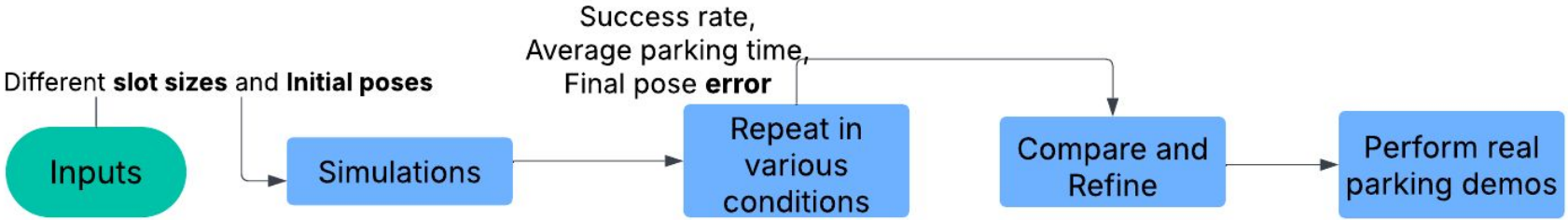
# Metrics for evaluation

**Accuracy** **Tracking Error**: Checks how accurately the car follows the planned path; final pose accuracy is crucial.

**Efficiency** **Parking Time** + **Steering Smoothness**: Evaluates steering smoothness (affecting comfort and control stability).

**Security** **Collision/Safety Distance**: Ensures minimum clearance from obstacles at all times.



# Reference


[1] https://github.com/hangcui1201/POLARIS_GEM_e2_Simulator

[2] Gómez-Bravo et al. (2001) F. Gómez-Bravo, F. Cuesta, A. Ollero, "Parallel and diagonal parking in nonholonomic autonomous vehicles," *Engineering Applications of Artificial Intelligence,* Vol. 14, Issue 4, 2001, pp. 419–434, ISSN 0952-1976, https://doi.org/10.1016/S0952-1976(01)00004-5.

[3] Paromtchik & Laugier (1996) I. E. Paromtchik and C. Laugier, "Autonomous parallel parking of a nonholonomic vehicle," *Proceedings of Conference on Intelligent Vehicles,* Tokyo, Japan, 1996, pp. 13–18, doi: 10.1109/IVS.1996.566343.