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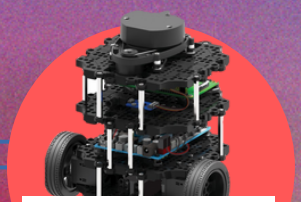
LANGUAGE STEERED AUTONOMOUS DRIVING USING VLM

LANG_DRIVE W/ LLAVA-7B

ROBOT PLANNING AND CONTROL

HIERARCHICAL REINFORCEMENT LEARNING



AUTONOMOUS GROUND ROBOT

PERCEPTION & CONTROL

E-VTOL URBAN AIR MOBILITY

GKN AEROSPACE

AIRCRAFT SAFETY BRAKING SYSTEM

AIRBUS

ROBOTICS & AUTONOMY PROJECTS

LangDrive: Language-Steered Autonomous Driving

- Project Overview: Development of a hierarchical autonomy stack within the CARLA simulator that integrates Vision-Language Models (VLMs) to bridge the gap between high-level semantic reasoning and low-level vehicle control.
- My Role: I architected the decision-making pipeline using LLaVA to process RGB camera feeds and natural language commands. I designed a custom control bridge to translate the VLM's high-level intent into actionable steering and throttle signals, enabling the system to reason about safety constraints and execute complex temporal maneuvers.
- Key Outcome: Successfully validated the "See, Decide, Act" loop in complex urban environments, demonstrating the system's ability to interpret human intent and adhere to safety rules without explicit rule-based programming.

Hierarchical Reinforcement Learning for Resilient Robotic Control

- **Project Overview:** Developed a hierarchical reinforcement learning framework for stable object stacking under perception and control uncertainty. Modeled as a POMDP, decoupling high-level strategic planning & force control to optimize long-horizon stability.
- **My Role:** I implemented a dual-policy architecture using Soft Actor-Critic (SAC) for continuous goal selection and PPO for execution. This involved engineering stability-based reward functions and a multi-stage curriculum to ensure robustness against sensor noise and actuation errors.
- **Key Outcome:** Achieved 2x average stack height compared to discrete baselines (27.18 vs 14.85 blocks), validating the system's ability to mitigate compounding errors in degraded conditions.

Full-Stack Autonomous Navigation System for Ground Robot

- **Project Overview**: Development of a full-stack autonomy solution for a wheeled robot designed to navigate cluttered indoor environments without human intervention. Utilizes a ROS2 architecture to integrate sensor data for real-time decision-making.
- **My Role:** I built the perception-planning-control stack from scratch. This involved integrating LiDAR and vision-based SLAM for localization and implementing a hybrid A*-DWA planner to handle obstacle avoidance. Also tuned feedback for the motion controller to ensure smooth trajectory tracking.
- **Key Outcome**: Successfully achieved self-navigation in dynamic environments, demonstrating a robust sensor and high-level path-planning integration.

Autonomous E-VTOL for Urban Air Mobility (GKN Aerospace)

- **Project Overview:** Design and systems integration of a 1:10 scale prototype eVTOL aimed at urban air mobility. The project required balancing aerodynamic efficiency with autonomous flight capabilities.
- **My Role**: I was responsible for the aerodynamic conceptual design and the flight systems integration. Implemented autonomous waypoint navigation and obstacle avoidance logic using MAVSDK-Python on a Pixhawk platform.
- **Key Outcome**: The prototype achieved a 14 km operational range and won Rank 1 (and a 300,000 cash prize) at the GKN Aerospace Sustainable Aviation Challenge.

Dynamic Safety Braking System for Inclined Runways (AIRBUS)

- **Project Overview:** A safety system designed to assist pilots during landing on inclined runways by predicting braking performance.
- **My Role:** I developed an algorithm that integrated flight and braking mechanics using Reduced Order Modeling (ROM). Additionally, I architected a runway slope prediction model using OpenCV to interface with the Automatic Flight Control System (AFCS).
- **Key Outcome:** Ranked 3rd in the Airbus National Flight Challenge for maximizing braking safety through computer vision and physics-based modeling.