Designing and Programming Autonomous Fly4Future Drones through ROS2

Sujjay Karthikeyan, UNC Charlotte
Ran Zhang, SmartNet Lab, Department of Electrical and Computer Engineering

HONORS COLLEGE

Introduction

- The development of autonomous drone swarms is critical for future applications in infrastructure inspection, search and rescue, and environmental monitoring.
- Reliable simulation environments are essential for developing and testing these complex multi-agent systems before real-world deployment.
- This project utilizes the Robot Operating System 2 (ROS2) and the Gazebo simulator in conjunction with the MRS UAV System to create a scalable platform for autonomous swarm programming.
- The current ROS Noetic Environment is outdated and the Gazebo Simulator version has crossed it's end of life date

Objectives

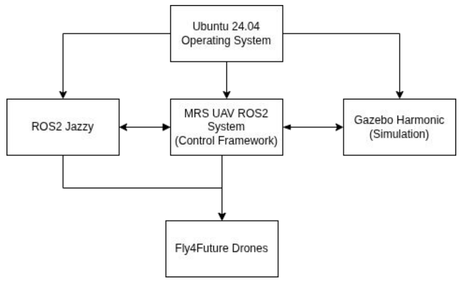
Using Ubuntu 24.04

- To successfully set up the MRS UAV System environment on ROS2 (Jazzy) and Gazebo Harmonic.
- To establish a stable, simulated flight environment for a single Fly4Future drone.
- To develop and implement custom modifications to the MRS-UAV launch files to enable cooperative control of a three-drone swarm.
- To demonstrate the simultaneous monitoring and execution of a path-following mission by the three-UAV swarm in Gazebo.

Method

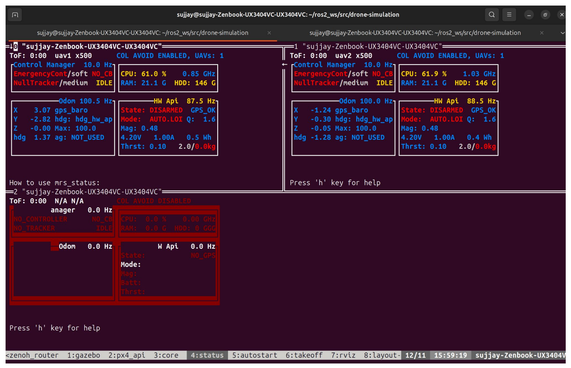
Implementation

- The project leveraged a custom repository (ROS2-Drone-Simulation) to integrate the MRS UAV System with bespoke launch configurations.
- The setup was executed using ./start.sh from the custom workspace to launch three independent, networked UAVs (uav1, uav2, uav3).
- Each drone runs a separate instance of the MRS UAV control stack, allowing for decentralized, cooperative command execution.

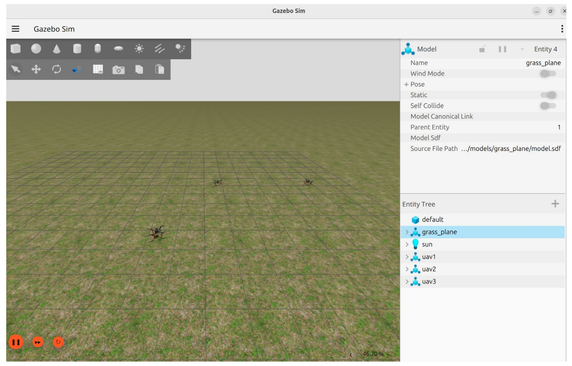


System Setup

Results



Real Time System Monitoring (In-Progress)



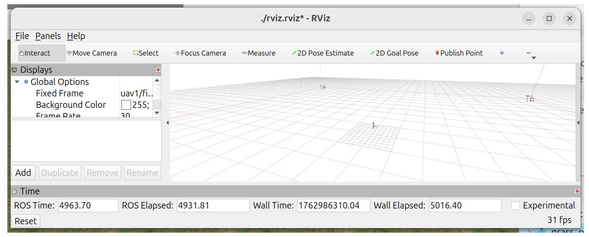
Three Drone Simulation in Gazebo

Real-Time System Monitoring:

- The system achieved real-time operational telemetry, with Odometry (Odom) updates constantly running at approximately **100 Hz** for each drone (e.g., 100.5 Hz and 88.5 Hz shown for uav1 and uav2).
- The terminal status windows confirmed that multiple UAVs were simultaneously controlled and monitored, showing key metrics like State: DISARMED, Mode: AUTO.LO1, and resource usage (CPU/RAM) in the computer.

Three Drone Simulation Successful

A three-drone swarm simulation was successfully launched and executed in the Gazebo environment, as visually confirmed in the simulator.



RViz- Drone Plotting Software

Fly4Future Drones in Action

Conclusions

- Created a functional, scalable three-drone swarm simulation environment based on ROS2 and the MRS UAV System, ahead of the full ROS2 release.
- Established a solid framework for future development of complex cooperative swarm algorithms, including advanced path planning and collision-avoidance maneuvers.
- Planning to integrate Q-learning algorithms to improve path-planning accuracy.

References

M. Saska, J. Vakula, and L. Preucil, "Swarms of Micro Aerial Vehicles Stabilized Under a Visual Relative Localization," in 2014 IEEE International Conference on Robotics and Automation (ICRA), Hong Kong, China, 2014, pp. 3570–3575.