

Environmental Perception Using ROS and MAVROS for Drone Applications

Objective

The goal of this project is to develop and simulate an environmental perception system for drones using the ROS (Robot Operating System) framework. This project will integrate several technologies and tools including MAVROS, Python, Darknet ROS, Gazebo, SLAM (Simultaneous Localization and Mapping) with depth cameras, PX4 flight controllers, and AI tools for person and plant detection. Students will transition their solution from simulation to a real drone equipped with PX4, a USB camera, depth sensors, and an optical flow sensor.

Key Components and Tools

1. ROS (Robot Operating System):
 - Middleware for robotic applications, providing tools and libraries for simulation, control, and communication.
2. MAVROS:
 - ROS package for MAVLink communication, bridging the PX4 flight stack with ROS nodes.
3. Darknet ROS:
 - Python for scripting and node development.
 - Darknet ROS for integrating deep learning models (e.g., YOLO) with ROS to perform object detection tasks like detecting persons and plants.
4. Gazebo Simulator:
 - Physics-based simulation environment integrated with ROS.
5. SLAM with Depth Cameras:
 - Implement SLAM algorithms such as RTAB-Map or ORB-SLAM2 using depth cameras.
6. PX4 with MAVROS:
 - PX4 as the flight control software.
 - MAVROS for real-time communication and command execution.

Methodology

1. Literature Review:
 - Research ROS ecosystem and MAVROS integration.
 - Study SLAM techniques and AI-based detection systems.
 - Explore similar projects for environmental perception.
2. ROS and MAVROS Setup
 - Install ROS and set up a workspace for development.
 - Configure MAVROS for communicating with Gazebo and PX4.
 - Test basic commands like arming, takeoff, and waypoint navigation using MAVROS.

3. Simulation Environment

- Gazebo Integration: create simulation scenarios with obstacles, persons, and plants.
- SLAM Implementation: deploy SLAM algorithms to build real-time 3D maps.
- Train and deploy AI models for person and plant detection.
- Use ROS nodes to process camera feeds and run detection algorithms.

4. Protocol Stack Integration

Use MAVROS topics and services for drone control and data exchange.

Deliverables

1. Software environment: Gazebo simulation environment and scenarios. SLAM-generated maps.
2. Algorithm Implementations: ROS nodes for SLAM, AI detection, and drone control.
3. Reports: detailed documentation of methodologies and results.