TEAM NEURAL KNIGHTS

AUTONOMOUS AGRICULTURAL ROBOT FOR MAPPING,CROP DISEASE DETECTION AND OBJECT RECOGNITION

AUTHORS

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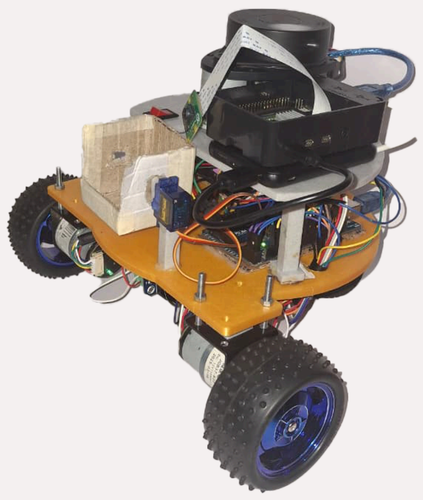
INTRODUCTION

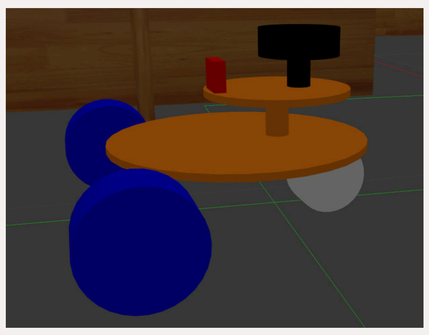
This project aimed to develop an autonomous differential drive robot that combines SLAM-based navigation, object unloading, color detection and crop disease detection. Using a 2D LiDAR it maps unknown fields while estimating its own position. A camera module simultaneously classifies leaf diseases and performs color detection. The system integrates differential-drive motion, sensor fusion and real time decision making in a small mobile platform.



OBJECTIVES

- Autonomous mapping and localization
- Object recognition
- Navigation across different terrain surfaces
- Object loading
- Path planning
- Object unloading

METHODOLOGY



Chassis design an fabrication
3D Printed using PLA

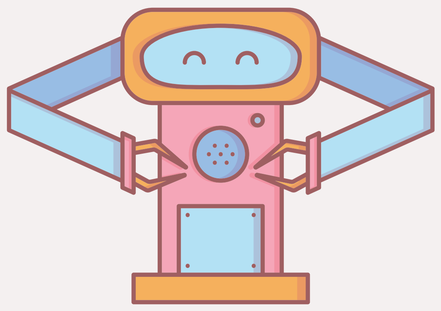
URDF Design and Simulation in Rviz and Gazebo

Ros2 Control

Color detection

Object Loading and Unloading Mechanism

Plant disease detection



ANALYSIS

- Navigation and mapping accuracy- LiDAR and odometry were effectively intergrated.
- Color and payload Detection- Camera successfully detects color and the IR sensor effectively detects the cube placement
- Loading and unloading success: Cube was successfully loaded and the servo mechanism unloaded the cube
- System Integration: Raspberry pi 4 managed computation, machine learning and computer vision, Arduino Mega handles the low level programming of the motors, the servo and the IR sensor.

HARDWARE OVERVIEW

RP LIDAR

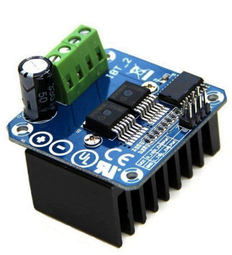
Scans distance and provides spatial data used for SLAM and obstacle mapping

RASPBERRY PI 4

Performs computation for the systema and sens commmands to lower layers

ARDUINO MEGA 2560

Manages low-level control, reads sensors, issues PWM to motors/servo and interfaces with the PI



MOTOR DRIVER

Amplifies control signals and drives DC motors

PI CAMERA V2

Captures images from the environment for color detection and disease recognition

RESULTS

The robot exhibits very low latency, driving almost instantly upon receiving commands. Its mapping via SLAM is highly accurate, reliably constructing a representation of its surroundings. The crop disease detection system performs strongly, distinguishing different potato blight stages correctly in most cases. Simultaneously, the camera successfully identifies cubes of various colors, enabling accurate object recognition and triggering the unloading routine.

CONCLUSION

This robot demonstrates the feasibility of using a differential-drive system with SLAM, computer vision and machine learning to autonomously navigate agricultural terrain, detect disease and color, and reliably unload objects.

REFERENCES

ROS 2 Control Working Group, ros2_control Documentation [Online]. Available: https://control.ros.org

Robotics Dojo, "Robotics Dojo," Substack.. Available: https://roboticsdojo.substack.com/.

_Articulated Robotics, ROS 2 Tutorials and Guides [Online]. Available: https://articulatedrobotics.xyz/

AFFILIATIONS