ROBOTICS DOJO COMPETITION 2026 · WASTE MANAGEMENT

Autonomous Waste Collection and Sorting Robot

ROS 2 mapping, navigation and YOLO-based vision for waste collection

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Introduction

Waste facilities and urban recovery zones are hard places to automate: uneven terrain such as gravel, sand and grass, plus moving people and shifting debris. This project presents a ruggedized Autonomous Mobile Robot for waste sorting and collection. Running ROS 2 and Nav2 on a Raspberry Pi 5, it uses LiDAR SLAM for mapping and navigation, an onboard AI camera to classify waste, and a rack-and-pinion plunger to offload automatically.

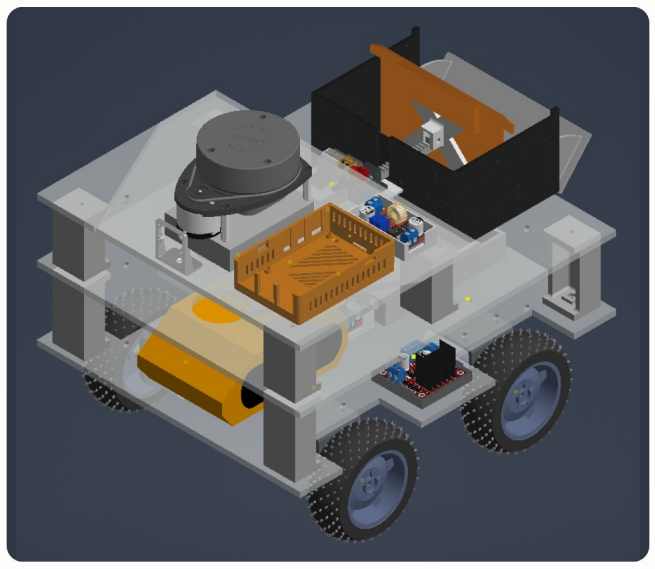
Objectives and constraints

- Navigate autonomously over sand, gravel, wet grass and a 7° ramp
- Detect waste with an onboard YOLO-based vision model
- Collect waste and discharge it automatically
- Constraints: 300 × 300 × 300 mm, about 3 kg unloaded, supply up to 24 V

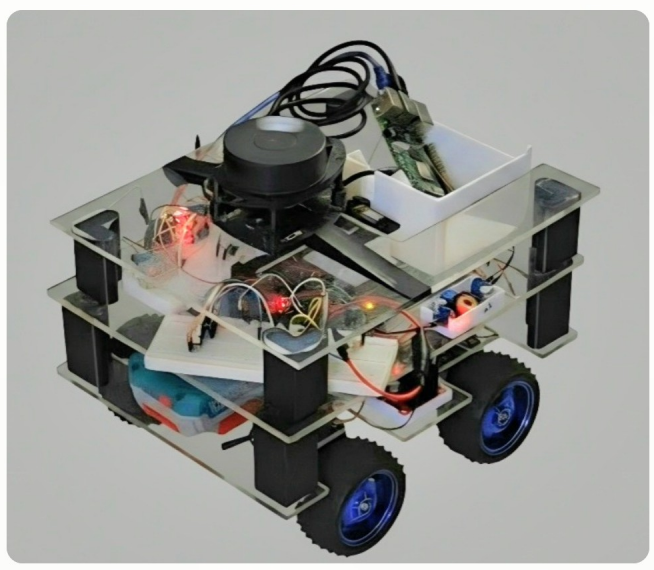
Hardware

- Compute: Raspberry Pi 5, ESP32
- Sensors: RPLIDAR A1 (2D), Raspberry Pi camera
- Drive: 4 × JGB37-520 (12 V, 110 RPM), 85 mm wheels
- Discharge: rack and pinion, N20 motor
- Power: 20 V tool battery, XL4015 buck converters

The robot

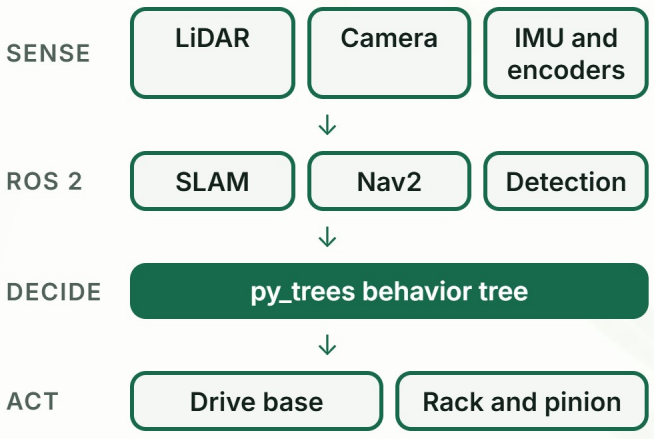


Final CAD design

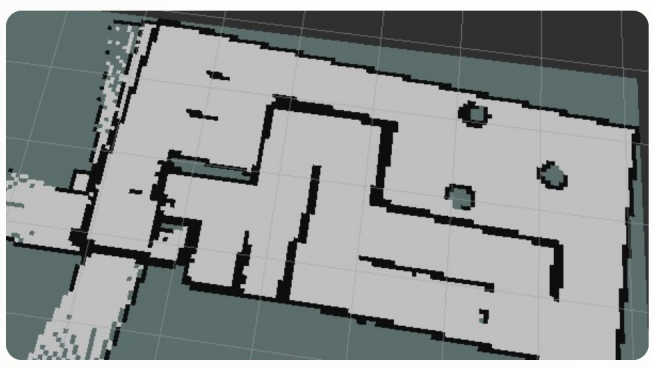


The robot as built

System architecture



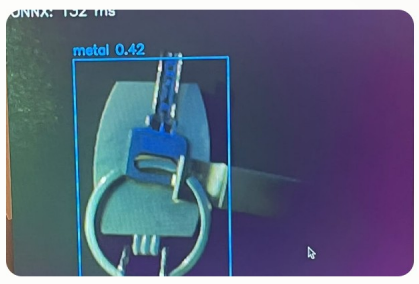
Mapping and navigation



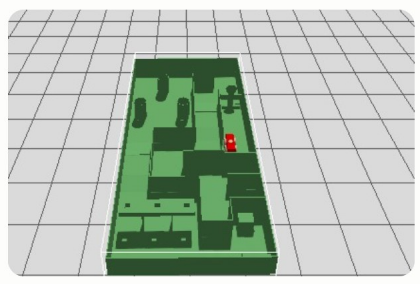
SLAM Toolbox builds a 2D occupancy map from LiDAR and odometry. Nav2 then localizes on that map with AMCL and plans paths around obstacles. Gazebo and RViz were used for simulation and visualization.

Detection and waste sorting

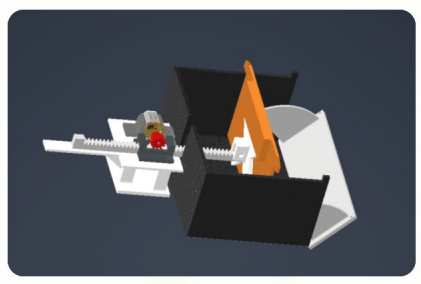
- YOLO-based detector with ONNX inference on the Raspberry Pi
- Camera frame, detection, waste type, then the behavior tree picks the action
- Inference runs on a separate thread, so navigation and safety stops are never blocked



Real-time waste detection with the YOLO-based vision system



Gazebo simulation used to test navigation before deployment



CAD model of the rack-and-pinion discharge mechanism

Results

2.9× Drive torque safety factor

1.7 kg Safe plunger payload

The SLAM map captured the gamefield and the YOLO detector identified the test waste.

Challenges and lessons

- Motor current spikes caused Pi 5 reboots; separate XL4015 buck rails fixed it
- The Pi 5 needs 5 V / 5 A, beyond power banks, so a buck converter feeds it
- Lessons: accurate CAD dimensions, detailed requirements, test every case

Future work

- Multi-robot fleet coordination
- Predictive route planning

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