ROBOTICS DOJO 2026 · WASTE MANAGEMENT CHALLENGE

Team 6

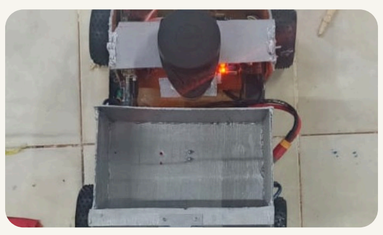
Autonomous Waste Management Robot

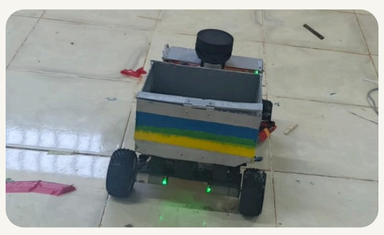
A skid-steer robot that finds, classifies and offloads waste, with ROS 2 on a Raspberry Pi, real-time control on an Arduino Mega and a custom YOLO11s waste detector.

JNNP Robotics Innovators Club · Jeremiah Nyaga National Polytechnic, Kenya



The rebuilt robot: tipping rear bin, RPLIDAR on top, four encoder gearmotors.







01 · THE CHALLENGE

Waste left mixed is hard to recycle. The robot must cross the competition field, recognise metal, organic and plastic waste, carry it and offload it at the right zone.

02 · OUR ROBOT

Sees
RPLIDAR A1M8 and Pi Camera Module 3

Thinks
Raspberry Pi 4, ROS 2 Jazzy, YOLO11s

Moves
Four encoder gearmotors, skid-steer, 0.15–0.60 m/s

Offloads
Rear bin lifted and tipped by an MG995 servo

03 How it works: a two-tier controller

Operator laptop
Arrow-key teleop and RViz

→

Wi-Fi + ROS 2
Zenoh link carrying /cmd_vel, /scan and /odom

→

Raspberry Pi 4
Ubuntu 24.04, ROS 2 Jazzy, waste AI (ONNX)

→

Arduino Mega 2560
USB serial at 115200 baud; encoders and servo

→

Monster Moto Shield
2 × VNH2SP30 driving 4 × GA25-370 motors

Sensors to the Pi: the LiDAR publishes scans for safety stops and mapping; the camera feeds the waste detector.

Power: one 4S LiPo feeds four buck rails: 5.11 V Pi · 6 V servo · 5.0 V encoders, fan, LED · 12 V motors.

04 · AI WASTE DETECTION

YOLO11s finds and sorts waste

mAP50 on 580 validation images

Metal		0.90
Plastic		0.82
Organic		0.59
All		0.77

Trained on 9,670 Roboflow images (Colab T4 GPU, 30 epochs), exported to ONNX and run on the Pi at about 0.6–1.4 s per frame. Each item is tagged LEFT, CENTRE or RIGHT so the robot knows which way to turn.

05 · ROS 2 ON THE ROBOT

A real ROS 2 robot

`/scan`	LiDAR scans
`/odom`	Wheel-encoder odometry
`/cmd_vel`	Left and right wheel speeds

Tested: the arrow-key teleop drove the real robot through ROS 2 over Wi-Fi, with odometry reporting correctly.

The real robot has mapped the field with SLAM Toolbox; Nav2 is installed for autonomous navigation.

06 · DRIVING SAFELY

Simple keys, built-in stops

↑	Forward	↓	Backward
←	Turn left	→	Turn right
Space	Stop	C	Camera AI on/off

- Arduino watchdog stops the motors within 0.5 s if Wi-Fi drops
- LiDAR blocks forward motion near obstacles
- Camera starts off, so the controls stay fast

07 · DESIGN, BUILD, TEST

What testing taught us

1. **Steel to acrylic.** A steel chassis and two batteries made turning hard. Rebuilt on acrylic with one LiPo, the robot went from 4 kg to 2 kg.
2. **The turn that went straight.** Tests on blocks showed the right motor channel was reversed; swapping its leads fixed it.
3. **Field tested.** Under teleop the robot handled the ramp, sand, runway and obstacles; turn calibration fixed a 30° swing in SLAM mapping.

08 · DRY-RUN RESULTS

Measured on the competition field

Robot mass	**2 kg (first build 4 kg)**
Ground speed	**0.15–0.60 m/s**
360° spin on the spot	**13 s**
Field run, teleop	**42–78 s**
Field run, SLAM mapping	**122–135 s**
Bin	**Lifts 0.5 kg, dumps in ~1 s**
Battery, 4 h session	**16.3 V → 15.13 V**

09 · THE TEAM



Jane Kabuchi Maina
Team Leader · Software Lead

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Francisco Mbugua Ngigi
Trainer · Robotics and Assistant Research Coordinator

Invent · Innovate · Automate · Dominate

Source code: github.com/jnnproboticsinnovators/jnnp-robodojo-robot

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