Asterix Technical Poster

Steve Muya, Ibrahim Gichemba, Andrew Muchangi, Jimmy Kimeu, Anilla Wambui.

Robotics Dojo 2026 Competition Theme: Waste Management

INTRODUCTION.

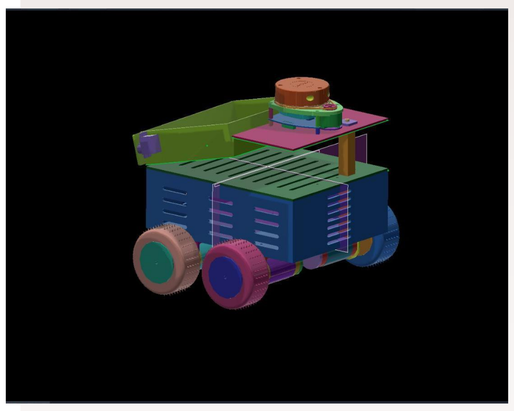
Team Asterix (Team 3) built OREO, a four-wheel-drive rover for the Robotics Dojo 2026 waste-sorting arena. In the arena it has to classify waste, load it, get past obstacles, a gate and a ramp, and offload it into the matching bin, with nobody touching it. The robot weighs about 3 kg and fits a footprint of roughly 0.26 × 0.30 m. We split the work in two. A Raspberry Pi 5 does the thinking: mapping, navigation and vision. An ESP32-S3 handles the reflexes: motor control, the IMU and safety stops. Keeping the two jobs apart meant a slow vision frame could never stall a motor loop.

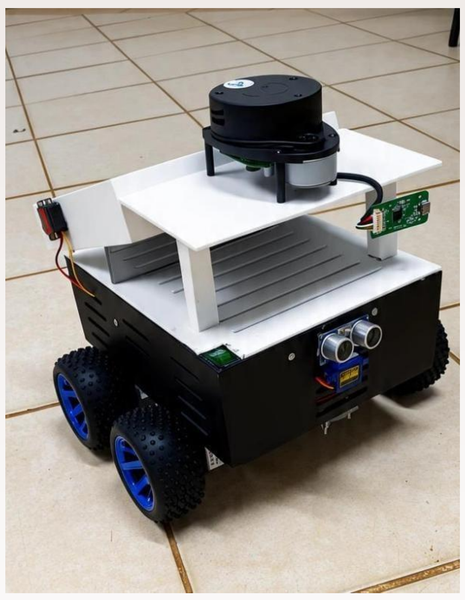
OBJECTIVES.

- Build OREO, an autonomous four-wheel-drive rover that completes the Robotics Dojo 2026 waste-sorting mission: classify, load, avoid obstacles, pass the gate and ramp, and offload into the matching bin.
- Design a compact, vented, 3D-printed chassis with good traction, a securely mounted LiDAR and a servo-driven hopper.
- Power the robot reliably from one protected 4S 18650 pack for about 42 minutes, with a stable supply for the Pi 5 and safety stops.
- Map, localise and navigate autonomously using slam_toolbox, AMCL and Nav2, with a behaviour tree sequencing the mission.
- Detect and classify waste in real time with YOLO26n on the Hailo-8L (CPU classifier as fallback), and improve accuracy on organic waste.

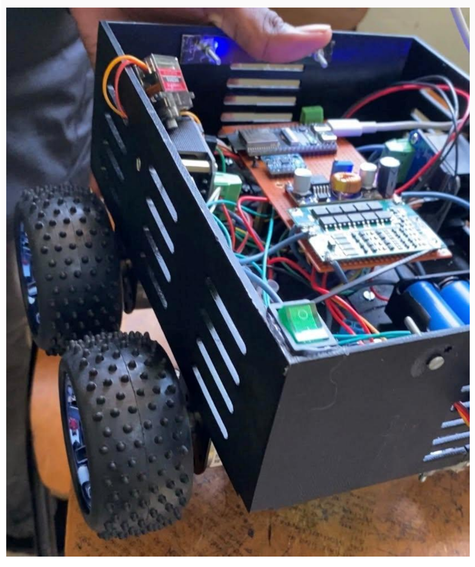
MECHANICAL DESIGN

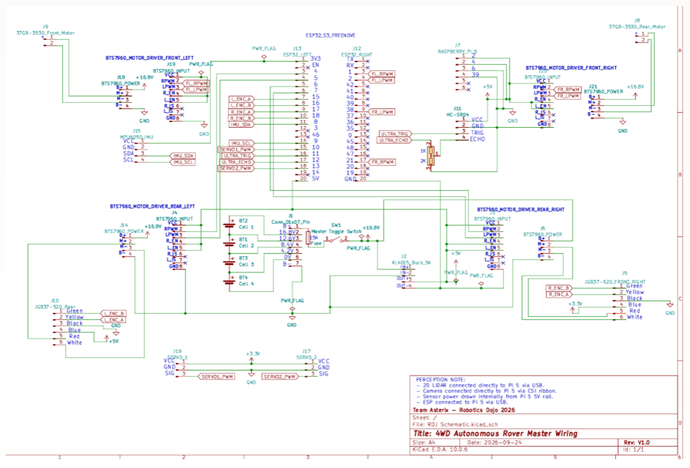
OREO's chassis is 3D-printed and vented, measuring 240 × 190 × 81 mm, and it rides on four 85 mm spike tyres for grip on the arena floor. The RPLIDAR A1 sits on a raised plate held up by support pillars, and a hinged, servo-driven hopper tips the load out at the bin. We modelled everything as a parametric assembly in Autodesk Inventor, so changing one dimension carried through the rest of the model. Late in the design we added a second support pillar, like the one already holding the LiDAR base, on the opposite side of the same base. Printed plates and parts were then assembled into the finished robot.





ELECTRONICS AND POWER





A 4S1P 18650 battery pack feeds the robot through a 4S 40 A BMS, a 15 A fuse and a master switch. Four BTS7960 drivers run the motors, with PWM capped at 180, which is about 11.9 V at the motors. The rear JGB37-520 motors (110 RPM) have encoders. The front 37GB-3530 motors (200 RPM) run open-loop at a 0.55 scale to match the rear. We estimate a nominal draw of 3.6 A and a peak of 12.25 A, which gives about 42 minutes of runtime.

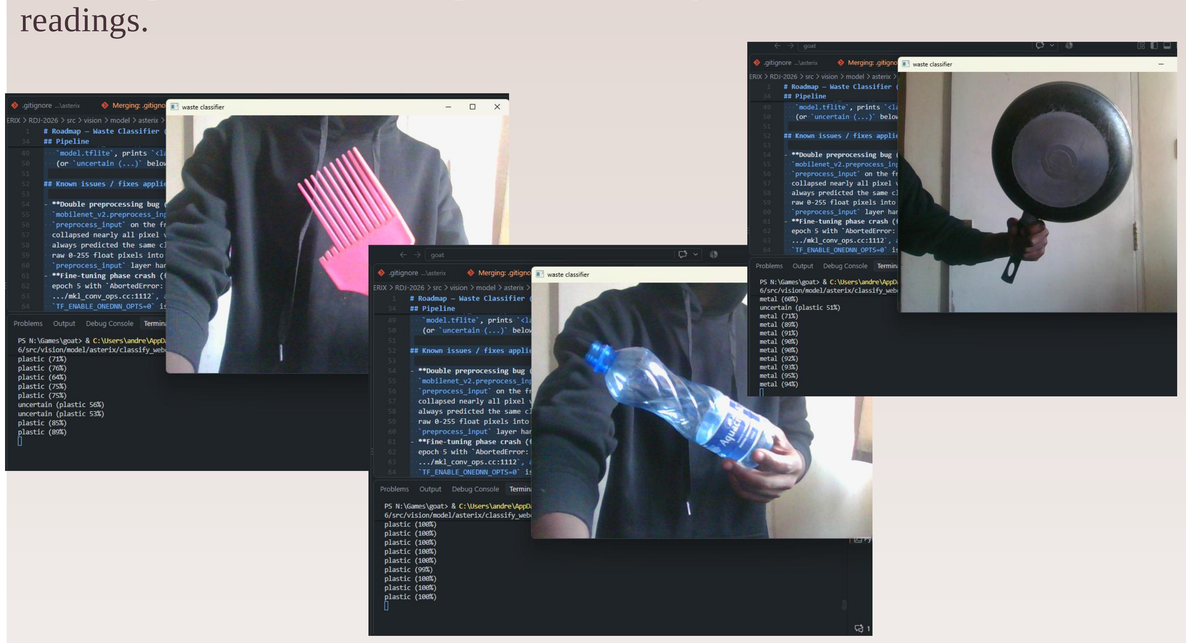
The ESP32-S3 firmware runs a 20 Hz PID loop with interrupt-driven encoders and a 100 Hz complementary filter on the IMU. It also has a 500 ms watchdog and a 15 cm ultrasonic auto-stop, which we are still verifying on the robot.

Our main electrical challenge was the Raspberry Pi 5. An XL4015 buck converter supplied it, and power reached the Pi but not enough for it to boot. Adding a 1000 µF capacitor across the converter's output pins fixed it, and the Pi booted. Occasional Pi power cuts are still an open issue.

AI AND COMPUTER VISION.

We trained two models. The main one is a YOLO26n detector trained on the Dojo dataset (rdj2026) and compiled for the Hailo-8L on the AI HAT+. It runs in about 23 ms per frame (roughly 43 fps). Our float model reached a precision of 0.68 and a recall of 0.72. It was strongest on metal (0.96), then plastic (0.80), and weakest on organic waste (0.51).

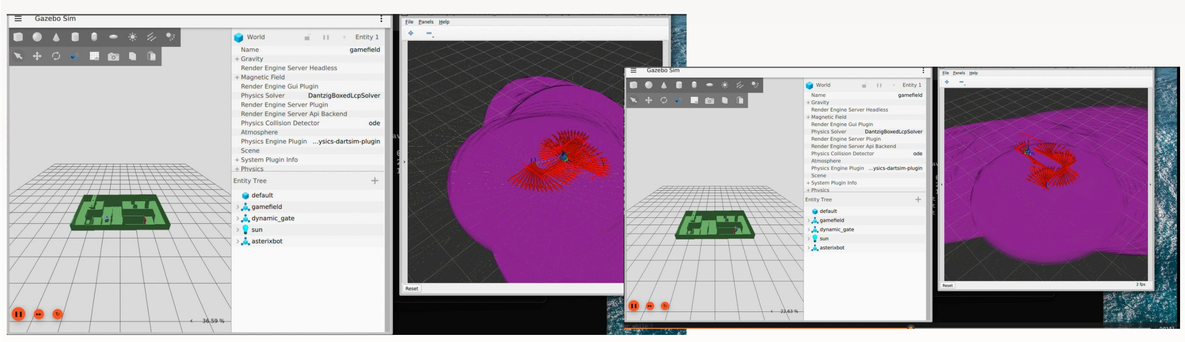
The second model is a MobileNetV2/TFLite classifier trained on a Kaggle waste dataset. It runs on the CPU as our fallback. In webcam tests it labelled a plastic bottle as plastic at 100% but a pink comb at only 71%, with some uncertain readings.



SOFTWARE AND NAVIGATION.

The Pi 5 runs Ubuntu 24.04 with ROS 2 Jazzy. We map with slam_toolbox and localise with AMCL, and a timed three-minute mapping run gave about 3 cm of wall error. Nav2 handles navigation, using NavFn for planning, Regulated Pure Pursuit to follow the path and a collision monitor for safety. We mask the LiDAR's hits on the robot's own body and apply an IMU level-offset filter to clean the scan.

A py_trees behaviour tree runs the full mission: classify, loading, obstacles, gate and ramp, offload, finish, and a controlled stop. Every stage works.



CONCLUSION

OREO, a four-wheel-drive autonomous rover, completes the Robotics Dojo 2026 waste-sorting mission. Computation is split between a Raspberry Pi 5 (SLAM, Nav2 navigation, vision) and an ESP32-S3 (motor control and safety), which keeps time-critical control independent of heavier processing. A YOLO26n detector on the Hailo-8L runs at about 23 ms per frame, with a precision of 0.68 and a recall of 0.72. Hardware iteration resolved two issues: a 1000 µF output capacitor gave the Pi 5 a stable supply, and a second pillar strengthened the LiDAR base. Together, these subsystems form an integrated platform that meets the mission requirements.

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