ARtPUT: Autonomous Rover to Pick Up Trash

Progress Report 3: Awaiting Materials and Starting on CAD and Machine-Learning Models

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Materials and Methods

Materials:

- DFRobot Devastator Tank Mobile Robot Platform serving as the tracked mobile base
- Raspberry Pi 4 Model B as the primary onboard computer for vision, navigation, and logging
- Arduino UNO for low-level motor, servo, and sensor control
- USB RGB camera with depth-sensing capability for object detection and grasp planning
- Ultrasonic sensors for short-range obstacle detection
- NEO-6M GPS module for position logging and route tracking
- Digital compass (magnetometer) for heading correction
- Infrared sensor for bin fill-level detection
- Two-finger robotic gripper actuated by a servo motor
- 12 V DC suction pump with relay module
- Suction-assisted collection bin with approximately 500–1000 mL capacity
- L298N motor drivers for drive motors
- Buck converters for voltage regulation
- Two 11.1 V Li-Po batteries to power onboard systems
- Wireless telemetry and onboard data logging storage
- Cones, measuring tape, stopwatch, and field notebook for controlled outdoor testing

Procedure:

1. Dataset & training: To train an object-detection model (YOLO/SSD-style), gather and label a significant number of photos of the target litter types in the target park. Use artificial occlusions to enhance.
2. Software stack: Put in place a perception pipeline (object detection on RGB-D + depth clustering), SLAM-based localization (Lidar + odometry), and a manipulation controller that translates detected object pose to a grasp technique. We'll test two modes of perception manipulation: Vision-only bounding-box grasping (A); vision plus depth-point-cloud grasp planning (B).
3. Three 10 m × 10 m test plots in a public park with low pedestrian traffic are chosen for the test. A fixed number (N = 20) of different litter items are placed in each plot at random locations (pre-approved with park authority). Mark the start and goal points.
4. Trials: For each mode (A, B) run 10 trials per plot (total 60 runs), each trial starting from the same location, time-limited to 15 minutes or until bin full. Rotate item arrangements between trials. Record video, sensor logs, and manual observer notes.
5. Baseline: Include 10 human-assisted pickup runs (human uses same route, picks items by hand) for performance comparison.

Data Collection Methods:

- Automated logs: timestamps of detections, attempted grasps, success/failure flags, battery consumption, distance travelled.
- Manual annotations: items missed, misclassifications, pedestrian interactions, environmental notes (wetness, wind).
- Post-run bin content check to count unique items collected.

Safety Concerns:

- The use of electronics and batteries in our project presents a risk of burns and electrical shock.
- The gears in our system may catch onto our limbs and clothing, potentially crushing our limbs.
- The rover may move erratically and hit someone, causing a harmful impact.
- We may drop heavy objects on our feet.

Risk Mitigation:

- We will always wear safety glasses, gloves, and proper footwear while working on our project.
- We will not wear baggy clothes that could potentially get caught in gears.
- There will always be a supervising adult while we are working on our project.
- The rover will always be fully powered off when working on it.

Data Analysis

The primary goals outlined in earlier progress reports have now been completed. All required zFairs documentation and forms have been submitted (unfortunately, we were unable to meet the deadline for GS@IP's Science Fair, so these forms are irrelevant now). In addition, the supply order form is completed and submitted. There have been some minor issues with some items on the list (like the DFRobot mobile base being backlogged until March), but they will be resolved shortly (see Figure 1). The total costs as of right now are just under $350, which is a bit higher than expected, but not completely out of our range. For outside help, it was hard to get a hold of potential contacts because everyone was on winter break and not checking their e-mails. Because of this, the team has been revisiting whether or not to rely on outside help. Our materials should be arriving soon, and from what we can tell, there are already quite a lot of autonomous rover examples and technical guides online, so we don't necessarily need outside input for the time being. This does not imply that we are closing the door on outside help; we can always seek guidance if it becomes necessary later on, but for now, we believe in our own capabilities and those of the resources already available to us. If anything, having something to show these individuals in terms of work already done will give them confidence that we are serious about this project, and only encourage them to help us if need be.

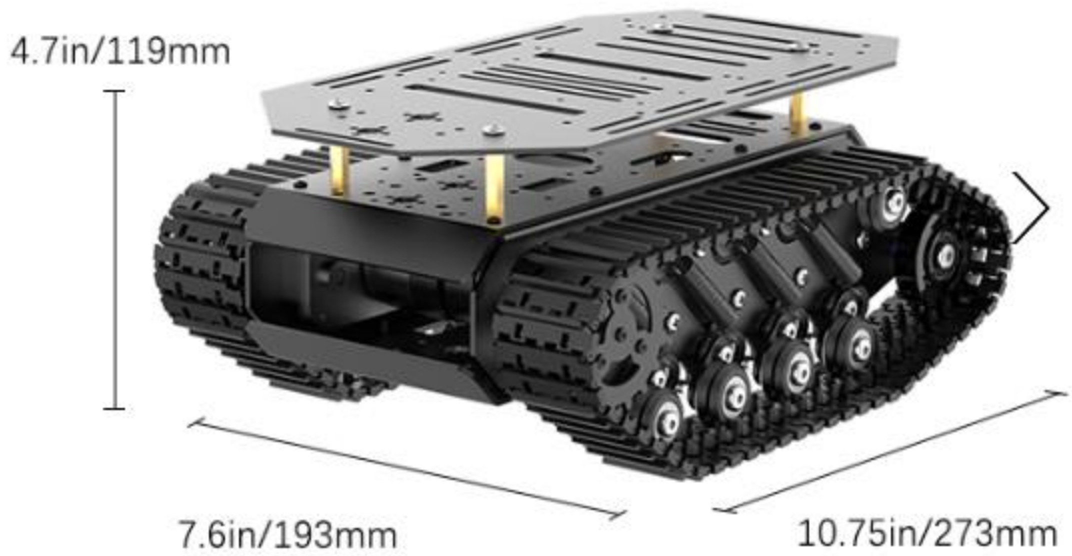

Figure 1: This is an example of another potential mobile base that we may be able to implement in the event we have to use an entirely different model (Amazon, 2026).

By the next progress report, we hope to have acquired all of our materials, which will allow us to begin the construction phase of the rover. Our current efforts are focused on developing a comprehensive CAD design that outlines every component and detail of the rover, ensuring that the theoretical model is both accurate and feasible for building. Along with this, we are putting significant time into making our machine-learning algorithm. We hope to enhance its capabilities and ensure proper performance during testing. By the time of the next report, we anticipate having made noticeable progress in both the CAD design and the machine-learning algorithm, bringing us much closer to building a fully functional rover prototype.

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