ARtPUT: Autonomous Rover to Pick Up Trash

Progress Report 1: Starting the Project

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November 18, 2025

Materials and Methods

Materials:

- Mobile base with differential drive, speed controller, and battery pack (specific model TBD)
- Onboard computer (like a NVIDIA Jetson or equivalent) running an application like Google Colab or Robot Operating System
- RGB camera with depth sensor (RGB-D)
- Lidar (2D) for localization and obstacle avoidance
- Small two-finger gripper and a suction-assisted collection bin with a 50 to 1000 mL capacity
- Wireless telemetry and logging storage
- Test zone marking cones, measured tape, stopwatch, and notebook for manual annotations

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

At the beginning of our project, we all collectively decided that we wanted to create something that would protect the environment. Our ideas range widely from simple filtration systems to devices that exterminate invasive species. Eventually, we chose to focus on designing a drone that would collect trash and litter. Once we were set on this project, we began researching and reading several articles (for which we have listed in the citations) on how drones worked and the various systems that would help us with our project. Our research led us to find out that there was no need for it to fly. Having a grounded rover rather than a drone would be far less expensive, allow us to carry a heavier load, and consume far less energy. We then wrote our experimental design, explaining what our project was, why it was needed, our design criteria, and a basic materials list. Next, we created a website where we would upload all our progress so far. Afterwards, we continued to work on our zFairs forms so that in the future, we can order supplies and begin creating our rover.

In the next few weeks, we plan to finish all our zFairs forms, email professors from several universities to seek guidance in our project, and submit our supply order form. For zFairs, we've completed a couple of forms, but most of them are partly completed and need a few more signatures. In addition, we also plan to cold email several professors or experts in the environmental engineering field, specifically those with experience in pollution disposal and autonomous machines. We aren't necessarily looking to receive money or anything of that nature, but more for their insight and advice based on their experiences. This information would be incredibly helpful in continuing our project. Last but not least, we plan to finish our supply order forms within the next couple of weeks. We've compiled a list of potential items we will need, and it should be about $250. These items include a mobile rover base, an onboard computer, a mounted camera, and an arm mechanism, among other things. Our main concern with purchasing parts is making sure that all of the equipment is compatible with each other, while still staying within our budget. We will choose from a list of possible models with the criteria being compatibility, durability, mobility in outdoor terrain, ability and ease of modification, and overall cost.

References

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