ARtPUT: Autonomous Rover to Pick Up Trash

Progress Report 2: Finishing Up Preparation

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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

Our goals for this progress report were to have finished all of our zFairs forms, to have emailed professors from several universities to seek guidance, and to finish our supply order form. In zFairs, we have finished all of our forms and are ready to begin testing whenever we get our parts. Speaking of parts, although we haven't formally submitted a supply order form, we've basically completed all of our parts list and are almost ready to submit it. We plan to use a DFROBOT Devastator Tank Mobile Platform (Figure 1) as our mobile base, and we plan to use Raspberry Pi onboard computing systems and devices, as they are all compatible with each other. Currently, our price is looking to be about $300, with some room for cost-cutting as well. As for emailing professors, we have researched emailing several professors, and are currently trying to connect with the following people: Dr. Alcherio Martinoli of École polytechnique fédérale de Lausanne (EPFL), Dr. Daniela Rus of Massachusetts Institute of Technology (MIT), and Dr. Berk Calli of Worchester Polytechnic Institute (WPI). We chose these individuals because their experience and recent work are somehow aligned with what we are trying to work in.

Figure 1: This is the DFROBOT Devastator Tank Mobile Platform we plan to use as our mobile base (2025).

By next progress report, we plan to have formally completed and submitted our supply order form (preferably before winter break starts), hope to have gotten some responses (positive or negative) from the professors listed above, and maybe begin some building depending on the timeline until the next report. For sure, we need to have ordered the supply list. As mentioned above, it is essentially finished, but we need to finish calculating some final costs and making some final decisions on what parts to choose. For the emails, we plan to make a cold-email template and use that for the people listed above as well as all future potential mentors. As for potential preliminary building, that just depends on when the parts we order arrive. Right now, our next progress report is slated for some time in mid-January, so essentially we need our

materials right after the break is done. At the end of the day, our priority is finishing up our supply order form and doing outreach to attempt to get advice from experts.

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