Progress Review 4

Individual Lab Report 5

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Team E:

Wholesome Robotics

Teammates:

Aaditya Saraiya

John Macdonald

Dung-Han Lee

Aman Agarwal

Hillel Hochsztein

Individual Progress

Capstone Project

Team E is creating an organic monitoring and weeding robot which has to autonomously navigate through crop rows. For this phase of the project, my task is to create an efficient localization pipeline for localizing the robot in the row as well as while switching rows.

As a follow-up to the previous work of setting up the ZED camera with ZOTAC, the last sprint involved testing the visual odometry results with the ZED camera onboard the Robotanist. Conclusions from both the indoor as well as outdoor tests will be provided in this progress report. Initial results on developing a particle filter based pipeline for localization will also be discussed.

Testing Visual Odometry on the Robot

Indoor results:

With assistance from Aman and Hillel, the ZED camera with the ZOTAC was mounted and powered via the Robotanist platform. The visual odometry generated from the ZED camera was tested out in the High Bay area in the FRC. The results suggested good tracking results with the visual odometry being able to track the robot's motion for turns as well.

Outdoor results:

During the outdoor test at Phipps Conservatory, the visual odometry results were satisfactory and led to successfully tracking the robot's pose, even in case of vibrations due to uneven terrain and muddy soil. Some example results from the outdoor test have been showcased in Figure 1(a) and Figure 1(b).

Motion model for Particle Filter

Figure 2 showcases the parameters which have been utilized to model the robot motion. The motion model adds noise to the rotation and translation aspects of the robot's motion between two successive poses. Currently, a triangular distribution has been utilized to sample noise values. However, a further test will utilize a Gaussian distribution and its subsequent comparisons with the triangular distribution.

Map and Robot trajectory visualizer

A visualizer was created to visualize the size of the rows as well as the spacing between successive rows. The visual odometry data from the ZED camera captured during the outdoors Phipps visit has been visualized as a sanity check before testing the particle filter on the data. Figure 3 showcases the map visualization with the plot of the robot's trajectory during the outdoor tests.

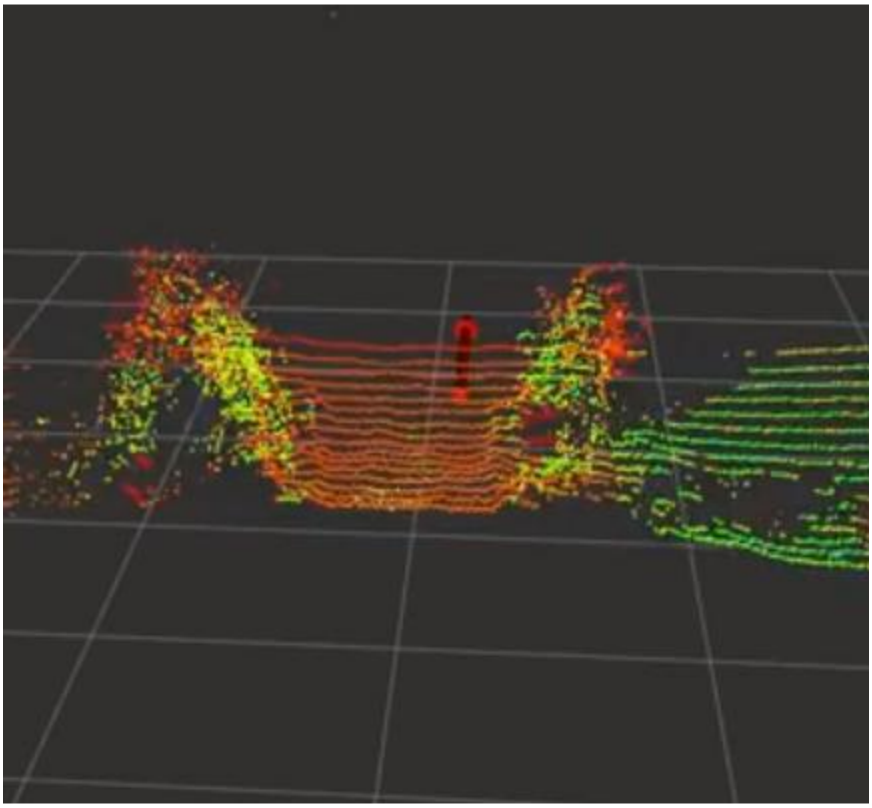

Fig. 1(a): Visual odometry tracking within the rows

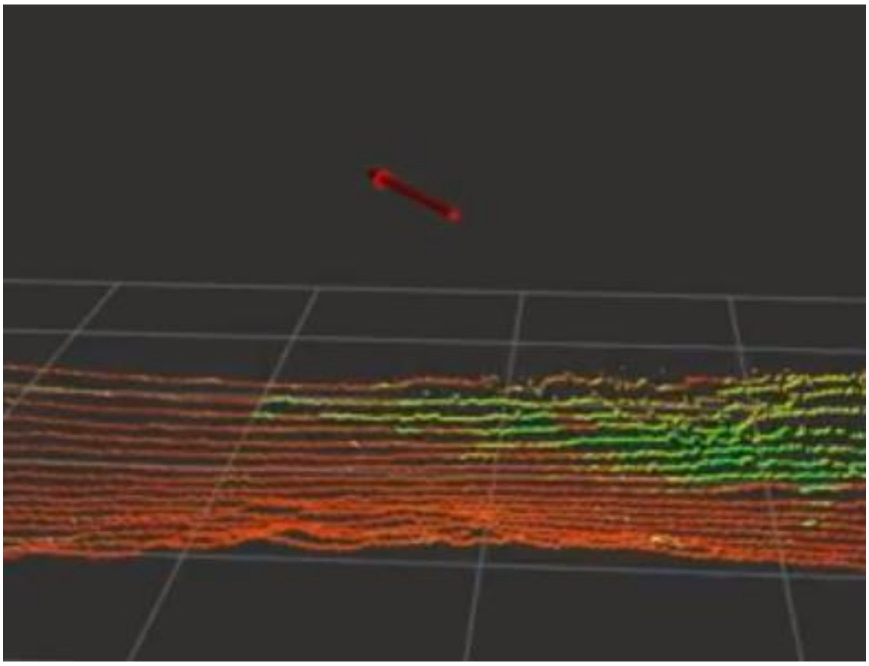

Fig. 1(b): Visual odometry tracking outside the rows

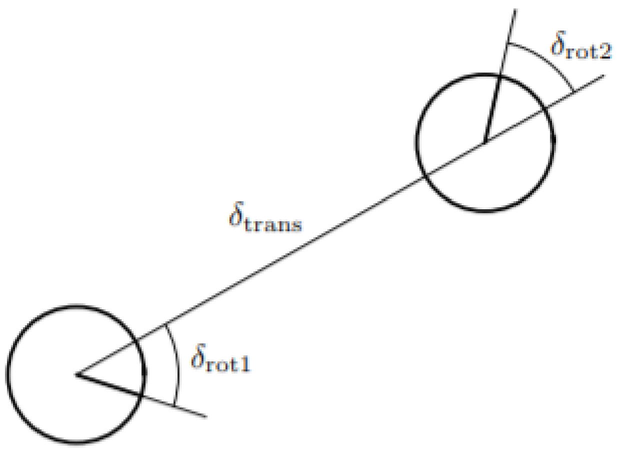

Fig. 2: Diagrammatic representation of the robot motion

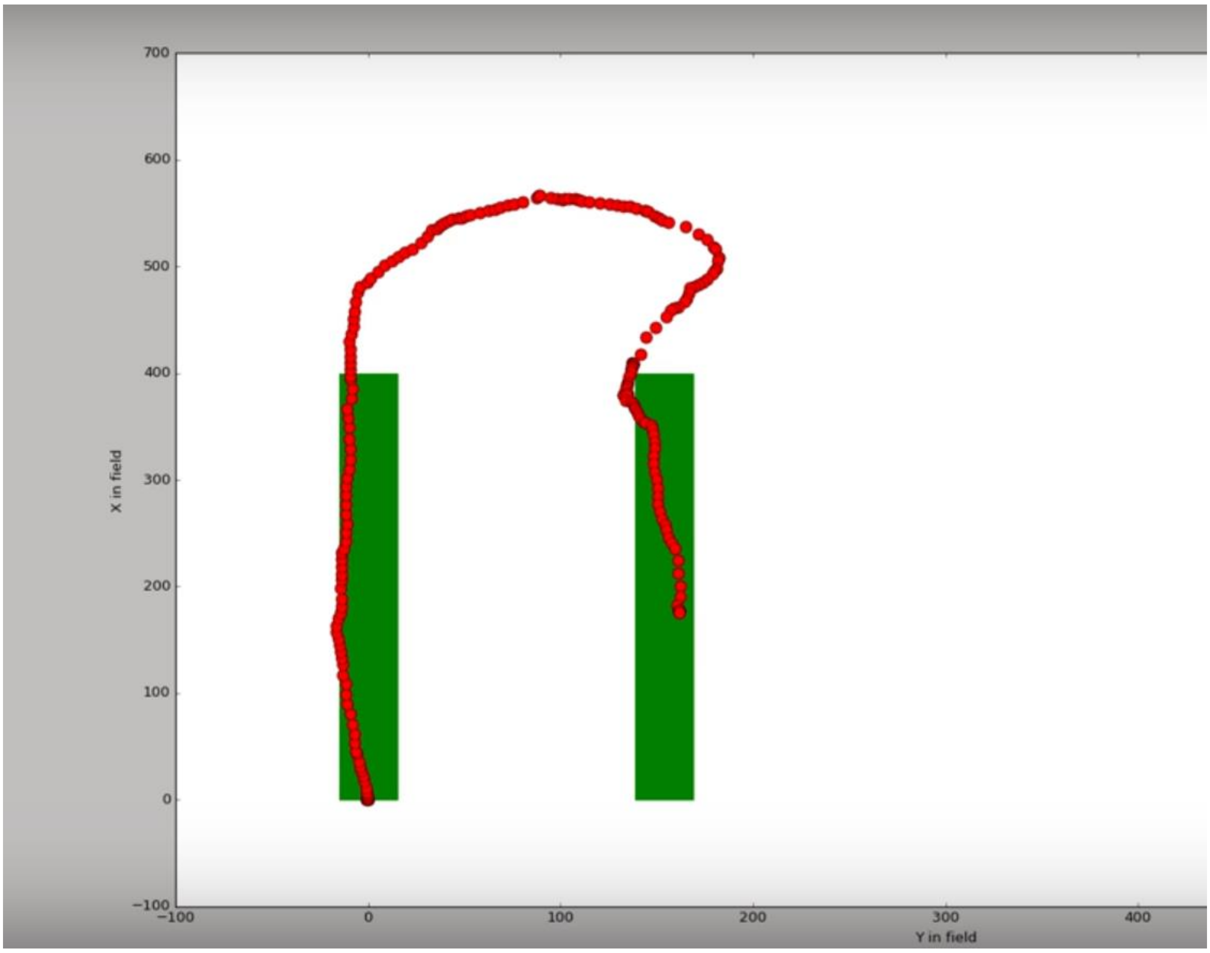

Fig. 3: Map and robot trajectory visualizer

Challenges

The major challenges faced during the recent phase of the project were deciding on the perfect pipeline for sensor fusion which will be relevant for the project. Linear and Non-linear least squares based methods were discussed as potential options for sensor fusion. However, these approaches were later dropped off due to lack of development time.

One specific challenge has been collaborating on specific code packages written by people for specific tasks and integrating them into one standard pipeline. It has also made me conclude that testing out the easiest options should always be preferred over the complicated ones, especially in case of real-world projects.

Teamwork

John Macdonald

John worked on software integration for this part of the project. He collaborated with Aman to develop and test out the planning and controls pipeline on the robot for straight line following and basic turning in indoor environments. He also worked with me in creating the particle filter pipeline which could be deployed easily on the robot.

Aman Agarwal

Aman worked on creating the core planning and controls pipeline for straight line motion and turning. He created a simulation of a coverage planner to traverse a field of crop rows with known width and height. He also worked on developing a new version of the mount for the ZED camera.

Hillel Hochsztein

Hillel worked on assembling the electrical subsystems for the new robot platform. He organized the Phipps outdoor field test by collaborating with officials from Phipps. He also utilized the robot's on-board supplies to power the ZOTAC.

Dung-Han Lee

Dung-Han Lee worked on a new version of the Mask R-CNN by using severity levels as a metric to signify the levels of holes and disease in a particular plant image. This has led to an improvement in the accuracy of the network to 75%.

Future Plans

Team

The future team goals for the upcoming weeks can be summarised as follows:

1) Test the complete particle filter pipeline on the robot in indoor and outdoor environments.
2) Improve the drive control algorithms on the robot to deal with edge cases related to turning which come up due to uncertain soil structure.

3) Develop a regression-based model to classify the severity levels which are output to the Mask R-CNN network.
4) Assemble and perform basic tests on electronic sub-systems and power distribution systems for the new robot platform.

Individual

The future individual tasks which are planned for the coming weeks can be summarised as follows:

1) Work on developing a measurement/sensor model for sensor fusion and test the results on the ROS Bag data collected from the Phipps visit.
2) Test the full particle filter pipeline on the ROS Bag data.
3) Collaborate on testing out the particle filter pipeline in real world outdoor and indoor scenarios.

Expected challenge

a. Dealing with edge cases and numerical issues involved with the particle filter while the robot tries to turn (especially for the measurement model).