Progress Review 2

Individual Lab Report 3

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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 SLAM pipeline for creating robust maps of the crop rows.

As a follow-up to the previous work, the last sprint involved developing further insights into the Lidar Odometry and Mapping (LOAM) algorithm pipeline and platform development work which has been described in the following sections.

Simultaneous Localization and Mapping

After developing a strong general understanding of the LOAM algorithm, the next step was to develop a well-defined process for quantifying the algorithm performance. The process started off with an in-depth reading of the source code and documenting what key points from the code. The explanations were kept terse and informative for utilizing the information for quick reference in the future. The documentation can be accessed via the given link.

With guidance from the Master's students from Prof. Kantor's lab, a test was designed to understand the effectiveness of specific parts of the algorithm. The test can be described as follows:

1) With the Velodyne-16P mounted on the Robotanist, drive the robot in a straight line. Specific focused will be placed on the laser_odometry frame and motion vectors to validate the success of the algorithm. A measuring tape can be used to quantify the LIDAR odometry performance.
2) The robot can be driven back along the same straight path and brought to the initial position. The drift between the predicted location and actual odometry can be measured using a measuring tape. Figure 1 showcases a suitable drift calculation experiment with a more complicated trajectory.

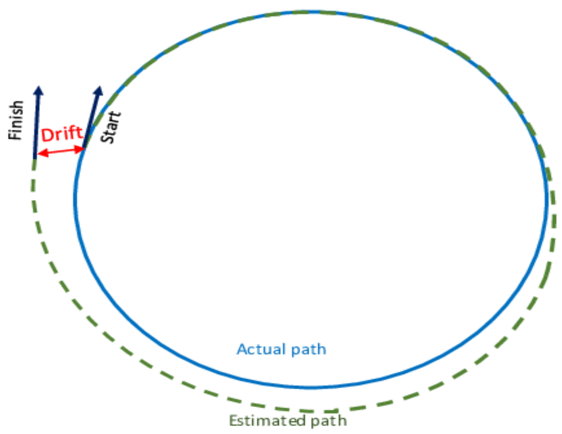

Figure 1: Testing efficiency of the LOAM algorithm

In the coming weeks, these basic tests will be performed to provide initial quantitative results on the SLAM algorithm performance.

Testing SLAM on Intel NUC

During the past week, the Intel NUC was set up by John for testing the HEBI motors. The Velodyne-16P was interfaced with Intel NUC. The LOAM algorithm was smoothly tested in real-time, validating the choice of Intel NUC as a companion computer to run the SLAM algorithm. All the upcoming performance tests will be directly done using the Intel NUC platform.

ZOTAC Setup

The ZOTAC EN1070K companion platform will be utilized for the monitoring process for training algorithms and to utilize the ZED Stereo camera. This setup includes an NVidia Geforce GTX 1070 GPU, 32 GB RAM, and 1 TB SSD Memory. This was the first time I assembled a computer from scratch and it was a good practical learning experience.

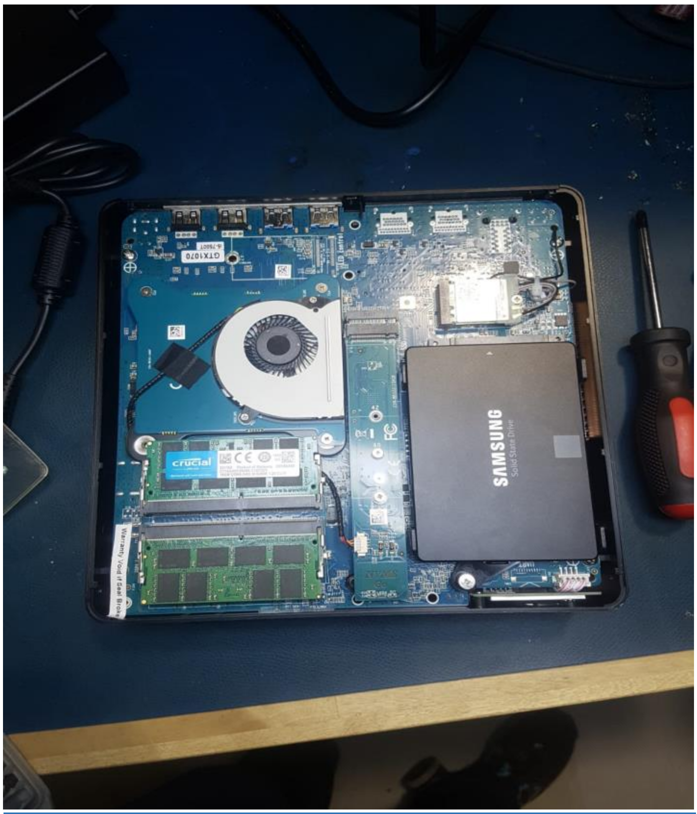

Figure 2: Internal Architecture of the ZOTAC EN-1070 Platform

Challenges

Capstone Project

My main target for this phase of the project involved developing a deeper understanding of the LOAM algorithm. A key sub-task was to check the algorithm performance with previously collected ROS Bags from the farm visit in September

2018. However, the ROS Bags collected previously had utilized a Quanergy LiDAR for acquiring point clouds. However, a lot of specifics of the LOAM algorithm like range data projection functions, horizontal and angular resolution, were based on Velodyne-16P. Hence, using the Quanergy LiDAR data would require significant changes in the LOAM source code, which was not planned for this phase of the project. The problem will be solved by collection of new LiDAR point cloud data from the Velodyne-16P during the upcoming farm visit on March 12th.

Secondly, this part of the project utilized a lot of unplanned time in systems integration. This included setting up ROS packages on the companion computer to be used with the Robotanist. The time required for system integration will have to be estimated conservatively in the schedule for future sprints.

Teamwork

Capstone Project

John Macdonald

John wrote an evaluator node which compares the sensor observations with the ground truth. He worked on setting up the HEBI motor controllers to actuate the HEBI motor. He is currently working on improving the performance of the particle filter for the localization task.

Aman Agarwal

Aman worked on the final edits for the drawings of the robot assembly before sending the drawings for manufacturing. He is currently creating initial versions of the controllers for following a straight line along the crop rows.

Hillel Hochsztein

Hillel manufactured the first prototype for the cultivator. He created a tilt mount to mount the Velodyne-16P LiDAR on the Robotanist, He worked on the initial version of the PCB circuit for the fan-thermostat based cooling system. He is currently working on creating schematics for the PCB circuit and testing the robustness of the cultivator.

Dung-Han Lee

Dung-Han Lee re-trained the Mask R-CNN network by training all layers using 500 training labels for 1 type of plant. He is currently working with association with me to create a trigger circuit for the active stereo camera for the monitoring task.

Future Plans

Team

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

1) Analyze and compare alternative neural network architectures and classical vision approaches to improve precision and recall for the disease and hole detection tasks.
2) Discuss the impact of schedule risks associated with manufacturing lead times and assembly times with Prof. George Kantor.
3) Develop a line-fitting based approach to improve localization accuracy within crop rows.
4) Start integrating and testing power electronics, network systems, motors and camera hardware for future robot assembly.

Individual

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

1) Perform outdoor tests to quantify LOAM performance outdoors.
2) Work with Dung-Han Lee in creating a trigger circuit for the active stereo camera. Following that, a ROS node will be created to trigger the camera.
3) Setup the 2.4 GHz radio for networking between different electronic sub-systems.
4) Interface ZED Camera with the ZOTAC and perform basic AR Tag detection using the ZED Camera.