Progress Review 3

Individual Lab Report 4

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March 28th, 2019

Team E:

Wholesome Robotics

Teammates:

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John Macdonald

Dung-Han Lee

Aman Agarwal

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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, the last sprint involved integrating the ZED camera with the on-board GPU and getting initial visual localization and odometry results from the camera.

Field Test and results relevant to localization

During the spring break, John and I drove to Rivendale farms in order to get initial test results related to localization and mapping. The results can be summarized as follows:

a) The robot was able to cover 60% of the row utilizing a naïve approach which works directly on LIDAR measurements to estimate the extent of the row and utilises a PID controller to stay within the row.
b) A 3D map of the row was not deemed necessary for the process of localization as was removed as a necessary requirement for localization.

During the field visit, I worked with John to set up the RTK GPS base station and develop a better understanding of the robot hardware. The challenges during the field visit will be described in detail in the challenges section.

Visual Odometry using ZED camera

One of the major task for the team (also reflected in the Spring Validation experiments) is the ability of the robot to successfully localize itself in the row. One additional challenge has been added to the development of this algorithm as the robot has to localize even outside the row while it is switching from one row to another.

One important step towards achieving this involves fusing state information from the LIDAR, ZED camera and IMU. The recent work has been in setting up the ZED camera and to get visual odometry on which will be used for estimating motion along the row. The step followed can be summarised as follows:

1) The NVidia 410 drivers with CUDA 9 with the ZED 9.0 SDK was installed and set up for operation with the ZED camera.
2) The ZED camera's default visual odometry and tracking algorithm were utilized. Some initial tracking tests were performed in indoor environments.

Figure 1 shows the tracking results of the ZED camera over an arbitrary part. The red path showcases how the ZED camera localizes itself using pure visual odometry and is able to return back to the same position from which it has started,

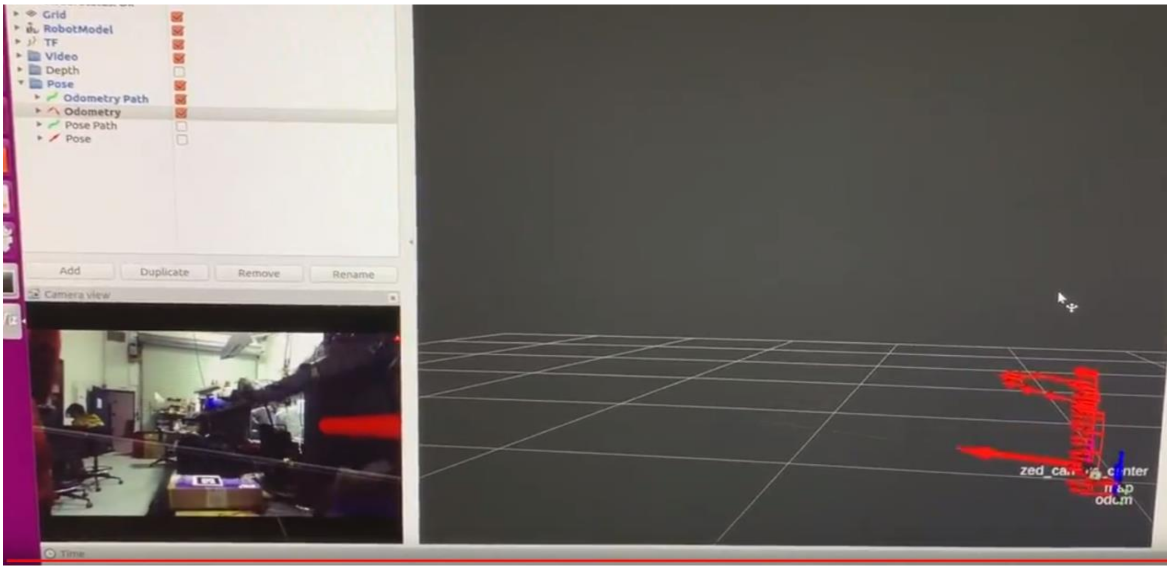

Fig 1: Visual Odometry with ZED camera in indoor environments

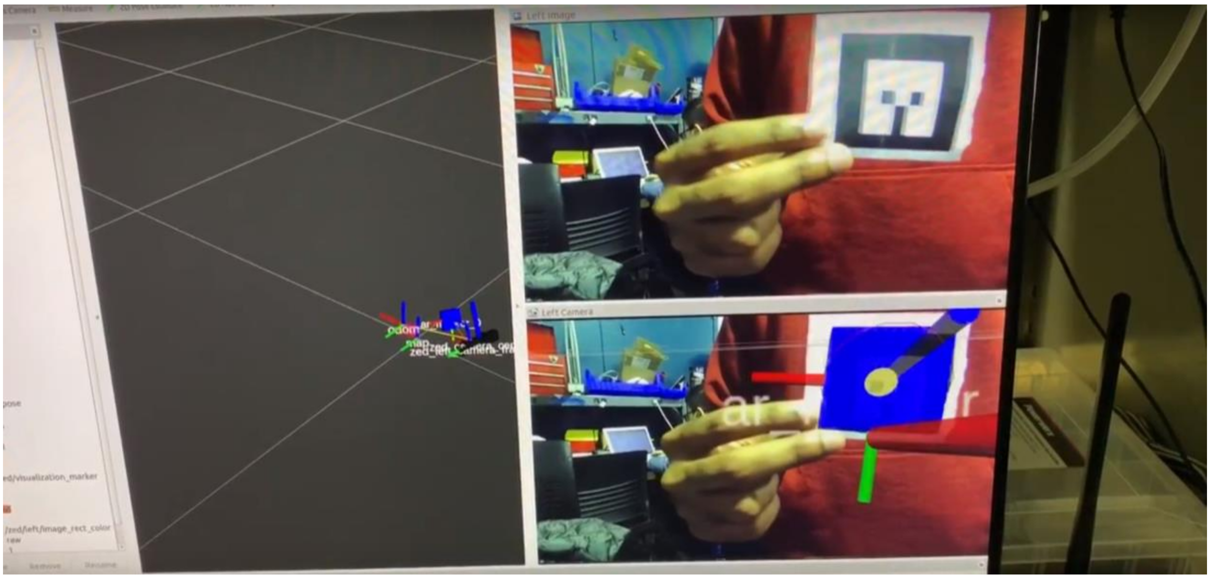

Fig 2: AR Tag detection and tracking using ZED camera

AR Tag detection and tracking using the ZED Camera

In order to provide a global estimate, to indicate that the robot has reached the end of the row, AR tags will be utilized. These AR tags will allow the robot to capture an absolute transformation between itself and a fixed landmark. Figure 2 shows the AR tag detection and tracking results using the ZED camera.

Challenges

The major challenges faced during the recent phase of the project were hardware related issues with respect to using the robot during the field visit for initial algorithm tests.

One specific challenge was that we had less information (sparse documentation) on how the RTK GPS base station and long-range WiFi communication antenna would be set up. This led to some wastage of time which could have been allotted to collecting more data. The conclusion from the previous field visit is that extensive testing as well documentation is required in order to deal with the hardware aspects of the project.

Teamwork

John Macdonald

John worked on developing an initial pipeline for row navigation and row perception which was utilized during the recent field visit. He also worked with Dung-Han Lee to use the active-lighting stereo camera to obtain leaf area using depth maps. He is currently working on developing a pipeline for ground segmentation as well as providing row measurements using the LIDAR.

Aman Agarwal

Aman worked on creating a design for mounting the ZED camera. He is currently working on creating an initial planning pipeline which will utilize map information to create a global path for in-row navigation and switching rows.

Hillel Hochsztein

Hillel worked on creating the PCB design for creating the fan-based cooling system for the robot’s on-board computers. He is currently researching and developing documentation to be able to assemble the on-board electronics for the new robot platform.

Dung-Han Lee

Dung-Han Lee has been working on evaluating alternative metrics to quantify the output from the Mask R-CNN network. He also worked on utilizing the active stereo camera to obtain a depth disparity map to estimate leaf area. He is currently working on labeling and training the network for learning disease and pest pressure severity metrics from the data.

Future Plans

Team

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

1) Develop new metrics for quantifying the plant health monitoring process which could be directly useful for the farmers. This will also involve labelling the test data according to this new metric.
2) Transfer the monitoring system to the on-board computing unit and test the full data collection and analysis pipeline.
3) Design and test the first version of the sensor fusion algorithm for in-row localization.

4) Develop a path planning pipeline which takes in input data from the map file and generates the path which the robot should take (both in row and while switching rows).

Individual

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

1) Write ROS nodes to collect information from ZED Stereo camera and IMU in real-time which at a rate which will be useful for the localization information.
2) Develop an initial version of the algorithm which will be used to fuse information from the IMU, ZED Stereo camera and the LIDAR data in order to localize the robot within the row.

Expected challenge

a. Create a general localization algorithm which can generalize for both in-row localization and localization while switching rows.