ILR09

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Team E: Wholesome Robotics
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Date: October 24, 2019

Individual Progress

Robot Localization

The current aim is to fuse the data from IMU, RTK GPS and Visual Odometry(VO) from ZED camera. The motivation is to get accurate yaw data and position data which does not oscillate due to uneven ground causing excessive GPS oscillations. This was made the focus of development after the last field visit where we saw that the robot's map transforms from UTM to map frame was inaccurate by a few degrees, leading to the robot hitting the row of plants. To do this fusion, robot_localization package was selected due to its widespread use, ability to fuse data from multiple sensors and also because other MRSD teams have made use of the package and thus can possibly support us in case we need to debug the problem.

After consulting teams which used the package before, I was highly recommended to go through the documentation of the package as misunderstanding the package was the most common reason where the teams were stuck.
Since the aim is to fuse continuous sources of data like IMU and Visual Odometry, along with absolute position i.e. the RTK GPS. The package recommends 2 separate fusion algorithms, one running fusion between IMU and VO and other running fusion between RTK GPS, IMU and VO. These separate nodes are required as GPS does not provide continuous measurement, further robot_localization makes use of three frames. First, is the 'base_link' frame which is the robot's frame, the next is the 'odom' frame which is the frame at the robot's starting position, the position in this frame can be subject to drifts and the 'map' frame which is a world fixed frame, the position in this frame need not be continuous and can have discrete jumps.
Thus, the first fusion between VO and IMU provides transform from odom to base_link whereas the second fusion node provides transform between map and base_link however to ensure consistency in the TF tree, its published as a transform from map to odom frame. The following figure represents the high-level architecture.

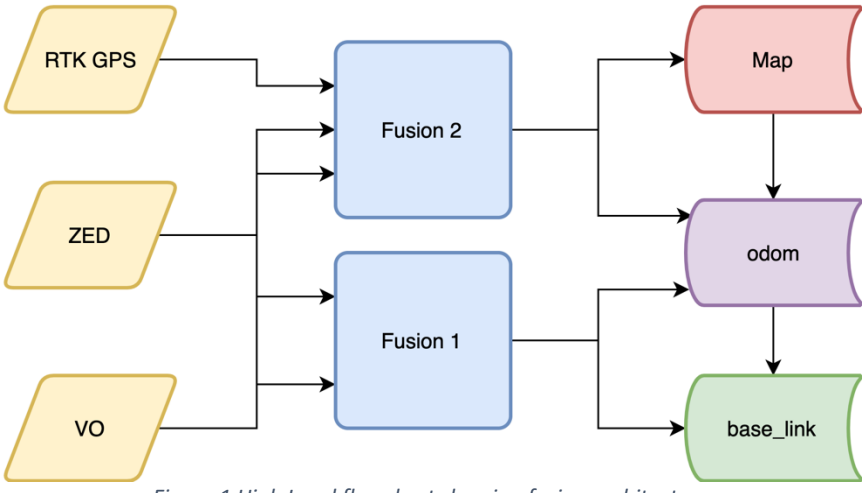

Figure 1 High Level flowchart showing fusion architecture

Challenge

ZED data does not have covariance data

The data collected in all the last few field visits stored the /zed/pose topic which does not contain covariance data. We need to store "/zed/odom" topic as the "robot_localization" package does not allow fusing pose data without covariance. For now, I have set up an intermediate node which publishes data at a user defined covariance.

IMU orientation

The package requires that the IMU stores data in ENU mode i.e. a frame aligned along East, North and Up. The output of the IMU currently installed seems to be in NED mode, i.e. North-East-Down frame. Further analysis of this is being done and I might write a transform node to transform the data from NED to ENU mode.

Choosing Parameters for Sensor-fusion

The package requires the user to set a lot of parameters before the fusion works well. Especially important ones are the initial covariance and process noise, these are quite difficult to tune and take significant amount of effort.

Teamwork

The team is working towards completing a fully functioning version of the entire robot working by the next PR. John and I are focusing on completing the Navigation MVP, from previous semester we are confident that the control and planning are pretty effective if localization is accurate. Thus, the focus is on getting the localization working properly as that is the only barrier towards achieving a working MVP. On the monitoring part Aaditya and Hillel are working on correcting final kinks in the Monitoring Visualization subsystem. Dung-han lee has a version of the inference pipeline already working with Masked-RCNN achieving 70% precision and recall. He is looking at alternative methods otherwise will stick with this itself. Once these issues are sorted out even an MVP of Monitoring will be complete. Aaditya is also going to join me in the fusion process and is currently reading literature on fusion process so that he can assist in tuning the system well.

Aaditya:
Correcting final flaws in visualization pipeline and helping in fusing data.

Dung-han Lee:
Trying out simpler segmentation methods to improve performance of the inference pipeleine.

Hillel:
Adding features to visualizer and correcting issues in visualization pipeline.

John:
Improving row-detection and looking to utilize that for localization and navigation

Future Plans

Team:

Complete Monitoring MVP

Complete Navigation MVP

Individual:

- Fuse data from IMU, RTK GPS and Visual Odometry