ILR10

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Individual Progress

Robot Localization Progress

From last progress review the focus was to get the package working, there were some challenges which were covered in the last progress review, like the covariance data missing from the sensor output, the local fusion node's output was always coincident with that of the visual odometry.

These challenges were handled by creating a new node which listens to the output of all these sensors and publishes another topic which has some user set covariance added to it. This ensured that the covariance observed by the robot localization package was not 0.0, which according to the package's documentation is automatically set to 1e-6 by the package. Further, by setting the initial covariance of the filter and covariance of ZED and IMU, I was able to ensure that the local fusion does not reject the IMU data which was my observation before. Manually setting covariance for these sensors, introduced another parameter to tune in the filter which ideally should be provided by the sensors and not set by me. In the future, Aaditya is working on estimating these values by calculating the mean and standard deviation about the zero-value obtained when the robot is static.

We tested the robot localization last Friday during a field visit. Before the field visit, I tuned the package on an old Ros-bag ensuring the package is decently stable and provides enough accuracy for our application. To ensure low noise in the estimate, I reduced the problem to 2D, i.e. (x,y,theta) frame, as other variables like roll and pitch were adding unnecessary noise to the estimate.

During the field visit, the performance of the filter was not good, the estimate was oscillating a lot and caused the robot to hit the row of plants during the autonomous navigation task. The following picture shows the estimate of localization from local fusion(yellow arrow) and global fusion(red arrow)

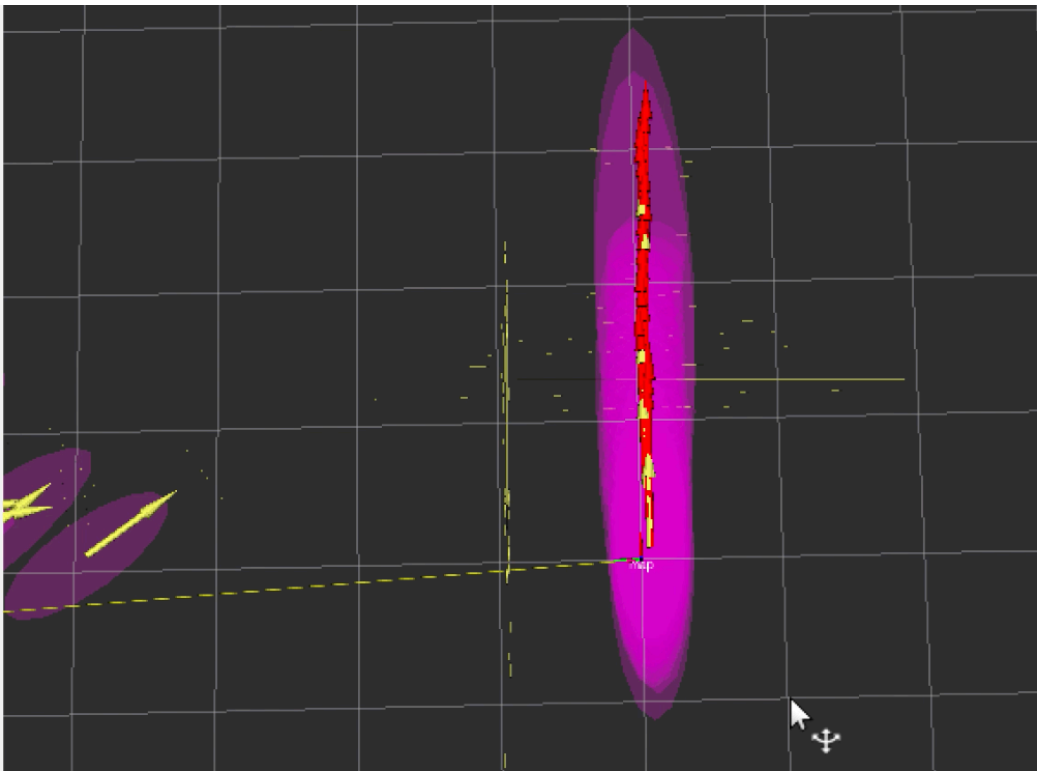

Figure 1 Position estimate from local and global fusion

I discussed with Aaditya to identify possible sources of error which could cause this issue. The identified sources of error are listed below-

1) **Misaligned sensor output**

   The robot localization package adheres to the REP-105 standard. According to the standard various sensors are expected to provide output in a particular orientation. For example, the IMU is expected to provide output in ENU mode i.e. East-North-Up mode. IMU's often provide output in NED mode, i.e. North-East-Down mode. Similarly, for Odometry, according to the way the static transform between the base-link and ZED camera are published, the robot should be along the X-Axis of the ZED camera. This is important as ZED provides us visual odometry and a misaligned axis can lead to erroneous position and orientation estimate. To verify this issue, we plan to physically move the robot in the desired position and orientations and verify that the sensor outputs conform to the discussed standards.

2) **Inaccurate Sensor Covariance**

   The covariance of IMU and ZED camera were chosen arbitrarily, the initial covariance and process noise were tuned according to the chosen sensor covariance on the ros-bag. These covariances might be underrepresenting the actual covariance of the sensor causing the filter to fuse the inaccurate readings with a higher confidence than it should. To tackle this issue, Aaditya wrote a script to measure the mean and variance of all sensor outputs calculated when the robot is static. This will ensure that the fusion process is more accurate.

3) **Improperly tuned Initial Covariance of state and Process Noise**
The package assumes that the robot is omnidirectional, this could lead to improper estimate of position as our robot follows a differential drive mechanism. Thus, the process noise as well as initial covariance have to be tuned appropriately. The current plan is to tune them directly on the robot after updating the sensor covariance.

Over the last few days, I have been able to resolve almost all these issues and now have a very stable filter working for the local fusion and hopefully the global fusion values would not be very far off. This would be done during outdoor testing at CMU itself, before the field visit on Sunday.

Challenges

1) **Erroneous output on same ros-bag**
While checking the rosbag of the field visit, I noticed that the robot_localization package often gives very noisy output. The cause of that bug has not been identified yet, but further pushed us to focus on direct robot testing than on a ros-bag.

2) **TF conflict**
During recent testing on the robot after the last field visit, I noticed that as soon as the robot_localization package starts, the zed and the package start causing a TF conflict due to inaccurate time. This was unexpected and took a lot of time to debug. Finally, with the help of Michael Fan, I was able to find the source of the issue which was inconsistent time between the robot's computer and the Zotac to which the Zed camera is mounted. This was resolved by time syncing the clock of the two computers.

3) **RTK GPS not working**
During our recent outdoor testing at CMU, we were not able to make the RTK GPS system work on the robot. Thus, the global fusion covariance values are still not tuned well and will be done soon. Debugging this is difficult before Sunday as John who has historically handled RTK GPS debugging is not available in Pittsburgh.

Teamwork

The team is still working towards completing a fully functioning version of the entire robot. We have the monitoring pipeline complete with endeavor to get more labelled data to improve the performance. The navigation pipeline is still not working well where localization seems to be the bottleneck in our work.

Aaditya:
He is helping me debug/tune the robot_localization package and is also handling outsourcing of data labelling.

Dung-han Lee:

Trying to improve the monitoring pipeline results and working with Aaditya to outsource data labelling

Hillel:
Adding plant guards and adding more features to the visualization pipeline.

John:
Improving row-detection and handling logistics for field visit.

Future Plans

Team:

Improve Monitoring MVP
Complete Navigation MVP

Individual:

- Tune the robot localization package
- Evaluate methods to further improve the planner