Swarm UAVs for Area Mapping in GPS-Denied Locations

Team Lead: Daniel Golan

Advisors: Dr. Sergey Drakunov

Student Team: Bryan Gonzalez, Patrick Kennedy, Ryan Taylor, Ethan Thomas, Joseph Perry, Ryan Ebrahimi, Kyle Fox

Introduction

- Fuses multiple point clouds from a swarm of drones to gain different points of views with an outcome of a higher fidelity map and a denser point cloud.
- Each Unmanned Aerial System (UAS) is nearly autonomous and operates within GPS-Denied locations through the use of Simultaneous Localization and Mapping (SLAM) and a sensor suite using an Extended Kalman Filter (EKF).
- The UAS generates a point cloud during the flight and then uses it to localize within its known world frame as well.
- Establish communication via MAVlink between the companion computer and Flight controller (FC), while using Wifi to send and receive ROS (Robot Operating System) nodes that facilitate communication between entities within the swarm.

Figure 1: UAS with camera and companion computer

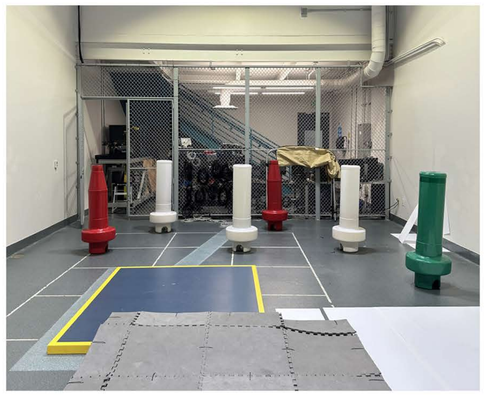

Figure 2: Testing Facility

Figure 3: 1 Point Cloud

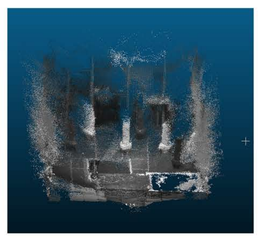

Figure 4: 3 Fused Point Clouds

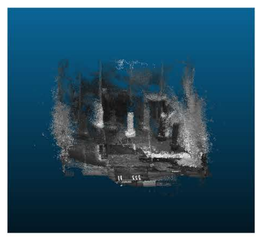

Figure 5: 5 Fused Point Clouds

Methods

- The FC determines the original position and pose using the EKF while RTAB-Map determines the drones real-time odometry and local positioning, all of which is updated via ROS nodes.
- RTAB-Map and VIO run through ROS coupled with OpenCV through the onboard Latte Panda 3 Delta.
- A transformation matrix is applied to the incoming map RTAB-Map data to align it with the VIO frame.
- The post flight data is processed, modified, fused, and analyzed with CloudCompare.

Results

- The drone can autonomously run a predefined flight plan while accounting for initial IMU drift.
- There is an appropriate amount maps that can be fused before the point clouds become oversaturated and too dense to be usable.
- The SLAM algorithm is suitable for predicting actual odometry with a high enough fidelity to account for errors during takeoff and landing.

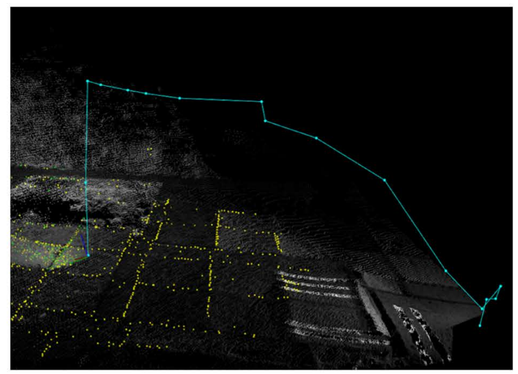

Figure 6: Odometry from pitch translation flight within the generated map

Conclusion & Future Work

- The UASs were able to consistently create a point cloud autonomously using a predefined controller. The issue of drift and stability that is being addressed by getting a new frame partnered with post-flight PID tuning. The next steps are to apply this autonomous program to a full swarm using a dual quaternion controller.