Carnegie Mellon

FlySense-Augmented Reality Based Assistive Technology for Safe Aerial Navigation

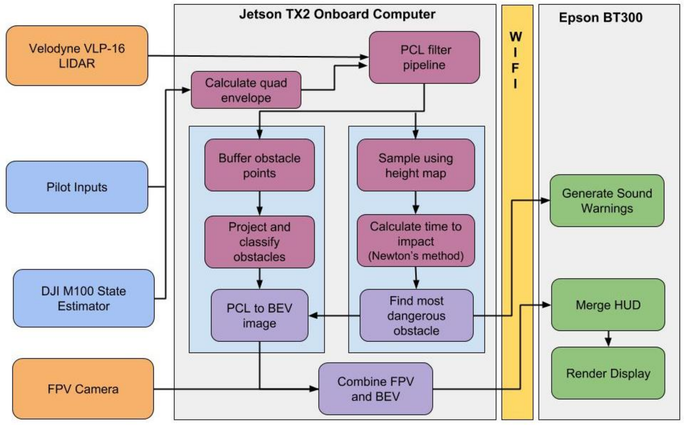
Shivang Baveja, Nick Crispie, Joao Fonseca, Harikrishnan Suresh, Nihar Tadichetty

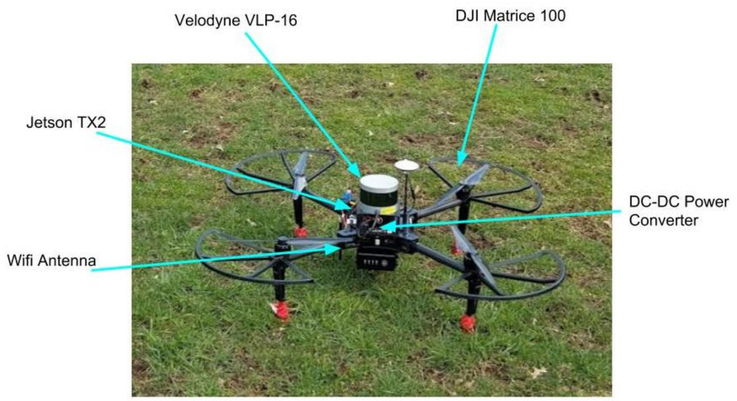
Carnegie Mellon University
The Robotics Institute

NEAR EARTH AUTONOMY

Overview

- Helicopters are very dangerous to fly, especially in task saturated landing situations.
- Developed an easy-to-use hybrid robotics system to give a pilot additional knowledge about the dangerous surroundings



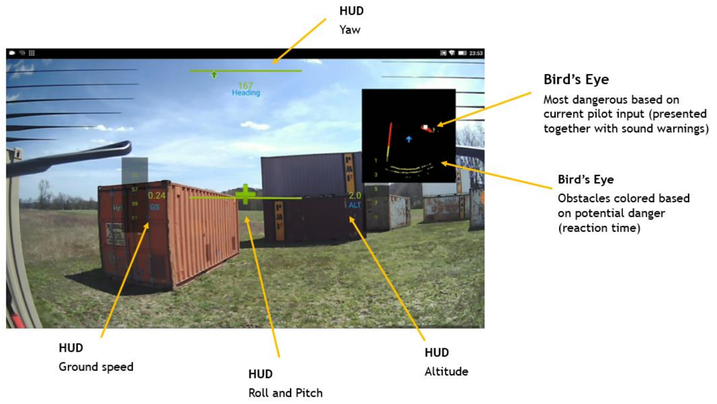


Testing

- Tested full system with NEA Pilots at Nardo Airfield

User Interface

- Single screen with FPV video overlaid with Bird's Eye View (BEV) and Head's Up Display (HUD)
- BEV provides 360º situational awareness
- HUD provides real-time feedback from the quadcopter with all relevant sensor information.

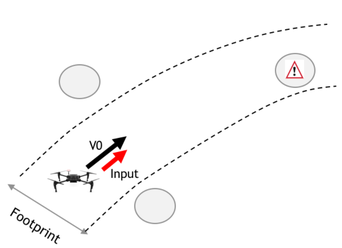


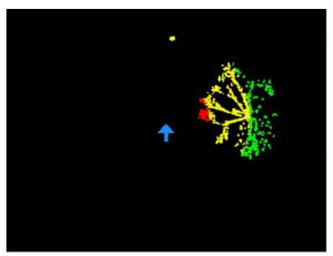
Point Cloud Processing

- Raw point cloud data cropped based on dynamic window
- Down sampled by 90% using a voxelized grid approach
- Outliers filtered out using point neighborhood statistics

Bird's Eye View

- Output of PCL processing registered in the global frame and buffered
- Buffered point cloud transformed back to the body frame, projected into 2D space and classified into red/yellow/green zones based on maximum possible pilot input.
- The most dangerous obstacle alerting the pilot through beeps flashes as a white dot.



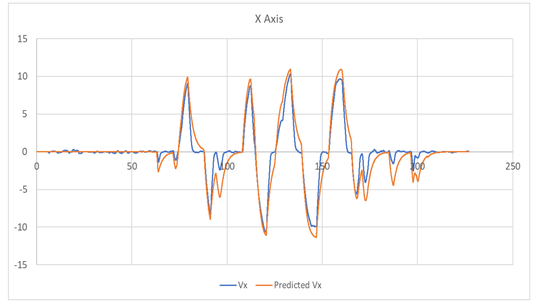


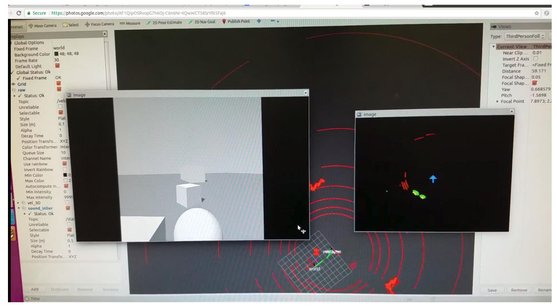
Sound Warnings

- Output of the PCL pipeline further sampled using a height map algorithm to get the relevant obstacle points
- Newton Raphson method used to combine the obstacle information with the current state estimate and the actual pilot input determines the most dangerous obstacle to the vehicle.
- Frequency of audio warning determined based on time to impact

Dynamics Modeling and Simulation

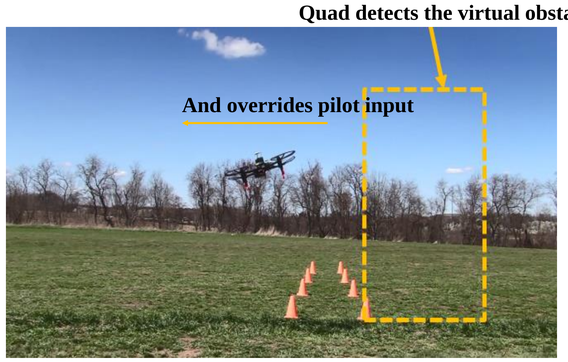
- Modeled the entire quadcopter dynamics to test the projected vehicle states to test Emergency Brake
- Developed a simulated system in Gazebo to test our Bird's Eye View and our Emergency Stop functionality before trying it in the air





Emergency Brake

- Emergency brake uses a feed-forward control, based on the quad dynamics, to override pilot inputs that would lead to a collision with an obstacle
- Controller accepts all other pilot inputs



Future Work

- Full perspective view on AR user interface
- Improve BEV by registering point cloud and build a map of the surrounding obstacles, not just the ones that are immediately visible
- Sample points for emergency stop better and implement better control scheme
- Improve latency by down-sampling video stream