Trajectory Following in GPS Denied Environments for UAVs using Receding Horizon Control

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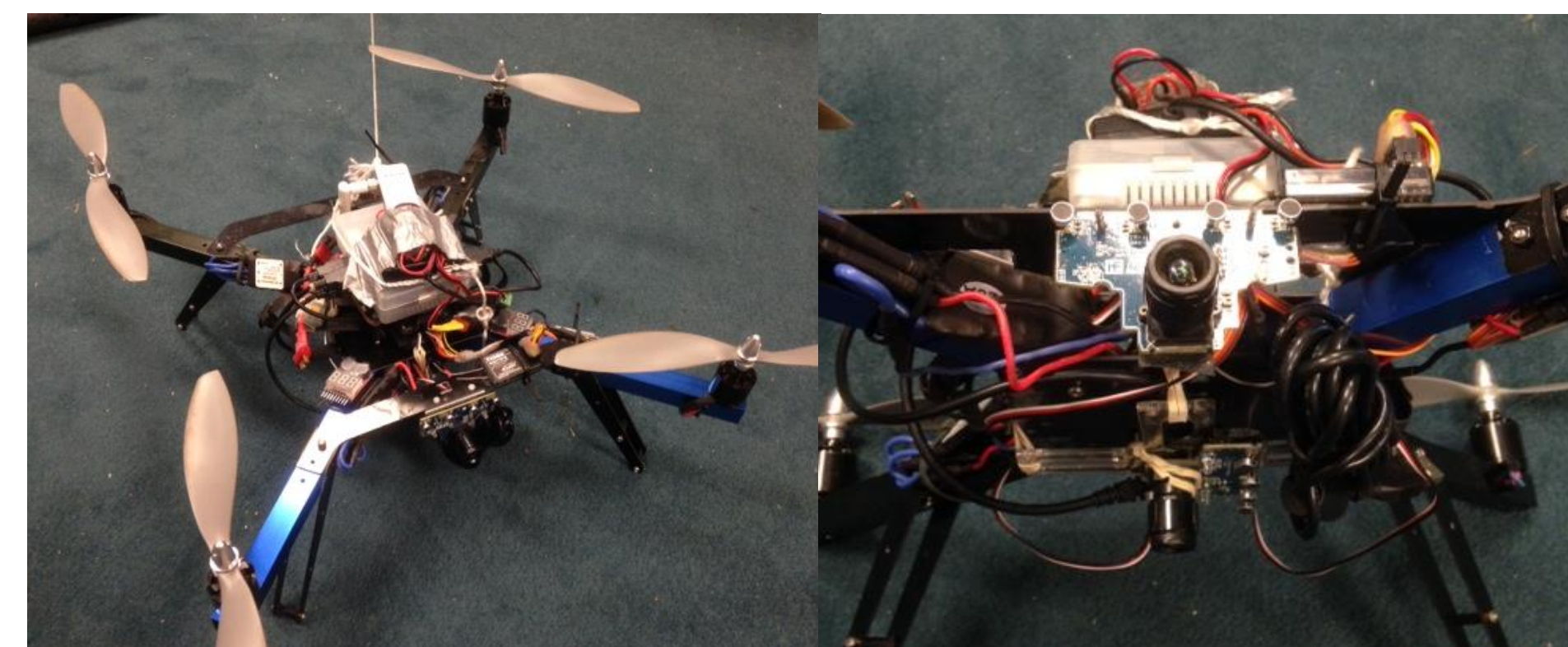
MOTIVATION

1.5m/s

PLATFORM

REACTIVE CONTROL
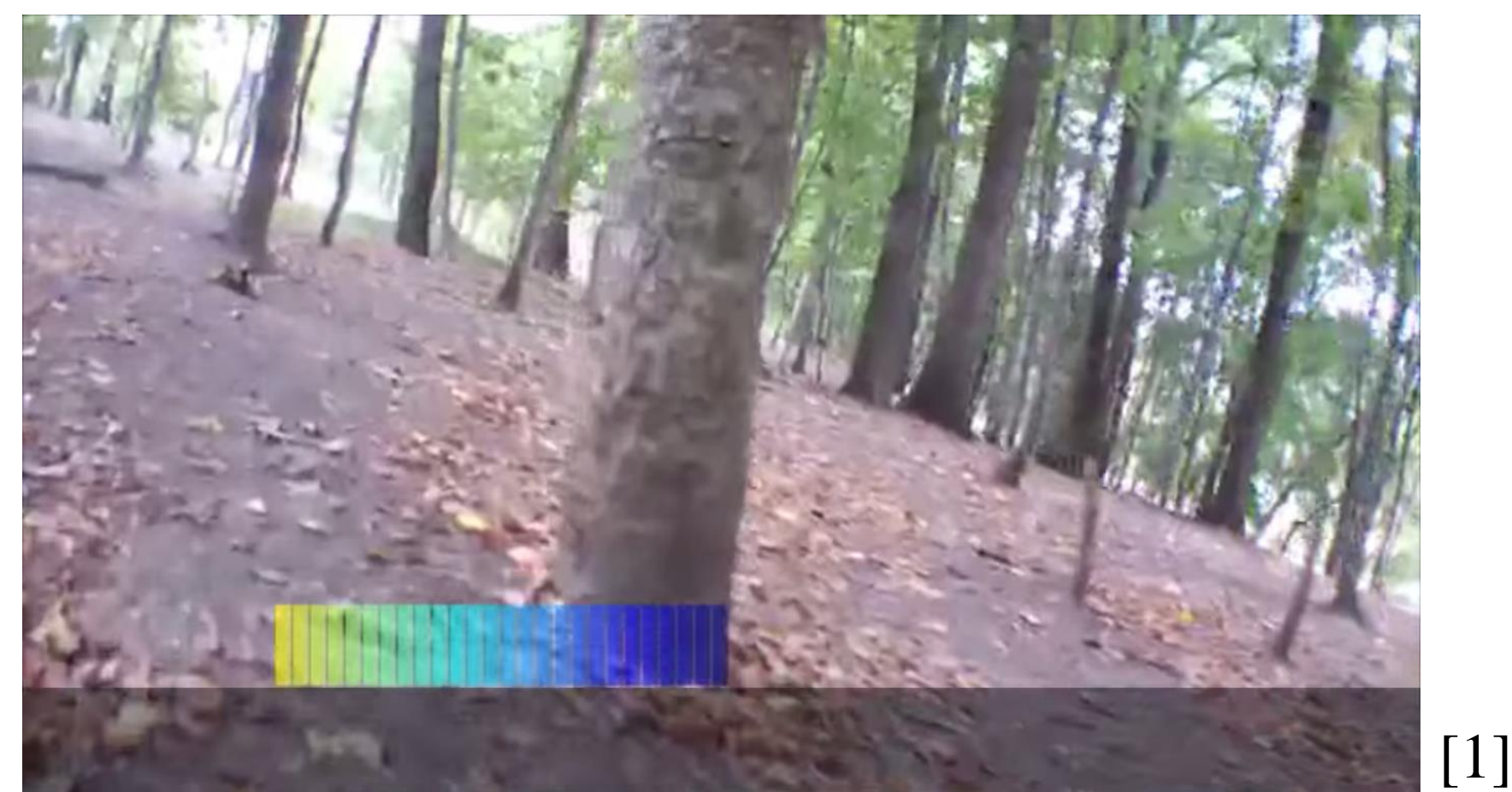
[1]

Pros:
• No Mapping

Cons:
• Myopic

DELIBERATIVE PLANNING
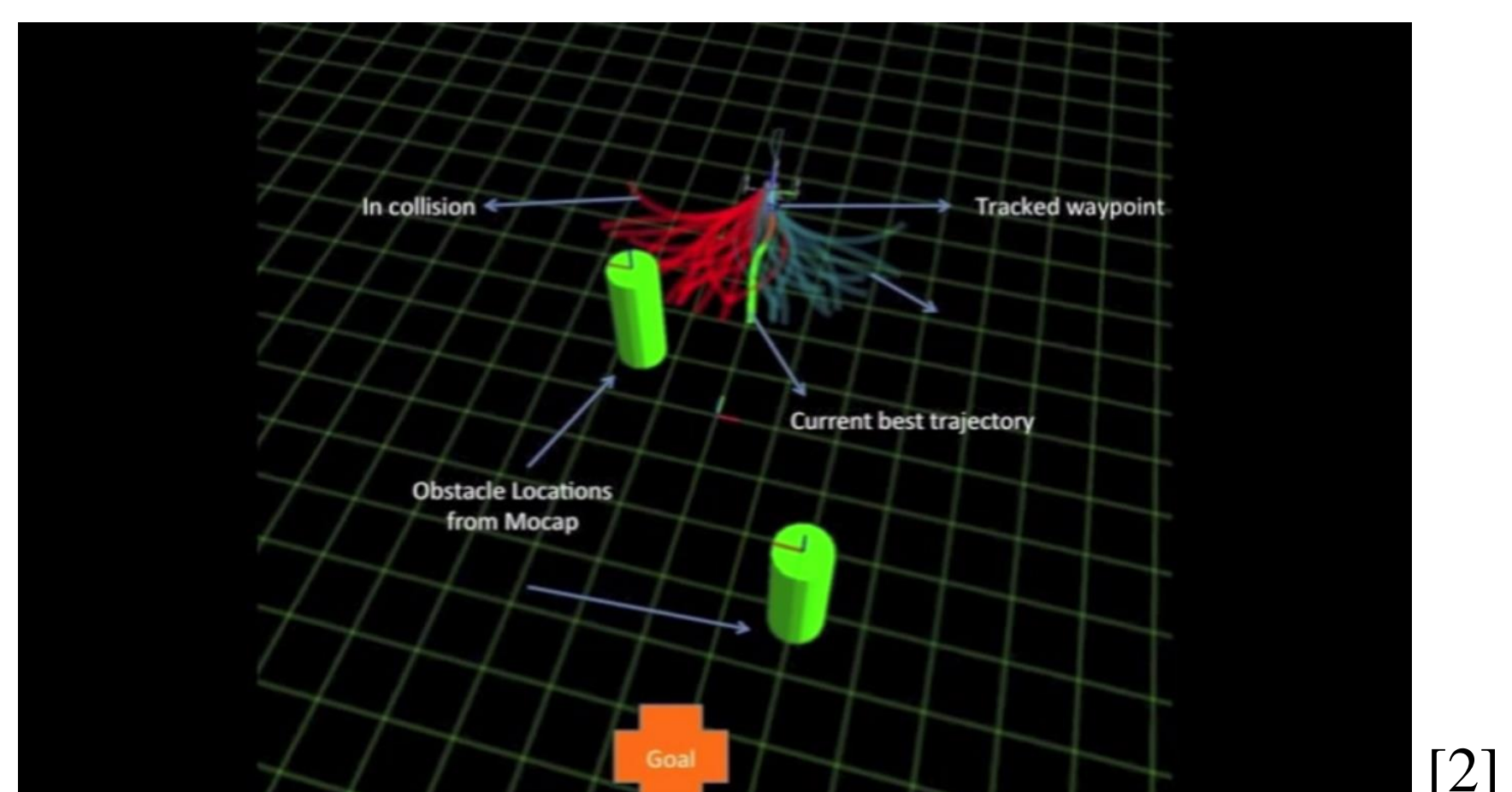
In collision   Tracked waypoint
Current best trajectory
Obstacle Locations from Mocap
Goal
[2]

Pros:
• Goal Planning

Cons:
• Computationally more expensive.

APPROACH

Forward Facing camera → Video Stream → Perception → Point Cloud → Receding Horizon Control → Trajectory to Follow

Roll, Pitch, and Yaw Rates (RPY Rates)

Downward Facing → Video Stream → Pose Estimation → Position and Velocity → Pure Pursuit Controller → Desired drone velocity → Control Loops

Trajectory from receding horizon control → Trajectory Follower → Desired Position → PD control on position → Desired Velocity → PD control on velocity → Desired RPY → PD control on pose → Desired RPY Rate → Ardupilot

Estimated Position
Estimated Velocity
Pose Camera
Estimated RPY
Estimated RPY Rate
IMU
RPY Rates
Motors

RESULTS

• Initially, the drone oscillated significantly around its desired trajectory as shown below:

• Tuning several parameters allowed us to rapidly improve trajectory following performance.
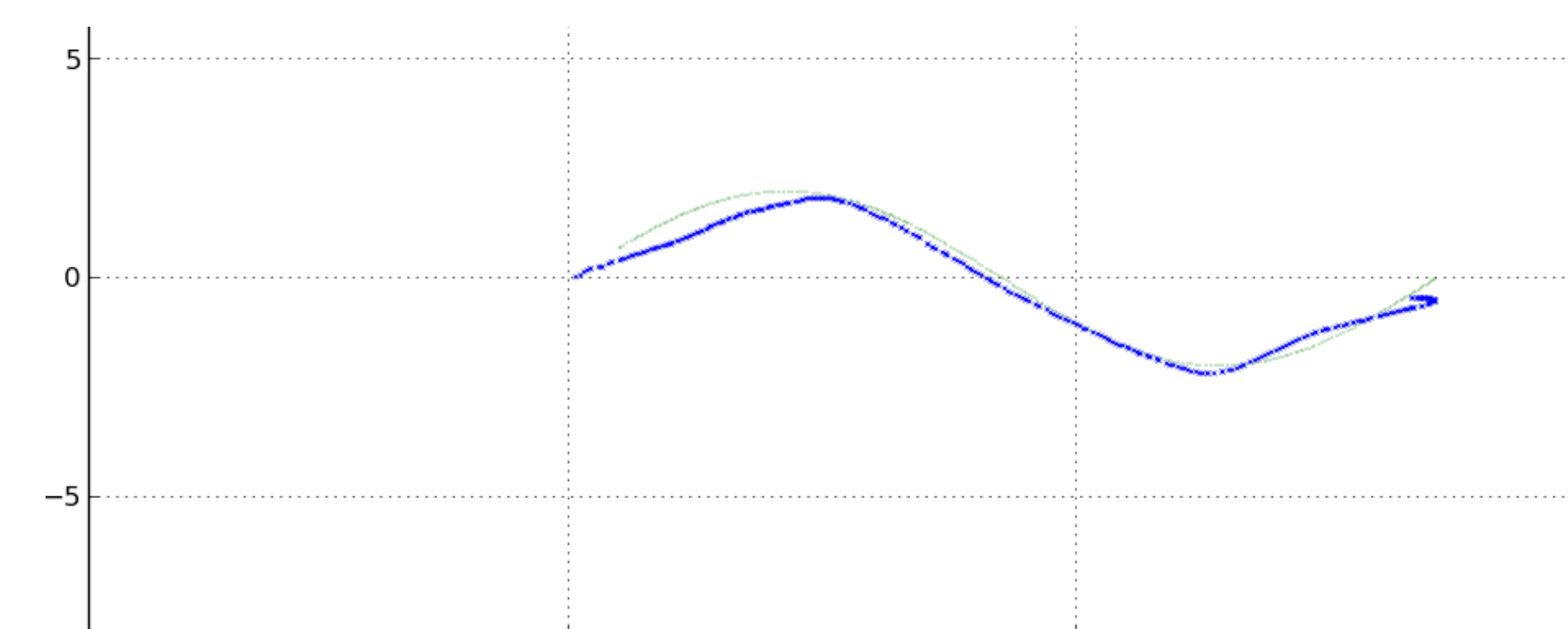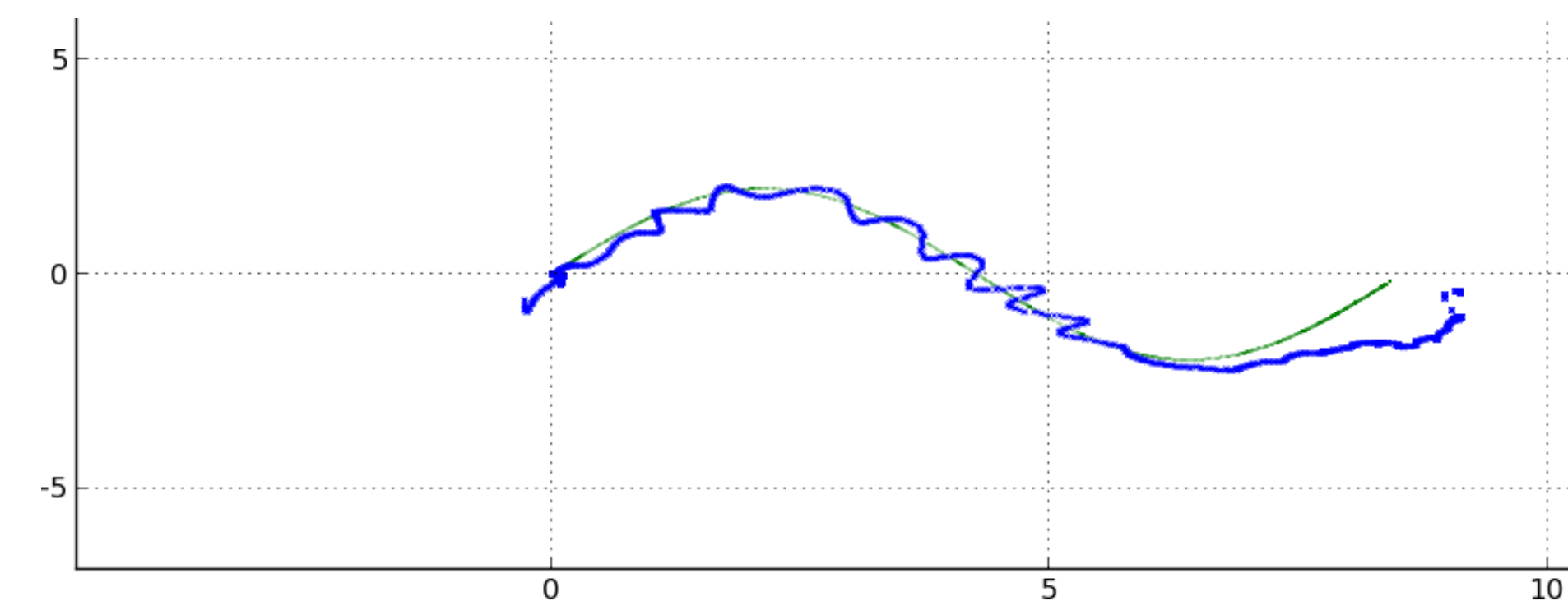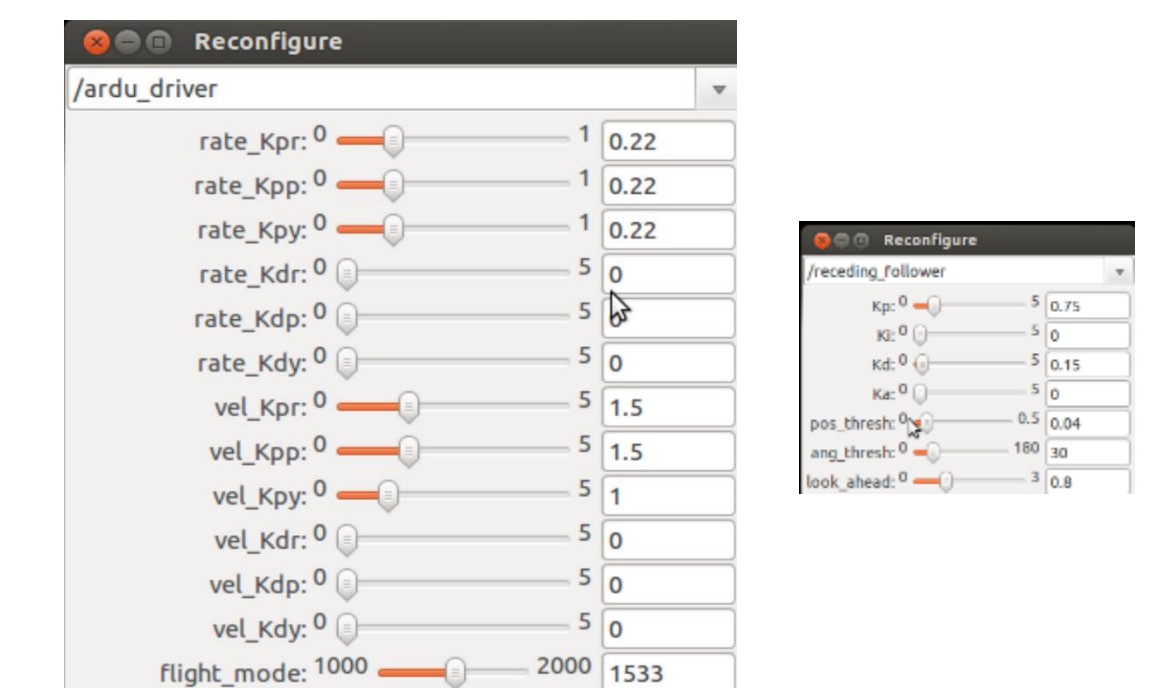

FUTURE WORK

• We plan to test the whole receding horizon pipeline in a dense forest setting once the vision side of the pipeline is working.
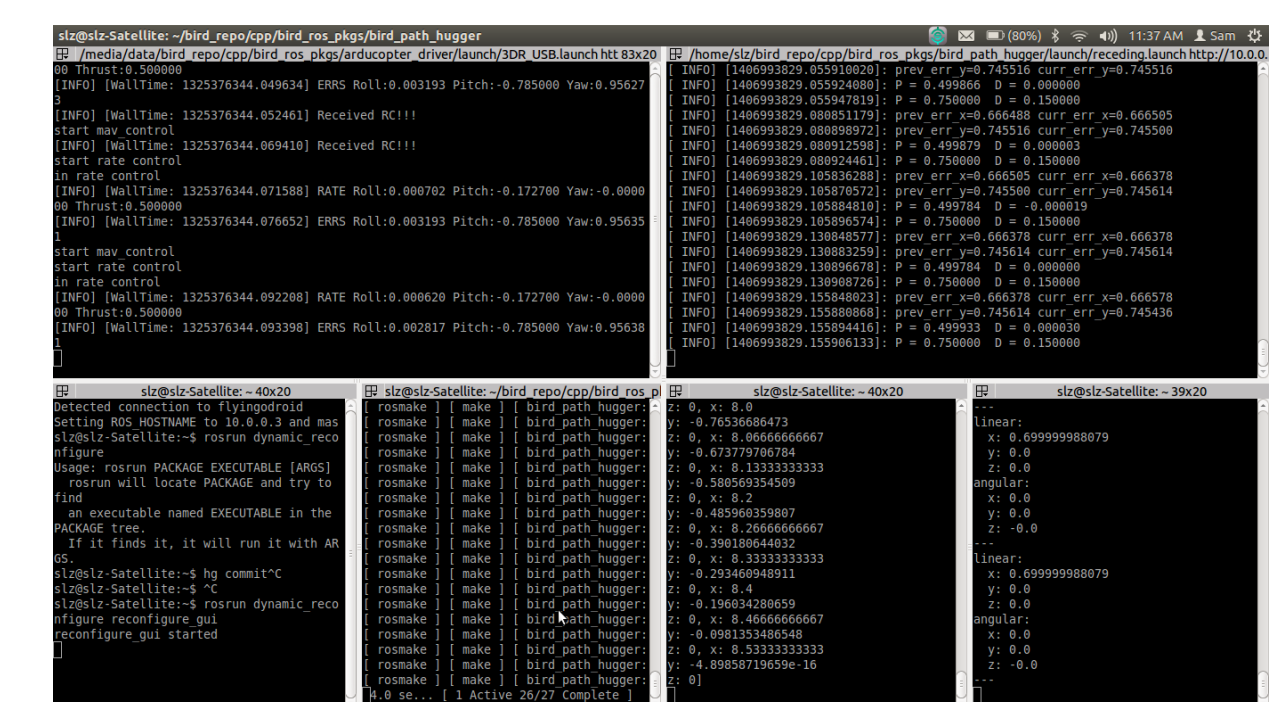
CHALLENGES & SOLUTIONS

Tuning:
• Hard to change gains during program runtime.
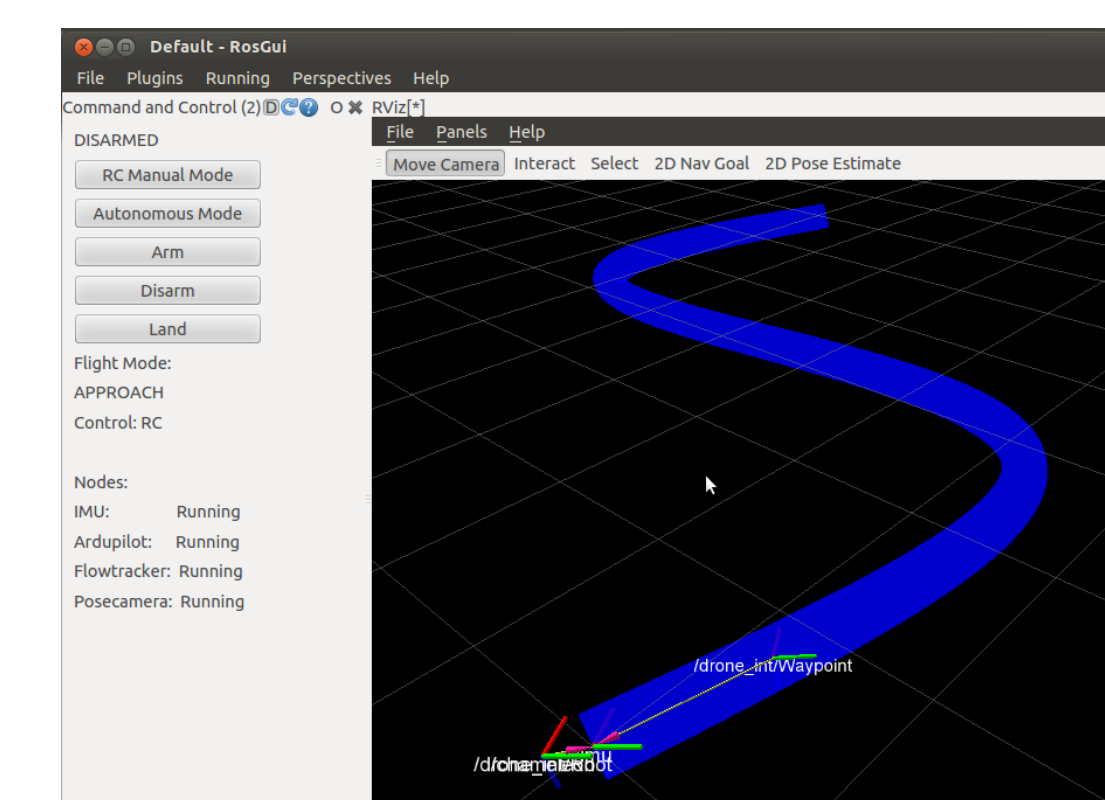

Command and Control Interface:

Using Terminals:
• Confusing
• No software kill switch
• Hard to track running nodes

Unified GUI
• Easy to use
• Safety buttons implemented
• Node status menu
• Ability to populate other plugins in the same window.

Altitude hold mode:
• A new flight mode that uses sonar and barometer sensors was implemented for altitude control.

ACKNOWLEDGEMENTS

REFERENCES

• [1] Stephane Ross, Narek Melik-Barkhudarov, Kumar Shaurya Shankar, Andreas Wendel, Debadeepta Dey, J. Andrew (Drew) Bagnell, and Martial Hebert, "Learning Monocular Reactive UAV Control in Cluttered Natural Environments," IEEE International Conference on Robotics and Automation, March, 2013.
• [2] "BIRD MURI." RobotWhisperer RSS. N.p., n.d. Web. 05 Aug. 2014.

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