Navigation and Control for an Autonomous Multirotor in an Indoor Environment

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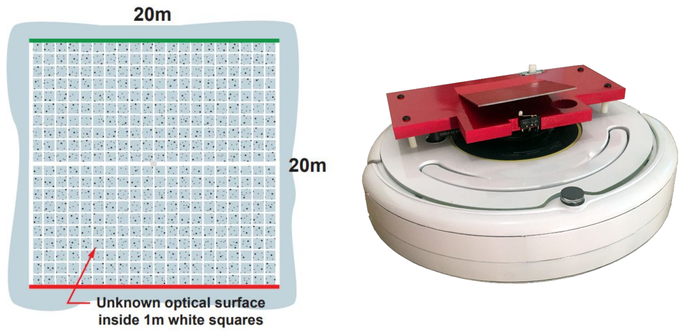
Competition Rules

The goal of IARC Mission 7 is to guide ground robots through physical interaction with an autonomous drone.

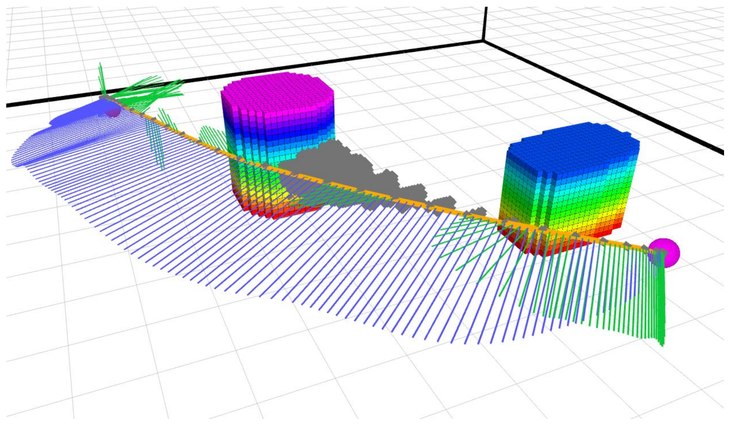


Rules:

- Top switch turns the robot 45 degrees
- Front bumper turns the robot 180 degrees
- Must get 4 robots across the green line
- 10 minutes of flight time allowed
- Autonomous from takeoff through landing
- No external navigation aids (GPS, SLAM)

Motion Planning

Planning for various tasks (waypoints, interactions, etc) is accomplished by a heuristic search-based planner, which accounts for both obstacles in the arena and dynamic constraints on the drone. The planner uses anytime search with bounded suboptimality to achieve real-time performance.



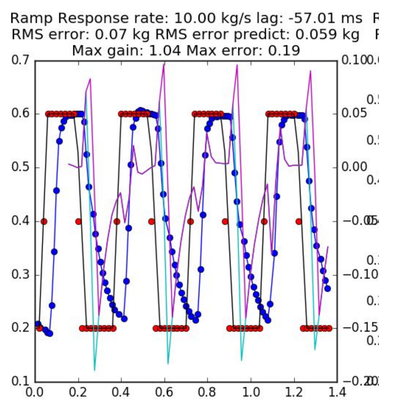
2017 Competition Drone

Thrust Model

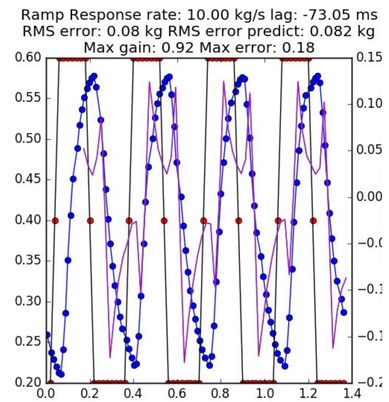
Accurate plant modeling is required for high speed maneuvers in an indoor environment. A nonlinear model was developed that can be used for almost any Electronic Speed Controller, motor, and propeller.

- Over 100 step responses are recorded to find the first order response at all operating points
- The voltage necessary to achieve the next required thrust is calculated based on the last thrust
- Compared to a steady state approximation, lag is reduced by 20-30ms and the slew rate is increased

Dynamic Model



Static Model



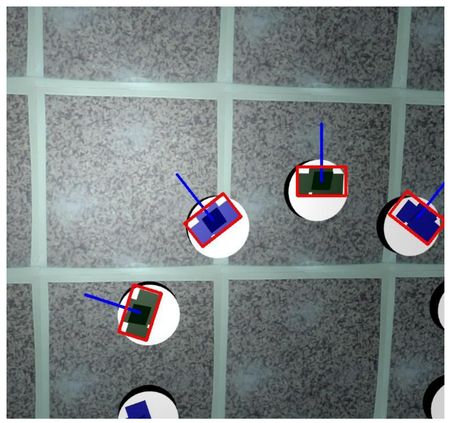
Target Tracking

Downward-facing camera

- Custom detector based on top plate color and geometry

Side cameras

- CNN based on modified Tiny YOLO architecture



Localization

The only features available for localization are the periodic grid-lines on the floor and the edges of the arena itself. An optical flow sensor and accelerometer are used for local positioning and custom grid detection algorithm eliminates drift in the local position estimates.

References

[1] S. Liu, N. Atanasov, K. Mohta and V. Kumar, "Search-based motion planning for quadrotors using linear quadratic minimum time control," *2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Vancouver, BC, 2017, pp. 2872-2879.

[2] Redmon, J., Divvala, S., Girshick, R., Farhadi, A.: You only look once: Unified, real-time object detection. In: CVPR. (2016)