ELEC 5660 Project 1: Phase 2

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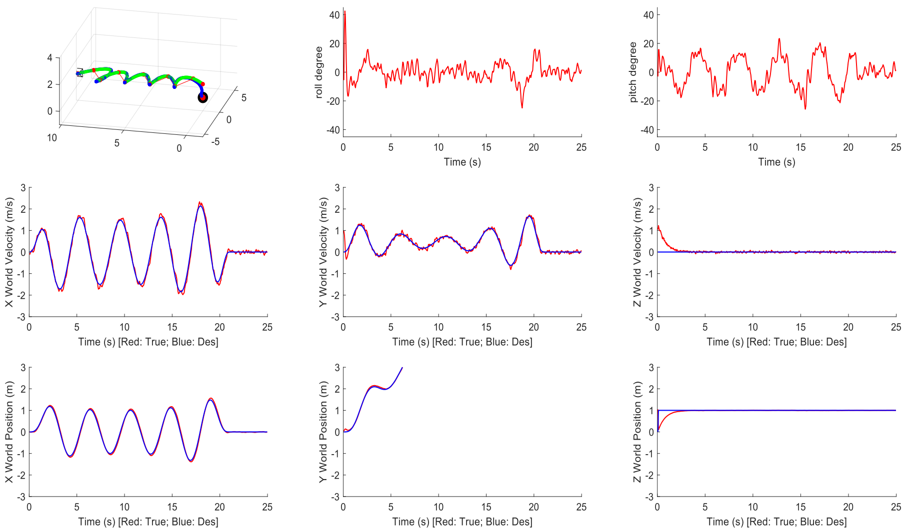
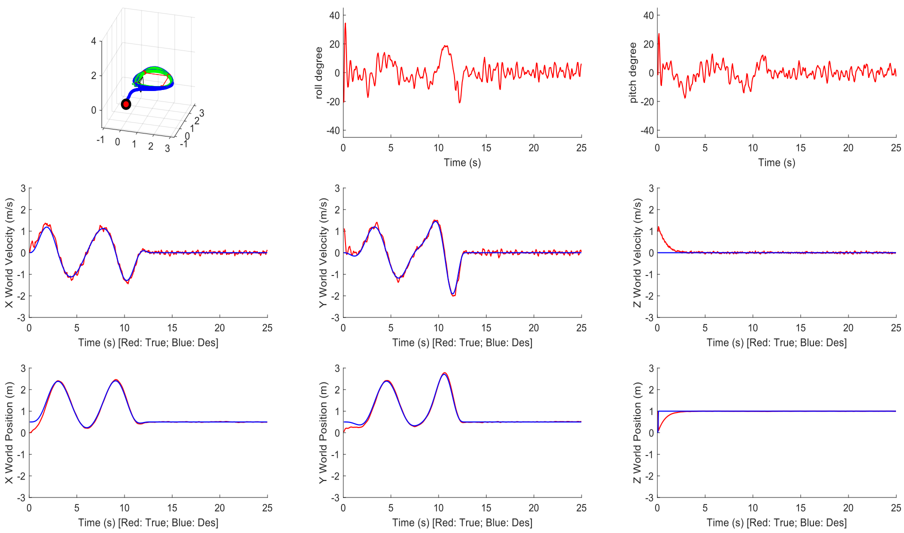
Figures

Waypoints are shown as red dots connected with red lines.

Path1:

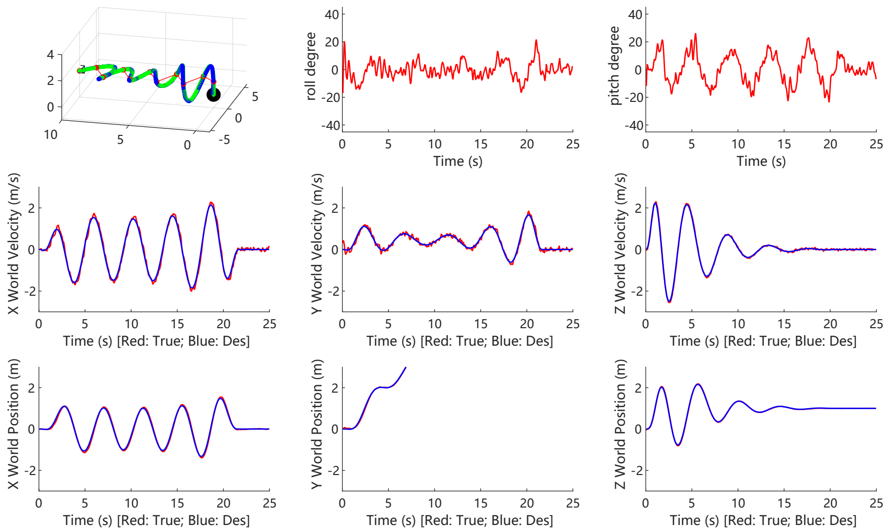


Path2:



Path1 with takeoff:

This path treats $[0, 0, 0]^T$ as the first waypoint.



Statistics

Trajectory	RMSE, position, (m)	RMSE, linear velocity, (m/s)
Path1	0.1479	0.2316
Path2	0.1852	0.2892
Path1 takeoff	0.0785	0.1577

Analysis

Generation of trajectory:

Close-form method, 7^{th} order minimum snap trajectory in this assignment. When we want to impose more equality/in-equality constraints, a general constrained QP should be used.

As the segment duration is fixed, the flight time of each segment is set proportional to the Euclidean distance of 2 endpoints of the same segment.

Miscellaneous

2. Sharp turning in waypoint sequence will result in "knots" of the smoothed trajectory. This could be a result of insufficient polynomial orders or improper segment flight time allocation.
3. RMSE can be further reduced at the cost of high frequency roll and pitch oscillation.
4. We define a trajectory in $\mathbb{R}^3 \times SO(2)$ space. While minimizing snap, the yaw angle is not considered for optimization, as quadrotors are symmetric around body z-axis and torque M is used to control yaw and it doesn't directly affects F. Trajectory generation for other forms of UAV (e.g. jets) will be more complex.
5. Selection matrix C on p20 of lecture note can be further simplified from 16×13 to 16×12, as $d_{T,1}^{(0)} = d_{0,2}^{(0)}$ is also a continuity constraint besides derivative constraint.
6. How to ensure physically feasible trajectory? How to optimize trajectory w.r.t flight time (e.g. collect waypoints in shortest time)?

Note

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