

Robotics Final Project

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Role of Each Member:

- David: Debugged the dynamics, receding horizon code and created the git repo where this project was held. <https://github.com/David-Rey/AE4803Quad/tree/improve-stability>
- Elliot: Created initial DDP implementation, implemented barrier states fully, added receding horizon code initially (later debugged by David), and debugged a ton.
- Kevin: Used git and MATLAB to tune and create ddp (forward and backward passes), regularization, line search, and barrier state code, as well as found bugs and alternative methods to regularization found in office hours and papers.
- Alexander: Created the full quadrotor dynamics model, made some plots of the state, and implemented a recursive tuning algorithm to get the best parameters.

1 Quadrotor DDP

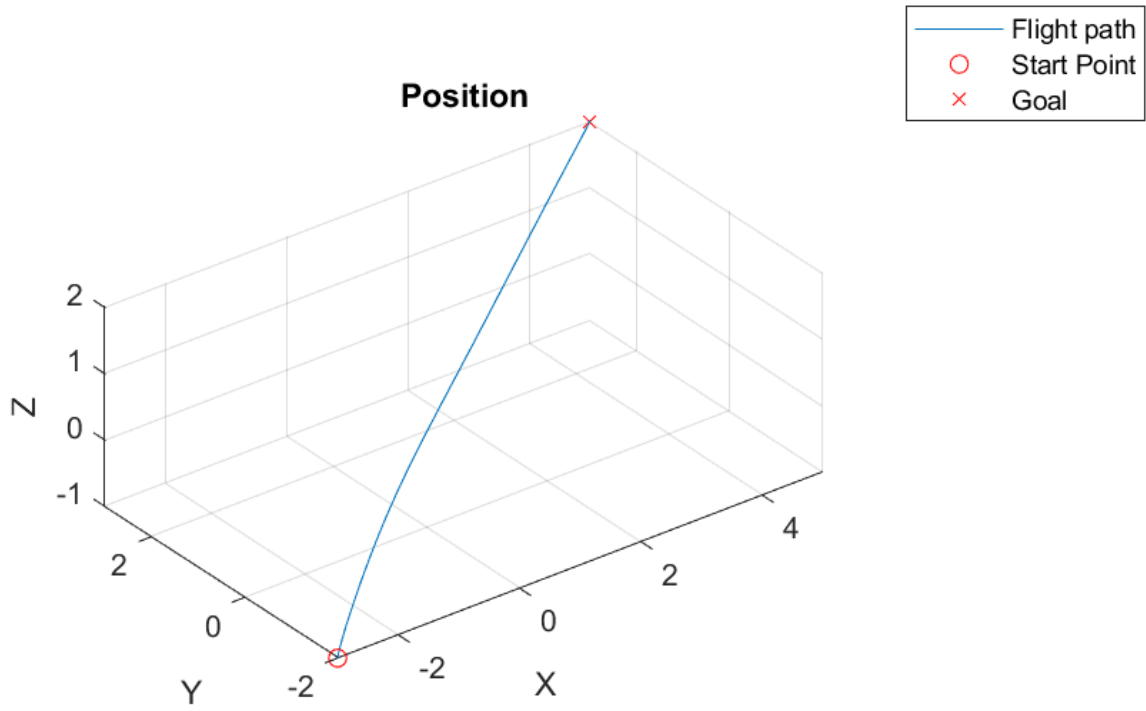


Figure 1: 3D trajectory with barriers visualized.

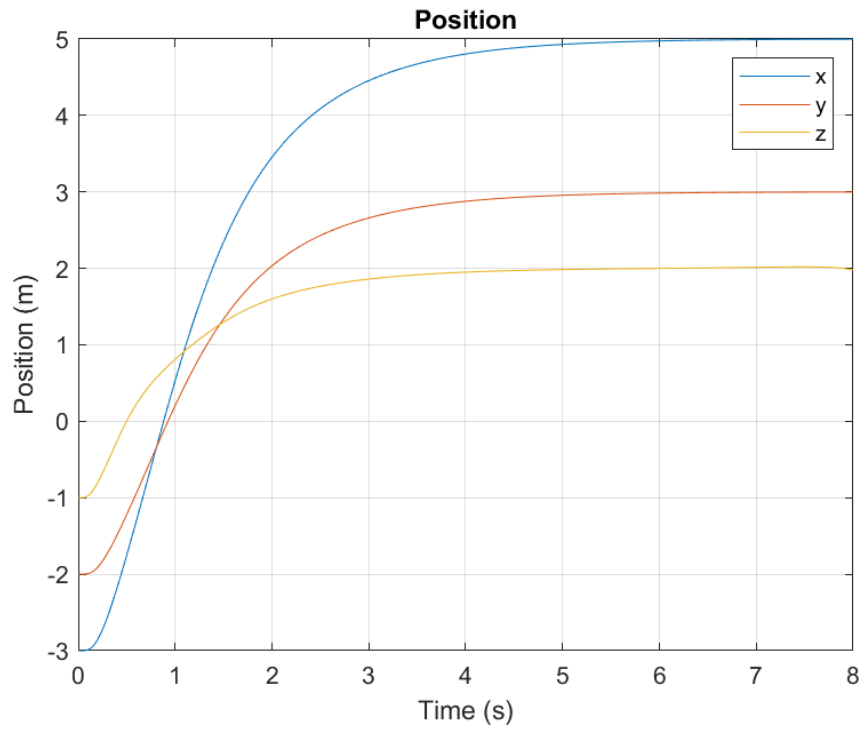


Figure 2: Position vs. time plot.

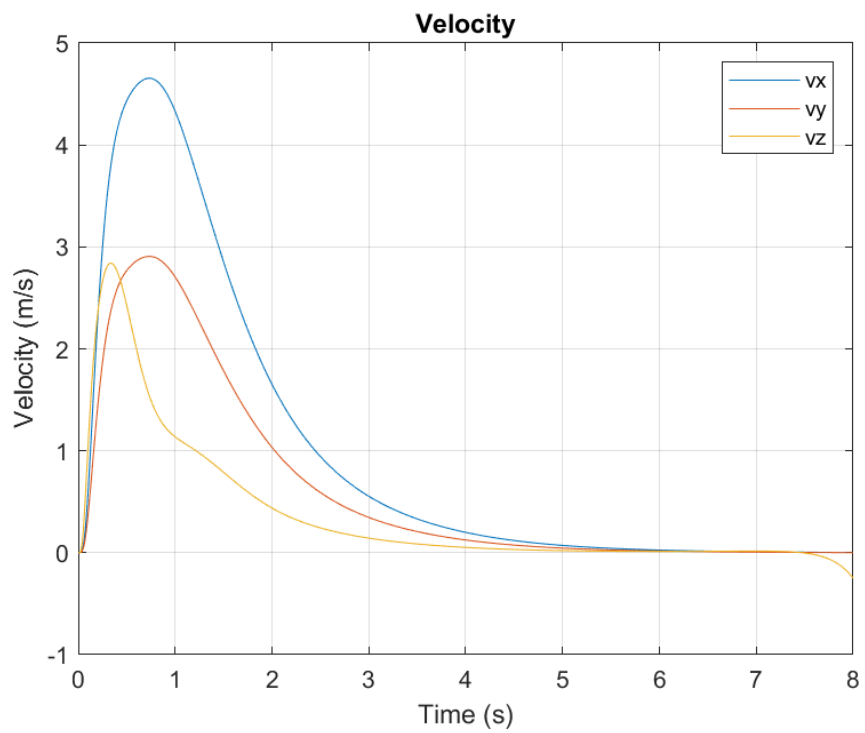


Figure 3: Velocity vs. time plot.

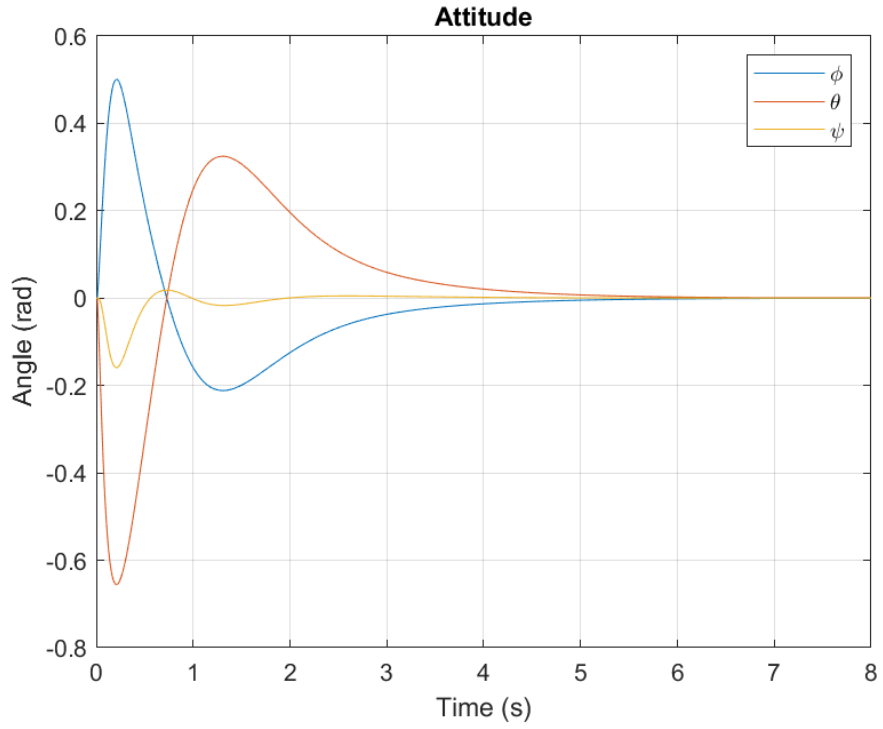


Figure 4: Euler attitude vs. time plot.

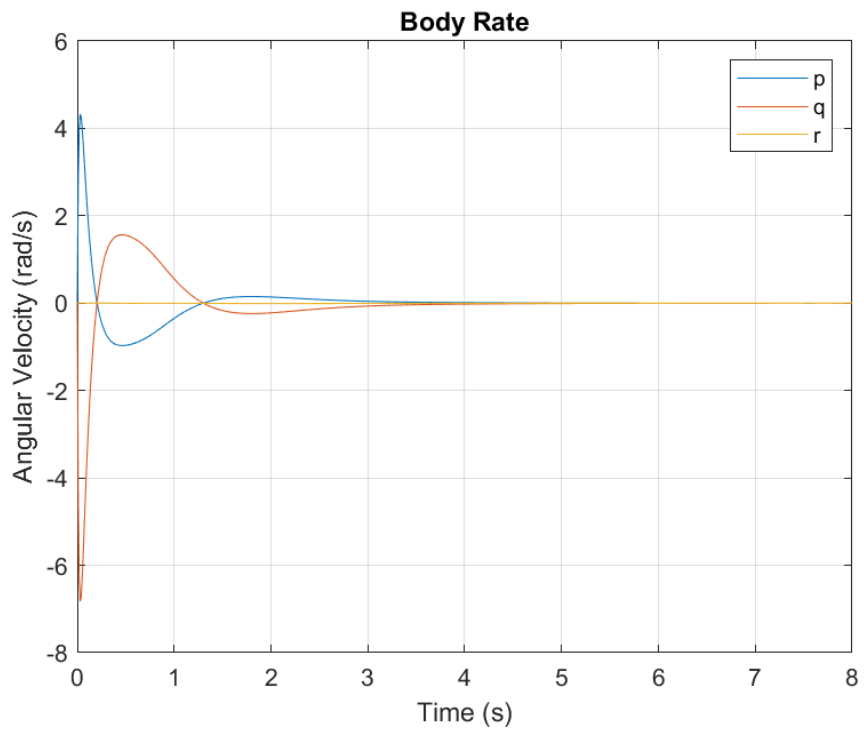


Figure 5: Body angular velocity vs. time plot.

```
pos_gain = 1;
vel_gain = 1;
ang_gain = 1;
ang_vel_gain = 1;
w_gain = 0; % no barrier state
Q = diag([pos_gain, pos_gain, pos_
R = 0.8*eye(4);
Qf = 180*Q;
```

Figure 6: Parameters of Q and R for main DDP

2 Quadrotor MPC

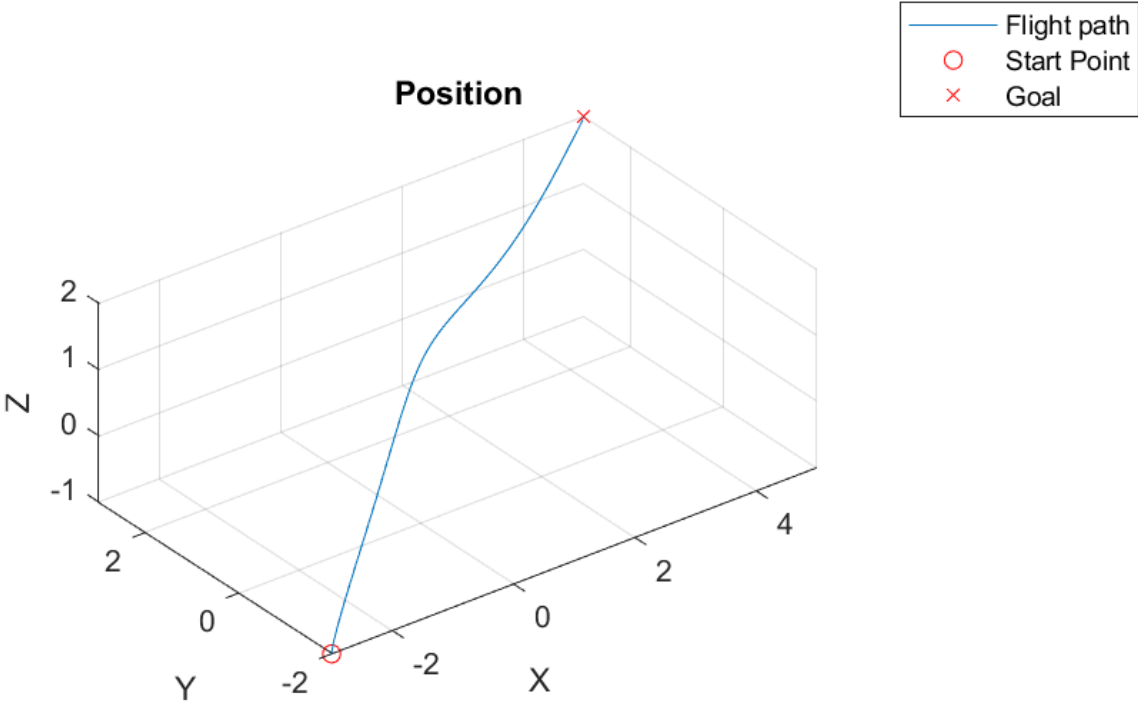


Figure 7: 3D trajectory with barriers visualized.

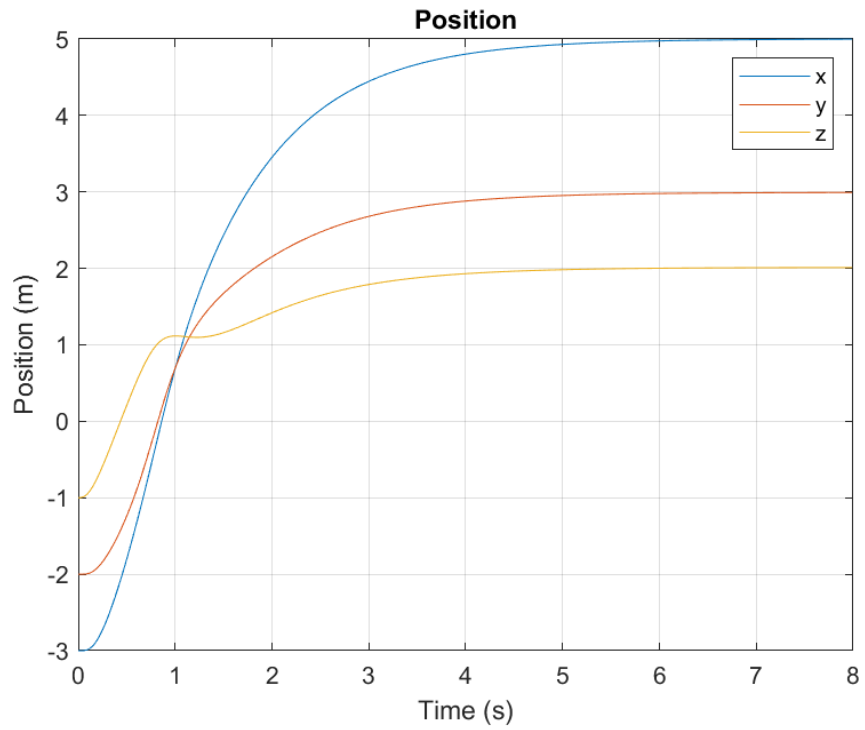


Figure 8: Position vs. time plot.

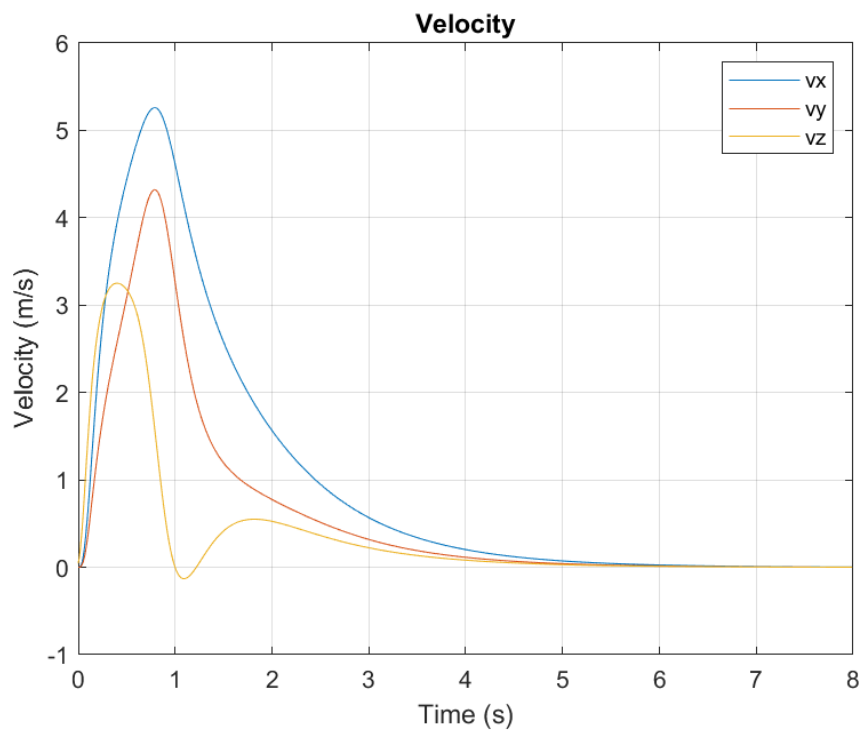


Figure 9: Velocity vs. time plot.

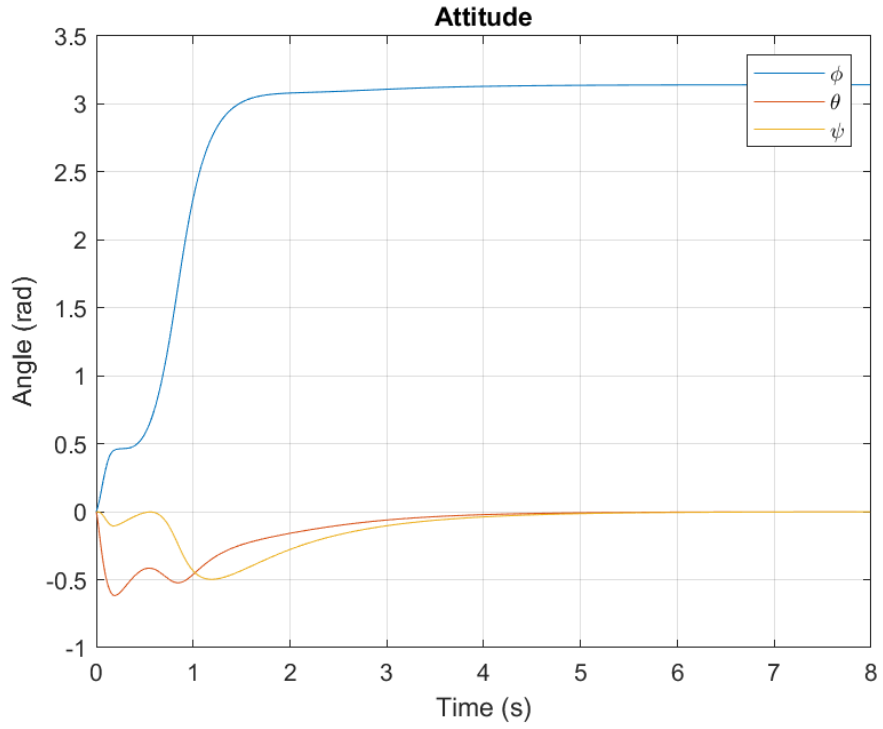


Figure 10: Euler attitude vs. time plot.

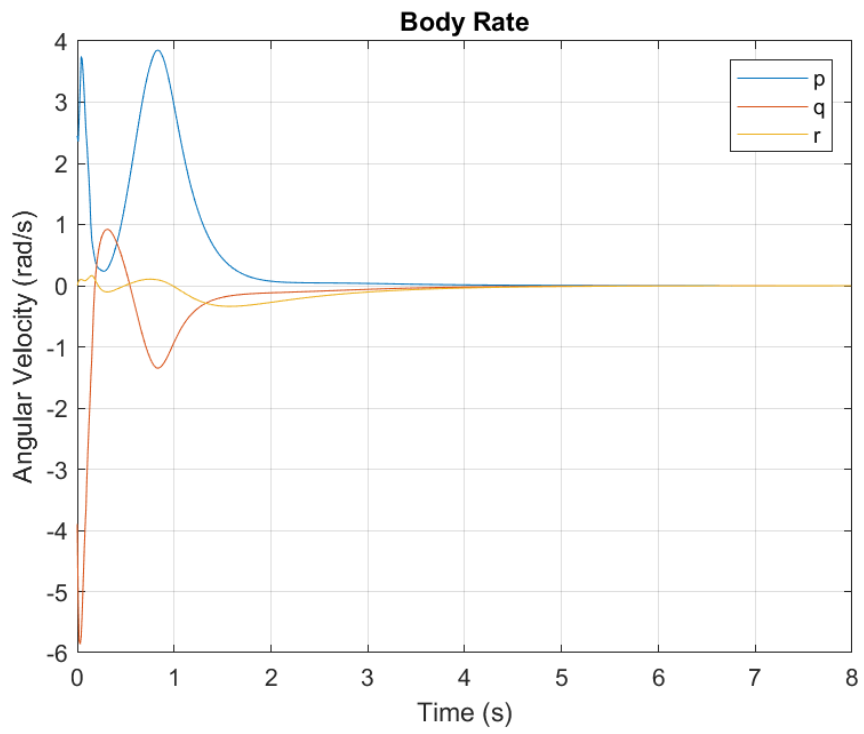


Figure 11: Body angular velocity vs. time plot.

```
% Tune here!  
pos_gain = 1;  
vel_gain = 1;  
ang_gain = 1;  
ang_vel_gain = 1;  
w_gain = 0; % no barrier state  
Q = diag([pos_gain, pos_gain, pos  
R = 1*eye(4);  
Qf = 10*Q;
```

Figure 12: Parameters of Q and R for MPC

3 Obstacle Avoidance

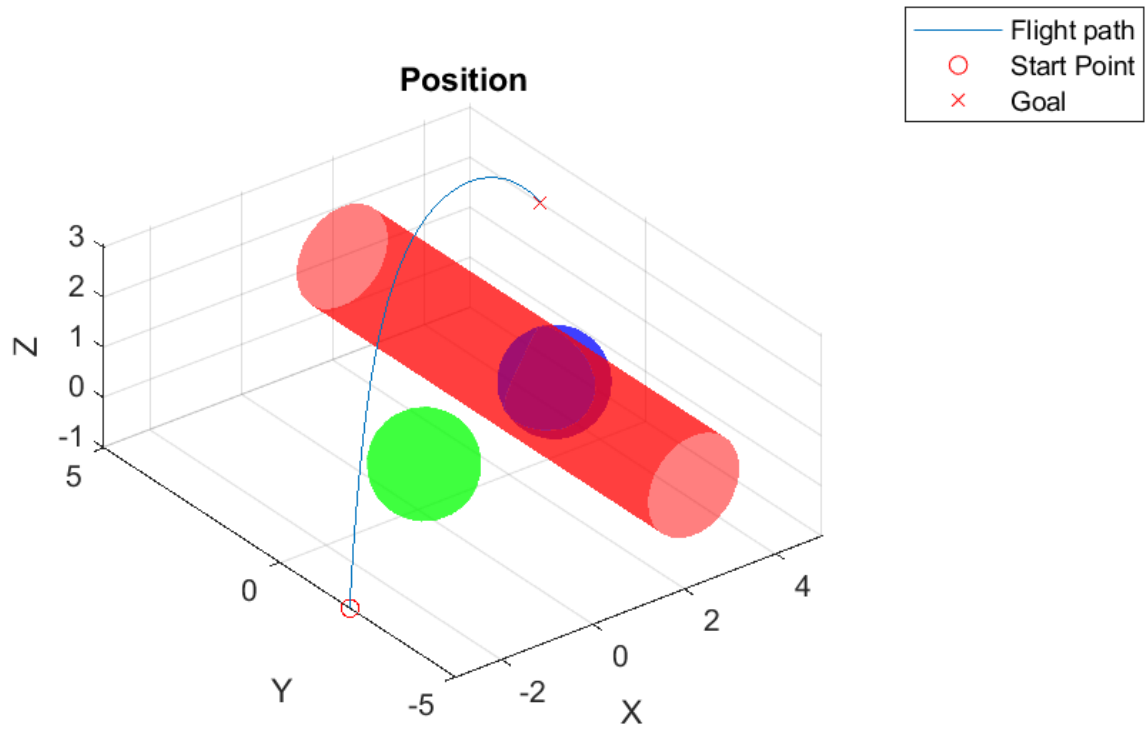


Figure 13: 3D trajectory with barriers visualized.

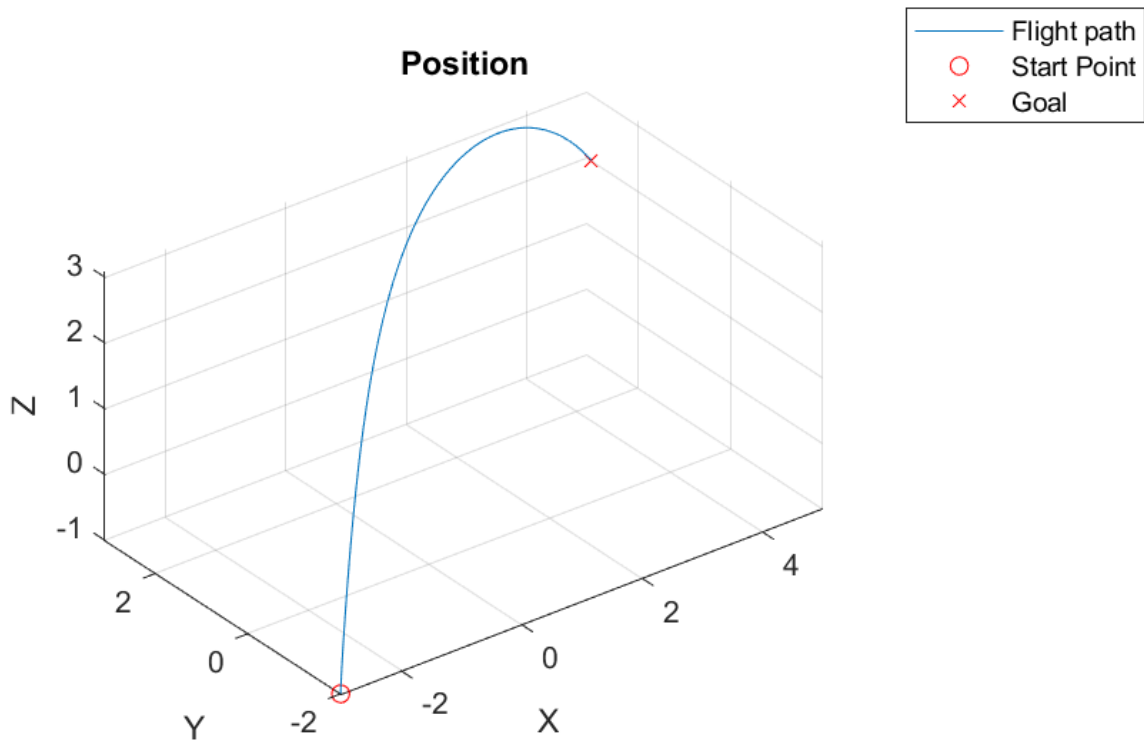


Figure 14: 3D trajectory without barriers visualized.

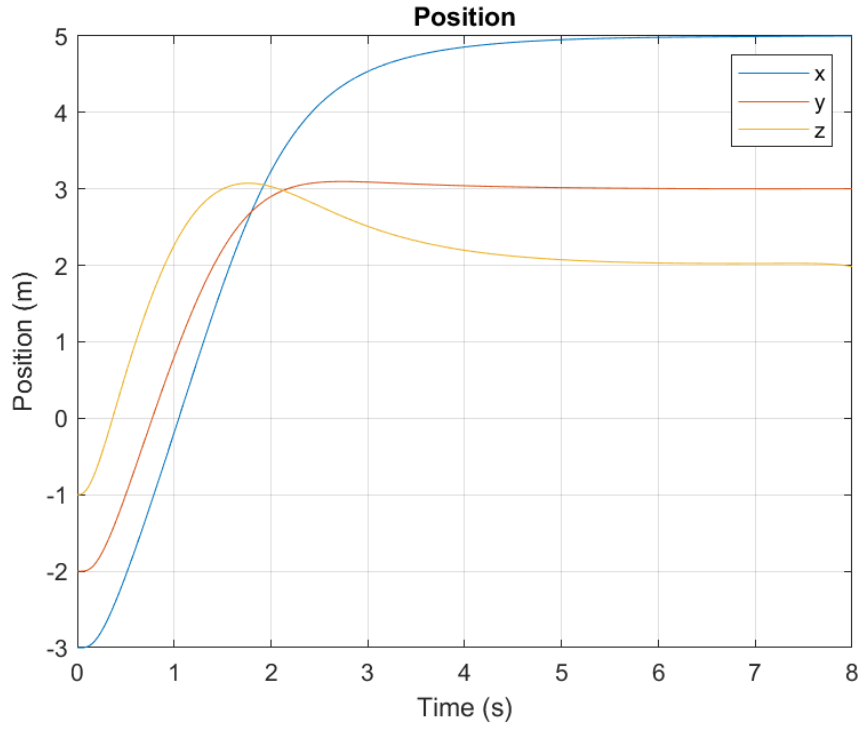


Figure 15: Position vs. time plot.

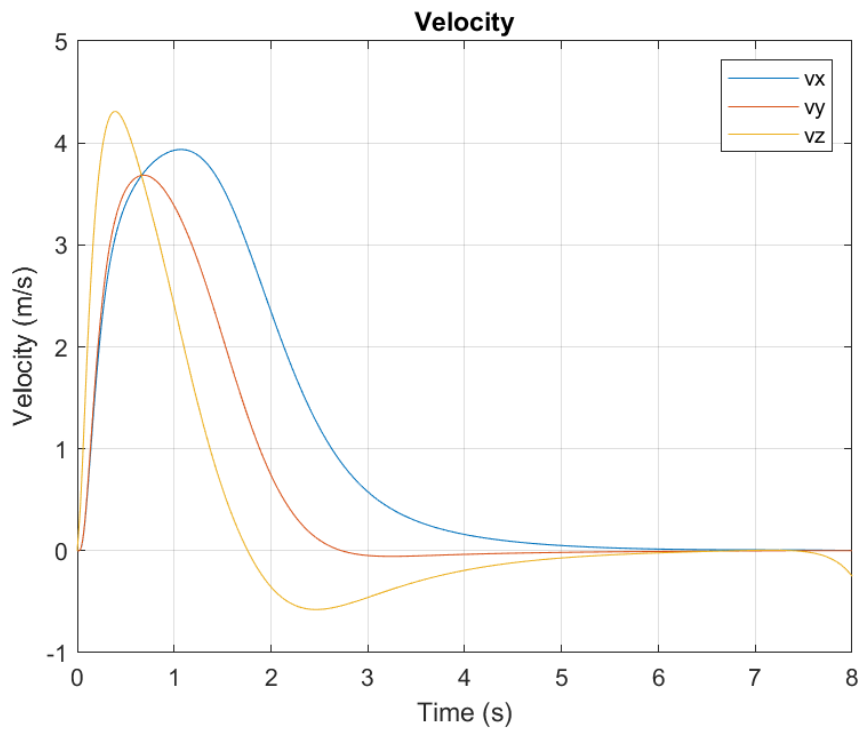


Figure 16: Velocity vs. time plot.

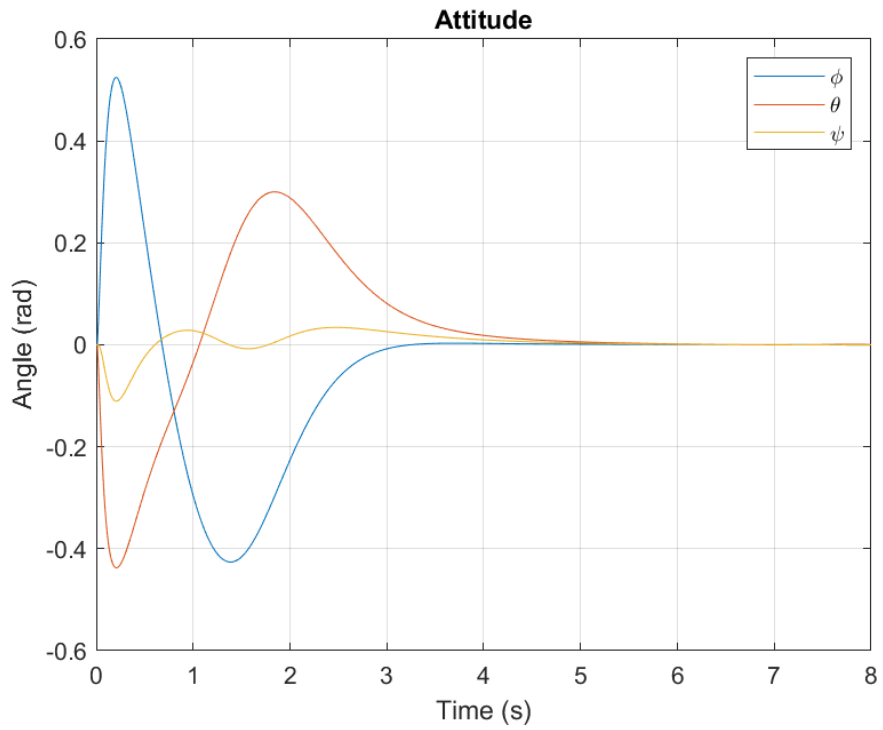


Figure 17: Euler attitude vs. time plot.

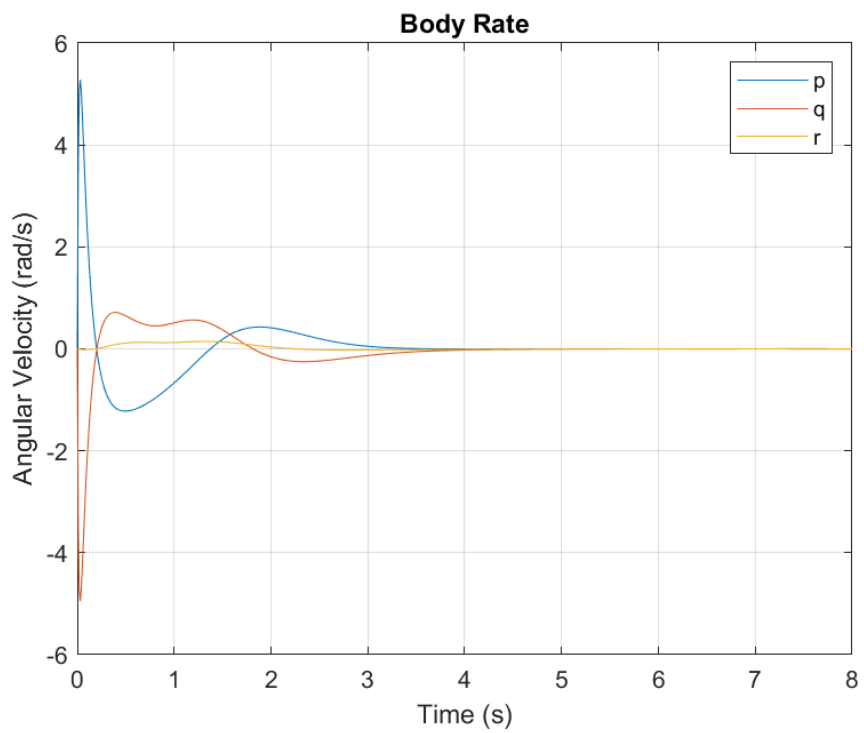


Figure 18: Body angular velocity vs. time plot.

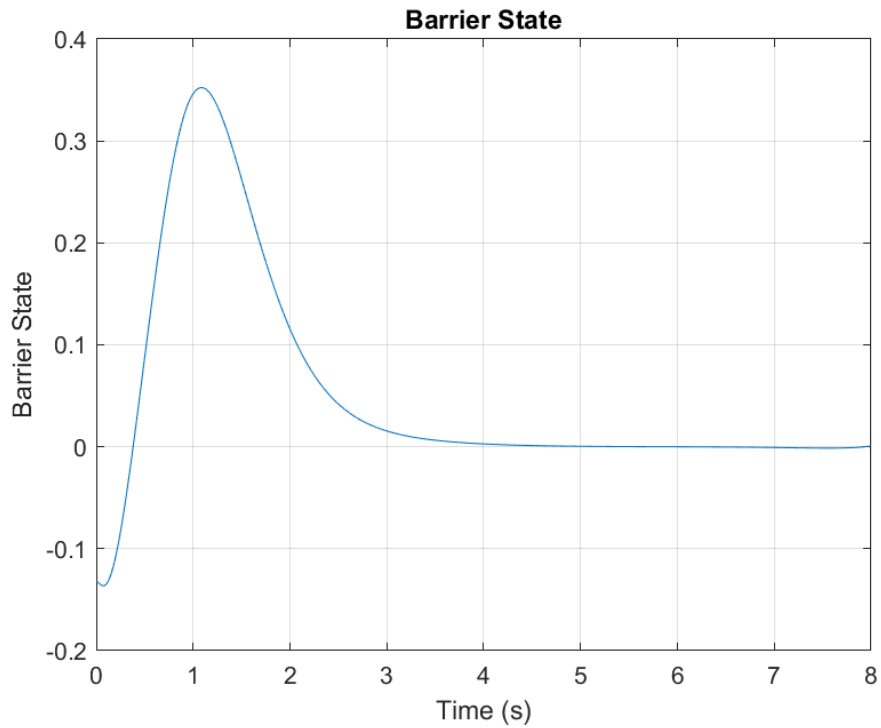


Figure 19: Barrier state vs. time plot.

```

% Tune here!
pos_gain = 1;
vel_gain = 1;
ang_gain = 1;
ang_vel_gain = 1;
w_gain = 100;
Q = diag([pos_gain, pc
R = 0.8*eye(4);
Qf = 180*Q;

```

Figure 20: Parameters of Q and R for barrier