ELEC 5660: Introduction to Aerial Robotics
Project 1: Phase 1

Assigned: Feb. 26th, 2019 Due: Mar. 5th, 2019

1 Project Work

In this project, you are provided with a quadrotor simulator (written in Matlab) posted on the course website. The simulator implements dynamics model of quadrotor and relies on the numerical solver `ode45`. Your tasks include:

1.1 Controller

You will need to implement controller in `controller.m`. The input of controller includes time `t`, current state vector `s` and desired state vector `s_des`. The output of controller is force `F` and moment `M`. Detailed derivation can be found in lecture notes and [1].

1.2 Trajectories

You will need to command the quadrotor through three sample trajectories: hovering, circle and diamond. All trajectory generators take time `t` and current state vector `s` as input and output desired state vector `s_des`. The duration of all trajectories should be 25 s. At least one circulation (for the last 2 trajectories) should be included. Besides, along the trajectory, the yaw angle of the quadrotor must be changing smoothly. **Note:** Be careful about the discontinuous point of the Euler angle, such as -180° to 180° .

`hover_trajectory.m`: Hover at $(0, 0, 0)$, the simplest motion. A sample code is given.

`circle_trajectory.m`: A helix in the xy plane of radius 4 m centered about the point $(0, 0, 0)$. The z coordinate should start at 0 and end at 3. The quadrotor should start at the point $(0, 0, 0)$.

`diamond_trajectory.m`: A "diamond helix" with corners at $(0, 0, 0)$, $(0, 2\sin 45°, 2\cos 45°)$, $(0, 0, 4\cos 45°)$, and $(0, -2\sin 45°, 2\cos 45°)$ when projected into the yz plane, and x coordinate starting at 0 and ending at 4. The quadrotor should start at $(0, 0, 0)$.

Sample trajectories are shown in Fig. 1. Sample codes for generating such trajectories have been provided by TAs, you can directly use them. Or you can write your own trajectories, but the above requirements for the trajectories must be satisfied.

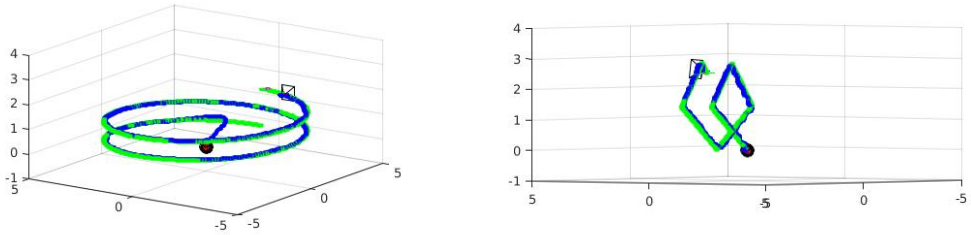

Figure 1: circle and diamond helix trajectories

2 Sturcture of Simulator

A brief introduction to the code can be found in `README.txt`.

3 Submission

When you finish the assignment you may submit your code and documents on **canvas** before **Mar. 5th, 2019 23:59:59**. The project name for this assignment is titled "`proj1phase1`".

Your submission should contain:

1. A **maximum 2-page** document including:
   (a) Figures plotted by simulator.
   (b) Statistics about your controller. (For example, RMS error between current state and desired state for position, velocity).
   (c) Analysis of your result. (For example, parameter studies).
   (d) Any other things we should be aware of.
2. Files `controller.m`, `hover_trajectory.m`, `circle_trajectory.m`, `diamond_trajectory.m`, as well as any other Matlab files you need to run your code.

We will reply to your submission for confirmation. You will be graded on successful completion of the code and how quickly and accurately your quadrotor follows the three paths and one other trajectory which will not be released.

References

[1] N. M, M. Daniel, L. Quentin, and K. Vijay, "The grasp multiple micro-uav testbed," *IEEE Robotics and Automation Magazine*, vol. 17, no. 3, pp. 56–65, 2010.