

# ELEC 5660: Introduction to Aerial Robotics

## Project 1: Phase 1

Assigned: Feb 21, 2023    Due: 11:59 PM, Mar 3, 2023

### 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`. You may use the Matlab R2021b in the virtual barn provided by the university. 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. 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  $-180^\circ$  to  $180^\circ$ .

`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 growing radius 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  $(0, 0, 0)$ . A sample code is given.

`heart_trajectory.m`: A "heart" with corners at  $(0, 0, 0)$ ,  $(0, -1, -1)$ ,  $(0, -0.5, 1.5)$ ,  $(0, 0, 1)$ ,  $(0, 1.5, 1.5)$ ,  $(0, 1, 1)$  when projected into the  $yz$  plane, and  $x$  coordinate starting at 0 and ending at 4. The quadrotor should start at  $(0, 0, 0)$  and finish two circulations within 25s. You should implement this trajectory.

Sample trajectories are shown in Fig. 1. Sample codes for the first two trajectories have been provided by TAs. You are required to implement the diamond trajectory. Bonus points will be given if you write your own trajectory besides the above three.

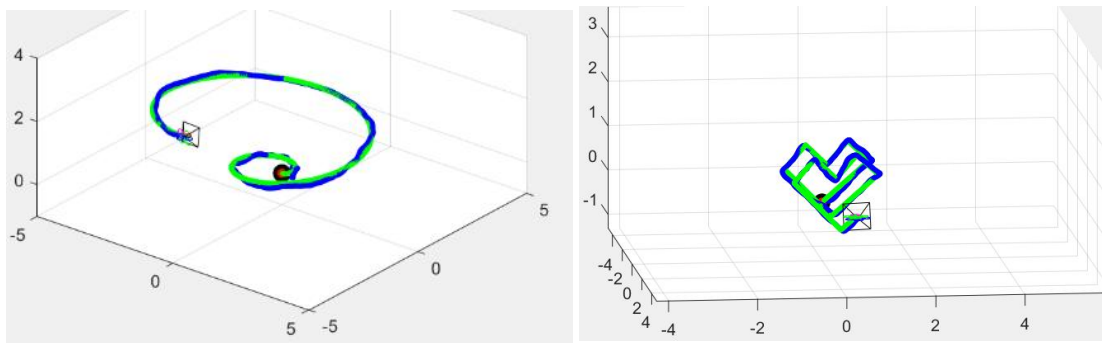


Figure 1: circle and heart trajectories

## 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 **11:59 PM, Mar 3, 2023**. 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` and `diamond trajectory.m`, as well as any other extra Matlab files needed to run your code.

Please don't modify files under the `readonly` folder. You will be graded on successful completion of the code and how quickly and accurately your quadrotor follows the three paths and one additional 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.