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

Assigned: Feb 27, 2024 Due: 11:59 PM, Mar 8, 2024

## 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 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 square. 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 25s. 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 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.

`square_trajectory.m`: A trajectory passes waypoints $(0, 0, 0)$, $(1, 2, 0)$, $(2, 2, 2)$, $(3, 0, 2)$, $(4, 0, 0)$. The quadrotor should start at $(0, 0, 0)$ and finish the whole within 25s. You should implement this trajectory. You may need to interpolate the waypoints by a straight line.

Sample trajectories are shown in Fig. 1 and Fig. 2. Sample codes for the first two trajectories have been provided by TAs. You are required to implement the square trajectory. **Bonus points** will be given if you write your own trajectory besides the above three.

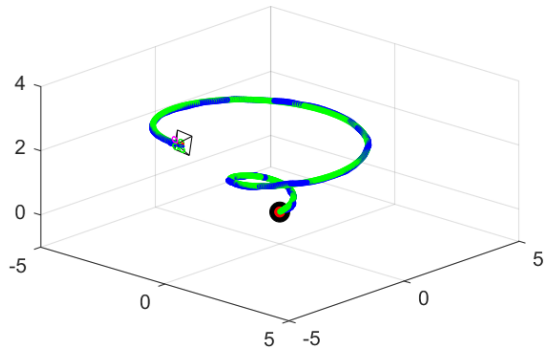


Figure 1: circle trajectories

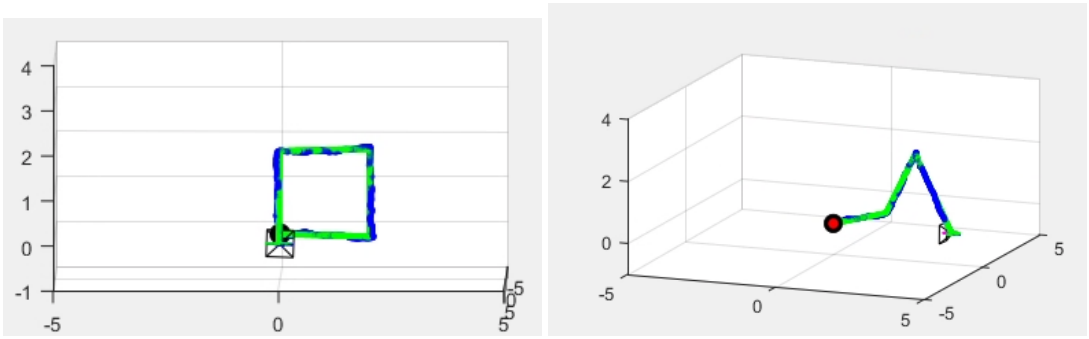


Figure 2: Square trajectories

## 2 Sturcture of Simulator

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

## 3 Submission

When you finish the assignment, you should submit your code and documents on Canvas before **11:59 PM, Mar 8, 2024**. Please submit a single zip file containing all the files. The submission name for this assignment is titled "`proj1phase1_Your_Name.zip`".

Please cite the paper, GitHub repo, or code url if you use or reference the code online. Please keep academic integrity; **plagiarism is not tolerated in this course.**

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 `square_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 the successful completion of the code and how quickly and accurately your quadrotor follows the trajectories.

# 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.