Flying Car and Autonomous Flight Engineer Syllabus

Contact Info

While going through the program, if you have questions about anything, you can reach us at support@udacity.com. For help from Udacity Mentors and your peers visit the Udacity Classroom.

Nanodegree Program Info

Version: 2.0.0

Length of Program: 93 Days*

** This is a self-paced program and the length is an estimation of total hours the average student may take to complete all required coursework, including lecture and project time. Actual hours may vary.*

Part 1: Introduction to Autonomous Flight

In this course, you will get an introduction to flight history, challenges, and vehicles. You will learn about our quadrotor test platform, work in our custom simulator, and build your first project—getting a quadrotor to take-off and fly around a backyard!

Project: Backyard Flyer

In this lesson you'll write the "Hello, world!" of drone programming as you write event-driven code that causes a quadrotor to take off, fly in a square, and land.

Supporting Lessons

Lesson	Summary
Welcome!	In this lesson you'll meet your instructors and go over some of the logistical details of this Nanodegree program.
Autonomous Flight	In this lesson you'll get a high level overview of the concepts underlying autonomous flight and the physical components from which flying vehicles are made.

Part 2: Planning

Flying robots must traverse complex, dynamic environments. Wind, obstacles, unreliable sensor data, and other randomness all present significant challenges. In this course, you will learn the fundamentals of aerial path planning. You will begin with 2D problems, optimize your solutions using waypoints, and then scale your solutions to three dimensions. You will apply these skills in your second project—autonomously navigating your drone through a dense urban environment.

Project: 3D Motion Planning

In this project, you'll get a chance to apply what you've learned about 3D motion planning from the last several lessons to plan and execute a mission in a complex urban environment!

Supporting Lessons

Lesson	Summary
Planning as Search	Solving the planning problem really comes down performing search through a state space to find a path from a start state to a goal state and here you'll get a chance to do just that!
Flying Car Representation	Your vehicle has a physical size and orientation in the world and here you'll learn how to think about position and orientation as part of your planning solution.
From Grids to Graphs	Graphs are really just a way of describing how your search space is connected. Here you'll learn about the tradeoffs between grids and graphs and each can be used in your planning representation.
Moving into 3D	Here you'll make the leap from two dimensions to three dimensions and discover how you can use different representations of your search space to optimize your planning solution.
Real World Planning	In this lesson, you'll dive deep into some advanced concepts that are crucial to motion planning in the real world, where a consideration for physics and preparedness for the unexpected are crucial.

Part 3: Controls

In the previous course, we implemented 3D path planning but assumed a solution for actually following paths. In reality, moving a flying vehicle requires determining appropriate low-level motor controls. In this course, you will build a nonlinear cascaded controller and incorporate it into your software in the project.

Project: Control of a 3D Quadrotor

In this project you'll implement a controller for a quadrotor in C++.

Supporting Lessons

Lesson	Summary
Vehicle Dynamics	Learn how flying vehicles move in one and two dimensions by understanding how propellers create forces and moments which cause accelerations and rotations.
Introduction to Vehicle Control	Learn how to control a drone moving in one dimension using Proportional Integral Derivative (PID) Control.
Control Architecture	The controls problem becomes more difficult in two dimensions. Learn how to use a cascaded PID control architecture to control a flying vehicle that moves in two dimensions.
Full 3D Control	In this lesson you'll take everything you've learned so far about vehicle dynamics and control and put it together to control a quadrotor that moves in three dimensions.

Part 4: Estimation

In this course, we will finish peeling back the layers of your autonomous flight solution. Instead of assuming perfect sensor readings, you will utilize sensor fusion and filtering. You will design an Extended Kalman Filter (EKF) to estimate attitude and position from IMU and GPS data of a flying robot.

Project: Building an Estimator

In this project you'll implement an estimator to track the position and attitude of a quadrotor moving in three dimensions.

Supporting Lessons

Lesson	Summary
Introduction to Estimation	Review basic probability and learn three approaches to state estimation for a stationary vehicle.
Introduction to Sensors	In this lesson you'll learn about the sensors a drone uses to localize itself in the world. You'll implement sensor models, analyze sources of error, and perform calibration of various sensors.
Extended Kalman Filters	In this lesson you'll learn how to estimate the state of a drone that's actually moving! You'll implement a Kalman Filter for a 1D drone and an Extended Kalman Filter for a non-linear 2D drone.
The 3D EKF and UKF	Take what you learned in the previous lesson and generalize to three dimensions. After learning about the 3D EKF you'll also learn another estimation algorithm called the Unscented Kalman Filter.

Part 5: Career Support

GitHub and LinkedIn are both widely used by tech recruiters to find and evaluate job candidates. Get personalized feedback on how to improve yours! You may elect to opt-out of these projects.

Project: Optimize Your GitHub Profile

Other professionals are collaborating on GitHub and growing their network. Submit your profile to ensure your profile is on par with leaders in your field.

Project: Improve Your LinkedIn Profile

Find your next job or connect with industry peers on LinkedIn. Ensure your profile attracts relevant leads that will grow your professional network.

Part 6: Congratulations!

Part 7: [Optional] Fixed Wing

While quadrotors are the ideal test platform for aerial robotics, flying cars and other long-range aircrafts leverage the aerodynamic efficiencies of fixed-wing flight. In this course, you will learn how to adapt the concepts you’ve learned so far and successfully fly a fixed-wing aircraft in simulation.

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