AMLAS (AERO 689) Assignment #2

Motion Planning

Objective The objective is to determine guidance trajectories for dynamical systems, starting from a given initial and final condition, and avoiding obstacles. We will consider a simple dynamical system that models a simple aircraft motion,

$$m\ddot{x} = T\cos(\theta), \tag{1}$$
$$m\ddot{y} = T\sin(\theta), \tag{2}$$
$$I_z\ddot{\theta} = M, \tag{3}$$

where T is the engine thrust and θ is the heading angle. The control variables, thrust is limited $T \in [0, 1]$, and the moment $M \in [-1, 1]$. The above equations model the planar motion of an aircraft.

You are to generate control trajectories $T(t)$ and $M(t)$ that takes the system from a given initial condition $(x_0, y_0, \theta_0, \dot{x}_0, \dot{y}_0, \dot{\theta}_0)$ to a final state $(x_f, y_f, \theta_f, \dot{x}_f, \dot{y}_f, \dot{\theta}_f)$. A few obstacles are also on the way, which can be modeled as circles centered at (X_i, Y_i) with radius R_i. You can choose the number of obstacles, their locations, and size.

Approach 1: Linear Combination of Basis Function Assume that the trajectories are linear combinations of known basis functions. For example $x(t) = \mathbf{\Phi}^T(t)\alpha_x$, etc. Use this formulation to setup a nonlinear optimization problem and solve it using Python's `scipy.optimize`. You can read the manual to figure out how to setup the problem and solve it.

Solve the problem with different kinds and different numbers of basis functions. You can try using polynomials, B-splines, and radial-basis functions.

Approach 2: Neural Networks Adapt the code shown in class to solve this specific problem. The code will be shared with you.

Analysis Describe the solution quality and computational complexity (run times) associated with the different approaches.