AA 274A HW2

Mark Paral

October 18 2023

1 Problem 1: A* Motion Planning & Path Smoothing

1.1 Part i

After defining the functions "is_free", "distance", "get_neighbors", and "solve", I ran the "Simple Environment" example. The following is my resulting plot.

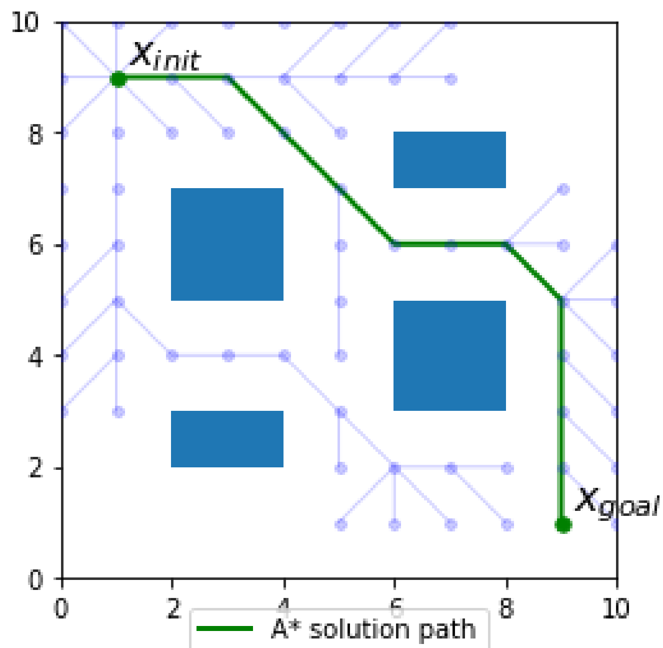

Figure 1: A* Path Planning

1.2 Part ii

After implementing the function "compute_smooth_plan" to smooth our path, I ran the function on the "Simple Environment" example above. The resulting smoothed plot using $\alpha = 0.03$ can be observed below.

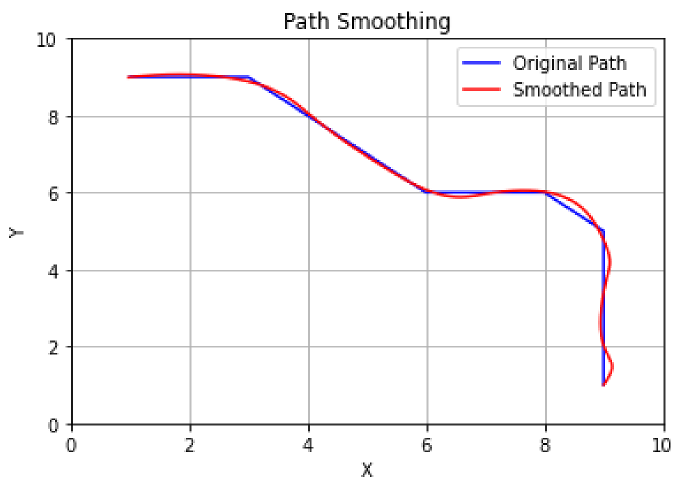

Figure 2: A* Path vs Smoothed Path (α = 0.03)

2 Problem 2: Rapidly-exploring Random Trees (RRT)

Collaborated with Anna Sulzer

2.1 Part i

After defining the functions "RRT.solve", "GeometricRRT.find_nearest", and "GeometricRRT.steer_towards", I ran the "Geometric Planning" example. The following is my resulting plot.

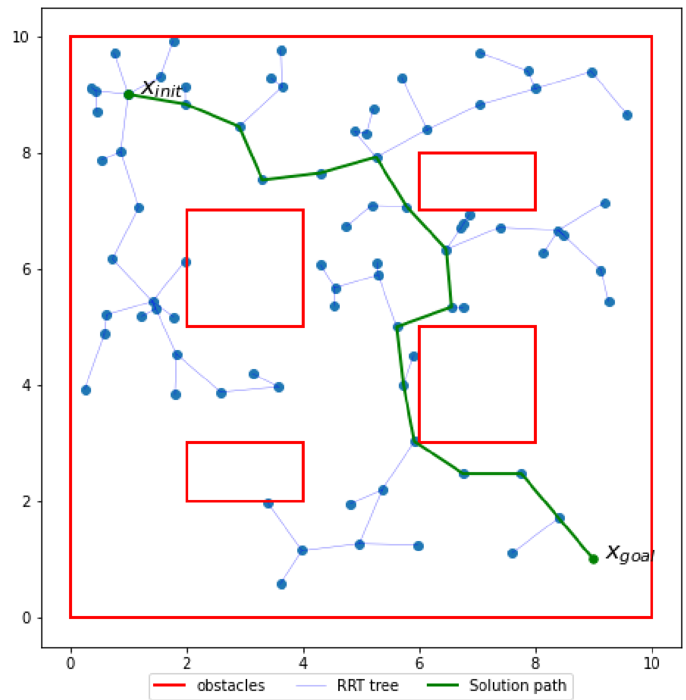

Figure 3: RRT Path Planning

2.2 Part ii

After implementing the function "RRT.shortcut_path", I ran the code in the "Adding shortcutting" example. The following plot is my result.

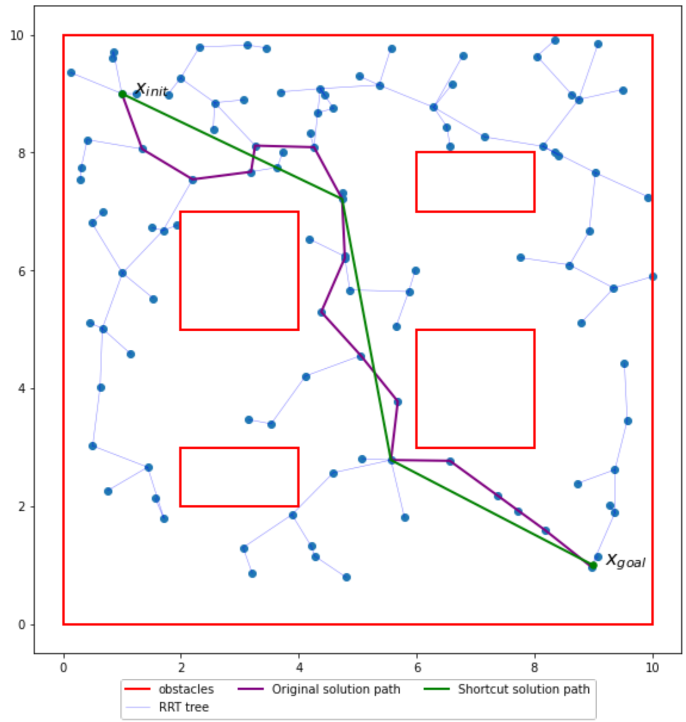

Figure 4: RRT Path Planning with Shortcut

3 Problem 3: LQR with gain scheduling

3.1 Part i

The dimensionality of the state space for the quadcopter is 6. The values are as follows:

x is the x position in the vertical plane

y is the y position in the vertical plane

v_x is the translational velocity in the x direction

v_y is the translational velocity in the y direction

ϕ is the angle of pitch

ω is the pitching rate of the quadcopter

3.2 Part ii

The dimensionality of the control space of the quadcopter is 2. The values are as follows:

T_1 is the thrust for the left propeller

T_2 is the thrust for the right propeller

3.3 Part iii

The method used to solve for the trajectory is a direct method. This can be described by the equations

$$min_{(x_i,u_i)} \sum_{i=0}^{N-1} \Delta t_i g(x_i, u_i, t_i)$$

$$x_{i+1} = x_i + \Delta t_i a(x_i, u_i, t_i), \quad i = 0, ..., N-1$$
$$u_i \epsilon U, \quad i = 0, ..., N-1$$

3.4 Part iv

After writing the code for section "LQR Controller and Gain Scheduling", I ran the example and returned the following plot.

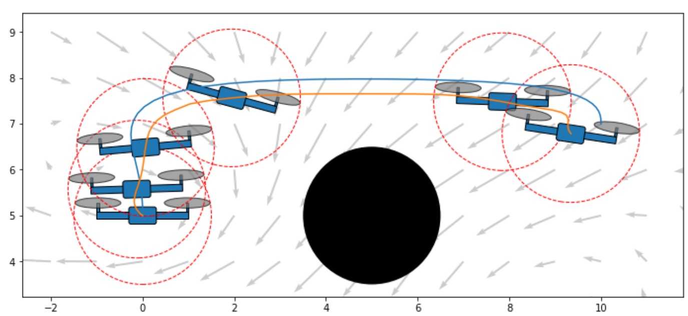

Figure 5: Drone Trajectory Plot