

Coding assignment for PhD candidates (2021)

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- Implement a SW solution that takes a trajectory in 2D, defined by a set of waypoints (blue dots), and produces a smooth interpolated path (green line) like illustrated below. Solution should also be able to handle constraints: 1) Avoidance of arbitrary circular objects, defined by center point and radius. 2) Variation of the starting point.

Solution:

Case 1 (without Constraints):

Given the initial and final values, the following line is simply generated. (For example, $x_0 = 0; y_0 = 0; x_f = 10; y_f = 2;$)

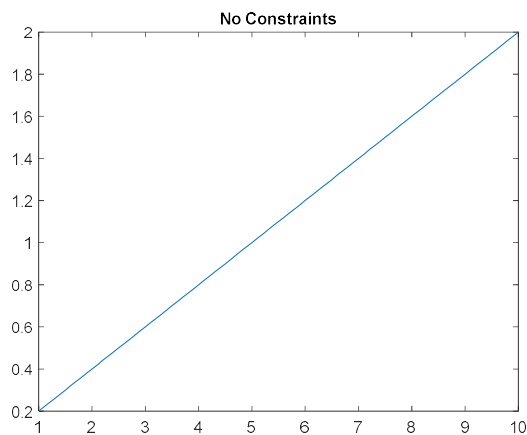


Figure. 1

Case 2 (Constraint-Objective Avoidance):

According to Fig. 2, the circular obstacle is problematic.

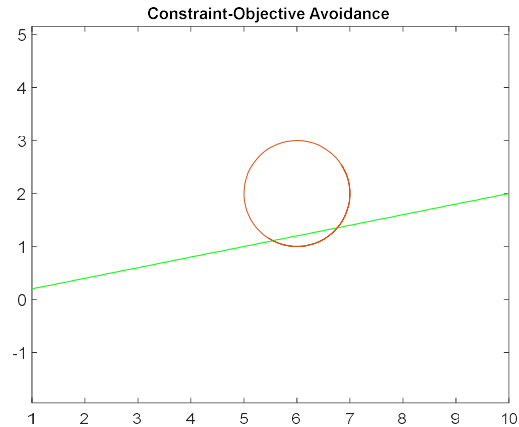


Figure. 2

Assumptions:

No optimization technique is required.

No restriction is imposed for the trajectory quality

The obstacle position and radius are detected by physical devices.

Only the start point can be changed.

Solution: First a safe area is defined for the system, and a circle with the same center with $2.r$ (r : the obstacle radius) is formulated. The closest distances from this safe area and the initial given points are first determined (by solving a set of equations). Then, a new point is determined such that its horizontal is the mean of the first two positions. And, its vertical position is set on the safe region. The vertical position is set upper or lower of the center such that the safe trajectory generation is ensured.

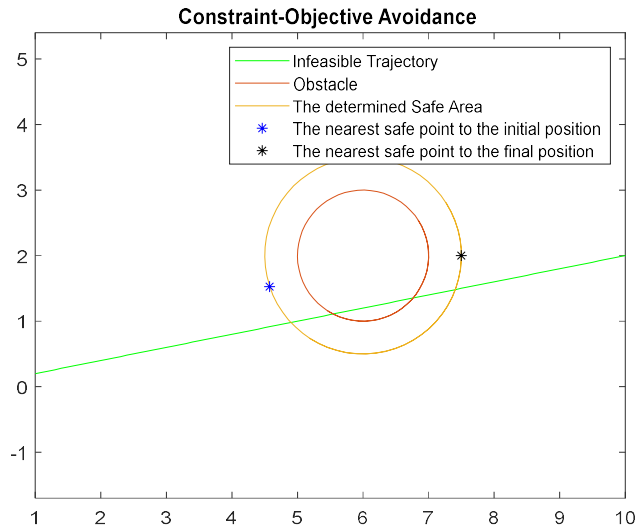


Figure. 3

Case 2 (Constraint-Objective Avoidance) + Changing the start point:

$x_0 = 0; y_0 = 0; x_f = 10; y_f = 2;$

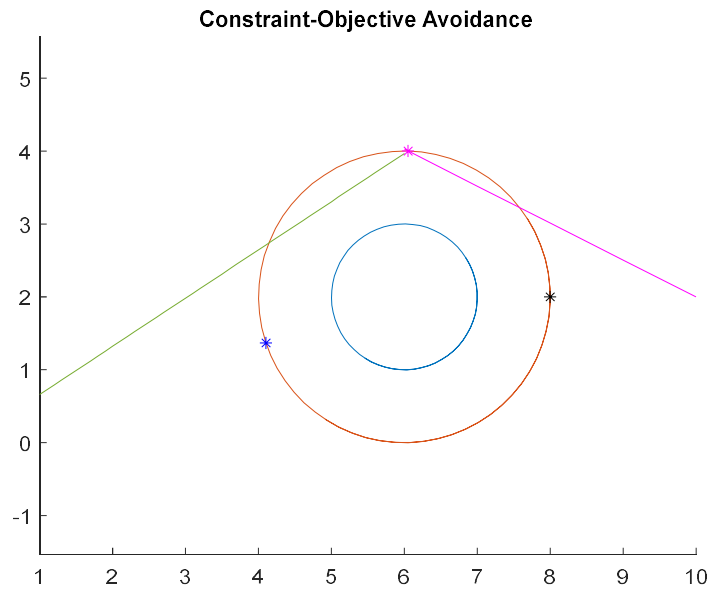


Figure. 4

$x_0=1; y_0=-1; x_f=10; y_f=2;$

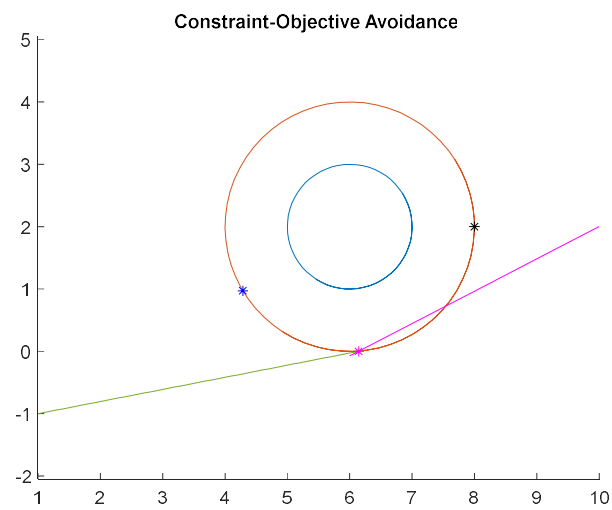


Figure. 5

$x_0=-5; y_0=-1; x_f=10; y_f=2;$

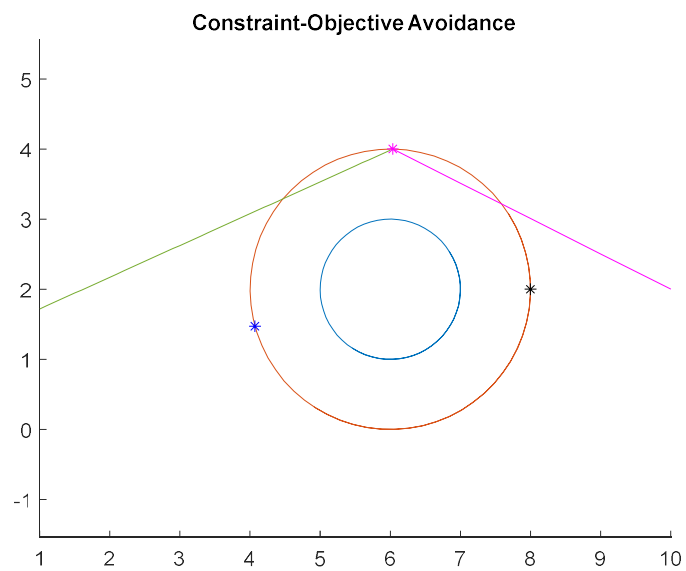


Figure. 6