

## Report

### Robotics: Dynamics and Control

#### Assignment 2

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##### 1. Test case result

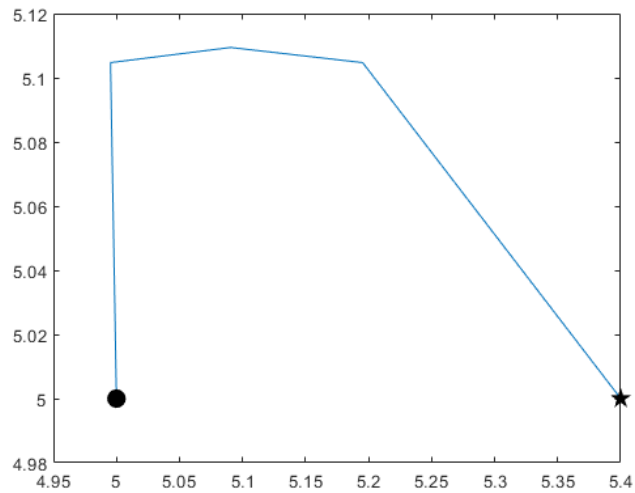
Initial state:  $x(0) = 5$ ,  $y(0) = 5$ ,  $v(0) = 1$ ,  $\theta(0) = \pi/3$

Target state:  $x(N) = 5.5$ ,  $y(N) = 4.9$

Tolerance: 0.1 for both x and y

$N = 4$ .

The solution can not be found for  $N < 4$ .



##### 2. Test case result

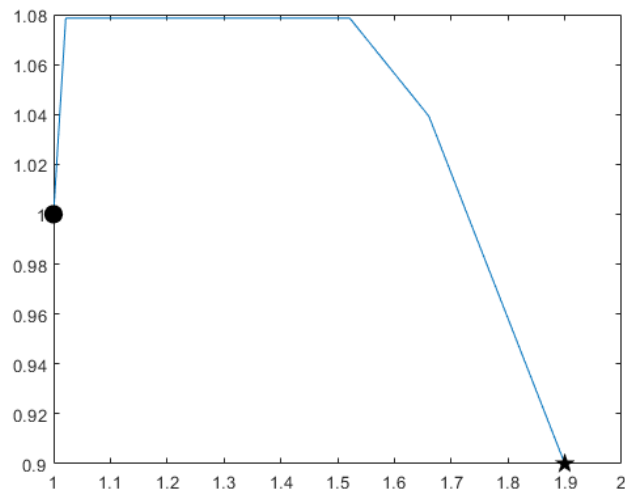
Initial state:  $x(0) = 1$ ,  $y(0) = 1$ ,  $v(0) = 1$ ,  $\theta(0) = \pi/4$

Target state:  $x(N) = 2$ ,  $y(N) = 1$

Tolerance: 0.1 for both x and y

$N = 8$

The solution can not be found for  $N < 8$ .



### 3. Background work

Handwritten notes on a notebook page showing a linear programming formulation and its iterative solution.

**Variables:**

- Var0:  $x_0, y_0, v_0, \theta_0$
- Var1:  $x_1, y_1, v_1, \theta_1$
- Var2:  $x_2, y_2, v_2, \theta_2$
- CI:  $w, w_2$

**Objective Function (LHS) and Constraints (RHS):**

LHS  $\rightarrow$  RHS

**Matrix A:**

$x_0, y_0, v_0, \theta_0, x_1, y_1, v_1, \theta_1, x_2, y_2, v_2, \theta_2, w, w_2$   
 $x_{2, \min}, x_{2, \max}, y_{2, \min}, y_{2, \max}, w, \min, w, \max, w_2, \min, \theta_{0,2}, \max$

**Iterative Solution:**

$x_{k+1} = x_k + \sqrt{1 - \theta_k} \cdot \delta$   
 $y_{k+1} = y_k + \sqrt{1 - \theta_k} \cdot \delta$   
 $v_{k+1} = v_k$   
 $\theta_{k+1} = \theta_k + w \cdot \delta$

**Control Input at each time step:**

$x_0 = 0$   
 $y_0 = 0$   
 $v_0 = 1$   
 $\theta_0 = \pi/4$

**Matrix A and b:**

$A = \begin{bmatrix} x_0 & y_0 & v_0 & \theta_0 & x_1 & y_1 & v_1 & \theta_1 & x_2 & y_2 & v_2 & \theta_2 & w & w_2 \end{bmatrix}$   
 $b = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$

Handwritten notes on a notebook page showing a linear programming formulation.

**Matrix A:**

$A = \begin{bmatrix} (N+1) \times 4 + N \\ 8 \end{bmatrix}$

**Matrix b:**

$b = \begin{bmatrix} 1 \\ 8 \end{bmatrix}$