Master's degree in Computer Engineering for Robotics and Smart Industry

# Robotics, Vision and Control

Report on the assignments given during the 2021/2022 a.y.

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# Contents

# Part I
# Robotics

# 1 Assignment 1

## 1.1 Implement in MATLAB 3rd-, 5th-, 7th-order polynomials for $q_i > q_f$ and $q_i < q_f$ and for $t \in [t_i, t_f]$ and $t \in [0, \Delta T]$

All polynomial trajectories can be expressed as:

$$
\begin{aligned}
q(t) &= a_7(t-t_i)^7 + a_6(t-t_i)^6 + a_5(t-t_i)^5 + a_4(t-t_i)^4 + a_3(t-t_i)^3 + a_2(t-t_i)^2 + a_1(t-t_i) + a_0 \\
\dot{q}(t) &= 7a_7(t-t_i)^6 + 6a_6(t-t_i)^5 + 5a_5(t-t_i)^4 + 4a_4(t-t_i)^3 + 3a_3(t-t_i)^2 + 2a_2(t-t_i) + a_1 \\
\ddot{q}(t) &= 42a_7(t-t_i)^5 + 30a_6(t-t_i)^4 + 20a_5(t-t_i)^3 + 12a_4(t-t_i)^2 + 6a_3(t-t_i) + 2a_2 \\
\dddot{q}(t) &= 210a_7(t-t_i)^4 + 120a_6(t-t_i)^3 + 60a_5(t-t_i)^2 + 24a_4(t-t_i) + 6a_3 \\
\ddddot{q}(t) &= 840a_7(t-t_i)^3 + 360a_6(t-t_i)^2 + 120a_5(t-t_i) + 24a_4
\end{aligned}
$$

For the 3rd-order polynomial $a_7 = a_6 = a_5 = a_4 = 0$ while for the 5th-order polynomial $a_7 = a_6 = 0$.

The problem of determining the $a_i$ coefficients of the polynomials is solved by setting up a system of equations using initial and final conditions on velocity (3rd-order), velocity and acceleration (5th-order), velocity, acceleration and jerk (7th-order).

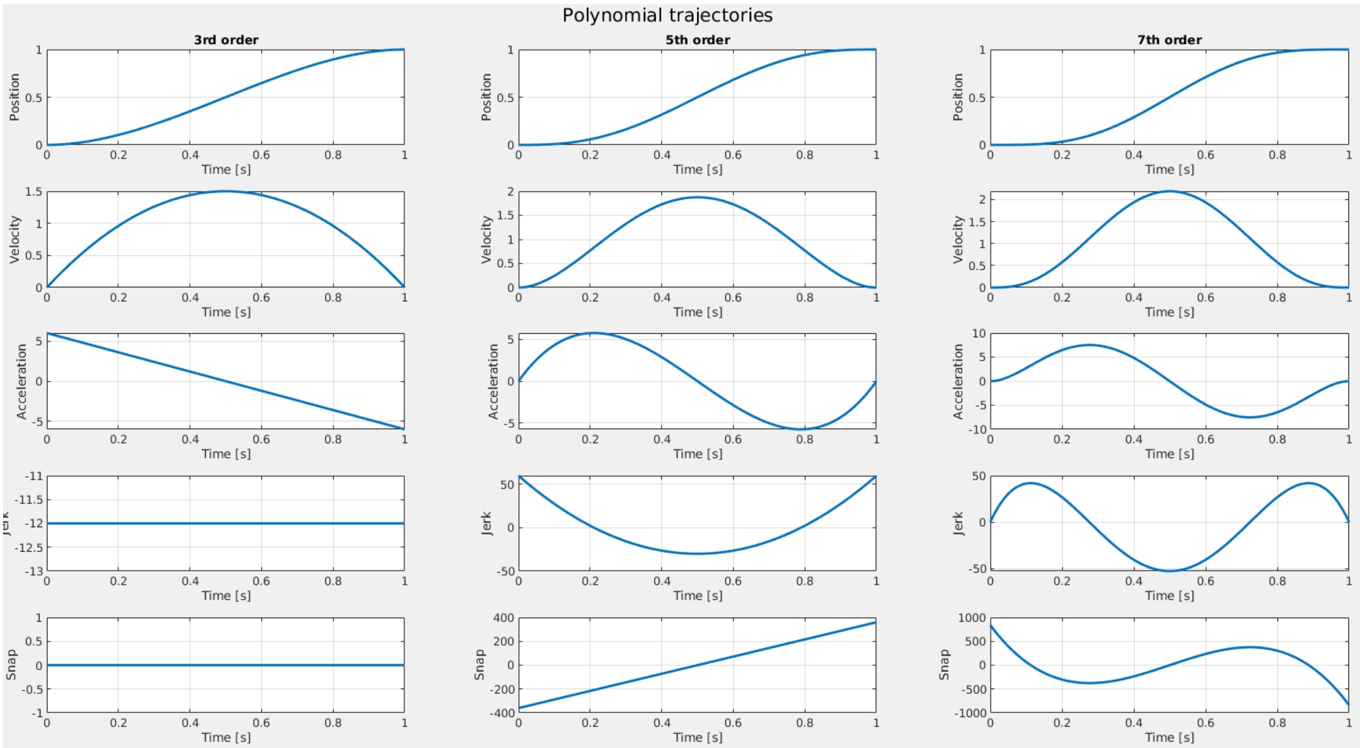


Figure 1: 3rd-, 5th-, 7th-order polynomial trajectories with $q_i < q_f$ and $t \in [0, \Delta T]$, $q_i = 0, q_f = 1, \Delta T = 1, v_i = v_f = a_i = a_f = j_i = j_f = 0$.

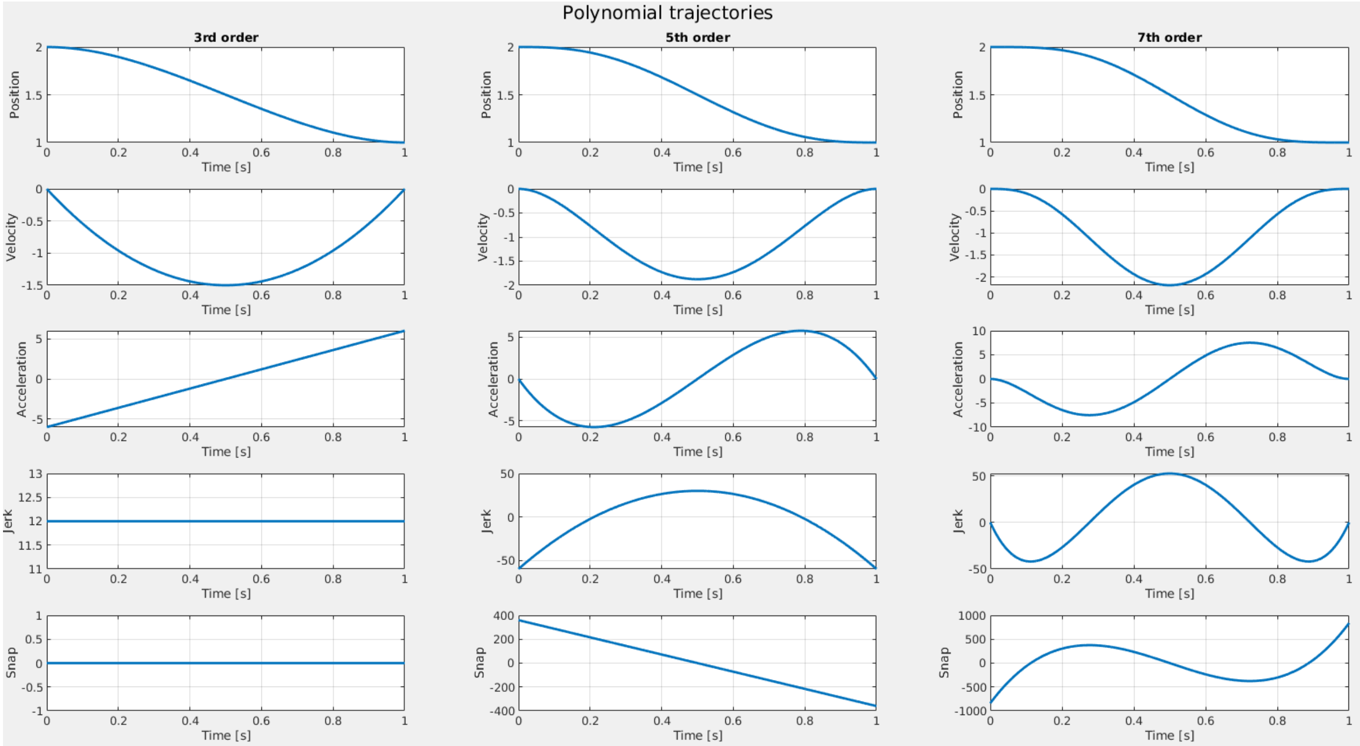


Figure 2: 3rd-, 5th-, 7th-order polynomial trajectories with $q_i > q_f$ and $t \in [0, \Delta T]$, $q_i = 2, q_f = 1, \Delta T = 1, v_i = v_f = a_i = a_f = j_i = j_f = 0$.

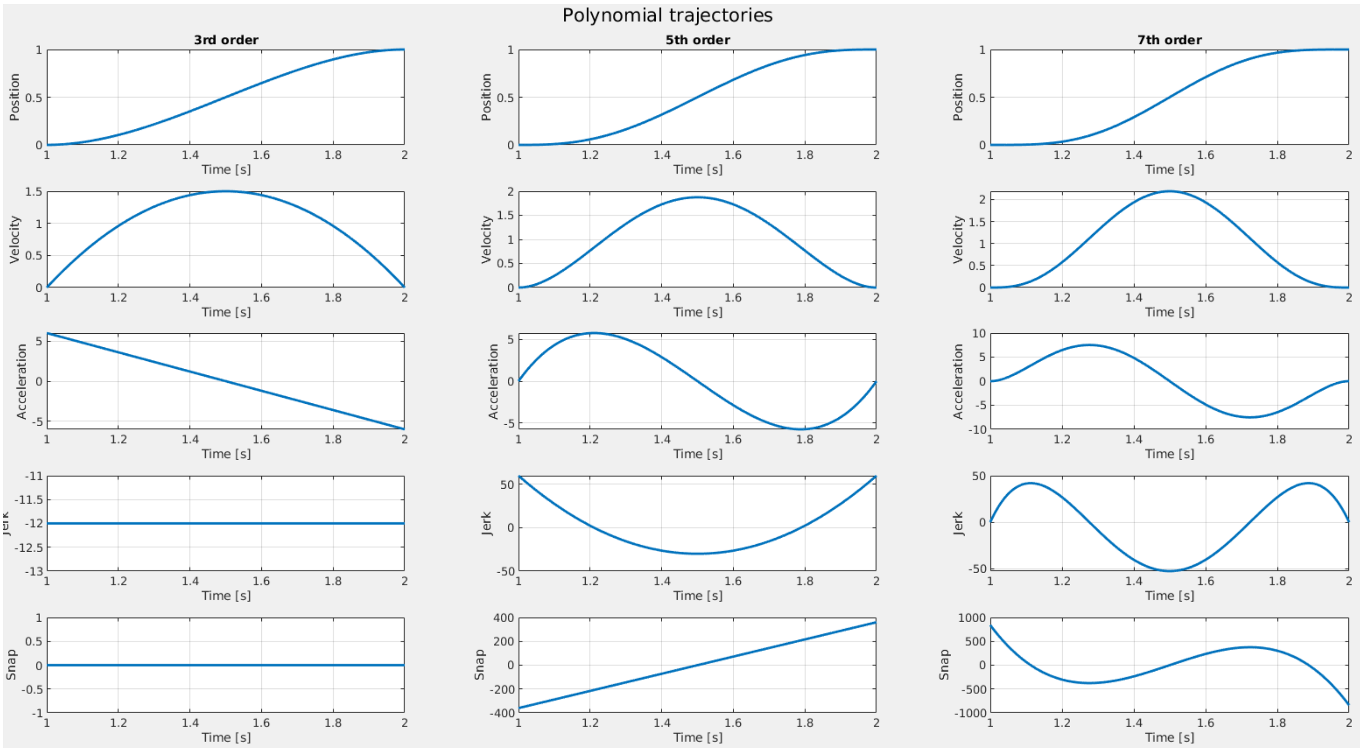


Figure 3: 3rd-, 5th-, 7th-order polynomial trajectories with $q_i < q_f$ and $t \in [t_i, t_f]$, $q_i = 0, q_f = 1, t_i = 1, t_f = 2, v_i = v_f = a_i = a_f = j_i = j_f = 0$.

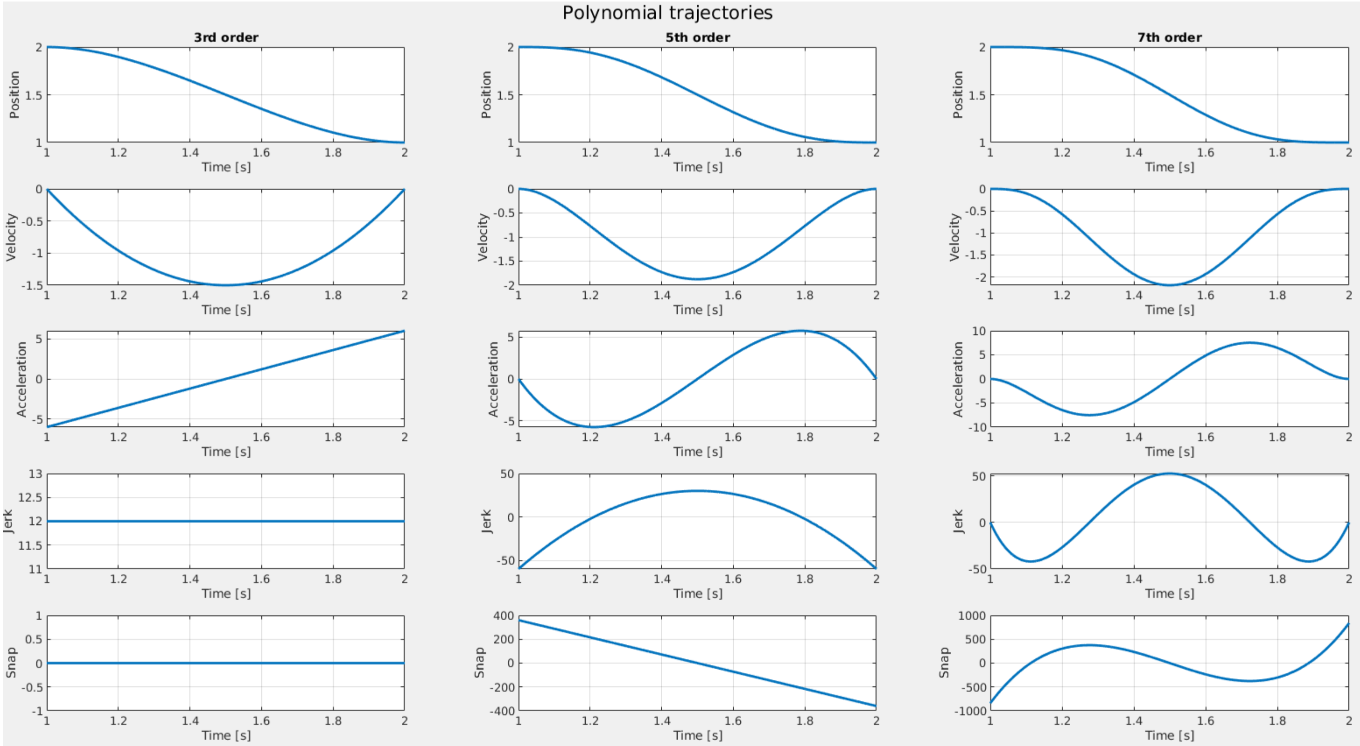


Figure 4: 3rd-, 5th-, 7th-order polynomial trajectories with $q_i > q_f$ and $t \in [t_i, t_f]$, $q_i = 2, q_f = 1, t_i = 1, t_f = 2, v_i = v_f = a_i = a_f = j_i = j_f = 0$.

# 2 Assignment 2

# 3 Assignment 3

# 4 Assignment 4

# 5 Assignment 5

# 6 Assignment 6

# 7 Assignment 7

# Part II
# Vision