SOLUTION
Trajectory Generation

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Gen3 lite Cursus

Table of contents

KINOVA

Manipulations

Part 1: Generating joint space trajectories

In this section, we will define a trajectory between two angular poses. First, we will do it using polynomial interpolation and then using trapezoidal velocity profiles.

1.1

$$a_0 = q_0$$

$$a_1 = \mathrm{v}_0$$

$$a_2 = \frac{1}{2}\mathrm{a}_0$$

$$a_3 = \frac{1}{2T^3}[20h - (8\mathrm{v}_f + 12\mathrm{v}_0)T - (3\mathrm{a}_0 - \mathrm{a}_f)T^2]$$

$$a_4 = \frac{1}{2T^4}[-30h + (14\mathrm{v}_f + 16\mathrm{v}_0)T + (3\mathrm{a}_0 - 2\mathrm{a}_f)T^2]$$

$$a_5 = \frac{1}{2T^5}[12h - 6(\mathrm{v}_f + \mathrm{v}_0)T + (\mathrm{a}_f - \mathrm{a}_0)T^2]$$

Where *h* is the displacement (q_1 - q_0)

1.2

See associated .m file.

1.3

$$v_{max} = \frac{1}{2a_{max}}\left(a_{max}T \pm \sqrt{(a_{max}T)^2 - 4a_{max}(q_f - q_i)}\right)$$

$$t_a = v_{max} / a_{max}$$

1.4

See associated .m fie.

Part 2: Generating cartesian space trajectories

2.1

See associated .m file.

Part 3: Validation with the robot

3.1

The validations are also performed by the robot. If the trajectories do not run, then the validation done by the students failed.

3.2

Notable points student could mention in the comparison include:

- Trapezoidal velocity profiles have discontinuous accelerations which can cause vibrations
- 5th order polynomials yield trajectories that are hard to intuitively predict for the whole robot.
- The cartesian method is sensitive to singularities which can cause failures.
- The cartesian method takes longer to process
- Only Newton's method will try to reach an unreachable point - the rest will fail the computation before the trajectory even starts.

3.3

See above.

3.4 (Optional)

As of firmware version 2.1.1, Gen3 lite uses Trapezoidal velocity profiles.

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