Experiment Procedure
Robot Modelling, Identification, and Control

CTC - Computed Torque Control of a Planar Manipulator

May 22, 2025

⚠ **IMPORTANT:** It is essential that you carry out the following steps before starting the experiment!

1.) Select "`Fixed-Step`" as the solver for your Simulink model with a variable Sample Time $T_s = 0.001$. You will select this later depending on the task. You can set this under "`Model Configuration Parameters`" in the upper bar.

2.) Avoid hardcoded values, i.e. only use variables within Simulink and define them outside in a central script which is called by the simulation via callback[1].

3.) Deactivate the check mark at "`Limit data points to...`" in Scopes in order not to lose any data points during longer simulation times.

4.) If you need to compare two systems, the easiest way is to copy the original system and make the changes to the copy. So you always have both versions available.

5.) For "`To Workspace`" blocks, select "`Array`" as the storage format, since they are the easiest to handle.

6.) If the function of a command is not clear, use MATLAB Help.

7.) Use the "`clear`" command in your main script to clean up your workspace before performing a task and avoid errors due to old data.

⚠ **IMPORTANT: Items marked with a ★ must be included in your experiment report**.

1 Experimental procedure

Consider the planar manipulator model and desired trajectory available on Moodle. Your goal is to design a joint trajectory tracking controller.
Consider the initial condition to be:
$q_0 = \begin{bmatrix} -\frac{\pi}{2} \\ 0 \end{bmatrix}$

Hint: since the commanded torque is limited to ± 200 Nm your controller gains must guarantee that you generate torques withing this range. Be careful not to saturate the torques.

T1 (**10 P**) Given the model and the given desired trajectory for the simple two-link robot provided in Moodle:

- Implement a traditional PID controller for a regulation task. The desired setpoint is: $q_d = \begin{bmatrix} 0 \\ -\frac{3}{4}\pi \end{bmatrix}$. Find a set of gains that gives reasonable performance.
- Now attempt to use your tuned controller for a tracking task; i.e. use the provided desired trajectory. Will it work?

★ **Include in your report plots for both cases, regulation and tracing. Discuss your observations.**

T2 (**10 P**) For the **same model**, **same initial conditions**, and same desired trajectory design now a computed-torque controller with a PD outer loop.

- Tune the PD controller gains so that the controller has an acceptable performance.
- Use the MATLAB step block to give a disturbance torque to the model at t = 5 s of 10 Nm.

★ **Include in your report a plot that shows tracking before and after the occurrence of the disturbance. Discuss your observations.**

T3 (**10 P**) Now use a PID controller in the outer loop and use the same disturbance torque as before. How does the tracking perform?
★ **Include in your report a plot that shows tracking before and after the occurrence of the disturbance. Discuss your observations.**