Assignment 01: Comparison between different controllers

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1 Answers

1.1 Question 1

The different implementations of the IC controller differ for some characteristics. We imposed stiffness and damping matrices as diagonal with constant stiffness values and damping values dynamically computed using the simulator mass matrix imposing a unitary damping ratio.

Every controller manages to converge to the desired end effector position except for the third one (Exact version). The first one (Simplified version) manifests a continuous movements of the arm even though the end effector remains still, this because we didn't minimize the null-space of the jacobian pseudo-inverse yet.

In the second (Simplified version + postural task) and fourth (Exact version + postural task) controller we don't notice any macroscopic difference from the simulations, the tracking errors are different: ... and they converge to an equilibrium in different times: ...

When we introduced the friction we noticed that the controller couldn't manage to always make the robot reach the desired e.e. position. This can be physically explained because the control torque is proportional (but not only) to the error position, once it becomes small enough the resulting control torque becomes equal and opposite to the sum of the friction torque and gravity compensation resulting in a torque equilibrium (fig. **??**) without ever reaching the desired position (fig. **??**).

Here are the average tracking errors of the controllers:

Simplified	Simplified + postural task	Exact	Exact + postural task
		Undefined	

1.2 Question 2

In the exact controller we see that the torques diverge and hence we can't finish the simulation, in the friction case scenario instead it manages to converge. This is explained by the behavior of the non controlled joint space: in the first case it diverges with increasing velocities until it reaches a singular configuration and simulation ends, in the second case the uncontrolled space is mechanically stable with the addition of friction hence controlling only with the main task results in a converging control overall (fig. **??**).

The other controls manage to stabilize the desired position because they are imbued with the postural task, the first case instead, even though it doesn't have the postural task, doesn't diverge because the non linear contributes (term h representing gravity and Coriolis contributions) is simply added to the control torque and not multiplied by the inverse of the jacobian.

1.3 Question 3

1.4 Question 4

1.5 Question 5

2 Plots