Exercise 2a: Dynamics of the ABB IRB 120

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Abstract

In this exercise you will develop a tool which implements the equations of motion of an ABB robot arm. To this end, you will need to compute the mass matrix, the Coriolis and the centrifugal terms, and finally the gravity terms. A MATLAB visualization of the robot arm is provided, as well as scripts which initialize the kinematic and dynamic parameters of the arm. The partially implemented MATLAB scripts, as well as the visualizer, are available at https://bitbucket.org/ethz-asl-lr/robotdynamics_exercise_2a.

1 Introduction

The robot arm and the dynamic properties are shown in figure 1. The kinematic and dynamic parameters are given and can be loaded using the provided MATLAB scripts. To initialize your workspace, run the *init_workspace_scripts.m* and *init_workspace_visualization.m* scripts. To start the visualizer, run the *load_Visualization.m* script.

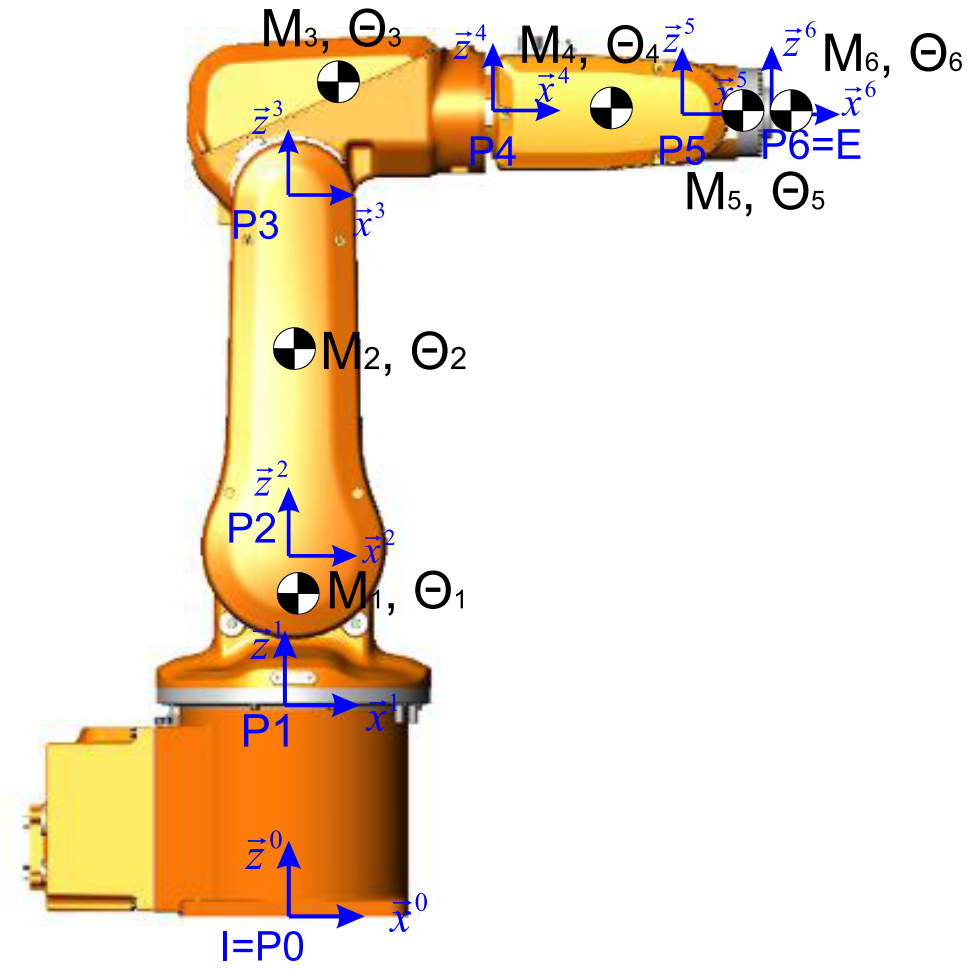

Figure 1: ABB IRB 120 with coordinate systems and joints

Exercise 1.1

This exercise focuses on implementing the mass matrix, the Coriolis and centrifugal terms, and the gravity terms (i.e. $\mathbf{M}(\mathbf{q})$, $\mathbf{b}(\mathbf{q}, \dot{\mathbf{q}})$, $\mathbf{g}(\mathbf{q})$). As you have seen during the lecture, to derive these quantities you first need to derive the jacobians of the center of mass ${}_I\mathbf{J}_{S_i}$ and ${}_I\mathbf{J}_{R_i}$ of each link. We have provided this implementation in the *generate_jac.m* script. This script takes advantage of the homogeneous transformation matrices found when computing the forward kinematics of the arm. Your task here is to fill in the missing code in the *generate_eom.m* script which generates all the quantities which are used in the equations of motion, as well as the total mechanical energy of the system. The latter can be used to validate your results (e.g. if no external forces are acting on the system, the total mechanical energy should remain constant over time). When you are done with the implementation, you should be able to run the *run_scripts.m* file. This script generates all the kinematic and dynamic quantities symbolically, and parses them to Matlab files which will be used in a Simulink block scheme to simulate the dynamics of the robot.