University of Maryland- College Park

ENPM662 Introduction to Robot Modeling - Fall 2021

Homework - 3

Due Date : October 27th 2021 11:59 pm

Total - 50

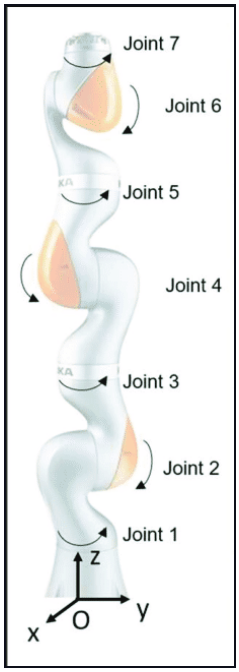
Problem 1: Forward Kinematics

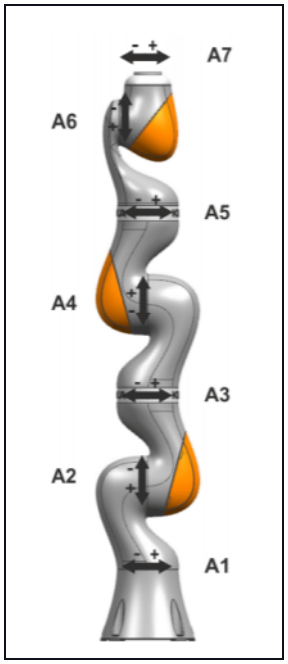
20

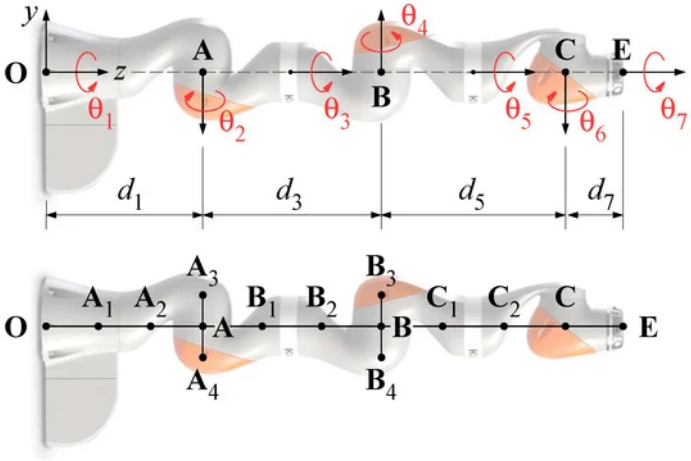
Derive the forward kinematics using the DH convention for the following KUKA robot. Assume the frame n for the end effector after the last link and orient the z direction according to convention (Usually zn is taken along the axis of action of the last physical link i.e. along the axis of rotation for a revolute joint or along the axis of translation for a prismatic joint). Assume the base configuration as given in the second figure below and frame 0 as given in the first figure and assume the link lengths in terms of variables.

a) Show all the Coordinate Frames. b) Show the DH table. c) Show all the transformation (T_i^{i-1})matrices. d) Show the final transformation between base frame and end effector frame T_n^0.

Validate the equations parametrically for five geometrically known configurations (rotate joints by 90 degrees). Use Python's SymPy library. Submit your codes with the final submission.







Problem 2: Velocity Kinematics

30

For the PUMA robot given below, do the following:

a) Show all the Coordinate Frames. b) Show the DH table. c) Show all the transformation (T_i^{i-1})matrices. d) Show the final transformation between base frame and end effector frame T_n^0.

Derive the Jacobian equation in terms of the generic z and o vectors (do not perform the computations) using **two different methods** (from lecture 6) and compare the outcomes. Write all z and o components needed to compute the Jacobian. You do not need to perform the computations for the Jacobian components (i.e.don't do the cross products). Provide a brief explanation for how these components were obtained.