ASE-9406 ROBOT MODELLING, CONTROL AND PROGRAMMING

Assignment 1: DH Parameters, Forward and Inverse Kinematics

Due Date 27.11.2016@ 11:55PM

Submit assignment on Moodle in a ZIP file, include a PDF of the report and the Matlab code properly commented/documented. Work in groups of 3 persons.

OBJECTIVE

The objective of this assignment is to use the tools offered by Robotics Toolbox for Matlab to design and analyze an automatic manipulator.

DESIGN OF A PUMA ROBOT

Suppose you are in charge of choosing the dimensions a PUMA robot for a given task. The robot you are designing must have the configuration of a PUMA robot (6 axis, RRRRRR) (see Figure 1), but you are free to choose the lengths and offsets of each of the links.

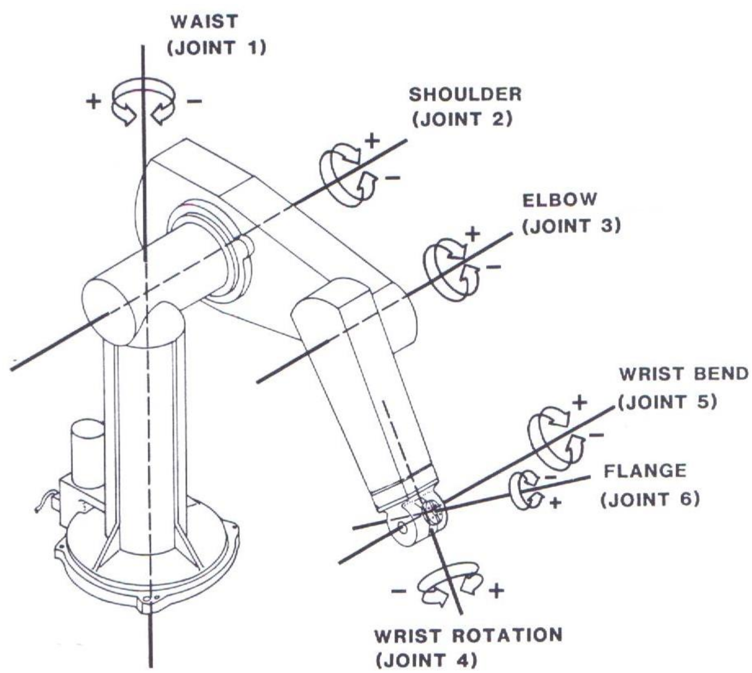

FIGURE 1. PUMA ROBOT CONFIGURATION

Lets consider that the base of the PUMA robot is at the origin of the world frame. In order to grasp the work pieces, a pneumatic gripper is mounted at the end of the robot, see Figure 2.

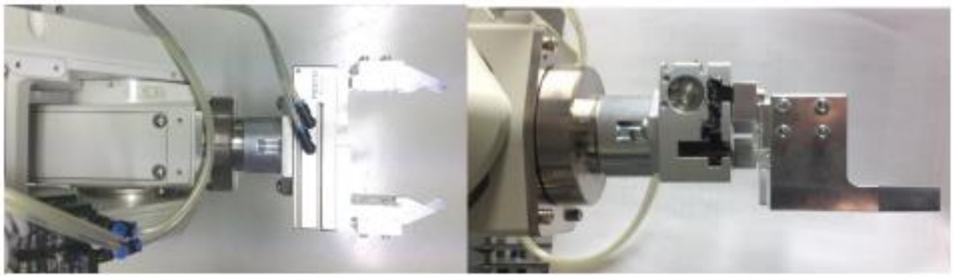

FIGURE 2. PNEUMATIC GRIPPER (TOOL)

The centre of the gripping jaws is 135mm from the end of the robot, and drops down 30mm.

The robot must be able to reach a work piece into different positions and orientations, **A** and **B**, see Figure 3. Notice that the fingers of the gripper **must be aligned with the black stripes** of the work pieces of Figure 3. Notice that the positions are given in meters.

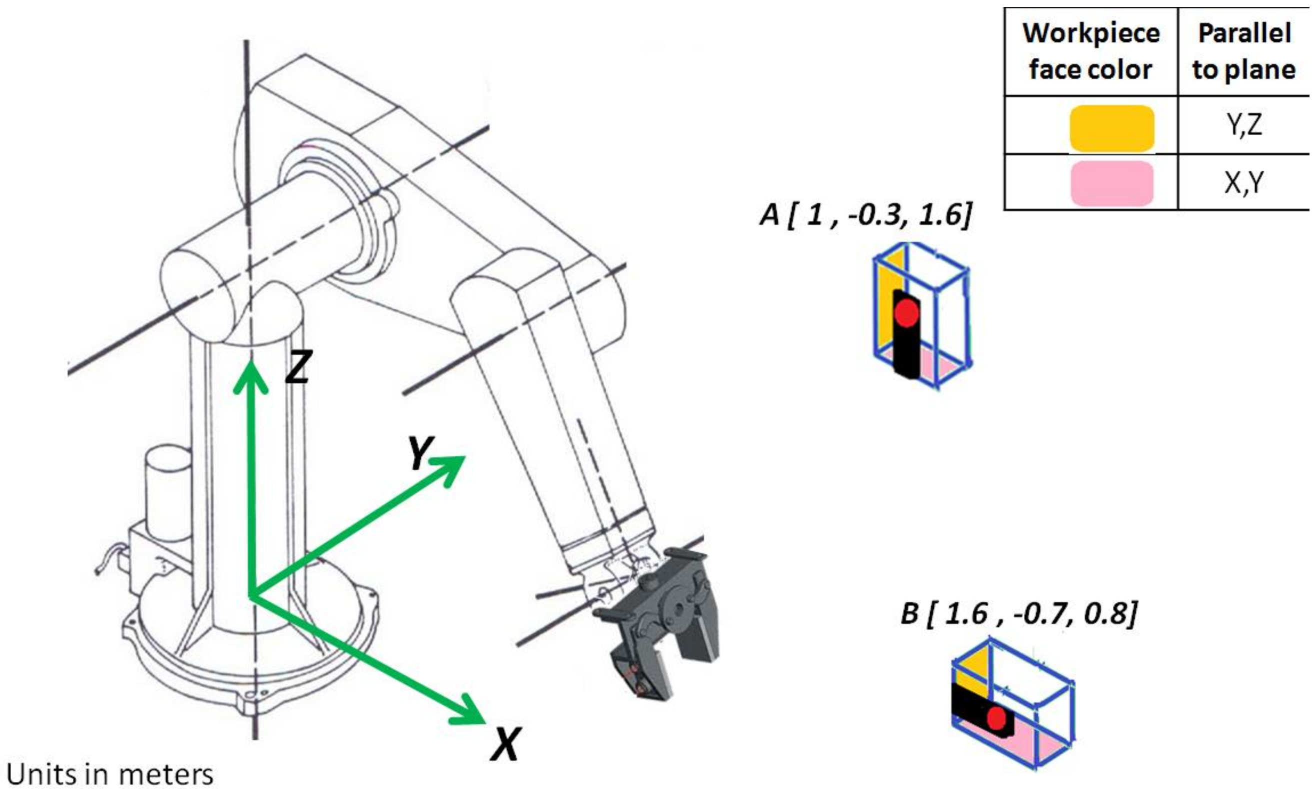

FIGURE 3. TARGETS POSITIONS AND ORIENTATIONS

APPROACH

1) Assign link frames
2) Determine the modified DH parameters for the PUMA robot of Figure 1. NOTE: parameters like link offset (d) or link length (a) should be assumed intuitively in this first iteration step. Joint twitst(α) can be determined from the figure
3) Model the manipulator with ***SerialLink*** command and attach the **tool** to the manipulator
4) Use ***teach*** command to jog the robot manually and visualize roughly if the working positions/orientations are within the robot workspace
5) Compute the inverse kinematics of the cases A and B shown in Figure 3, if the inverse kinematics method can not find a solution, go to step 2 and modify link offsets (d) and lengths (a)

QUESTIONS

Modified DH Parameters

- Explain **clearly** any choices you made when placing the link frames
- Draw a diagram showing the link frames on the robot
- Explain the different options you had when assigning the link frames
- Provide the modified DH Parameter table of the PUMA manipulators you designed.
- Using the Symbolic Math toolbox, give the transformation matrix between link frames.
- Give the homogenous transformation matrix for the robot when all the joint angles are set to zero. What is the position in X, Y and Z of the manipulator?

Robotics Toolbox

- Model the robot using MATLAB robotics Toolbox. Give the code you used to create your model.
- Plot the robot in the zero angle position.

Forward kinematics

- Determine tool transformation, and apply it to the model you created.
- Provide the tool transformation.
- Plot the robot in different configurations and provide: joint angles, end frame homogenous transformation matrix and position (x,y,z) of the tool tip
    - Straight vertical
    - Straight horizontal
    - Working position as the one shown in the figure 1.

Inverse kinematics

- Solve the inverse kinematics for the target in cases **A** and **B** shown in figure 3.
- For each case, provide the code you used to calculate them, the joint angles values and the robot plotted in those positions.
- How can you verify that the joints angles that you computed, actually will drive the robot tool to the desired position and orientation?

Assignment submission

Work in groups of three persons. Submit your reports with the answers, diagrams and plots required in the questions section in a pdf file. Submit also the matlab code you generated properly documented/commented. Both files, should be in a ZIP folder.

The code will be tested to verify the results and therefore a properly commented code is required. So this will be considered for the grading of the assignments.