TÉCNICO LISBOA

Robotics

Spring 2019

Departamento de Engenharia Electrotécnica e de Computadores

1st lab assignment

Direct and Inverse Kinematics of Serial Manipulators

(To be demonstrated no later than March 18-22/2019)

1 Objectives

Develop/improving skills on

- Use of homogeneous matrix transformations to represent positions and orientations of the rigid bodies forming a robot, and
- Synthesis of kinematic models for serial manipulators.

2 Syllabus

The aim of the work is to compute the kinematic model for a serial manipulator with 6 degrees-of-freedom (dof) in figure 1.

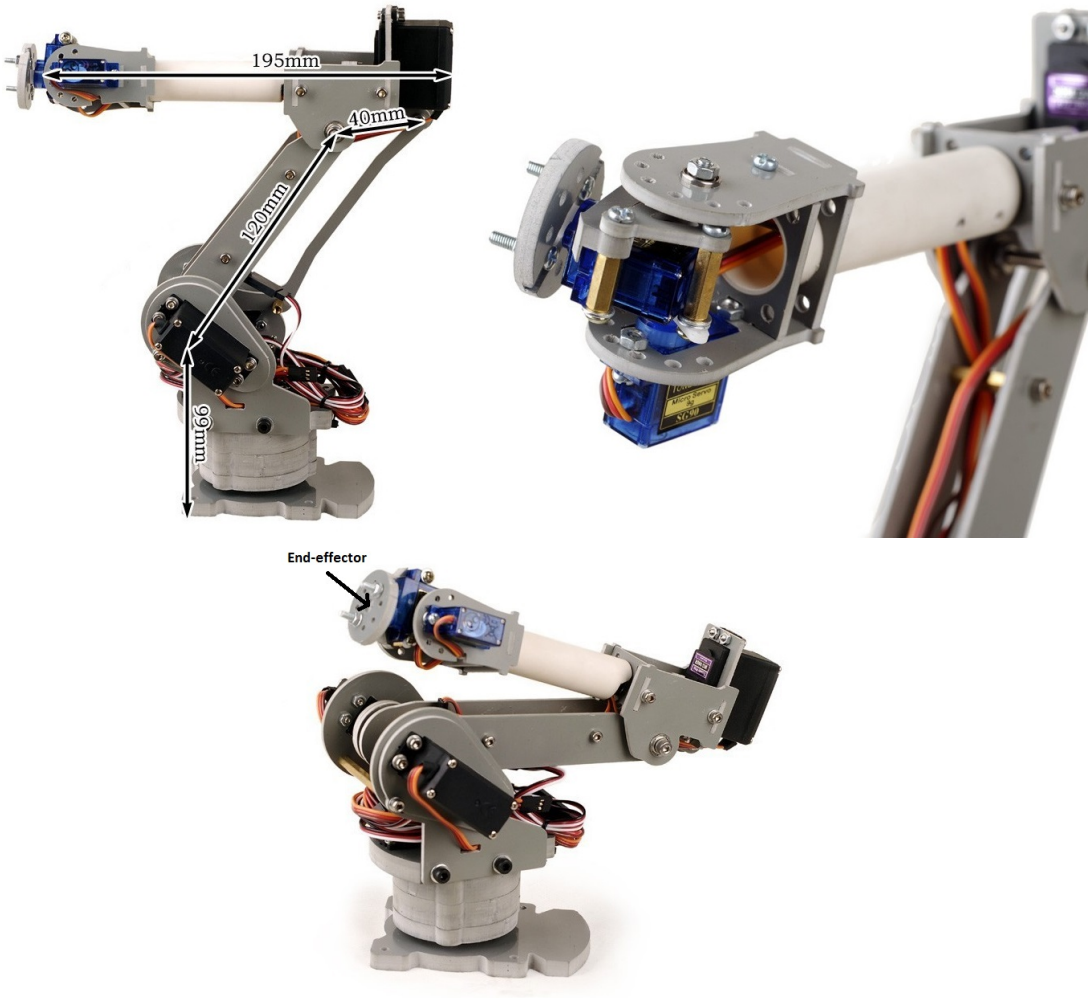

Figure 1: The 6-dof serial manipulator

In this assignment students are required to develop two functions that compute, for the robot in the figure,

1. The direct kinematics,
2. The inverse kinematics.

The direct kinematics function must accept a set of 6 angles (one for each dof) and return the position and orientation of the end-effector.

The exact location to be considered for the end-effector is shown in figure 1. The 3 coordinates, x, y, z, must be relative to a reference frame with the origin located at the base of the robot.

Dimensions not shown in the figure can be safely assumed within reasonable, nonzero, bounds (they can be checked directly on the real device in the lab sessions).

The orientation must be described by 3 Euler angles (α, β, γ) or by a rotation axis and a rotation angle around that same axis.

The inverse kinematics function must accept a position and orientation of the end-effector and return all the corresponding solutions in the space of the joint angles.

Figure 1 also shows the physical dimensions (in mm) to be used to determine the direct and inverse kinematics.

It is not necessary to account for the physical limits of each of the joints.

3 Expected outcome

- Two Matlab^{TM} (M-files) implementing the direct and inverse kinematics of the robot, respectively. As an alternative, Gnu Octave©, R©, or Python^{TM} scripts can be used.
- A demonstration of the code developed will be agreed with the course responsible for the week of March 18-22.
- Report detailing all the steps and assumptions taken. **The method to represent the orientations and the link transformations must be clearly explained**.

  The report must include

  - A set of tests showing the output of the direct and inverse kinematics for a significant set of input data, and
  - A user manual or brief explanation on how to use the M-functions developed.

  The report should not have more than 8 A4 pages - To be handed to the course responsible no later than 1 week after the demonstration.
- A zip/rar file with the software developed and the report in pdf format is to be handed to the course responsible.

4 "No bonus points"

Will be awarded for fancy graphical interfaces.

5 “Bonus points”

Will be awarded for analytical study on the singularities (check the theory classes) of this specific robot.