FR-S25: Home task (Kinematics)

Task:

1) Select a robot's elbow model from one of the following: Assign yourself a model from here
    a. Stanford Manipulator
    b. Spherical Manipulator
    c. Antropomorphic
    d. Puma
2) Couple your elbow model with a spherical wrist that satisfies Euler angles arrangement (xyz, xzy, xyx, xzx, yxz, yzx, yxy, yzy, zxy, zyx, zyz, zxz) (Make sure it is a spherical wrist)
3) Demonstrate the assignment of coordinate frames on the selected model (hand drawn or using any drawing tool)
4) Solve Forward Kinematics Problem (using DH-Parameter is **optional**). You can use 6 transformations between two frames.
5) Analyze the workspace and reachability of the robot. (plot the reachable workspace)
6) Solve inverse kinematics problem using any approach you like.
7) Validate the inverse kinematics solution by feeding 50 different random joint positions into the forward kinematics function, use the output from FK as input to the IK function and check that one of the solutions is the same as the input.
8) Write a code class that inherits the robot's properties and kinematics information and functions. Write the forward kinematics and inverse kinematics that take the required input format and update the robot's state accordingly.
9) Write supporting functions for plotting the robot and its frames.

Important Notes:

- You need to write everything from scratch. Using robotics libraries is allowed only to validate the correctness of your solution.
- It's recommended to write the code in a python notebook.

References:

It is recommended to refer to these references for information about Euler Angles and the listed manipulator models.

1) B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, "Robotics: Modelling, Planning and Control", 3rd Edition, Springer, 2009
2) Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Dynamics and Control, Second Edition, John Wiley & Sons, Inc. 2008

Submission:

You should submit a working code (python) and a report.

In your report (your report can be as a markdown in your python notebook):

- A simple graph of your model
- Assignment of Coordinate frames on robot's joints
- Forward kinematics solution (only symbolic, the code is responsible for calculations)
- Inverse kinematics solution (demonstrate the method and the analytical calculations)
- Results of code implementation
- Validation of inverse kinematics solution (inverse kinematics solution should correspond to forward kinematics solution)