Design and Control of a Robotic Manipulator

The goal of this project is to design and control a robotic manipulator using Dynamixel MX-28AR servo motors to accomplish some tasks defined by yourselves. Your team will be graded upon:

Table 1: Grading Rubric.

#	***Content***	***Point***
1	Design	10%
2	Forward Kinematics	25%
3	Inverse Kinematics	25%
4	Simulation	10%
5	Demo	10%
6	Presentation	10%
7	Report	10%

Design

You are required to design a robotic manipulator, operated in 3D with at least 4 DoF, using Dynamixel MX-28AR servo motors as actuators. When you are designing, you can consider:

- The configuration to accomplish the task
- The link length constrained by the motor torque
- The joint angle constrained by the physical interference
- A gripper as the end-effector can be a bonus
- Prismatic joints can be a bonus
- Any interesting mechanisms can be a bonus

Forward Kinematics

You are required to derive the forward kinematics for your designed manipulator, from the base frame to the end-effector frame. The numerical values must **not** be used until the very end.

Inverse Kinematics

You are required to derive the inverse kinematics for your designed manipulator, using either algebraic or geometric method. The numerical values must **not** be used until the very end. Describe how you deal with multiple solutions.

Simulation

You are required to code your kinematics in MATLAB and do a simple task simulation to verify your kinematics via animation. An example is provided. The corresponding animation in SolidWorks is recommended but not required.

Demo

You are required to show your manipulator performing the task. You can either make a video in advance or live demo during the presentation. Sample tasks can be:

- Path following
- Grasping can be a bonus
- Feedback control can be a bonus

Presentation

You are required to present your work (partially if not finished) in class on Nov. 30th and Dec. 2nd. The total time should not exceed 12 minutes including Q&A.

Report

You are required to submit a report by the midnight of Dec. 10th. The pdf file should be emailed to the TA, along with everything you should deliver as a zip file including CAD files, MATLAB codes, demo videos, etc. The following contents can be included not necessarily in the exact order:

- Manipulator configuration to accomplish the task
- Design highlights and difficulties
- Static force analysis
- Derivation of kinematics
- Solution selection for inverse kinematics
- Singularity discussion
- Workspace analysis
- Task simulation
- Performance analysis in comparison with the commercial products
- Any constructive comments for the project can be a bonus
- An interesting team name/logo can be a bonus
- A well-written and well-organized report can be a bonus
- The maximum page number is 10 **excluding** the cover page, references, appendix, etc.
- At **least** 12-point font in Times New Roman