Robotic Systems

Assignment # 3

[32 points]

1) State True or False for the following:
   a) Configuration space for any manipulator is unique.
   b) There are 12 basic parameters characterizing a link (also called link parameters).
   c) Parallel robots are the way to go for high reachability.
   d) Each joint can physically have only one joint variable associated with it.
   e) Joint variables are always angles.

   [5 points]

2) For the manipulator shown here, do the following:
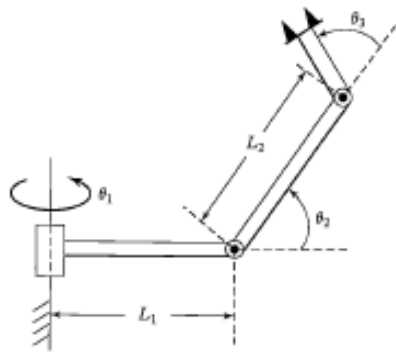
   a) Derive the link parameters (to find the transformation from wrist to base frame).
   b) In MATLAB, First create a function to determine the transformation matrix (T_i^{i-1}) based on the values of the 4 link parameters. First create a function to determine the transformation matrix (T_i^{i-1}) based on the values of the 4 link parameters (you can use the same function developed in class for the simple manipulator).
   c) Use this function to calculate all matrices required to go from tool frame to base frame. [Try to do this in a recursive fashion by writing a script that calls the function automatically multiple times, for different values of link parameters.] [Assume L1 = 10m, L2 = 10m, L3 = 0m, and $\theta_1 = 45°$, $\theta_2 = 30°$, $\theta_3 = -30°$, or any arbitrary values for angles are also acceptable].
   d) Use this further to create a function to find the end effector position for given joint angles [Hint: End effector position is only the translational part of the homogeneous matrix].
   e) Plot the workspace for the robot, for $\theta_1 \in [0°, 90°]$, $\theta_2 \in [0°, 90°]$, $\theta_3 \in [-45°, 45°]$.

f) For a particular configuration, $\theta_1 = 45°$, $\theta_2 = 30°$, $\theta_3 = -30°$ plot the robot links. [Hint: It doesn't have to be a fancy plot. Just find the end points of each link and join them with lines. You can use "plot3" command in MATLAB, and use the option "LineWidth" to control the thickness of the line. Or use the "quiver" command used before, or use anything of choice]

[15 points]

3) Imagine an arm like the PUMA 560, except that joint 3 is replaced with a prismatic joint (Note that PUMA 560 is discussed in one of the examples in the textbook). Assume the prismatic joint slides along the direction of X_1 in the figure. However, there is still an offset equivalent to d_3 to be accounted for. Make any additional assumptions needed. Derive the kinematic equations.

[10 points]
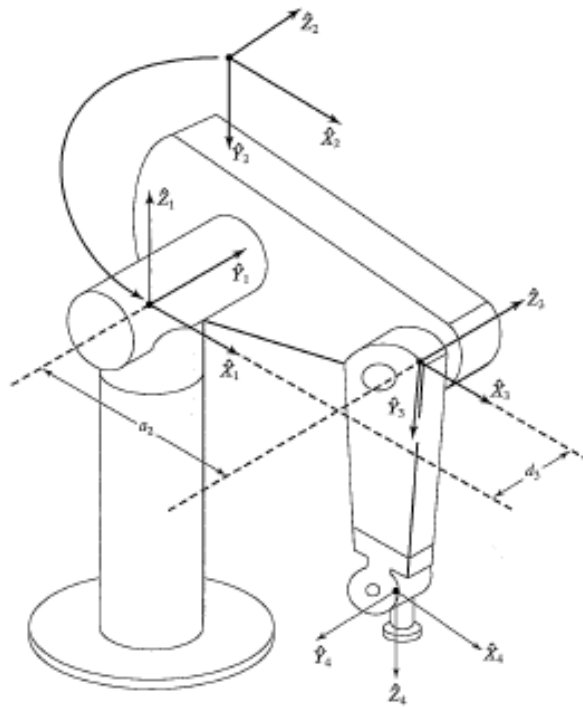
4) Indicate your teammate's name for the class project (quadrotor dynamics and control). If you are planning on doing anything other than the suggested topic, please specify.

[2 points]