CSE4421/5324: Assignment 2

Burton Ma

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The Denavit-Hartenberg parameters for the A150/255 robot shown in the figure are

	a	α	d	θ
1	0	90	10 (254)	θ_1
2	10 (254)	0	0	θ_2
3	10 (254)	0	0	θ_3
4	0	-90	0	$\theta_4 - 90$
5	0	0	2 (50.8)	θ_5

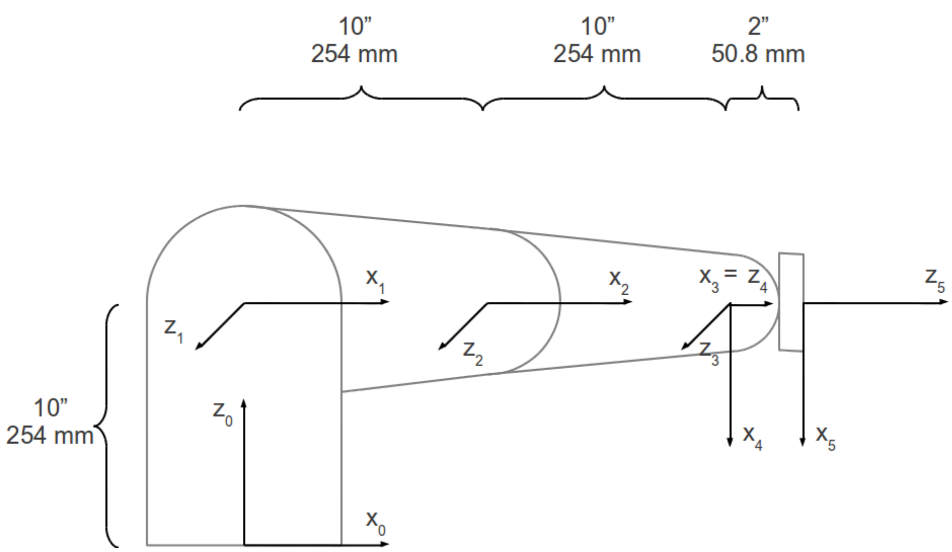

Figure 1: Frame locations for the A150 and A255 robots. The A150 uses dimensions in inches, and the A255 uses dimensions in millimeters. The wrist center o_c is located at the origin of frames 3 and 4.

1. Derive the matrix T_5^3 using the DH parameters; you will need the individual matrix entries for the next step.

2. Solve the inverse kinematics problem for the wrist; i.e., given T_5^3 solve for the values of θ_4 and θ_5.

3. Solve the inverse kinematics problem for the first three joints given the wrist center $o_c^0 = \begin{bmatrix} x_c & y_c & z_c \end{bmatrix}^T$; i.e., given o_c^0 solve for the values of θ_1, θ_2, and θ_3. Try to find all of the possible solutions (i.e., find all

solutions disregarding the physical constraints on the joint angles), and then indicate which set applies to the A150/255 arm.

4. In Matlab implement the method with signature `move(T)` that takes as input a 4×4 matrix $T = T_5^0$ describing the pose of the gripper (expressed in the base frame of the robot); the function should then move the gripper to the input pose, or output a message indicating that the position is not reachable. The motion can be accomplished using a single invocation of `madeg`; i.e., you do not need to compute a trajectory.

   Consider adding a method that solves the inverse kinematics problem for the arm, rather than putting all of the inverse kinematics code inside of `move`; see the next step of this assignment.

5. In Matlab implement a method with signature `moveLinear(T)` that takes as input a 4×4 matrix $T = T_5^0$ describing the pose of the gripper (expressed in the base frame of the robot); the function should then move the gripper to the input pose, or output a message indicating that the pose is not reachable.

   The wrist center should move *in a straight line from the current position*, whereas the gripper orientation should change smoothly over the complete path; i.e., angles θ_1–θ_3 should produce a straight line Cartesian path, and angles θ_4 and θ_5 should produce a joint space path.

Everyone should hand in paper copies of Parts 1–3, and Parts 4 and 5 can be done in pairs. Submit your Matlab code using the command

```
submit 4421 a2 *.m
```