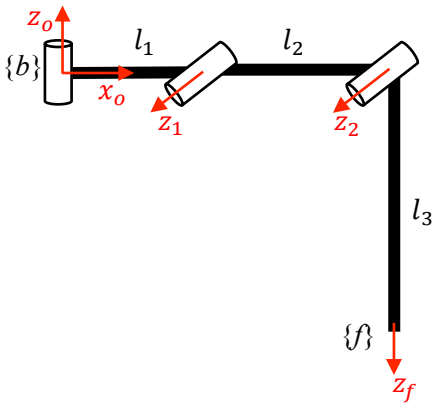
Mid-Term Exam, 10/8/2017

Robot Dynamics

Due Wednesday, 10/11/2017 @11:59 PM

Problem

Consider a 3-DOF leg of a hexapod walking robot in its home position as shown below. For this leg:



1) Show/draw the workspace of the foot tip from front and top view. **(10 Pt.)**
2) Draw/complete all coordinate systems meeting D-H conventions. **(5 Pt.)**
3) Write up D-H parameters' table. **(10 Pt.)**
4) Write up the transformation matrix. **(5 Pt.)**

For the following questions (5 to 10), consider $l_1 = 0\ mm$, $l_2 = 70\ mm$, and $l_3 = 100\ mm$:

5) Solve the forward kinematics for the home position. In other words, calculate the position of the tip of the leg with respect to the body frame $\{b\}$ when the leg is in its home position (in the home position, all joint angles are zero). **(5 Pt.)**
6) If we have the vector $[0,0,10]\ mm$ in the foot frame $\{f\}$, calculate the same vector in the body frame $\{b\}$ when all joint angles are zero (the home position). **(5 Pt.)**
7) Inverse Kinematics: For the foot tip of the leg to be in the position of $[80,0,-100]\ mm$ with respect to the body frame $\{b\}$, solve for the required joint angles of $\theta_1, \theta_2, \theta_3$. Present all solutions if the solution is not unique. **(20 Pt.)**
8) Derive the Jacobian of the leg. **(15 Pt.)**
9) Find Singularities of the leg, if any. **(10 Pt.)**
10) Calculate the set of joint velocities leading to the foot/tip linear velocity of $[0,0,10]\ mm/sec$ with respect to the body frame $\{b\}$. **(15 Pt.)**

You are always welcome to ask questions. However, before asking any questions, make sure that the answer cannot be found above.

Good Luck!