MeEn 537 Homework #4

1. Sketch the configurations where the following manipulators are in a singular configuration (i.e. the columns of the Jacobian are no longer linearly independent):

   (a) robot from problem 2d) in HW 2

   (b) robot from problem 2f) in HW 2

2. For (a) and (b) in problem 1, please sketch the reciprocal wrenches (directions in which the structure of the robot can apply/withstand "infinite" force) in the default position of the robot.

3. Using the code provided called "robot_6dof.m", and either using your own workspace estimation code from HW 3, problem 2g), or my solution code on Learning Suite "problem_2g.m" modify the code if needed and do the following (methods below are relatd to section 8.6 reading in the book):

   (a) Randomly or expressly pick 10 arm configurations and their corresponding position only in Cartesian space and do the following for both a starting joint configuration of q_1 =[0, 0, 0, 0, 0, 0] and then again for a starting configuration of q_2 =$[\frac{\pi}{2}, \frac{\pi}{2}, \frac{\pi}{2}, \frac{\pi}{2}, \frac{\pi}{2}, \frac{\pi}{2}]$ (the reason for picking 10 poses you know you can get to, is because otherwise, you may pick a pose outside of your reachable workspace):

      i. Use damped pseudo-inverse to find an inverse kinematics solution for your 10 goal positions starting from q_1 and q_2

      ii. Use the Jacobian transpose to find an inverse kinematics solution for your 10 goal positions starting from q_1 and q_2

      iii. Compare the solutions between your IK algorithms and the configuration that gave you the original position. How are they different? Are there specific positions that one or both algorithms failed to find from the given starting configurations? What could you do about this? Turn in at least one plot that shows the joint configurations for all three (the original position joint angles and the two IK method solutions). Also turn in your code and please keep this code and/or data available as you will use it again in future homework assignment.