Homework 4. ME 7752
A simple servo-position-controlled robot

To attempt after completing and verifying HW3

Roughly by Nov 20, 2015

All usual homework guidelines apply. Total = 30 points.

The robot in room W294 has 5 actuated degrees of freedom, with 5 servo motors – including the gripper, the "end-effector." I will make an announcement when I leave the robot in the room. If you want access after hours, please make sure you have swipe-access to the room.

a) Servo motors. Look up and learn a bit about servo motors in general. The servo motors on this robot are inexpensive 'hobby servos', which has a potentiometer for position feedback – used to control the angle to a desired value. The MATLAB programs control these servos directly by specifying and updating the angles. Look up the specific servo models and report their maximum torque capabilities.

b) DH parameters. Define the Denavit-Hartenberg parameters for the robot. Note that the 'reference' configuration when the robot is plugged in has all angles equal 90 degrees. Use lengths measured using a ruler (perhaps).

c) Reachable workspace. By moving the joints when the robot has no power, estimate the joint ranges of motion approximately. Then, using the DH parameters, determine reachable workspace of the end-effector (gripper).

d) Forward kinematics. Use the RootLoopServo.m program to make the robot go through some particular periodic motion by prescribing some periodically changing joint angles. Do an animation of the robot in MATLAB doing exactly the same motion. Do the real robot motion and the animation look the same?

e) Inverse kinematics. Given some point inside the reachable workspace, use fsolve to solve for the joint angles to reach this point with the end effector. Are the joint angles unique? Now, use the obtained angles to drive the actual robot to the desired point. Before you command the robot to go to these angles, make sure that they are in the range of motion of the servos, so that you do not exceed the capabilities!

Make an iPhone video of your answer, explaining focusing on your MATLAB input and then the robot doing what you asked it to do. No blooper reel, please!

Some notes

Note that the at the 'default position' of the robot, the internal reference configuration angles are 90 degrees. You need to connect your computer to the robot through the USB cable already connected to arduino on the robot. The sub-folder FunctionToSetEachServos has a little function you can use to set each joint angle separately. Use this function in your code when you want to set the servo angles. Run the root program in this folder to see what happens and modify appropriately. If you get an error, look at the root program comments to fix the error. If you still get an error, you may need to install the 'matlab arduino hardware support' on your computer. http://www.mathworks.com/hardware-support/arduino-matlab.html