Legged Robotics

HW #4

WPI

Problem 1 – 60 pts. (Inverse Kinematics)

a. Consider a hexapod walking robot with a schematic shown in slides 5-6 of the lecture notes from Week 9, Class 15. Use the exact same x-y direction, leg configuration, leg numbering, and values for the leg segments. Consider a base frame located on the ground (X-Y-Z) and a local frame located in the middle of the top platform (*x-y-z*). Assume that the hip joints are evenly distributed around the top platform with angle of 60 degrees (radially symmetric) as shown in the lecture slides. Let $\vec{s}_i$ be the distance vector from the origin of the local frame to the ith hip joint on the top platform where $i = 1, ..., 6$. Let $\vec{u}_i$ be the distance vector from the origin of the base frame to the ith foot tip on the ground. Define vector $\vec{O} = [x, y, z]^T$ *mm* connecting the origin of the base frame to the origin of the local frame. Define $\vec{\alpha} = [a, b, c]^T$ as the vector of Euler angles representing the rotation (orientation) of the local frame w.r.t. the base frame. Assume that the feet are evenly distributed and located on a circle on the ground with a diameter of 480 *mm*. The diameter of the top platform is 300 *mm*. For the given pose $P = [x, y, z, a, b, c]^T = [0,10,100,5,5,0]^T$, calculate the 18 joint angles if α represents **XYZ** Euler angles in degrees. If you think some information is missing in this problem, simply use the information provided in the lecture. Make sure to show your work.

b. Validate your solution and show your validation process. In other words, show how you make sure that your results from part (a) are correct.

Problem 2 – 40 pts. (Gait Analysis)

a. Design a Kinematic Phase Diagram for a spider-like (octopod) walking robot to walk based on a symmetric forward wave gait with duty factor of 0.7. Assume that the robot walks based on the regular gait which means all the eight legs have the same duty factor. You MUST do your work with computer and draw an exact diagram. Handwork is NOT accepted.

b. Repeat Part (a) for duty factor of 0.5 instead of a wave gait.

Good Luck!