Lab2Prep

Thursday, October 15, 2020 5:30 PM

1) Pseudocode for geometric Jacobian

```
def jacobian(q, myrobot):
    J = zeros(3, n)
    Hn = forward(q, myrobot)
    On = Hn[1:3,4]
    for i in range (1, length(q)):
        if (i==1):
            H = eye(4)
        else:
            H = forward(q[1:i-1], myrobot)
        Z = H[1:3, 3]
        O = H[1:3, 4]
        J[1:3, i] = crossproduct(Z, On-O)
        J[4:6, i] = Z
    return J
```

2) Pseudocode for analytic Jacobian

```
def ajacobian(q, myrobot):
    H = forward(q, myrobot)
    R = H[1:3, 1:3]
    θ = atan2(√(1-R[3,3]²), R[3,3])
    ϕ = atan2(R[2,3], R[1,3])
    B = [0  -Sϕ  CϕSθ
         0  Cϕ   SϕSθ
         1  0    Cθ]
    temp = [I  0
            0  B⁻¹]
    Jgeom = jacobian(q, myrobot)
    Ja = (temp)(Jgeom)
    return Ja
```

3) Write jacobian.m

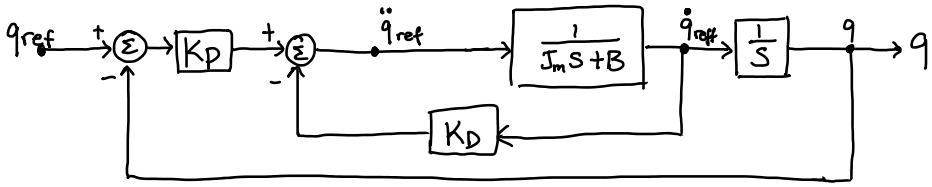
See Code file

4) Write ajacobian.m

4) Write Jacobian

See Code file

5) Draw Block Diagram of controller making q track $q_{ref}(t)$.



6) Compute K_p and K_d

Given the charateristic polynomial and $s = -2$

$$\Delta(s) = s^2 + \left(\frac{B}{J_m} + \frac{k_d}{J_m}\right)s + \frac{k_p}{J_m} = (s+2)(s+2) = 0$$

$$= s^2 + 4s + 4$$

$$\therefore \quad \frac{B + k_d}{J_m} = 4 \qquad \frac{k_p}{J_m} = 4$$

$$B + k_d = 4J_m$$

$$k_d = 4J_m - B \qquad k_p = 4J_m$$

Joint	J_m	B	k_P	k_D
1	2×10^{-4}	1.48×10^{-3}	0.0008	-0.00068
2	2×10^{-4}	8.17×10^{-4}	0.0008	-0.000017
3	2×10^{-4}	1.38×10^{-3}	0.0008	-0.00058
4	3.3×10^{-5}	7.12×10^{-5}	0.000132	0.0000608
5	3.3×10^{-5}	8.26×10^{-5}	0.000132	0.0000494
6	3.3×10^{-5}	3.67×10^{-5}	0.000132	0.0000953

$$K_P = \begin{bmatrix} 0.0008 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.0008 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.0008 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.000132 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.000132 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.000132 \end{bmatrix}$$

$$K_D = \begin{bmatrix} -0.00068 & 0 & 0 & 0 & 0 & 0 \\ 0 & -0.000017 & 0 & 0 & 0 & 0 \\ 0 & 0 & -0.00058 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0000608 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.0000494 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0000953 \end{bmatrix}$$