Homework 1

Submission Instruction: Create a directory called HW1. Then create two subdirectories called Q1, Q2 and so on. Place the answers of each question in the corresponding directories. Finally, zip the HW1 directory and submit.

1. (50 pts) As A = $\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$, B = $\begin{bmatrix} \cos\beta & -\sin\beta & 0 \\ \sin\beta & \cos\beta & 0 \\ 0 & 0 & 1 \end{bmatrix}$, p = $\begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}$,

    (a) (10 pts) compute AB, Ap, ABp, ABp+p; draw vectors Ap, ABp, ABp+p in a 3D coordinate system

    (b) (10 pts) If $\alpha = 30, \beta = 15$, compute AB, Ap, ABp; draw vectors Ap, ABp in a 3D coordinate system

    (c) (5 pts) If $\alpha = 45, \beta = -15$, compute AB, Ap, ABp; draw vectors Ap, ABp in a 3D coordinate system

    (d) (15 pts) If $\alpha = 45, \beta = 15$, compute AB^{-1}, AB^{T}, $A^{-1}p$, $A^{T}p$, $AB^{-1}p$, $AB^{T}p$; draw vectors $A^{-1}p$, $A^{T}p$, $AB^{-1}p$, $AB^{T}p$ in a 3D coordinate system

    (e) (10 pts) If $\alpha = 45, \beta = -45$, compute (Ap)x(Bp), ||(Ap)x(Bp)||; draw vector (Ap)x(Bp) in a 3D coordinate system

    You can write the results and draw them on paper, scan and save as a PDF file. You can also compute them and draw them with Python code.

2. (30 pts for undergrads) Please write Python functions to compute AB, Ap, $A^{T}p$, $A^{-1}p$, $p_1 x p_2$, $p_1^{T} p_2$, $A_1 A_2 A_3 A_4 A_5 A_6 A_7$. (Upper case characters are matrixes, lower case characters are vectors).
    (a) (20 pts) The functions work for all reasonable size matrixes and vectors
    (b) (5 pts) The functions check dimension matching
    (c) (5 pts) The functions are properly commented

    Your submission should include test code. Feel free to use Python packages.

3. (20 pts) Download and install the robot simulator CoppeliaSim from https://www.coppeliarobotics.com/ . Create a scene with one table and one UR5 robotic arm. Take a screen shot and submit it.