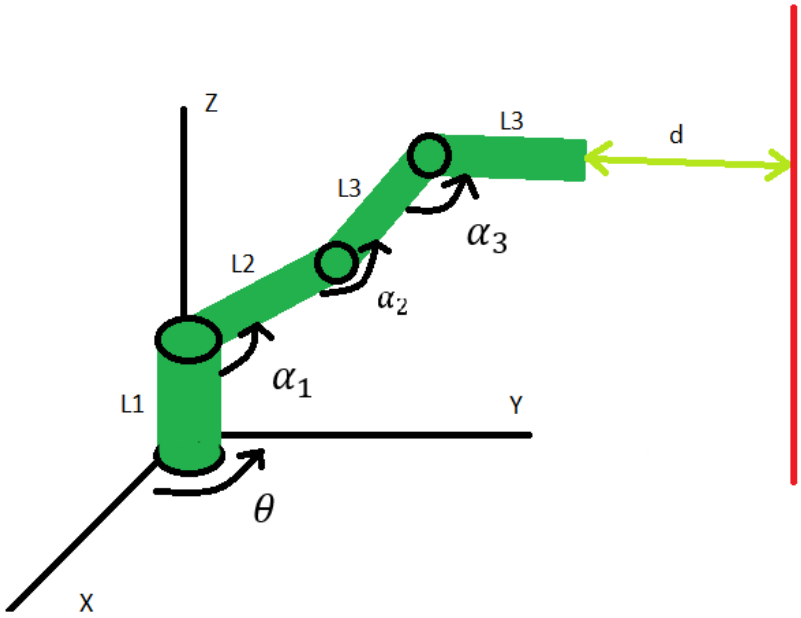
Task 2

The adopted robot arm model is presented in the figure



Symbols:

L – arm length

d – measured distance by sensor

α - pitch angle

θ - yaw angle

Transformation matrices:

$$T_{rot,Z,\theta} = \begin{bmatrix} cos\theta & -sin\theta & 0 & 0 \\ sin\theta & cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_{rot,X,\alpha} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & cos\alpha & -sin\alpha & 0 \\ 0 & sin\alpha & cos\alpha & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_{tr,Z,L} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & L \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_{tr,Y,L} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & L \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T = T_{tr,Z,L1} \cdot T_{rot,Z,\theta} \cdot T_{tr,Y,L2} \cdot T_{rot,X,\alpha_1} \cdot T_{tr,Y,L3} \cdot T_{rot,X,\alpha_2} \cdot T_{tr,Y,L3} \cdot T_{rot,X,\alpha_3} \cdot T_{tr,Y,d}$$

If we multiply matrices we obtain matrix T (4x4), wherein 4th column there is the distance vector. 1st, 2nd, 3rd elements of the vector are respectively x-coordinate, y-coordinate, z-coordinate. The total distance from the point that was measured by the sensor, to the robotic arm base link, equals:

$$total\ distance = \sqrt{T_{(1,4)}^2 + T_{(2,4)}^2 + T_{(3,4)}^2}$$