Robotics Assignment – Spatial Descriptions and Transformations

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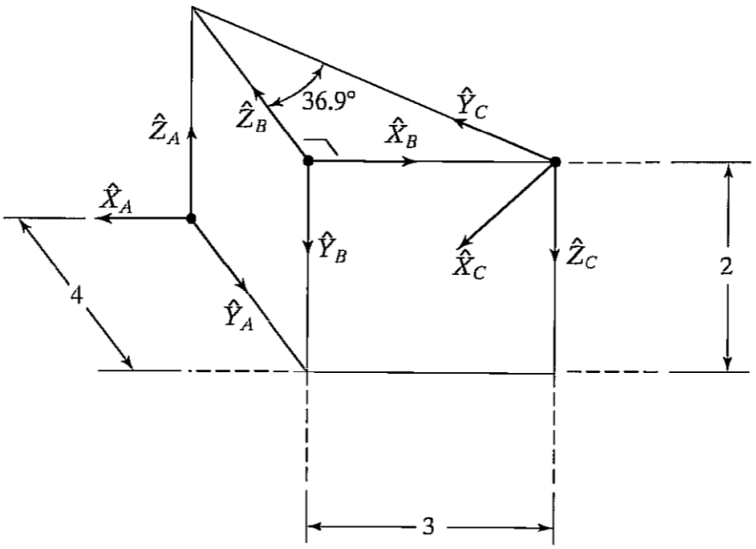
1 A frame $\{B\}$ is initially coincident with frame $\{A\}$. We rotate frame $\{B\}$ about $\hat{Y}_A$ by 30 degrees, then it is subsequently rotated about $\hat{X}_A$ by 45 degrees. Give the rotation matrix that accomplishes these rotations in the given order.

2 A frame $\{B\}$ is initially coincident with frame $\{A\}$. We rotate frame $\{B\}$ about $\hat{Z}_B$ by 30 degrees, then it is subsequently rotated about $\hat{X}_B$ by 45 degrees. Give the rotation matrix that accomplishes these rotations in the given order.

3 Referring to the figure, find ${}^A_C T$.



4 The figure shows a schematic of a typical industrial robot with all angles multiples of $\pm\frac{\pi}{4}$ and the dimensions labeled. Frame 0 is attached to the ground and Frame 6 is attached to the end-effector to which a camera is fixed and pointing in the $-y_6$ direction.

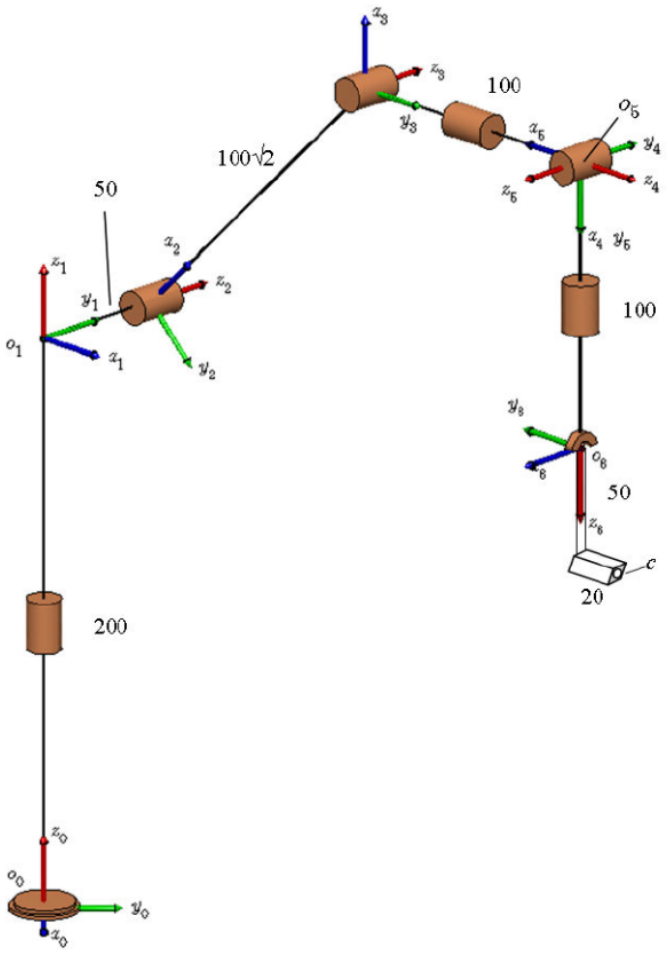
(a) Determine the matrices ${}^{i-1}_{i}T$.

(b) Calculate the matrix ${}^0_6 T$ and check if it makes sense by inspection.

(c) The end-effector is rotated in a circle about x_6 from the shown starting position through the angle $0 \leq \theta \leq 2\pi$.

(i) Determine the end-effector motion ${}^0_6 T$ as a function of θ.

(ii) For the camera mounted to the end-effector, determine the motion of point c at the lens (${}^0 P_c$) as a function of θ.



5 For the robot vehicle shown in the Figure, find ${}^{0}_{4}T$