09-11-2016

MECE 401 Midterm

Q1) For a 4 DOF (degree of freedom) robot the following information are given

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | α (in degrees) | λ (in meters) | d (in meters) | Θ(in degrees) |
| d1 (prismatic joint) | 0 | 0 | d1 | 0 |
| Θ2 (revolute joint) | 90 | λ2 | 0 | Θ2 |
| Θ3 (revolute joint) | -90 | 0 | d3 | Θ3 |
| Θ4 (revolute joint) | 0 | 0 | 0 | Θ4 |

The original coordinate frame O is given below with its axis’ directions.



1. Find the transformation matrix i-1Ai for each link. (15 points)
2. Draw each coordinate frame after the link transformation is performed. (20 points)
3. Draw the shape of the robot arm. \*\* (15 points)

\*\* For a prismatic joints use a prism whose joint axis is zi-1 as shown below and for a revolute joint use a cylinder whose joint axis is zi-1 as shown below

 

Q2) After a roll-pitch-yow transformation we obtain the coordinate frame T where

$$T=\left[\begin{matrix}\begin{matrix}-1&0\\ 0&1\end{matrix}& \begin{matrix}0 &0\\0 &0\end{matrix}\\ \begin{matrix}0&0\\0&0\end{matrix}&\begin{matrix}-1& 0\\ 0& 1\end{matrix}\end{matrix}\right]$$

Find row angle φ, pitch angle θ and yow angle ϕ. (30 points) (Find at least two sets of solutions)

Q3) A coordinate frame is given by the transformation matrix A with respect to the original coordinate frame as

$$A=\left[\begin{matrix}\begin{matrix}-1&0\\ 0&1\end{matrix}& \begin{matrix}0 &1\\0 &1\end{matrix}\\ \begin{matrix}0&0\\0&0\end{matrix}&\begin{matrix}-1& 0\\ 0& 1\end{matrix}\end{matrix}\right]$$

What is the differential transformation performed corresponding to a differential translation vector of d=1i+0j+0k and differential rotation vector of δ=0i+0j+0.1k with respect to base coordinate frame. (20 poinst)