

Robotics

Problem Sheet 1

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Notes

The homework serves as preparation for the exams. It is strongly recommended that you solve them before the given deadline - but you do not need to hand them in. Feel free to work on the problems as a group - this is even recommended.

1 Problem

Given the homogeneous matrix A with

$$A = \begin{pmatrix} 0.866 & -0.433 & -0.250 & 2 \\ 0 & -0.5 & 0.866 & -4 \\ -0.5 & -0.75 & -0.433 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

What is the rotation matrix part R_A of A ? Is it a right- or a left-handed rotation?

What is the inverse A^{-1} of A (use an as simple as possible computation)?

2 Problem

Given a Yaw-Pitch-Roll system, i.e., first a rotation by γ around the z-axis, followed by a rotation β around the y-axis, and finally by α around the x-axis.

Now show that this system has a Gimbal lock, i.e., there is a case where one degree of freedom is lost. To ease things, you get the hint that this case happens when $\beta = \pi/2$.

3 Problem

Given the quaternions $q_1 = (1, (2, 3, 4))$ and $q_2 = (0.4811480, (0.1984591, 0.7246066, 0.4517253))$.

Which of the two represents an orientation? And why?

4 Problem

Given point $p = (2, 3, 4)^T$. Use quaternions to rotate it

- by 30° around the y-axis
- by 30° around the axis $(1, -1, 3)^T$
- first by 30° the y-axis, then by 90° around the axis $(1, -1, 3)^T$

5 Problem

Use the Rodrigues formula to rotate $p = (2, 3, 4)^T$ by 30° around the axis $(1, -1, 3)^T$.