

16-741 Mechanics of Manipulation

Fall term, 2018

Assignment 3, Out: 8 October 2018

Due: 17 October 2018

1. Exercise 3.11 from the text:

Construct quaternions for the null rotation, and for rotations of π and $\frac{\pi}{2}$ about each coordinate axis.

2. Exercise 3.13 from the text:

For the rotation described by the matrix below, produce the rotation axis and angle, the unit quaternion, and the Euler angles.

$$\begin{pmatrix} -2/3 & -2/3 & 1/3 \\ 2/3 & -1/3 & 2/3 \\ -1/3 & 2/3 & 2/3 \end{pmatrix}$$

3. Exercise 3.16 from the text:

For this question you will conduct an experiment to answer the question: What is the average angle of rotations in \mathbf{E}^3 ?

- (a) Write code to generate uniformly distributed unit quaternions.
- (b) Write code to produce the smallest rotation angle for a given quaternion, in the range from zero to π .
- (c) Write code to generate a lot of unit quaternions, uniformly distributed, and take the mean angle. For additional insight plot a histogram.

How does one produce a uniform distribution on the surface of a sphere in \mathbf{E}^4 ? One easy way is to generate four real numbers uniformly in the interval $[-1, 1]$. That defines a uniform distribution in a cube. If we discard every quadruple with magnitude greater than 1, we will have a uniform distribution in the interior of the sphere. Normalize to get a uniform distribution on the surface of the sphere.