Quaternions In the Use of Three-Dimensional Rotation

Lukas Goodman
Pennsylvania Western University at Edinboro
Lukasgoodman23@gmail.com

ABSTRACT

In most Introduction to Linear Algebra classes, students learn to use matrix multiplication to rotate points in Euclidean, three-dimensional space. However, for at least one angle of rotation on one axis, this method does not consistently provide the correct result. This is because of an idea known as Gimbal Lock, which describes the mathematical loss of one axis of rotation during a three-dimensional rotation in space. What students are not introduced to are Quaternions. Quaternions, a type of imaginary number, can be used for three-dimensional rotations in space and have the added benefit of not being subject to Gimbal Lock. In this talk, I will show the mathematics behind Gimbal Lock, give an overview of how quaternion rotations are performed, and give a graphical demonstration of an object rotating in three-dimensional space, using both matrix multiplication and quaternions in both situations where Gimbal Lock does and does not occur.