Earth orientation quaternion and modeling the satellite orbit using quaternions

D. Svehla

Institute of Astronomical and Physical Geodesy, Technical University of Munich, Germany
(E-mail: svehla@bv.tum.de, Phone: +49-89-28923180)

We present recently established service that on daily, routine basis provides rotation information between the earth-fixed and inertial system in the form of a quaternion. The four Euler symmetric parameters written in the form of a quaternion are a minimal set of parameters for defining the nonsingular mapping to the corresponding rotation matrix. Besides their symmetrical properties, modeling the finite rotation using quaternions has many advantages compared to Euler angles since any interpolation or integration can be performed on the sphere preserving orthonormality of the rotation transformation. Hamilton or quaternion algebra avoids use of the rotation matrix and any sequence of successive rotations can be represented very elegantly by the quaternion operator. This also holds for the derivatives of the successive rotation and the treatment of the kinematic equation.

In this paper we show how Hamilton algebra can be applied to interpolate Earth orientation quaternion preserving orthonormality of the transformation. We introduce a transition quaternion derived from the kinematic equation without any a priori information on rotation. In the same way we model attitude of the satellite and show its relation to angular velocity and angular acceleration. We extend the use of the quaternion algebra for rotations and present a method for modeling satellite orbits using unit quaternions. We show that quaternions can be used to build a so-called geometrical integrator, in order to model the satellite motion preserving the geometrical properties of the orbit.