A Numerical Scheme to Integrate the Rotational Motion of a Quasi-Rigid Earth

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A ncw numerical scheme to integrate the orientation of a quasi-rigid body is presented. The basic variables are $(L, L_X, L_Y, L_A, L_B, f)$; the magnitude and the X-, Y-, A-, and B-components of the spin angular momentum vector L, and the longitude of A-axis measured from X-axis along the great circle perpendicular to L. The orientation matrix is generated by the five successive rotations in the sense of 1-2-3-2-1 as $(\mathbf{e}_A, \mathbf{e}_B, \mathbf{e}_C) = \mathcal{R}_1(\sigma)\mathcal{R}_2(-\varphi)\mathcal{R}_3(-f)\mathcal{R}_2(\beta)\mathcal{R}_1(-\xi)$ where $\sigma = \tan^{-1}(L_Y/\sqrt{L^2 - (L_X^2 + L_Y^2)})$, $\varphi = \sin^{-1}(L_X/L)$, $\beta = \sin^{-1}(L_A/L)$, and $\xi = \tan^{-1}(L_B/\sqrt{L^2 - (L_A^2 + L_B^2)})$. Not all these basic variables but the corrections to their nominal linear motions for some components instead such as $(\Delta L, \Delta L_X, \Delta L_Y, L_A, L_B, \Delta f)$ are actually integrated in the inertial coordinate system whose Z-axis is chosen to be close to L at the initial epoch of integration. These corrections correspond to the variation of LOD, the nutation in obliquity and in declination, the polar motion, and the variation of UT] in terms of the Earth rotation. Numerical simulations showed that the ncw scheme integrates the Earth orientation matrix 6-7 digits more precisely than the ordinary Eulerian approach does while the required computational time does not change significantly.

Abstract submitted for AAS [DDA] meeting

Date submitted: March 13, 1995 Electronic form version 1.6