Spacecraft analytical attitude propagation with non-singular and gravity gradient torque

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An analytical approach for the attitude propagation is presented using the non-singular canonical variables to describe the rotational motion. Two sets of variables were introduced for FUKUSHIMA in 1994 by a canonical transformation. These sets are useful when the angle between z-axis of a coordinate system fixed in artificial satellite and the rotational angular momentum is zero (J=0) or when the angle between Z-inertial axis and rotational angular momentum vector is zero (I=0). Special attention in this paper is given for the case with J=0, because it can be applied for the Brazilian satellites (SCD1 and SCD2). Analytical solutions for the torque-free rotational motion dynamical equations are discussed in terms of the elliptic functions and by application of some simplification to get an approximated solution. These solutions are compared with a numerical solution and the results show a good agreement for many rotation periods. When the mean hamiltonian associated with the gravity gradient torque is included, an analytical solution is obtained by the method of successive approximations. The goal of this analyze is to emphasize the geometrical and physical meaning of the non-singular variables and to validate the approximated analytical solution for the rotational motion without elliptic functions for a non-symmetrical satellite.