66th International Astronautical Congress 2015

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (2) (4)

Author: Mr. Harishkumar Sellamuthu
Karunya University, India, sellamuthu@karunya.edu

Ms. Anugraha Arumanayagam Jeevi
Karunya University, India, anugraha.aj@gmail.com
Dr. Ram Krishan Sharma
Karunya University, India, ramkrishansharma@gmail.com
Prof.Dr. Shobha Rekh
Karunya University, India, shobhapaulson@karunya.edu

ORBIT PREDICTIONS OF HIGH ECCENTRICITY SATELLITE ORBITS WITH LUNI-SOLAR EFFECTS USING KS ELEMENTS

Abstract

Eccentric Earth satellite orbits mainly experience the effects of Earth's gravity, atmospheric drag, luni-solar perturbations and solar radiation pressure. There is a complex interplay of atmospheric drag and luni-solar gravity in eccentric orbit evolution with perigee altitude between 170-500 km. However, if the perigee altitude is more than 600 km, the effect of atmospheric drag reduces considerably and luni-solar gravity perturbations are dominating. The satellite experiences the differential accelerations of Moon and Sun which may result in increase or decrease in the perigee altitude. The problem of third-body perturbation from Moon and Sun on Earth's satellites has been studied extensively over the years using different approaches [1-3].

The classical Newtonian equations of motion are not ideal choice for numerical and analytical integration. These equations can be regularized and reduced to linear differential equations of a harmonic oscillator of constant frequency with KS (Kustaanheimo and Stiefel) transformation. KS regular elements equations of motion are regular everywhere and are smoothed for eccentric orbit. These have been found to be very effective for numerical as well as analytical solutions [4-5].

Sharma utilized the KS elements to generate analytical expressions for orbit prediction including the effects of Earth's oblateness and air drag [6-7]. Motivated by the success of these studies, we have made an attempt in the present study to develop an analytical solution for the motion of the Earth satellites in high eccentricity orbits under the effects of luni-solar gravity. Gravitational perturbations are conservative, therefore there is no change in energy. Due to the symmetry of the equations of motion, only two of the remaining nine equations are integrated analytically to get the solution and is compared with numerical integration. The results are found to be satisfactory. Owing to the low memory requirements, this theory can be used for on–board guidance and navigation packages, where luni-solar perturbation modeling is necessary.

References
[1] Blitzer, L. 1959 Am. J. Phys., 27, 634.
[2] Cook, G.E. 1962 Geophys. J. Roy. Astr. S., 6, 271.
[3] Roy, A.E. 1969 Astrophys. Space Sci., 4, 375.
[4] Stiefel, E.L. and Scheifele, G. (1971) Linear and Regular Celestial Mechanics. Springer, Berlin.
[5] Sharma, R.K. and Mani, L. 1985, Indian J. pure appl. Math. 16, 833.

[6] Sharma, R.K. 1997 Planet. Space Sci. 45.
[7] Sharma, R.K. 1997 Proc. R. Soc. Lond. A 453, 2353.