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ORIGINAL ARTICLE

Resonance in a geo-centric synchronous satellite under the gravitational forces of the Sun, the Moon and the Earth including it's equatorial ellipticity

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Abstract Resonances in a geo-centric synchronous satellite under the gravitational forces of the Sun, the Moon and the Earth including it's equatorial ellipticity have been investigated. The resonance at two points resulting from the commensurability between the mean motion of the satellite and Γ (angle measured from the minor axis of the Earth's equatorial ellipse to the projection of the satellite on the plane of the equator) is analyzed. The amplitude and the time period of the oscillation have been determined by using the procedure of Brown and Shook. We have observed that the amplitude and the time period of the oscillation decrease as Γ increases in the first quadrant. The radial deviation (Δr) and the tangential deviation ($r_c \Delta\theta$) have been determined. Here r_c represents the synchronous altitude. The effects of the arithmetic sum of amplitudes λ_i involved in the perturbation equations on orbital inclination $0° \leq \alpha_0 \leq 90°$ are shown. It is observed that $\sum_{i=1}^{46} \lambda_i$ increases as α_0 increases. We have also determined the displacement ΔD (called drift) due to the oscillatory terms under the summation sign involved in the equations of motion of the satellite. We have observed that the value of ΔD is less than 0.5°.

Keywords Geo-synchronous satellite · Earth's equatorial ellipticity · Resonances · Drift

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1 Introduction

Frick and Garber (1962) have discussed the in-plane perturbations of a Geo-centric satellite under the gravitational effects of the Sun, the Moon and the oblate Earth. They have assumed that the Sun, the Moon and the Earth all lie in the plane of the ecliptic and the satellite's orbital plane coincides with the Earth's equatorial plane. The in-plane perturbations of the satellite caused by the attraction of the Sun and Moon are in the nature of small amplitude oscillations which could result in a maximum deviation from the desired synchronous position of about 72.42 km.

Bhatnagar and Mehra (1986) have studied the motion of a geosynchronous satellite under the combined gravitational effects of the Sun (including it's radiation pressure), the Moon and the oblate Earth (including it's ellipticity). They have studied only the motion of the orbital plane of the satellite. They have observed that the orbital plane rotates with an angular velocity lying between 0.042°/year and 0.058°/year for a synchronous satellite.

It is further shown that the regression period increases as both the orbital inclination and the altitude increase.

Bhatnagar and Kaur (1990) have studied the in-plane motion of a Geosynchronous satellite under the effects of the Sun, the Moon and the oblate Earth. They have shown that the sum of the oscillatory terms in the radial deviation (Δr) for different inclinations is a small finite quantity whereas the sum of the oscillatory terms in ($r_c \Delta\theta$) for different inclinations is quite large due to the presence of the low frequency terms in the denominator.

In Yadav and Aggarwal (2013b) we have investigated the resonance in the Earth-Moon system around the Sun including Earth's equatorial ellipticity. The aim of this paper is to investigate the resonances in the equations of motion of geocentric synchronous satellite under the gravitational forces

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