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STUDY GENERAL CASE OF SPACECRAFT SYSTEM CALCULATION WITH A GIVEN BREAK-UP

The analysis of the general case of the calculation of the spacecraft system with a given break-up.

Keywords*: Zonal harmonic, Draconian period, spacecraft, circular orbits, orbital period.*

We pose the problem of determining the necessary number of satellites in the system and their relative positioning at the set break of service.

Calculation spacecraft system with a predetermined gap in service can be performed, if known the following inputs:

- time to maintain the gap $-t_p$;
- the minimum allowable angle of elevation above the horizon satellites - δ_{min} or the amount of on-board equipment viewing angle $-\gamma$;
- time service $-t_{обсл}$;
- height range in which the spacecraft can operate the system, $-r_{крmin} \cdot r_{крmax}$.

These raw data are due to constraints imposed on the work as a board, and the ground apparatus and associated with a target designation system. Then the order of calculation of the spacecraft system with a given break in service will be reduced to the next.

Assuming the radius vector values circular orbits $r_{кр}$ in the range $r_{крmin} < r_{кр} \le r_{крmax}$. We determine the value of

$$\phi_{раб} = \phi_з - \phi_{опр}. \quad (1)$$

By $\phi_{ра}$ be the angle of inclination of the orbital plane to the equatorial plane:

- for the global service systems

$$i_{max} = 90° - \phi_{раб}; \quad (2)$$

- for spot delivery systems

$$i_{max} = \phi_в - \phi_{раб}. \quad (3)$$

Given the latitude inclination i start point ϕ_n and an ejection phase length can determine the value of the argument of latitude μ_0 point O spacecraft orbit system with a given pad. With $i, \mu_0, r_{кр}$, define dracontic period spacecraft system according to the formula:

$$T_\Omega = T\left\{\begin{matrix} 1 - 0,75 \cdot C_{20}\left(a_e/r_{кр}\right)^2 \times \\ \times\left[1 + 5\cos^2 i - 6\sin^2 \mu_0 \sin^2 i_0\right]\end{matrix}\right\}, \quad (4)$$

where $T = 2\pi\sqrt{r^3{}_{кр}/k}$ – star treatment period;

$C_{20} = -0,109808\ 10^{-2}$ - the coefficient of the second harmonic decomposition of the zonal earth potential in a series of spherical harmonics;

$a_e = 6378$ км - the equatorial radius of the earth.

Define the process of spacecraft orbits units per day in view of the 2nd zonal harmonic:

$$\Delta\Omega_{сут} = \frac{3\pi\pi_2 \cos i}{kr_{кр}^2(1-e_0^2)^2} n, \quad (5)$$

where $\pi_2 = -1,77 \cdot 10^{25}$ m5 / sec2; $n = T_{зв}/T_\Omega$ - the number of SVs revolutions per sidereal day.

Knowing the daily care of the nodes of the orbits of spacecraft systems, determine the time required for the rotation of the Earth from the ascending node to the orbital ascending node of the orbit (the effective period of revolution of the Earth T_{eff}):

$$T_{eff} = T_{зв}(1 - \Delta\Omega_{сут}/2\pi). \quad (6)$$

For known values of the effective period T_{eff} and Draconian period T_Ω. We expect interturn distance

$$\lambda_{m.B} = 2\pi \cdot T_\Omega / T_{eff} \quad (7)$$

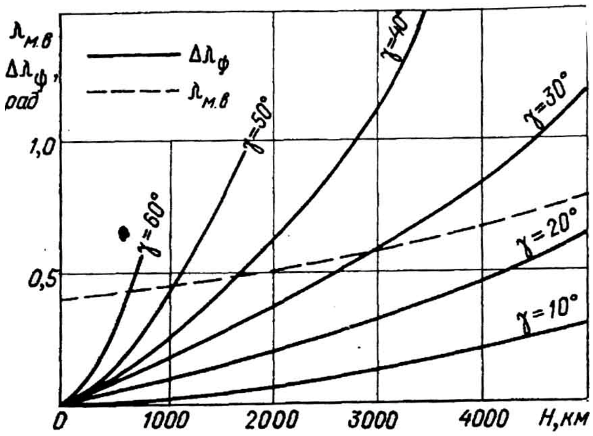

Fig. 1. Dependence for circular polar orbits for various values of the angle γ

For selected r_{kp} defined width swath $\Delta\lambda_{\phi}$ on the lower latitude service area. In this case, there are two possibilities:

a) there is a circular orbit height r_{kp} within a given range, where the condition

$$\Delta\lambda_{\phi} = \lambda_{M.B}; \quad (8)$$

b) within a predetermined range of heights condition $\Delta\lambda_{\psi} \geq \lambda m.B$. It is not satisfied.

Fig. 1 shows the value $\lambda_{м.в}$ and $\Delta\lambda_{\phi}$ for circular polar orbits for different values of the angle of view of the onboard equipment γ.

Consider the first case.

If condition (8) is satisfied, it is possible to determine the angle of longitudinal discontinuity of service

$$\lambda_p = 2\pi \cdot t_p / T_{eff} \quad (9)$$

and then the required number of satellites in the system

$$N = \pi/\lambda_p \quad (10)$$

In general, the number of satellites in the system of fractional turns, so it should be rounded up to a whole in a big way:

$$N_1 = \left[\pi/\lambda_\rho\right] + 1. \quad (11)$$

Given integer units in the system determines the final time gap in service:

$$\lambda_\rho^{/} = \pi/N_1 \quad (12)$$

and

$$t_p^{/} = \lambda_\rho^{/} T_{eff} / 2\pi. \quad (13)$$

The physical basis of the proposed method for calculating the SC systems with a predetermined gap in service concluded that the spacecraft system located near the Earth so that their slopes are the same. Condition (8) says that the interturn distance should always be covered by the review areas of spacecraft. If at predetermined viewing angles onboard equipment in layer heights $r_{kpmin} \leq r_{kp} \leq r_{kpmax}$ (8) is not satisfied (the second case), the interturn distance populated areas viewing additional spacecraft

$$n^{/} = \left(\lambda_{m.в} - \Delta\lambda_{\phi}\right)/\Delta\lambda_{\phi}. \quad (14)$$

Moreover, if the spacecraft at a distance interturn arranged so that the argument of latitude μ for all space vehicles is the same (ie, the spacecraft separated from each other in longitudinal relation to the $\Delta\lambda_{\phi}$), The gaps in service are equal to a predetermined gap.

Conclusion

If the space vehicles, filling the coverage areas of one interturn spacing, are arranged in one plane and offset from each other by an angle $\Delta\omega$, The gap in the observation will differ from the calculated value by an amount $\pm\Delta T$ (where $\Delta T = \Delta\lambda_{\phi} \cdot T_{зв} / 2\pi$). Thus, we identify the needs of the number of satellites in the system with the specified service break.

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ДОСЛІДЖЕННЯ ЗАГАЛЬНОГО ВИПАДКУ РОЗРАХУНКУ СИСТЕМИ КОСМІЧНИХ АПАРАТІВ ІЗ ЗАДАНИМ РОЗРИВОМ СПОСТЕРЕЖЕННЯ

К.С. Козелкова

Проведено аналіз загального випадку розрахунку системи космічних апаратів із заданим розривом спостереження.

Ключові слова: *зональна гармоніка, драконічний період, космічний апарат, період обертання.*

ИССЛЕДОВАНИЕ ОБЩЕГО СЛУЧАЯ РАСЧЕТА СИСТЕМЫ КОСМИЧЕСКИХ АППАРАТОВ С ЗАДАННЫМ РАЗРЫВОМ НАБЛЮДЕНИЯ

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Проведен анализ общего случая расчета системы космических аппаратов с заданным разрывом наблюдения.

Ключевые слова: *зональная гармоника, драконический период, космический аппарат, период обращения.*