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Analysis of the major aspects of the existence of satellites capable of collecting and transmitting information for environmental monitoring

The main aspects of the existence of satellites capable of collecting and transmitting information.
Keywords: spacecraft; artificial satellite; into orbit.

Introduction

The study of the Earth by spacecraft has promising sector of human activity.

The missile, having the ability to accelerate their movement, and with it the space payload launches' apparatuses (CA) to a predetermined height of the conditions of the task.

It is known that due to the resistance of the atmosphere below 150 km the spacecraft can not to make move around the Earth. Having reached a predetermined height, the SC should be additionally impart velocity motion vector.

Note that when the spacecraft is moving relative to the Earth, the force of its gravity will bend the path of motion, so that the centrifugal forces arise that prevent distortion of the path of movement and aimed in the opposite direction of Earth's gravity. Provided that when the acceleration centripetal forces of gravity will be equal to the acceleration of the centrifugal force, possibly motion on a circular orbit.

It is known that the magnitude of the centrifugal force and the centrifugal acceleration depends on the speed and the flight orbit radius: the higher speed and smaller orbit radius, the larger these values.

Consequently, there exist well-defined hard speed limit below which the existence of the satellite is not ensured. As a border accepted the escape velocity. To obtain a mathematical relationship to the circular velocity, turn to the equation of motion.

Main part

If the body is moving with velocity V along the orbit radius r, then this raises the centrifugal acceleration

$$a = \frac{V^2}{r}.$$

This value should be balanced by the attraction of the Earth

$$a = \frac{b_0}{r^2},$$

where r — the distance from the center of the Earth to the spacecraft (the radius of the orbit); b_0 — the gravitational constant of the Earth (from the table of constants $b_0 = 3{,}986 \cdot 10^5$ km $^3/_{s^2}$). Equating these accelerations obtain the relation

$$V = \sqrt{\frac{b_0}{r}}.$$

The first cosmic speed depends on the mass of the planet, which is made with respect to the flight (by the magnitude b_0) and the radius of the orbit (altitude over the planet).

The dependence of the first cosmic velocity we obtained, based on the conditions that the gravitational field of the Earth is the central (the planet is a sphere with uniform density), the acceleration of (Earth's gravity) is directed to the center, and its value is determined on the basis of the law of gravitation of Newton, the mass of the spacecraft by compared to the mass of the Earth is negligibly small, atmospheric drag, radiation pressure, the attraction of other planets and the Sun was not considered.

In this connection, this value corresponds to approximately valid only at small time intervals.

Rotary speed for a given altitude is unambiguous and well-defined value. Even a slight change in velocity results in deformation of the orbit, and it ceases to be circular.

In accordance with the law of universal gravitation, all bodies attract each other with a force proportional to the product of their masses and inversely proportional to the square of the distance between them. Therefore with increasing altitude attraction force will decrease.

At an altitude of 200 km weight to 6% less than the surface of the Earth; at 800 km weight reduction reaches 20% and at a height of 2640 km body becomes easier twice. For this reason, after getting spacecraft to have a certain height it requires less speed to get into a circular orbit. So, the higher the raised spacecraft, the smaller the rate required for a flight in a circular orbit. If the satellite is raised to a height equal to three Earth radii ($r_{\text{Earth}} = 6371$ km), the first cosmic velocity would not 7,791 km/s (to a height of 200 km) and 2 times less and will be only 3,956 km/s.

We consider two elements of circular orbits, independent of each other. Hence, the circular orbit can be characterized either by the velocity, or its radius.

With the speed and the radius of the orbit of the third element is connected — the period of revolution spacecraft that is interval of time during which the spacecraft completes one revolution. The length of the coil is $2\pi r$, dividing it by the speed of flight, we obtain the dependence for calculating the period of revolution

$$T = \frac{2\pi r}{V}.$$

Substituting the rate of its value $\sqrt{(b_0/r)}$, we obtain the dependence of the radius of the orbital period of the planet's mass and orbit

$$T = 2\pi r \sqrt{\frac{r}{b_0}}.$$

Hence, the period of treatment is also a single-valued function of the radius of the circular orbit. Increasing the radius of the orbit by 1,7 km corresponds to an increase in the circulation period of 2 seconds. These data indicate that even small changes in one element of the orbit immediately lead to changes in others.

Quantitative and qualitative results of the circular movement confirm that the speed of the fundamental need for the existence of the satellite. It automatically determines the radius of the circular orbits, and the period of treatment. Each circular orbit is inherent only one circular velocity. At the same orbit cannot fly at different speeds.

In order to communicate via the satellite accounts receiving the transmitted center and other subscribers antenna systems to monitor the movement of the spacecraft on a pre-calculated target indications.

There was a question, is it possible to launch the satellite in such a way that it is fixed with respect to subscribers, while eliminating the need for tracking; antenna directed toward the satellite 1 times during its existence.

New in this statement is that the orbit of the spacecraft is seen not in isolation but in relation to its position relative to the Earth, which rotates around its own axis and, carrying the satellite is flying around the Sun.

Based on the assumptions that the orbital period of the satellite depends on the radius of its orbit, the Earth rotates at a constant angular velocity, and the plane of the satellite's orbit passes through the geometric center of the Earth, is at the equator, we will make a flight around the center of the Earth at a distance of 6371 km with a period of one round per day. It follows that if you run the satellite so that the plane of its orbit coincides with the plane of Earth's equator and the orbital period is also made equal to one day, he «hangs» over us. He will perform a circular motion around the center of mass of the Earth, but at the same time in the same direction and with the same angular velocity rotating around the center of the Earth and is the point where we stand. Such an orbit is called stationary.

The main characteristic of a circular motion — flying at a constant speed. Create a circular orbit — this means to bring the spacecraft on a strictly predetermined height at precisely calculated value of the speed and direction of flight. Due to the error management system booster, as well as differences from the central field of the Earth, form a purely circular movement almost impossible. If the speed or direction will differ from the calculated circular, the orbit will be elliptical.

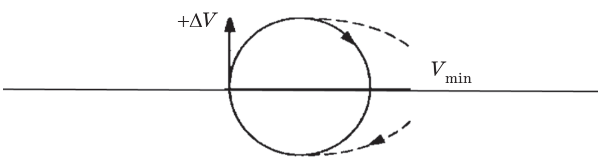
For consideration of dependency flight elliptical orbit we have to use the law of conservation of energy, which reads as follows: the sum of kinetic and potential energies of the spacecraft is constant.

The potential energy is numerically expressed product of body weight per height. The higher we climb, the greater the potential energy supply. With a decrease in the height of its stock decreases. When flying on a circular orbit, that is, at a constant distance from the center of the Earth and the fixed rate, potential and kinetic energy does not change the spacecraft during flight. In the case of motion in an elliptical orbit altitude for one round varies from a minimum value (at perigee) to the maximum (at apogee). Accordingly, a change in the height will change the potential energy of the spacecraft. However, since the mechanical energy must remain the same, the change in altitude will result in a change in the kinetic energy, and this, in turn, — a change and speed. There is a transfer of potential energy into kinetic spacecraft and back. At perigee, where the altitude is minimal, the kinetic energy and the speed of the peak. At the same time the speed of flight apogee is minimal. Thus, a flight in an elliptical orbit is accompanied by periodic (from turn to turn) changes in the magnitude and direction of speed, as well as altitude.

Now consider the conditions of formation necessary for the practical purposes of the elliptical orbit. In particular for the purposes of communication and monitoring in the northern hemisphere are used highly elliptical orbits with 12-hour orbital period, the apogee of about 36 000 km and a perigee of 400 km. SC is in sight to the country for more than 8 hours. The formation of the orbit is carried out in two stages. Booster displays spacecraft to nearly circular, so-called reference, orbit with a radius of perigee formed elliptical orbit and then to the south: Hemisphere included upper stage spacecraft. There is an increase in speed; apparatus goes outwardly from the circular orbit. The height of the peak will depend on the increment rate, and the perigee remains the same. This is because when moving in a circular orbit centrifugal force is balanced by the force of attraction of the Earth. When the airspeed is increased, then this balance of forces is broken, since the centrifugal force which is dependent on the speed increases. Because of this power the spacecraft starts to go into the outer side of the circular orbit.

However, after that the direction of the flight speed is not perpendicular to the radius vector. Therefore, some part of the Earth's gravity will braking spacecraft motion, that is decrease its speed with simultaneous rotation velocity to the Earth. Braking process will continue until it reaches apogee. The apogee of the flight speed will be lower, but perpendicular to the radius vector. After passing the peak component of the force of gravity will accelerate the spacecraft, bringing it closer to Earth. By the end of the SC coil returns to the original point with the same rate with which it was thrown away.

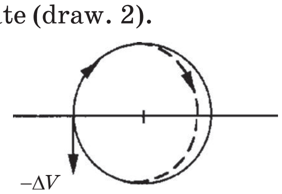
Thus, after increasing the speed of the spacecraft's orbit becomes elliptical, fully embracing the initial circular (draw. 1).



Draw. 1. Formation of the elliptical orbit increases the velocity of spacecraft flying in a circular (reference) orbit

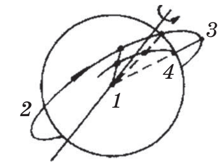
If the flight speed in a circular orbit to reduce (slow down the flight), while the balance of power will change in the same direction. The strength of the Earth's gravity will prevail over the centrifugal, and CA change its trajectory into a circular orbit.

Then the flight will take place with the growth rate, and after passing perigee to decrease it. After completion of the round of the spacecraft returns to its original state (draw. 2).



Draw. 2. Formation of the elliptical orbit decreasing velocity of spacecraft flying in a circular (reference) orbit

Thus, in the case of reducing the circular velocity of the spacecraft's orbit becomes elliptical, but lying inside the circular (draw. 3).



Draw. 3. The route of flight spacecraft:
***1* — the center of the Earth; *2* — orbit satellites;**
***3* — position of the satellites in orbit over time;**
***4* — under satellites points connected to the track**

Here, we draw attention to the fact that when flying on a circular orbit an increase in speed results in a decrease in the opposite point of the elliptical orbit and, conversely, inhibition leads to an increase in the speed of the opposite point of its elliptical orbit.

This fact is widely used in solving problems of maneuvering in order to enter in a given area at a particular time.

Conclusion

The article describes the main aspects of the existence of satellites capable of collecting and transmitting information.

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АНАЛІЗ ОСНОВНИХ АСПЕКТІВ ІСНУВАННЯ ШТУЧНИХ СУПУТНИКІВ ЗЕМЛІ, ЗДАТНИХ ЗАБЕЗПЕЧИТИ ЗБІР І ПЕРЕДАВАННЯ ІНФОРМАЦІЇ З МЕТОЮ ЕКОЛОГІЧНОГО МОНІТОРИНГУ

Розглянуто особливості функціонування штучних супутників Землі, що забезпечують збір і передавання інформації за результатами екологічного моніторингу.

Ключові слова: космічний апарат; штучний супутник Землі; орбіта.

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АНАЛИЗ ОСНОВНЫХ АСПЕКТОВ СУЩЕСТВОВАНИЯ ИСКУССТВЕННЫХ СПУТНИКОВ ЗЕМЛИ, СПОСОБНЫХ ОБЕСПЕЧИТЬ СБОР И ПЕРЕДАЧУ ИНФОРМАЦИИ В ЦЕЛЯХ ЭКОЛОГИЧЕСКОГО МОНИТОРИНГА

Рассмотрены особенности функционирования искусственных спутников Земли, обеспечивающих сбор и передачу информации по результатам экологического мониторинга.

Ключевые слова: космический аппарат; искусственный спутник Земли; орбита.