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THE ROLE OF CONVERGENCE MANEUVER AND MEETINGS OF THE SPACECRAFTS FOR THE MODERN SPACE TECHNOLOGY

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A spacecraft is any piloted or unpiloted vehicle designed for travel in space. The systems and instruments a spacecraft must carry depends upon the data it will gather and the functions it will carry out. Their complexity varies greatly but all must endure the hostile environment of space. Spacecraft may be broadly categorized according to the missions they are intended to fly.

Implementation of many orbital and interplanetary missions due to the solution of the problem of convergence and meeting space vehicles (SV) [1, 2, 3, 4, 5]. The process of approach is a controlled movement of two or more spacecrafts, which resulted the conditions necessary for the implementation of the joint flight. Under the joint flight is understood a movement of vehicles at presence of physical contact between them (flight docked condition) and their movement at a certain distance from each other (a joint group flight).

The role of convergence maneuver and meetings of the spacecrafts for the modern space technology is extremely high. Its implementation may be required in solving a number of problems related to the further development of outer space and creating various large space structures. In particular, these problems include:

- assembling heavy spacecrafts and space stations (SS);
- delivery containers with fuel and other necessary supplies to the spacecraft and SS for the operation of board equipment;
- carrying out repair and maintenance work on the spacecraft belonging to the different

permanent system;

- periodic change crews of SS, supply them with food and life support equipment;
- rescue of the crew of manned spacecrafts in emergency situations;
- moving unused or fulfilled own tasks spacecrafts and other cosmic bodies, which may interfere to execution of an operation in outer space, or providing safeness of space flights.

In addition to these problems associated with the development of near-Earth space, meeting maneuver required for missions to the Moon, Mars, Venus and other planets in our solar system. Maneuver of convergence has already been used for the delivery of the crew from the surface of the Moon on the main SC, who was in selenocentric orbit.

Therefore, the main purpose of the convergence maneuver and meetings of the spacecrafts the implementation of which is necessary to solve these problems is the fact that at the time of its completion the vector $\bar{q}$ (t) relative state of two satellites involved in the operation of the meeting, adopted a set value, which in most cases is close or equal to zero.

Vector $\bar{q} = \left| \begin{matrix} \bar{D}(t) \\ \bar{V}_{rel}(t) \end{matrix} \right|$ is determined by three components of the relative position $\bar{D}(t)$ and three components of the relative velocity $\bar{V}_{rel}(t)$. Vector $\bar{q}$ (t) completely describes at any time the relative position and relative velocity of the center of mass of devices. Usually, one of the spacecrafts performs a maneuver meeting, while the second unit makes free orbital flight. The first spacecraft called active, and the second - a passive spacecraft.

Depending on which end conditions must be realized at t_k, maneuver ending, there can be considered three types of this maneuver.

1 . *Soft contact*. In this case, all the vector components of the relative state must be zero at the meeting time:

$$\bar{q}(t_k) = 0 \quad [\bar{D}(t_k) = 0, \bar{V}_{rel} = 0] .$$

This maneuver is commonly used in solving the problem of assembling SS, delivery of cargo, change of crew and others.

2. *Hard contact*. In the case of performing this type of convergence at the meeting time only components of the relative position vector should be zero, but the components of the relative is different from zero:

$$\bar{D}(t_k) = 0, \bar{V}_{rel} = \bar{V}_k .$$

This maneuver convergence may require, for example, for the destruction of the spacecraft, fulfilled their tasks, as well as other space objects that may interfere to perform an operation in space or endanger the safeness of the space flights.

3. *Hang* (group flight). When performing this maneuver (at its end) the components of the relative velocity vector must be zero, and the components of the relative position vector should take given values, that is:

$$\bar{D}(t_k) = \bar{D}_k, \bar{V}_{rel}(t_k) = 0 .$$

After the implementation of the considered species maneuver and further special group flight management, which provides a constant relative position of the following devices, active spacecraft freezes relatively to passive device at a distance determined by the constant $\bar{D}_k$. The need for such situation may occur while conducting special science researches at some distance from the space station при решении задач ремонта КА на орбите, а также при решении других задач, while solving problems of the satellites repair in orbit, as well as for other tasks, which require the implementation of the group flight of spacecrafts. Implementation of the spacecraft convergence maneuvers by the traditional methods associated with significant energy costs.

The application of the related space objects allow reduce costs substantially, and in certain

cases the convergence and meeting in space using a binder can be carried out without any fuel consumption.

With the successful development work on space cable systems, probably in the middle of the XXI century can be created long-term manned space station of the new generation. In the future, both in experiments and in the operation of the board systems will be carried out various scientific researches by using the opportunities created by the deployed cable systems.

Literature

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