METHOD OF COMPUTER-AIDED CONCEPTUAL DESIGN OF LAND REMOTE SENSING SPACECRAFT WITH REGARD TO TARGET EFFICIENCY PARAMETERS

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There exist a couple of approaches to the choice of main design parameters and conceptual design of land remote sensing satellites (LRSS):

- based on heuristic method, when the satellite designing starts with a blank slate (it is typical for completely new projects with on-board systems utilizing advanced principles);
- using allocation of target and support systems in the satellite body with prescribed envelope;
- based on prototypes improvement (such as Yantar, Neman, Resurs satellites);
- using improvement of target systems allocated in payload section without changes in support systems section (such as, for instance, universal mother space vehicle Yahta or spacecraft Condor);
- using allocation of telescopic optical system and sensitive gages at temperature-stabilized platform (LRSS Pleades);
- based on use of several target systems with limited total mass and their integrated work, etc.

When implementing these approaches, all target indices (monitoring frequency, ground resolution, swath width, productivity, operational efficiency, operating lifetime and others) must certainly comply the requirements.

The design approach based on regard to required efficiency indices deserves specific attention.

The principle of this approach is that optimization of the basic LRSS design parameters is realized in implicit form, without setting the mathematical programming problem, which requires formulation of objective functions and limitations. It allows realizing exact approximation concept.

The advantage of this approach is that the designed spacecraft will have potentially better mass-dimensional, inertia, energy and other characteristics than the spacecraft, designed, for example, through the development of a prototype with borrowing of some elements.

On the other hand, its disadvantage is that it is not always economically reasonable to create more advanced elements, if one can borrow an existing, proven operating, albeit less efficient ones.

In this respect, the above LRSS may be regarded as reference one concerning its mass-dimensional, inertia, energy and other characteristics, in other words, as virtual spacecraft, characterizing the degree of space vehicles perfection.

It should be noted that this approach is most useful when creating new spacecraft, dimensions and shape of which are not associated with substantial restrictions concerning their placement on the launcher, for example, for generation small LRSS conceptual design.

The essence of the proposed methodology summers down to the formation of such a sequence of design procedures, which provides a choice of the basic design parameters and formation of conceptual design with a minimum number of iterations.

Here, the results obtained in the form of mass-dimensional, inertia, energy, and other LRSS characteristics, would provide implementation of onboard systems with required parameters.

Given data are: monitoring frequency, ground resolution, swath width, productivity, operational efficiency, operating lifetime.

Limitations: orbits are circular, sun synchronous; orbit altitude does not exceed 1000 km; launcher maximum payload capacity; fairing zone limitations.

The approach items are as the follows.

1. Acquisition and processing of statistical data on the space system (SS) and characteristics of LRSS (for specification of regression dependences in the software).

2. Choice of minimum orbit altitude based on the width of swath.

3. Assessment of periodic sequence and operational efficiency (with the help of EFKAN software, based on simulation technology).

4. Updating orbit group parameters, number of LRSS, number of downlink points, needed to provide indicators of periodic sequence and operational efficiency.

5. Choice of structure and principles of target equipment and on-board systems operation.

6. Calculation of mass-dimensional and energy characteristics of target equipment, on-board systems and LRSS structure (with the help of SYNTHES software or problem-oriented designing systems (PODS)) needed to provide specified characteristics of the target efficiency.

7. Transfer of the main obtained mass-dimensional characteristics from SYNTHES software or PODS into 3D design system for providing automated formation of spacecraft components with calculated dimensions in assembly window.

8. Formation LRSS assembly model (satellite structure) in 3D design system based on selected criteria and existing constraints.

9. Specification of LRSS external elements (solar cell battery panels, radiators, star coordinate measurement unit, satellite navigation system antennas, etc.) location and setting angles, checking the feasibility of target efficiency indices (with the help of SATELLITE software).

10. Updating the preliminary mass balance and definition of center of gravity and inertia characteristics.

11. Evaluation of spacecraft cost with regard to the launcher choice.

12. Development the solid models of LRSS under the launcher nose fairing allocation and animation the process of LRSS separation and deployment.

13. In-process printing of protocols with LRSS design structure and characteristics.

Precision of LRSS mass-dimensional and energy characteristics computation with the help of SYNTHES software depends on the accuracy of equations (models). Statistical data acquisition and processing is carried out for updating some of certain models used in the software.

In the paper the proposed approach implementation is demonstrated with the help of simple example.

Use of the proposed methodology in conjunction with developed software lets to speed up the process of the LRSS basic design parameters choice and concept design generation.

Mass-dimensional, inertia, energy characteristics obtained by means of the method, may be regarded as reference ones, characterizing the degree of space vehicles perfection.

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