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FORMATION OF FEATURE SETS FOR SATELLITES CLASSIFICATION IN THE TASK OF ASSESSING THEIR CAPABILITIES

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Scientific and technological development has influenced the quantitative and qualitative composition of modern space systems, which is actively changing: the number of spacecrafts is increasing and their functionality are improving.

The experience of using the space component in world events of recent decades - local conflicts and wars, elimination of natural and man-made disasters - has shown that the space component is an effective instrument in their elimination and prevention. The use of the space component of its armed forces in the war against Ukraine by the Russian Federation deserves special attention.

Thus, Space support and, in particular, space domain awareness (space situational awareness) is an urgent need in the planning process of many areas: from national security and defense to the educational component of educational institutions [1].

In the modern conditions of using information on the state and changes of the space situation, reliable and complete information on the purpose of spacecraft is required, which is complicated by certain limitations on the use of measuring instruments, etc. [1, 2, 3].

In order to increase the accuracy of determining the purpose of satellites, the reliability of their assignment to a certain class, it is proposed to use the mathematical apparatus of the theory of fuzzy sets to classify satellites based on a priori and a posteriori information that can be obtained from open sources. A

spacecraft classification model using a fuzzy inference system is proposed to use for implement this approach (Fig. 1) [4].

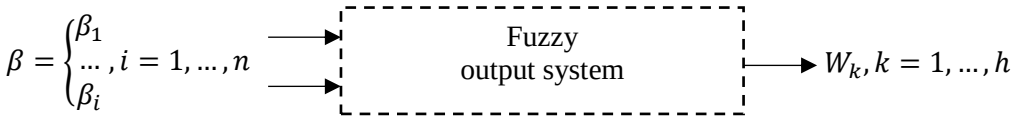

Fig. 1. **Spacecraft classification model using a fuzzy inference system**

At the same time, it is necessary to form sets of spacecraft features that will be used for classification.

It is possible to classify satellites according to the information that precedes their launch and the information that is available for analysis after its launch. Thus, it is possible to distinguish a priori (before launch) and a posteriori (after launch) features of classification, which, in turn, can be direct and indirect [5, 6], numerical, categorical or linguistic.

Table 1

Information from the satellite launch plan

Category of information	Type of a priori feature
The stated purpose of the satellite	direct, categorical
The launch site (cosmodrome).	indirect, linguistic
The type of launch vehicle	indirect, linguistic
Name of satellite	direct, linguistic
The customer of the satellite	indirect, linguistic
The developer of the satellite	indirect, linguistic
Configuration of the satellite	direct, linguistic
Launch mass of the satellite	indirect, numerical
Estimated (warranty) period of operation of the satellite	indirect, numerical
Type of orbit by altitude	indirect, linguistic
Type of orbit by shape	indirect, linguistic
Orbital stability	indirect, linguistic
Luminosity of the satellite	indirect, linguistic
Inertial longitude of the ascending node of the orbit	indirect, numerical

data generated from [1].

Next, define the sets of terms for each of the linguistic variables by the (1) and the sets of terms T_i for each of the linguistic variables by the (2):

$$\beta_i = \text{Category of information}, i = 1 \dots n\,, \quad (1)$$

$$T_j = \{t_1, \dots, t_j\}, j = 1 \dots m\,. \quad (2)$$

Next, fuzzy linguistic rules will be form, the values of the output variables will be determined, and membership functions will be built. The proposed steps will become the basis for solving the problem of complex classification of spacecraft, taking into account most of the critical heterogeneous features.

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