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APPLICATION OF PRECEDENT TECHNOLOGY TO SUPPORT DECISION-MAKING TO ENSURE THE EFFICIENCY OF COMPLEX TECHNICAL SYSTEMS

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Currently, there is an increase in the use of decision-making technologies for the effective operation of complex technical systems (CTS) [1, 2]. Such systems are hierarchical structures with non-trivial internal structures, multiple functional subsystems, components, elements and complex connections between them, which are in various states of failure. The operation of CTS is subject to uncertainties that are difficult or impossible to fully describe, understand or predict. One of the main causes of man-made accidents associated with the operation of CTS used in transport, aviation, energy, etc. remains the failure of their subsystems, components, and elements [3]. With increasing requirements for the safety of expensive CTS, the requirements for their efficiency, which depend on the time and resource during operation of the systems, are simultaneously increasing. In order to identify signs of pre-failure technical condition (TC) of CTS equipment at an early stage of its development, it is necessary to use intelligent information technologies to support decision-making [4]. The core of such information technologies are conceptual stochastic models and methods for diagnosing vehicles, effective systems for intelligent decision support (IDS) for assessing, forecasting and controlling vehicles. The use of reasoning methods based on case-based reasoning (CBR) precedents simplifies decision-making for various types of uncertainties in the initial data of the CTS and the knowledge of experts, as well as in cases of emergency situations [5].

Methods for finding solutions in intellectual decision support systems (IDSS) based on precedents is an approach based on the use of analogies with previously solved problems to find and adapt solutions to new situations. Similar methods include the steps that form a CBR cycle: 1. Capturing precedents from the precedent library (BP); 2. Indexing (organization of precedents for quick search of similar cases); 3. Search for the most suitable precedents for a new task. 4. Adaptation (modification of the found precedent to suit the current task); 5. Evaluation and implementation (checking the adapted solution for its suitability and, if necessary, implementation). Advantages of case-based reasoning: 1. Adaptability (the ability to use the experience of previous solutions to adapt to new situations without the need for complete retraining); 2. Working with incomplete information (the ability to work effectively with incomplete or unstructured data); 3. Universality (applicable to a wide range of tasks and subject areas, since it is based on the principle of analogy and does not require knowledge of the subject area as a whole); 4. Learning from experience (the ability to improve and learn from new precedents, allowing you to become more effective over time). Use cases can be represented in a variety of ways, including text descriptions, diagrams, tables, prototypes and use cases, and modeling via UML. Each of these methods can be effective depending on the context and goals of the project. The development of IDSS systems for assessment, forecasting and control of vehicle subsystems, components, elements in order to ensure the survivability of ship CTS under adverse impacts and damaging factors is one of the promising areas in ensuring the safety of CTS operation. Such IDSS systems can be implemented both in the form of separate stand-alone solutions and in the form of modules that complement ready-made general-purpose control and decision-making systems with the necessary functionality. They will make it possible to quickly make decisions at the stage of eliminating the consequences of adverse impacts and damaging factors, to ensure the efficiency of operation of ship CTS due to the ability to identify, evaluate, predict and control their vehicles.

In the proposed CBR cycle (Fig. 1), the initial task generation block receives a set of input diagnostic parameters of the CTS vehicle and an array of ontologies representing a structured description of the domain area for a specific CTS.

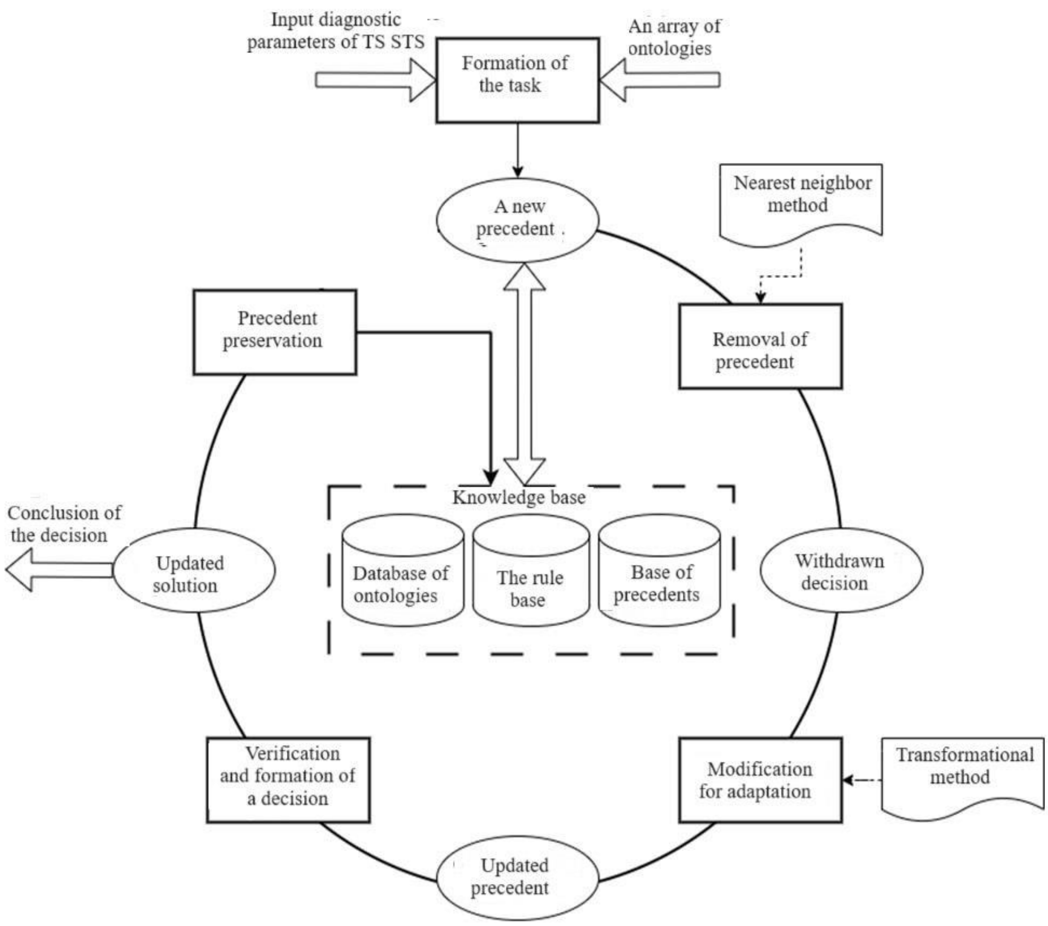

Figure 1 – CBR cycle structure

As a result, the structure of a new precedent object is generated, the contents of which are extracted based on the application of the nearest neighbor method based on the results of assessing the degree of similarity (proximity) of the scenario under consideration with the CTS vehicle, taking into account the available data in the knowledge base.

Based on the implementation of this procedure, a solution object is formed, which can be changed for its target adaptation, taking into account all aspects of the considered risk scenario of failures of subsystems, components, elements and their mutual connections based on the application of the transformation method.

After this, the updated precedent is checked for logical consistency based on the use of predicative productions using the Hermit ontological method for constructing logical inference. The resulting decision is exported as a separate object containing recommendations for the decision maker and metadata. The precedent is then saved to the precedent database, which is part of the knowledge base.

Conclusion. The use of the precedent method in expert systems allows:

- significantly reduce the time for making a decision; — increase the adequacy of decisions made in the absence of sufficient time to assess the situation;

- carry out a forecast of the situation, as well as the state of the object after issuing a control action on it.

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