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V.V. Shulevka, post-graduate student,
L.V. Panchuk, post-graduate student
(National Aviation University, Ukraine)

Algorithm of the intelligent control system gas-turbine engine

The analysis of existing intellectual technologies is made. Algorithm of the intelligent control system for a gas-turbine engine is considered.

Software and information complex for automatic diagnostics and control of operating modes of the gas turbine engine (GTE) of the new generation provides [1]:

- ensuring control of the engine's performance;
- creation of effective tools for diagnosis, control and management;
- methodical, technical and organizational support of specialized units of diagnostics, control and management;
- development of diagnostic methods and algorithms, selection of controlled parameters, development of algorithms for decision making, etc.
- At present, the uneasy state of the industry in Ukraine has led to a significant reduction in the production of gas turbines, components to them and the simultaneous increase in their value. The pace of active upgrading of existing types of engines has slowed down. These factors increased the interest of the operational units of the aviation, marine and gas industry not only in Ukraine but also in many other countries in the transition to resource-saving technologies, as well as to the operation of the main equipment "in technical condition" [2]. Today, the practice of operating the GTE introduces a progressive and cost-effective way of operating under the actual technical condition. Such a method of operation at the actual state provides a higher level of reliability of the components of the GTE in general and significantly reduces the damage caused by periodic preventive inspections and emergency stop GTE. According to statistical data, the cost of unreasonable maintenance and repair, according to the system of planned preventive maintenance, is almost 8.0% in relation to all operating costs.

During the operation of the change in the technical condition of the engine occur under the influence of factors that are determined by the conditions of use of the GTE, and in particular its operating modes, the properties of the working environments, the influence of the environment, as well as the timeliness and quality of maintenance and repair, optimization of the modes of operation of the GTE on the basis of the conducted research of actual characteristics of engines, compliance with service personnel rules of technical operation, correct installation of the GTE. In addition, the actual technical characteristics of even new equipment in one way or another differ from the passport values. The reasons for these deviations are the spread of the characteristics of individual GTE within the technical conditions for the supply of manufacturing plants. It manifests itself in the deviations of the values of the initial indicators of the same type of equipment from the passport, as well as in the levels and dynamics of changes in time of actual indicators during operation.

The intellectual classification of the engine's TC is a combination of tools that allow you to build reliable and adequate models of GTE, with low redundancy, high efficiency and the ability to adapt to changes in the external and internal environments of the diagnostic object (process) [1].

Implementation of the methods and means of diagnostics and forecasting of the TC GTE in the gas transport, aviation and shipbuilding enterprises directly in the process of its exploitation with the use of intelligent technologies allows [1]:

- to move from the traditional scheme of planned preventive repairs to actual repairs, which contributes to increasing the fleet of GTE fleet for repairs, reducing repair costs, reducing the need for spare parts and repair personnel;
- to increase the stability during the inter-repair period of the values of such starting values of the efficiency of the GTE as the efficiency, and to prevent the destruction of such elements as blades of compressors and turbines, gear, etc .;
- reduce the probability of sudden failures of the GTE and thus increase the safety of operation of the pipeline, aviation and maritime transport, as well as provide the necessary level of flight safety;
- to carry out operative control and classification of the GTE, as well as continuous control of the vibration of bearing units, which will automatically change the mode of operation of the GTE to reduce the negative impact of vibration on individual engine units;
- timely stop the GTE in the event of an emergency and exclude the stopping of the GTE during occasional, short-term vibration levels or change the operation of the GTE depending on the situation.

Developed software complex is intended for implementation of the process of automatic classification and forecasting of changes in the vibration state of the GTE in the course of operation.

It provides solutions to the following tasks:

- synthesis of intelligent control system (ICS) for different types of GTE, taking into account changes in vibrational states and their operating modes;
- classification of the current technical condition of the GTE;
- formation of frame structures with diagnostic information and entering them into the base of the ICS classes of the GAD.

For the synthesis of the ICS GTE, a priori information is required on technical indicators, the ICS base class with typical diagnostic features, built-in diagnostic software, and application software applications. Diagnostic information about the vibration state of the engine is collected in an automatic mode with the help of monitoring equipment, and the information about the target tasks is entered by the operator (dispatcher). As a result of the synthesis of the ICS GTE may increase in the process of operation, all its subsystems are autonomous modules.

Classification is carried out both in the monitoring mode of the technical condition GTE, and periodically, depending on the need for diagnosis.

The developed ICS program complex consists of a number of subsystems are [3]:

1) the subsystem of the organization of the dialogue with the operator ICS. This subsystem provides the provision of diagnostic information, the visualization of the stages of the classification process of the technical diagnostic, the display of

information from the class base, and the results of the operation of other subsystems of the complex in a convenient form for the perception of the controller, with the ability to construct graphs, diagrams, graphic representation of the models of the GTE. The controller does not require knowledge of high-level programming languages or specialized languages, knowledge of the theory of artificial intelligence, decision support or system analysis;

2) the subsystem of the semantic interpreter, which performs the transformation of the information introduced by the user in the natural language in the submission, is acceptable for the processing of the ICS GTE, and the results of the system's decisions are provided to the controller in a convenient for perception form;

3) ICS structural synthesis subsystem, which enables to generate ICS for each individual type of GTE, taking into account the features of its technical state, operating modes, operating conditions, means of receiving diagnostic information, target tasks;

4) a subsystem of forecasting, which provides a forecast for changing the vibration state of the gas turbine at a given time interval. The technical states of the GTE are foreseen, which are proposed to be evaluated qualitatively in the form of the following ranges: good, acceptable, admissible, requires action, is not acceptable;

5) subsystem of identification, which allows determining the technical condition GTE;

6) a database of classes containing diagnostic information, expert knowledge of the TS of a typical GTE and the diagnostic process, algorithmic knowledge about the synthesis of the architectures of the neural network experts, the procedures for calculating the characteristics of the GTE;

7) the database stores all the results of the work of the ICS software complex.

Conclusion

Using the latest software packages, the application software of the intelligent system for the automatic diagnosis of the classification of the vibration state is developed, which allows the implementation of control and diagnostic algorithms for both individual elements and the GTE as a whole, as well as to automatically change the mode of operation of the GTE, which reduces the negative impact of vibration and thus will allow to increase the motorcycle of the GTE.

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