UDC 681.396

Kut V., Veretenikov I., Logvinenko O.

IMPROVEMENT OF THE VIBRATION DIAGNOSTIC SYSTEM OF GAS TURBINE ENGINES

The basic element of the power plant of weapons samples (aircraft, some samples of armored vehicles) is a gas turbine engine. Such an engine contains a multi-stage vane machine, which includes a set of rotating (nozzle) devices of a compressor and a turbine. The technical condition of the turbocharger rotor determines the resource and reliability of the power plant of weapons samples, therefore, affects safety [1, 2]. Thus, control of the technical condition of the gas turbine engine by vibration parameters is an important direction in the general system of technical diagnostics of weapons samples [3].

The development of effective systems of nondestructive control of parameters of the technical condition of elements of weapons samples is an urgent task [4, 5].

Compared to other diagnostic methods, vibration analysis has a number of characteristic features. This is due to the fact that the latter usually record the results of the force load, and with the help of vibration methods, direct control of the most dynamic force effect is carried out. From this follows the fundamental possibility of earlier, compared to other methods, detection, and even prevention of a malfunction [1, 6].

The application of vibration analysis methods is limited by the lack of systems for collecting and analyzing information from vibroacoustic signals that are fairly easy to use and maintain [3, 4]. The paper proposes a system for collecting, inputting and processing analog signals, which is intended for measurement and digital processing of vibroacoustic signals during vibrodiagnostics of gas turbine units in turbine construction. The developed system has the necessary characteristics for timely and reliable detection of possible failures during the control of the technical condition of the gas turbine engine of weapons samples.

Carrying out technical diagnostics of gas turbine engines of weapons samples in real time allows to move from the operation of engines by time to the operation of engines by technical condition [2]. One of the main elements of technical diagnostics is vibration diagnostics [4, 5].

Vibrations, that is, mechanical oscillations, are usually defined as the system's response to the action of disturbing forces. Exasperating loads acting on the elements of the gas turbine engine are determined by the principle of operation and features of the turbocompressor, which is a bladed rotary machine and forms the basis of a modern gas turbine engine, as well as the operating conditions of the power plant. Internal and external disturbing forces are mainly of mechanical and gas-dynamic (aero-mechanical) origin. When used in ground

installations, there are additional external influences from the electric generator of the compressor.

The main source of vibration of the gas turbine engine is the rotating rotor of the turbocharger. Statistical and dynamic imbalances of the rotor lead to the emergence of forces and moments that cause vibration of both the rotor itself and the entire turbomachine as a whole.

Rotor aeromechanical vibration is caused by gas-dynamic non-stationary loads. Its main source is the surrounding non-uniformity of the gas (air) flow flowing through the moving and stationary grates of the blade apparatus.

Vibration caused by acoustic noise created by the compressor and turbine, and also occurs during the operation of the inlet device, jet nozzle and combustion chamber.

Vibration generated by toothed connections found in engine gears and drive systems.

Vibration generated by bearings. It is caused by geometric errors that occur during their manufacture and installation.

There are two classes of devices for measuring these parameters: analog devices and digital systems, special methods of digital signal processing. Analog systems make it possible to obtain values of measured parameters in real time - (real-time systems). Signal filtering is the basis of these systems. But this class has a significant drawback - the minimum error in determining the amplitude is 10%. It should be noted that the registration of analog signals is complicated. Therefore, in the last (10-15) years, digital methods have become widely used. Vibration diagnostics is performed with the help of information and measurement systems. Currently, it is digital methods that have become widely used in vibration diagnostics of gas turbine engines. They are based (if the power spectral density estimate is calculated) on the use of Fourier transformation, autoregression estimation methods - special calculation algorithms that allow working in quasi-real time.

In connection with the above, it is possible to outline a general list of tasks that should be solved by the development module for inputting measurement information: removing parameters; analog-digital conversion; accumulation of information; digital processing.

Thus, there is a problem of developing equipment for measuring vibration parameters. The sensors must monitor the rotational harmonics of the engine. But this is not enough, it is necessary to know the amplitude-frequency characteristic of the engine in order to predict its condition, that is, the accumulation of information with subsequent processing is necessary. The main requirement is to maintain a stable frequency or discretization of the channel sampling period during the entire operation. The possibility for the module to work at a variable sampling frequency of the input signal should be implemented.

References

1. S. Yevseiev, O. Kuznietsov, S. Herasimov and etc. Development of an optimization method for measuring the Doppler frequency of a packet taking into account the fluctuations of the initial phases of its radio pulses. *Eastern-European Journal of Enterprise Technologies*, 2021, 2 (9) (110), p.p. 6-15, https://doi.org/10.15587/1729- 4061.2021.229221.

2. O. Brytov, D. Bieliaiev, S. Kukobko and etc. Justification of the Method of Evaluation of the Efficiency of Air Reconnaissance by Unmanned Aviation of Ground (Sea) Objects, *Proceedings of the 3rd International Scientific and Practical Conference* "*Scientific Trends and Trends in The Context of Globalization*", UMEA, SWEDEN, 2122.12.2021, p.p. 431-434, https://doi.org/10.51582/interconf.21-22.12.2021.050.

3. V. Dzhus, Y. Roshchupkin, S. Kukobko and etc. Estimation of Noise Radiance Point Sources Multichannel Direction Finding Systems Resolution by Linear Prediction Method, *Information Processing Systems*, 2021, Issue 4 (167), p.p. 19-26, https://doi.org/10.30748/soi.2021.167.02.

4. S. Herasymov, V. Olenchenko, S. Yevseiev and etc. Investigation of the Dynamic Filters' Characteristics for the Analysis of Random Signals During Data Transmission, *2022 IEEE 3rdKhPI Week on Advanced Technology* (KhPIWeek), p.p. 162-166.

5. S. Herasimov, E. Roshchupkin. Parameters of monitoring the technical condition of airspace radio engineering monitoring systems, *International scientific and practical conference* "*Application of information technologies in the preparation and operation of law enforcement forces",* March 15, 2022, p.p. 31-32.

6. S. Herasimov, V. Soroka, S. Yevseiev and etc. Development of a Method for Measuring small Nonlinear Distortions of Periodic Electrical Signals, *2022 International Symposium on Multidisciplinary Studies and Innovative Technologies* (ISMSIT), 2022, p.p. 49-52, https://doi.org/10.1109/ISMSIT56059.2022.9932685.