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MULTILEVEL SPECIAL PURPOSE COMPUTER SYSTEM FOR OPERATIONAL VIBRATORY STRESS STATE ANALYSIS OF TURBOMACHINE COMPONENTS AND ELEMENTS.

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Summary.

Multilevel Special Purpose Computer System (MSPCS) was developed for operational vibratory stress state analysis of turbomachine. MSPCS provides control, tracking processing and diagnostics of stress and vibration of turbomachine components and elements in bench tests.

Keywords: dynamic process, stress state, turbomachine, computer, memory.

Quality and efficiency improvement of analysis of dynamic processes, recorded during turbomachines bench tests, is an urgent task aimed at building reliable machines in short periods. Shortening time of turbomachines strength development with improvement at the same time of their reliability demands extension of bench tests programmes and leads to dynamic stress information volume growth. This in its turn demands to accelerate processing and analysis of dynamic stress information using advansed technique of sig-

nal digital processing for optimal design changes in due time.

Multilevel Special Purpose Computer System (MSPCS) on the basis of IBM PC AT/386 type personal computers (PC) and multichannel system of input/output of analogous and digital signals was developed for this aim. Principle of MSPCS its structure and software were developed taking into account the specific of analized dynamic processes. Their main feature is high information density due to wide frequency and complex structure of vibration spectrum of the investigated objects and the period of realizations time. As MSPCS is to provide final test results in real time scale of engine strength development, so for development of optimal processing procedure and corresponding MSPCS structure there was adopted analogous-digital two-stage scheme of storage and processing of experimental data on investigated objects vibrational load.

On the first stage with the help of multichannel program-controlled input system MSPCS isolates dynamic processes envelopes and inputs their values to PC memory, where relationships are made on each channel:

$$A = f(N,t), \tag{1}$$

where: A - process amplitude; N - engine operational power setting; t - time.

Multichannel detector isolates envelopes in the mode of operation to select maximum and root mean square values of amplitudes:

$$A = \begin{cases} Amax(dt,N,t); \\ S(dt,N,t). \end{cases} \tag{2}$$

where: Amax - maximum value of process amplitude; S - root mean square value of process amplitude; dt - time of detection.

If it is required a special unit in MSPCS can plot histograms of numerical estimation of dynamic processes amplitude density of distribution function. Input signal for this special unit is detector signal and output signal is process amplitude with pre-set by researcher probability, that this level

will not be exceeded. Then forming of relationships (1) taking into account (2) will be as follows:

$$A(N,t) = A(dh), \quad P(a<A)=\text{const}, \tag{3}$$

where: dh - time base for histogram plotting; P(a<A) - probability of amplitude current value a not exceeding level A.

Discretization of envelopes signals is performed with the help of quick-acting analog-to-digital converter (ADC), which interrogates all channels one by one through multiplexer. A device of original structure with its own buffer memory provides a unique time section of numerical data over all channels. Accumulation of discrete data is performed in two conditions:

- along the channel of direct access (DMA) to PC internal storage;
- along the channel DMA to hard disk of "winchester" type.

Special points of relationship (1), where diagnostic analysis of the process is needed, are selected according to main extrema criteria or according to the other criteria, defined by investigated problem.

The realizations of the base process, corresponding to the selected special points of relationship (1), are input to PC memory with the help of ADC and their diagnostic analysis is performed on the second stage. Duration of the realization is defined by the stationarity condition with adopted by researcher assumption.

The proposed method of preliminary reduction of dynamic state information saves significantly PC memory capicity and shortens processing time due to the fact, that discretization period at input of process envelope representing low-frequency process, is much more, than needed period of discretization of the process itself. Dynamic information flow density is reduced by this too. The use of device for histogram plotting provides dynamic information reduction of the higher rate, that is defined by realization duration dh , serving as the base for histogram plotting.

MSPCS is easily adapted to various test-bed instrumentation and compatible with a wide range of transducers and converters.

MSPCS provides control, tracking processing and diagnostics of stress and vibration of turbomachine components and elements in bench tests. The developed software enables solving of the above-mentioned problems in steady-state and transient operations of turbomachines in a wide range of frequencies and amplitudes of investigated processes and includes: estimation of stationarity and ergodicity of vibrational processes; amplitude analysis; statistic analysis; frequency analysis; estimation of interrelation of vibration processes; identification of sources of vibration and dangerous dynamic states; diagnostics of vibration types; disign of natural dynamic characteristics according to test results; digital filtering and tracking analysis.

MSPCS has an open architecture, enabling to increase the number of applicable PCs, besides there is possibility of switching PCs to a larger-powered computer. MSPCS provides interactive mode and significantly widens researcher's capabilities and guarantees quality of final results. One can output graphical and table-text forms of information to PC and computer peripheral devices.

MSPCS is approved for investigations of stressed state of fan blading, nozzle and guide vanes and blade rows of turbomachines. MSPCS experimental service operation proved, that offered methodology of dynamic information processing and analysis, based on preliminary reduction of data flow and application of advanced technology of digital processing of signals, provides reliable estimation of operational vibrational load of turbomachine units and parts.

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