METHOD OF IDENTIFICATION OF PERIODIC PROCESSES IN EXPERIMENTAL INVESTIGATIONS

Nikitin A.A., Ugolnikov S.V.
National Technical University
«Kharkiv Polytechnic Institute», Kharkiv

Extremely high loads are typical for optimized mechanical systems, while the reliability and long-term strength of systems significantly depend on the nature of the dynamic processes that form in them. Existing calculation methods are not always able to reveal possible vibration disturbances and their parameters, and experimental studies of dynamic processes are hampered by their complex spectral composition.

A technique for detecting stable periodic components in a polyharmonic pseudo-random dynamic process and determining their parameters is considered. It is assumed that the investigated periodic processes are statistically stable, have the properties of ergodicity and stationarity, and the noise component has a distribution function close to the normal law. The search for so-called "hidden periodicities" is performed in the frequency domain using digital Fast Fourier Transform techniques. To reduce the influence of the noise component and obtain consistent estimates of the parameters of vibrational processes, averaging over an ensemble of realizations is performed.

The proposed method uses the concept of the frequency response function, namely, the phase frequency response calculated for dynamic processes registered at two points of the system spaced apart in space. The spatial shift causes a shift in time between the recorded processes, which characterizes the direction and speed of movement of the vibration process. In the frequency domain, the time shift translates into a phase shift, the magnitude of which depends on the frequency. The direct use of the phase-frequency characteristic is complicated by the uncertainty of the magnitude of the phase shift, which is associated with the infinity of the arc tangent. If the process is polyharmonic, which is often observed in practice, it becomes possible to restore the uniqueness of the phase-frequency characteristic by switching to the analysis of frequency increments and phase difference for several harmonics.

On the basis of the considered methodology, a scheme of a measuring and information complex was formed to reveal the structure of periodic dynamic processes and determine their parameters. The complex includes four subsystems:

- measuring: fast-response transducers with power supplies, pre-filters, amplifiers, switches, primary signal recorders (analogue and digital);

– transformations: anti-transposition filters, fast Fourier transform blocks, blocks for calculating the phase-frequency characteristic, cross-correlation function, coherence functions, accumulators for current and averaged calculation results;

- analysis: a block for the formation, storage and use of the frequency-phase-coherence database for the identified harmonic components of the process, a block for analyzing frequency and phase increments, a block for calculating the main characteristics of periodic processes;

– interaction with the operator: universal display unit, documentation unit, interactive interaction unit operator-information complex.