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**SOFTWARE-ALGORITHMIC COMPLEX FOR CASCADE PNRP
DECOMPOSITION OF VIBRATION SIGNALS IN MULTI-ROTOR
AIRCRAFT GAS-TURBINE ENGINES**

The vibration condition of the aviation gas-turbine engines (AGTEs) is formed under the influence of a superposition of many complex oscillatory processes. A key problem in the vibration diagnostics of multi-rotor systems is requirement to accurate separation of deterministic rotor harmonics and the stochastic component of vibrations under non-stationary operating conditions. An adequate mathematical model for describing such vibrations is the theory of periodically non-stationary random processes (PNRP), the fundamentals of which was developed by scientists of the Karpenko Physico-mechanical Institute of the NAS of Ukraine [1, 2].

The practical application of classical PNRP analysis methods is complex because of its algorithmic parameterization [3]. The purpose of this work is to create a specialized software tool, PNRP Analyzer, which integrates PNRP models into a user-friendly computational environment. The scientific novelty of the development consists in improving the polyharmonic least squares method by introducing an algorithm for adaptive parameterization and step by step separation of harmonics. Unlike existing solutions, the developed approach allows to:

- automatically synchronize the base frequency of the PNRP model with the data of the primary impulse tachometer;
- dynamically calculate the maximum allowable number of harmonics based on the Nyquist-Shannon theorem to eliminate the effect of spectral aliasing;
- step by step extract regular components from several kinematically uncoupled rotors (cascade method) with subsequent analysis of the “cleaned” stochastic noise.

The generalized structural scheme of the developed cascade decomposition algorithm is presented in Figure 1.

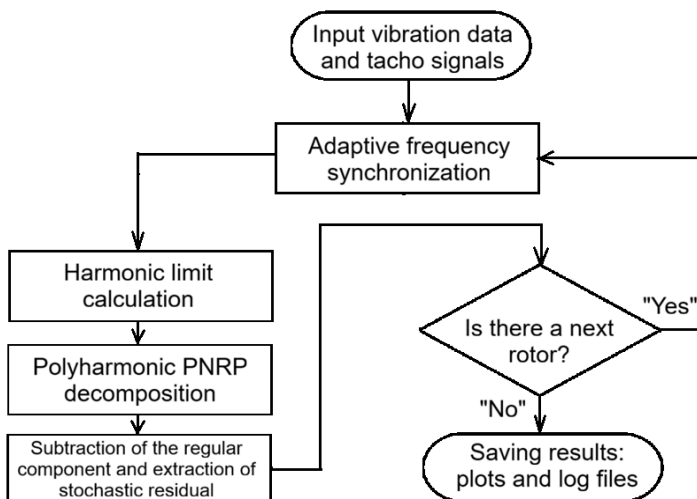


Figure 1 – Flowchart of the adaptive cascade PNRP decomposition algorithm for multi-rotor systems.

The implemented software complex automates knowledge-intensive processes of vibration signal processing. Translating complex theoretical decomposition algorithms into a cascade analysis format provides engineers with the ability to detect hidden structural nonlinearities of AGTE systems at the early stages of defect initiation.

REFERENCES

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