Autoresonant excitation and control of parametric vibration

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The central problem in applications of parametric resonance is excitation of vibration within special frequency band and control of the oscillation instability with the aim of keeping the amplitude at a desired level making the oscillations well-ordered to create a stable response. The problem of excitation and control of parametric resonance is drastically complicated when structure has variable loads changing unpredictably as well as complex nonlinearities.

The autoresonance method is used to control the system response due to its ability to deal with nonlinearity and its robustness when confronting systems with a wide range of uncertainties. This method is well established for machining applications [1-6]. The displacement signal of the unit performing a working process is fed to the actuator directly by means of positive feedback. The control feedback system includes a sensor, control system unit and actuators. The input of the system is a sensor signal measuring the vibration of unit performing a working process, and the output is the excitation force generated by actuator.

The signal is used by the control system unit, and generates a control signal, in its simplest form, shifting the phase of the vibration signal from the sensor and amplifying its magnitude. The powerful signal produced feeds a synchronous type power actuator which transforms the signal to the excitation force with the same frequency and phase shift calculated by a control system unit. Negative feedback is used to fix the level of amplitude response within the expected range.

Autoresonant control is thoroughly investigated and output tracking is reported. The control developed provides the possibility of self-tuning and self-adaptation mechanisms that allow the vibrating structure to maintain a parametric resonant mode of oscillation under a wide range of uncertainty of mass and viscosity. Influence of nonlinear factors is investigated and results of possible applications are discussed.

References

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