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Independent harmonic control for structural engineering (Article)

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Abstract

A procedure for optimizing the control action with respect to the foreseen forcing function and constrained by an upper bound on the control action was presented. The procedure was based on the harmonic decomposition of the forcing function and on the ideal distribution of the control action over the frequency range in an optimal fashion with respect to the expected power density distribution of the active force. The results showed that the adopted procedure achieved an improved time response, both in the transient and in the steady-state field, with respect to a control strategy based on classical linear control which minimized the response norm conditioned by a bounded control.

Author keywords

Frequential decomposition; Harmonic control; Norm algorithm

Indexed keywords

Engineering controlled terms: Algorithms; Closed loop control systems; Fourier transforms; Harmonic analysis; Linear control systems; Mathematical models; Structural design

Engineering uncontrolled terms: Frequential decomposition

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INDEPENDENT HARMONIC CONTROL FOR STRUCTURAL ENGINEERING

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In a previous paper [Baratta and Corbi, 1999] one has defined a procedure allowing to identify a closed-loop control algorithm with feedback based on the whole record of the response time-history rather than on instantaneous response parameters. The control force results from control of each harmonic component of the forcing function, simply integrated over the frequency domain. Every harmonic is controlled, independently of each other, by a classical linear control whose coefficients are calibrated in way to make the relevant response component a minimum compatibly with the control effort one wants to apply at the corresponding frequency. The distribution of this control intensity over the frequency range remains a arbitrary choice; such a choice however lends itself to be effectively assisted by intuition, much more than similar choices in other procedures (e.g. : the coefficients of the quadratic norms in the J-index optimization). The result is that every harmonic remains controlled by a different couple of optimal coefficients (corresponding to the proportional and to the derivative terms in the linear control law), and the overall control force for an arbitrary disturbance, after Fourier inverse transformation, is produced by feedback integration over the whole response time-history.

The procedure, tested with reference to simple and composed harmonic excitations incoming a s.d.o.f. structural system, has proved a good agreement of the numerical results with the theoretical treatment; furthermore it has shown that the main limit of such an approach consists of referring the dynamic equilibrium solution to a particular solution, that, neglecting the initial conditions, may introduce some unstable components in the oscillation. In the paper the effects induced in the controlled structural system response by the adoption of the proposed procedure are deepened and an improved strategy is presented, able to overcome the detrimental transient effects determined by the original algorithm. The final adopted control law is shown to achieve an improved time response, both in the transient and in the steady-state field, in comparison to a control strategy based on classical linear control minimizing the response norm conditioned by a bounded control.

Keywords: Harmonic control; frequential decomposition; norm algorithm

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