11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Design of Functionally Graded Piezoactuator for transient reponse by means of gain velocity feedback control through Topology Optimization Method (TOM)

Mariana Moretti[1] and Emílio C. Nelli Silva[1]

[1] Department of Mechatronics and Mechanical Systems Engineering, Polytechnic School of University of São Paulo, SP, Brazil

Abstract

Recent developments in structure design based on TOM have covered the optimal distribution of piezoelectric material over a host structure to reduce its transient response with an active control law instead of the static analysis so broadly studied until then. Continuing on the dynamic applications mainstream, this work is devoted to the design of a piezoactuator structure operated by two piezo-ceramic medias, one for sensing purpose and the second one for actuation purpose. The piezo-ceramics has fixed positions within the domain while the metallic structure layout is designed by using TOM and functionally graded material concept for reducing mechanical energy over transient time-interval under a step-like input. The current amplifier definition is applied to convert the sensor output into a voltage input on the actuator by means of a specified feedback gain, what in terms of the dynamic governing equations will result in a constant gain velocity feedback. TOM is implemented based on the SIMP material model, which is employed for void and two metallic material properties to obtain a graded optimal structure where pseudo-densities are interpolated at each finite element. The sensitivity analysis is calculated by using the adjoint method. The discrete approximation of the sensitivity is evaluated with a direct time integration method after the continuous function differentiation in time was taken, an approach denominated differentiate-than-discretize. Examples are limited to two-dimensional models and one-dimensional material gradation constraint. The influence of the control gain over the correspondent optimal output attenuation will be discussed.