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

Optimal Design of Piezoelectric Transducers

D. Ruiz[1], A. Donoso[1], J.C. Bellido[1]

[1] Universidad de Castilla la Mancha, Spain

Abstract

Modal sensors/actuators [1] measure or excite only a single mode, and remain insensitive to the rest. Due to the reciprocity of the piezoelectric effect, the shape that observes a particular mode (from a sensor point of view) is the same that excites this particular mode (actuator). Our objective is finding the optimal shape and electrode layout for a MSA, that maximizes the output charge for a single mode. In a previous work [2], this has been demonstrated, although restricted to the design of the electrode layout for a given structure.

Coming back to our problem of simultaneously designing the ground structure and the electrode profile, an interesting particular case, which has been studied in [3], is the static case. In this talk, we will report on our work on the general case, where the state equation is an eigenproblem and both cost and constraints depend on eigenmodes, with all the difficulties involved when dealing with eigenfrequencies and eigenmodes (switching, repeated eigenvalues, spurious modes, etc.). We would like to remark that is a very novel issue to deal with functionals depending on eigenmodes.

This method is not restricted to the size of the transducer, but all the designs are done in the micro-scale, having in mind the wide range of applications of MEMS (micro-grippers, surface probes, micro-optical devices, etc.).

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[3] Ruiz D, Bellido JC, Donoso A, Sánchez Rojas JL, Design of in-plane piezoelectric sensors for static response by simultaneously optimizing the host structure and the electrode profile. Struct. Multidisc. Optim. Volume (48), 1023-1026, 2013.