Bending waves focusing in arbitrary shaped plate-like structures: application to spatial audio

N. Benbara*, M. Rébillat* and N. Mechbal*

* Processes and Engineering in Mechanics and Materials Laboratory
(PIMM, UMR CNRS 8006, Arts et Métiers ParisTech (ENSAM)),
151, Boulevard de l'Hôpital, Paris, F-75013, France.
e-mail: nassim.benbara@ensam.eu

ABSTRACT

Audio applications are more and more demanding with respect to the visual impact of loudspeakers while still requiring more channels for high quality spatial sound rendering. The use of arbitrary plate-like structures driven by electromagnetic actuators or by piezoelectric elements appears as a promising solution to tackle those issues. However, to meet spatial rendering audio constraints, the generated bending waves must be focused to a certain extent within the host plate. Theoretically, this means being able to invert the spatiotemporal wave propagation operator for the generated bending waves to fit a given target shape. Several methods are here investigated to perform this task depending on the available knowledge of wave propagation in the plate (theoretical, partial spatial and full spatial knowledge) and using several projection bases (modal basis and eigenvalue basis). The various methods are presented in a unified theoretical framework and their performances are compared by means of three key performance indexes (focus localization error, focus width error and spatial contrast) and with respect to various parameters (damping in the structure, experimental noise level). The study will involve numerical simulations and experiments to compare them, firstly on a simple plate and after on a more realistic structure as a stiffened plate.

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