M2 internship subject

Sound radiation of light vibrating membranes

IMSIA Institute of Mechanical Sciences and Industrial Applications

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Duration: 5-6 months spring-summer 2019

Supervisors: Benjamin Cotté, Olivier Doaré, Emil Garnell, Corinne Rouby
IMSIA ENSTA Paristech – 828 Bd des Maréchaux – 91120 Palaiseau, FRANCE

Context

At IMSIA, researches are performed on the use of active plates or membranes to produce sounds (piezoelectric plates, dielectric elastomers membranes). The coupled electro-mechanical equations governing the linear dynamics of these structures are solved either analytically of by finite elements. We are then able to compute transfer functions between electrical input and dynamical output of the solid (displacement, velocity, acceleration).

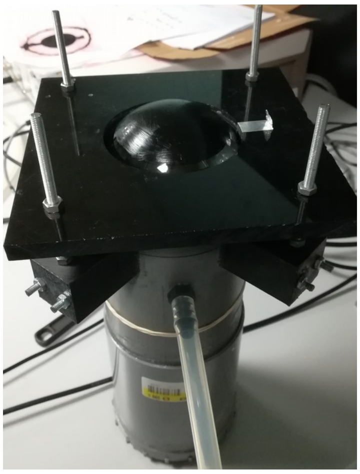

Figure 1: An inflated dielectric elastomer membrane.

To compute the acoustic radiation, the classical approach using a Rayleigh integral is used for now. This approach is valid when the vibrating structure is flat and baffled in an infinite plane. Therefore, the assumptions required to use this integral are not fulfilled in the present case. There is thus a need to properly model and solve the radiation of non-plane vibrating structures, including the diffraction by the solid it is embedded it and by the vibrating surface itself.

Objectives

One objective of the internship is to develop a numerical tool based on Python FeniCS to calculate the radiation of a compliant structure baffled in a perfectly rigid solid. Two approaches may be used to solve this kind of problem. The first one involves the meshing of the fluid domain using finite elements, and considering an absorbing outer layer in order to prevent incoming waves due to reflection on the domain outer boundaries. The second approach consists of utilizing the boundary element method (BEM), where only the fluid-solid boundary is meshed. Both methods have pros and cons. The first step will be to choose one of the two methods. Next, numerical simulations will be performed and compared to simple geometries where analytical or well documented experimental results exist. The work will be then to investigate numerically a configuration studied experimentally in the lab and include the pressure feedback on the membrane dynamics.

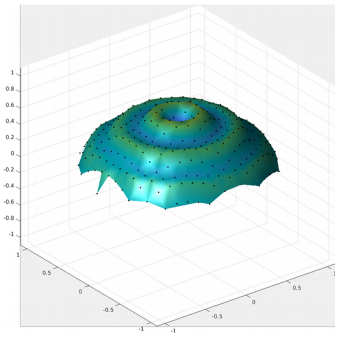

Figure 2: Example of a measured eigenmode using a scanning laser vibrometer.

Keywords: Numerical acoustics, innovative loudspeakers, vibrations, dielectric elastomers

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Profile of the student: A student in acoustics or mechanical engineering, with a strong interest in numerical simulation or a student in applied mathematics interested in applications in vibro-acoustics.

Contact: olivier.doare@ensta-paristech.fr