6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Thin wall optimal positioning in an acoustic cavity using Xfem and a gradient-enhanced metamodel

A. Legay[1] and L. Laurent[2]

LMSSC, Conservatoire National des Arts et Métiers,
Case 2D6R10, 2 rue Conté 75003 Paris, France
{[1]antoine.legay,[2]luc.laurent}@lecnam.net

Keywords: *XFEM, vibro-acoustic, gradient-enhanced metamodel, optimization*

Noise reduction is a design constraint which is more and more took into account. For instance, this constraint occurs in aircraft cabin design on which the noise propagation is minimized by finding the optimal arrangement. Classical design processes requires many expensive numerical computations. In order to reduce the computation time, a new strategy is proposed based on two specific tools: (1) a finite element solver which provides responses and gradients of the objective function to (2) a gradient-enhanced metamodel which interpolates both kinds of information.

The acoustic fluid problem is governed by the Helmoltz's equation. A porous material present in the acoustic cavity is modeled by the Biot-Allard's constitutive law. The structural problem corresponds to thin walls placed in the fluid and governed by elasto-dynamics equation. The air-structure problem is solved using xfem [1] in order to be able to consider an arbitrary structure placed in the acoustic cavity. In order to reduce the computation time, a reduced model is built from the full coupled problem [2] using a Craig-Bampton's approach. In addition, the calculation of the gradients with respect to the design parameters is proposed by considering an intrusive approach.

A gradient-enhanced surrogate-based optimization is used in order to reduce the number of calls of the mechanical solver. The approach is based on the Efficient Global Optimization composed of two phases: (1) a gradient-enhanced cokriging [3] metamodel and (2) an iterative scheme.

The whole strategy is applied on some 2D and 3D cavity on which the position of a wall is determined in order to minimize the mean quadratic pressure in a control volume.

REFERENCES

[1] A. Legay. An extended finite element method approach for structural-acoustic problems involving immersed structures at arbitrary positions. *IJNME*, 93(4):376–399, 2013.

[2] A. Legay. The extended finite element method combined with a modal synthesis approach for vibro-acoustic problems. *IJNME*, 101(5):329-350, 2015.

[3] L. Laurent, R. Le Riche, B. Soulier, and P.-A. Boucard. An overview of gradient-enhanced metamodels with applications. *ARCME*, Jul 2017.