A digital twin approach in architectural acoustics: smart noise cancellation in interior rooms

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ABSTRACT

Nowadays, the extensive use of Building Information Modelling (BIM) and the extensive use of the digital twin approach [1] allow us to take into account novel capabilities not only in the design and testing phase of an industrial process (such as the construction of a building) but also on the management phase. The present talk focuses its attention on the mathematical modelling and the numerical simulation of an acoustic problem in interior rooms, which suffer from a high noise level in operational circumstances (such as industrial or manufacturing plants). More precisely, the primary goal consists in the numerical simulation of a multichannel passive–active noise control system based on devices involving a particular kind of cell.

Each cell consists of a parallelepipedic box with all their faces rigid, except one of them,

where a porous veil or a rigid micro-perforated plate [2,3] is placed. Firstly, the frequency response of a single passive cell is computed, when it is surrounded by an unbounded air domain (an anechoic room) and harmonic excitations are imposed. For the numerical solution of this three-dimensional problem, the original unbounded domain is truncated by using exact perfectly matched layers and the resulting partial differential equation is discretised with a standard finite element method. Secondly, the passive cells are transformed into active by assuming that the opposite face to the passive one may vibrate like a piston in order to reduce noise. The corresponding multichannel active control problem is stated and analysed in the framework of the optimal control theory. A numerical method is proposed to assess and compare different control configurations in a real-life building environment [4].

References

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