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Convected acoustic radiation using a mapped infinite partition of unity method : axisymmetric and three-dimensional applications.

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ABSTRACT

A major drawback in acoustic simulations corresponds to the increase of computing resources with the increase of the excitation frequency [1]. The authors propose a numerical method to compute acoustic propagation with a lower cost than classical methods such as the finite element method. The proposed method, the mapped infinite partition of unity method, allows to compute convected inner or outer propagation in the frequency domain.

The formulation is based on the convected wave equation to take into account the influence of non-uniform irrotational mean flow. The infinite computational domain is decomposed in an inner and an outer region. The inner region is meshed with conventional finite elements and the approximation is built with a polynomial partition of unity method [2]. The outer region is discretized with a finite number of mapped infinite partition of unity elements which allow to mesh the whole infinite outer region. The infinite shape functions are chosen to match with the inner partition of unity formulation at the interface between the inner and the outer regions. In the outer region, the infinite approximation corresponds to a polynomial partition of unity approximation coupled to radial functions created with shifted Legendre polynomials. The radial behaviour (propagation and decay of the wave) is based on Astley-Leis conjugated formulation [3].

The performance of the method is illustrated with convergence analyses for an axisymmetric and a three-dimensional formulation. The results are based on acoustic propagation in cavities or radiation in an outer domain with applications such as convected duct propagation and dipole radiation.

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