Use OpenFoam coupled with the Finite Element Method suitable for Computational AeroAcoustics

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A hybrid method of aeroacoustic noise computation based on Lighthill's Acoustic Analogy is applied to investigate the noise radiated by a low Mach number flow through obstacles. The simulation method is a two-step hybrid approach relying on Lighthill's acoustic analogy, assuming the decoupling of noise generation and propagation. The first step consists in an incompressible Detached Eddy Simulation of the turbulent flow field, during which the hydrodynamic pressure is recorded only instead of the more classical and well-known Lighthill's tensor. In the second step, a variational formulation of Lighthill's Acoutic Analogy using the Finite Element Method is solved in the Fourier space. To save some CPU time and some space disk to store the data, the aero-acoustic source term is transferred from the fluid mesh to the acoustic mesh by a conservative algorithm to guaranty the quality of the aeroacoustic phenomena on the fly, i.e. at the end of each time step during the CFD computation. This approach appears to be very suitable for industrial applications and is applied to a three-dimensional ducted diaphragm with a low Mach number flow. Aerodynamic results and the mapping between both meshes are dealt by the OpenFoam software. The acoustic computations are treated by a VAOne prototype solver. Very good agreements are found in terms of flow dynamic and acoustic results compared with experimental measurements (PIV for the flow and downstream microphone for the acoustic) proving the relevance of the method.