NUMERICAL SIMULATION OF NOISE GENERATION AND PROPAGATION FROM A SUBSONIC CAVITY

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The motivation of the research is to simulate noise generation and propagation by a subsonic cavity. Cavity noise is a common noise source in many transport systems. It can be a major component of airframe noise sources. In many experimental studies it has been observed that cavity flow produces intense noise tones superposed to broadband sound. The objective of this work is to simulate accurately such a phenomenon and understand the basic physics behind.

The purpose of this Ph.D. project is to develop a tool to investigate numerically the noise generation induced by a subsonic shallow cavity and to propagate this noise accurately. The aim of the project is to simulate the source region with Large Eddy Simulation (LES) and implement the Linearized Euler Equations (LEEs) via Residual Distribution method. With an accurate simulation the identification of different sound sources are expected.

Despite the simple geometry the cavity problem gives a wide range of flow phenomena. The cavity noise is associated to the feedback loop between the acoustics and fluid flow. This interaction can be resolved only by compressible flow simulation where both the aerodynamic and acoustic quantities are present. The so called M219 case is chosen. This test case was measured by QuinteQ and simulated by several organizations for validation purposes (ONERA, FOI, Southampton University, Fluent).

The implementation of LEEs is realized in the COOLFluiD framework. A space-time Residual Distribution approach is used to resolve the unsteady Linearized Euler equations. Verification has been done through basic test cases with analytical solution. The method is applied for impulsive and periodic sources with and without mean flow on fully unstructured triangular elements (prismatic in time). After the validation of the LEE solver it has been connected to DNS solver in order to be able to apply it later for the cavity case. Qualitatively good agreement has been achieved with the test case of two co-rotative vortices (Figure 1).

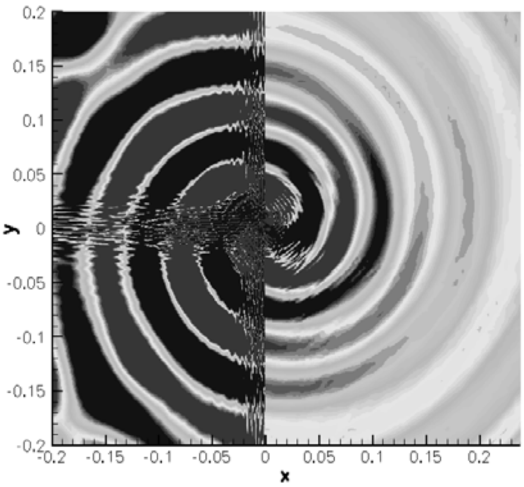

Figure 1: Dilatation field from two co-rotative vortice. x<0: DNS results, x>0: LEE results