Unified aerodynamic-acoustic formulation for aero-acoustic structure coupling

ABSTRACT

Conventional coupled BE/FE (Boundary-Element/Finite-Element) method and modeling of structural-acoustic interaction has shown its promise and potential in the design and analysis of various structural-acoustic interaction applications. Unified combined acoustic and aerodynamic loading on the structure is synthesized using two approaches. Firstly, by linear superposition of the acoustic pressure disturbance to the aeroelastic problem, the effect of acoustic pressure disturbance to the aeroelastic structure is considered to consist of structural motion independent incident acoustic pressure and structural motion dependent acoustic pressure, which is known as the scattering pressure, referred here as the acoustic aerodynamic analogy. Secondly, by synthesizing the acoustic and aerodynamic effects on elastic structure using an elegant, effective and unified approach, both acoustic and aerodynamic effect on solid structural boundaries can be formulated as a boundary value problem governed by second order differential equations which lead to solutions expressible as surface integral equations. The unified formulation of the acousto-aeroelastic problem is amenable for simultaneous solution, although certain prevailing situations allow the solution of the equations independently. For this purpose, the unsteady aerodynamic problem which was earlier utilizes well-established lifting surface method is reformulated using Boundary Element (BE) approach. These schemes are outlined and worked out with examples.