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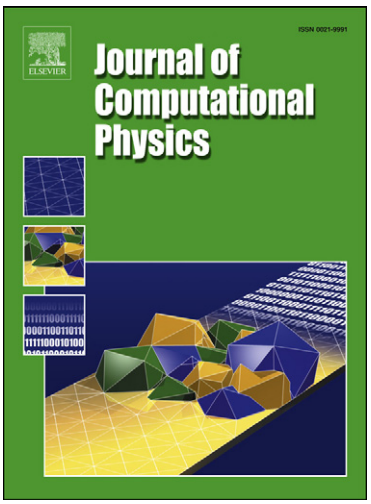

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Abstract

This paper presents an advanced method to synthetically generate flow turbulence via an inflow boundary condition particularly designed for three-dimensional aeroacoustic simulations. The proposed method is virtually free of spurious noise that might arise from the synthetic turbulence, which enables a direct calculation of propagated sound waves from the source mechanism. The present work stemmed from one of the latest outcomes of synthetic eddy method (SEM) derived from a well-defined vector potential function creating a divergence-free velocity field with correct convection speeds of eddies, which in theory suppresses pressure fluctuations. In this paper, a substantial extension of the SEM is introduced and systematically optimised to create a realistic turbulence field based on von Kármán velocity spectra. The optimized SEM is then combined with a well-established sponge-layer technique to quietly inject the turbulent eddies into the domain from the upstream boundary, which results in a sufficiently clean acoustic field. Major advantages in the present approach are: a) that genuinely three-dimensional turbulence is generated; b) that various ways of parametrisation can be created to control/characterise the randomly distributed eddies; and, c) that its numerical implementation is efficient as the size of domain section through which the turbulent eddies should be passing can be adjusted and minimised. The performance and reliability of the proposed SEM are demonstrated by a three-dimensional simulation of aerofoil-turbulence interaction noise.

Keywords: , Synthetic eddy method (SEM); Inflow turbulence; Computational aeroacoustics (CAA); Aerofoil-turbulence interaction (ATI)

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