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(Research Article)
Implementation and evaluation of Curle's acoustic analogy in order to far-field noise prediction for a square geometry

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Abstract

In this paper, we aim to implement, evaluate and validate Curle's acoustic analogy in predicting far-field noise emitted due to the turbulent flow around a two-dimensional square geometry. Flow is considered to be incompressible with two Reynolds numbers of 46000 and 69000. Open- source software OpenFOAM is utilized for flow simulation using both k-w and large eddy simulation turbulence models. To predict far-field sound pressure levels, the Curle acoustic analogy implemented within the software and pressure fluctuations data over the surface of a square geometry have been used as one of the inputs to the Curle analogy. The average aerodynamic coefficients, mean pressure coefficients, and Strouhal number were determined and it was found that the fluctuations of lift and drag forces, as well as the turbulence intencity are the main factors affecting the far field sound pressure level. The far-field sound pressure is well predicted by a combination of large eddy simulation and Curle's acoustic analogy, which at two different observer locations and two Reynolds numbers of 46000 and 69000, are 90.62 and 97.8 (dB), respectively. Finally, the agreement of numerically predicted far-field sound pressure level with the experimental results indicates the efficiency of Curle's acoustic analogy incorporated within the OpenFoam.

Keywords: Numerical investigation, Large eddy simulation, K-W turbulence models, Curle's acoustic analogy, OpenFOAM software.

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