High-fidelity analysis of airfoil trailing edge noise and its control using an unstructured grid CFD solver

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Abstract

To clarify the computational conditions required for quantitative reproduction by an unstructured mesh solver through comparison with the world's first TE-noise high temporal and spatial resolution wind tunnel experimental results obtained by the applicant's group, and to obtain champion data that can be directly compared with experimental results.

Reasons and benefits of using JAXA Supercomputer System

In this study, three-dimensional unsteady calculations are performed, and sufficient grid resolution in the boundary layer and near the trailing edge of the lower surface of the wing must be ensured. Due to the large memory requirements, a supercomputer is indispensable.

Achievements of the Year

First, to evaluate the feasibility of the computational solver (FaSTAR), we performed a calculation with Re = 5.0 × 10^4 in accordance with previous studies by others (Ricciardi e t al. J. Fluid Mech. 937 (2022), A23). As a result, it was found that the dominant frequency of the far-field pressure fluctuation, the time-averaged velocity near the wall, the RMS value, and other parameters that are important in this phenomena were all in good agreement with our calculation. Next, a calculation with Re = 3.5 × 10^5 was performed to be compared with the experimental data. As a result, we succeeded in qualitatively capturing the phenomena observed in the experiment, such as the generation of primary and secondary tones and the formation of a laminar separation bubble on the pressure side wall. On the other hand, the flow field on the suction side wall, which is the origin of the secondary tones, showed a stronger coherent structure than in the experiment. In the calculations of others (Ricciardi and Wolf Phys. Rev. Fluids 7 (2022), 084701), performed at a similar Reynolds number, the structure associatedd with the secondary tone disappeared. This discrepancy is presumably due to inflow turbulence, and we are able to clarify our direction for further calculations.

Publications

- Oral Presentations

Miyamoto, I., Ogura, K., Konishi, K., Kojima, Y. and Kameda, M., "High-fidelity analysis of airfoil trailing edge noise using an unstructured mesh CFD solver,"57th Fluid Dynamics Conference / 43th ANSS, to be presented.

Usage of JSS

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	4608 - 8640
Elapsed Time per Case	568 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.41

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	10,594,289.45	0.48
TOKI-ST	35,086.60	0.04
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	46,125.48	3.33
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	554.17	0.37
/data and /data2	38,038.33	0.18
/ssd	5,677.38	0.30

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	17.59	0.06

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	765.89	0.52

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.