Research on Airframe Noise Reduction Design in the FQUROH Project

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Abstract

This research is being carried out as part of the FQUROH project aimed at raising the technical maturity level of the noise reduction technology for high-lift devices and landing gear, which draws international attention to reduce noise in areas around airports, to a level applicable to future development of aircraft and related equipment. This contributes to reduction of aircraft noise in local communities around the airport and airline operating costs by reducing landing fee. One of the objectives of the FQUROH project is to verify the feasibility of practical noise reduction concepts and design methods based on advanced, large-scale computational simulations based on Large/Detached Eddy Simulations (LES/DES).

Ref. URL: http://www.aero.jaxa.jp/eng/research/ecat/fquroh/

Reasons for using JSS2

The JSS2 was used to understand detailed physics of noise generation, and to optimize noise reduction designs. The FQUROH project aims to accelerate technology maturity of airframe noise reduction methods using advanced large-scale, high-fidelity computational simulations on the JSS2's high performance computing platform and to demonstrate the high-fidelity design technologies through flight tests. Computational simulations using the JSS2 made it possible to design low-noise devices by understanding detailed physical phenomena, which was difficult only with wind tunnel tests.

Achievements of the Year

Leading-edge slats are recognized as major airframe noise sources. A high-order, high-resolution numerical scheme was introduced to resolve vortices that plays an important role for the noise generation, and was then tested with flow simulations around a wing with an extended slat (Fig. 1). The effect of a subgrid length scale in Delayed Detached Eddy Simulation (DDES) was also studied to improve the turbulence model. Aeroacoustic simulations with different slat positions were conducted to demonstrate a noise reduction concept for the slat. Under the condition of quasi-3D simulations, the possibility of reducing the slat noise without losing aerodynamic performance has been shown (Fig. 2). Based on the findings, noise reduction design of a real slat was also investigated by using quasi-3D flow simulations around representative parts of an actual aircraft wing.

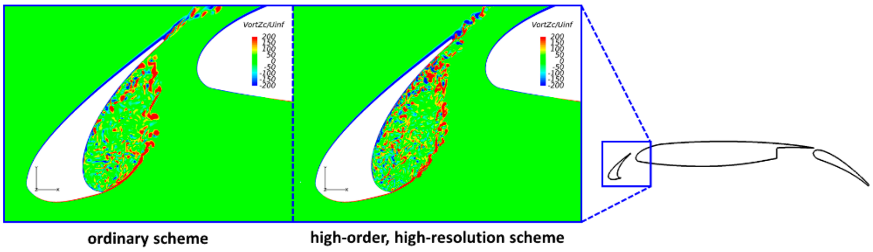

Fig. 1: A high-order, high-resolution numerical scheme applied to a flow simulation around a wing with an extended slat (z-vorticity distribution)

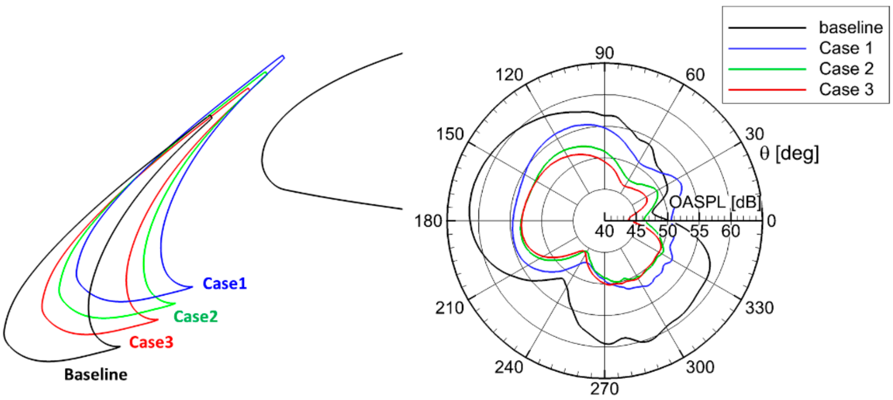

Fig. 2: Overall sound pressure level (OASPL) directivities with different slat positions

Publications

- Non peer-reviewed papers

1) Sakai, R., Ishida, T., Murayama, M., Ito, Y., and Yamamoto, K., “Slat Noise Simulation on Unstructured Grid with Reduced Dissipation Approach,” 25th AIAA/CEAS Aeroacoustics Conference, Delft, The Netherlands, May 2019, to be presented.

- Oral Presentations

1) Murayama, M., Yamamoto, K., Ikeda, T., Sakai, R., Amemiya, K., Hirai, T., and Tanaka, K., “BANC-V Category 7 Slat Cove Noise: 30P30N-Modified Slat Configuration—JAXA’s result using structured grid UPACS,” 5th AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-V), Dallas, TX, June 2018.

2) Sakai, R., Murayama, M., Ito, Y., and Yamamoto, K., “BANC-V Category 7 Slat Cove Noise: 30P30N-Modified Slat Configuration—JAXA’s Result,” 5th AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-V), Dallas, TX, June 2018.

3) Sakai, R., Murayama, M., Ito, Y., and Yamamoto, K., “BANC-V Category 6: DLR Slat Noise Configuration—JAXA’s Result,” 5th AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-V), Dallas, TX, June 2018.

Usage of JSS2

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	660
Elapsed Time per Case	644 Hour (s)

- **Resources Used**

Fraction of Usage in Total Resources[*1] (%): 3.59

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2] (%)
SORA-MA	33,168,064.93	4.06
SORA-PP	41,147.13	0.33
SORA-LM	1,068.72	0.50
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	82.16	0.09
/data	8,446.07	0.15
/ltmp	2,520.07	0.22

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	268.29	9.39

[*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.