Research on Airframe Noise Reduction Design (FQUROH+)

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Abstract

This research is being carried out as part of the FQUROH (Flight Demonstration of Quiet Technology to Reduce Noise from High-Lift Configurations) 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 and benefits of using JAXA Supercomputer System

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 to obtain only with wind tunnel tests.

Achievements of the Year

A reduced dissipation approach for improving the numerical resolution was used in aeroacoustic simulations for a slat, which is known as one of major airframe noise sources, in order to capture vortices around it relating to the noise generation and gain a further understanding of its noise generation mechanism (Fig. 1). Noise reduction

concepts for the slat were proposed and evaluated based on the findings on aerodynamics and aeroacoustics obtained from benchmarking problems using a high-lift airfoil for slat noise simulations. These concepts were assessed and the noise reduction design for the actual aircraft was also investigated through aeroacoustic simulations around the representative part of the main wing with the deployed slat as well as the slat track rail.

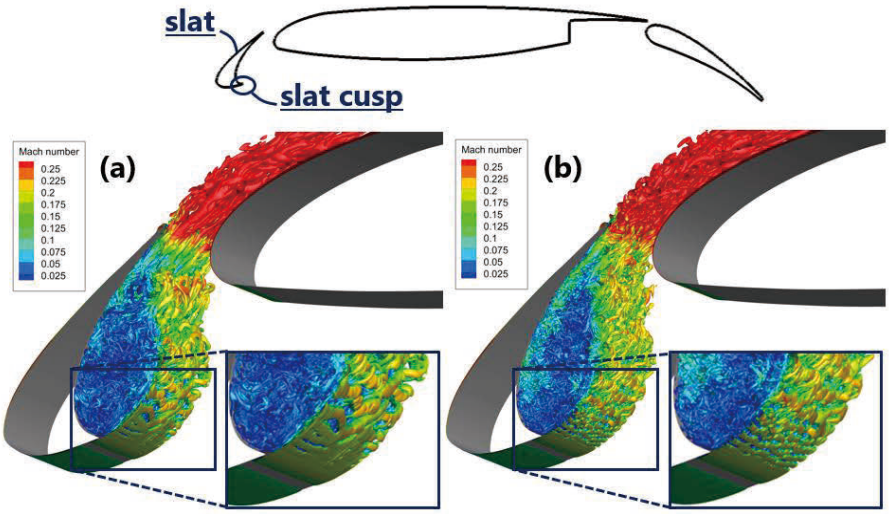

Fig. 1: Improvement of the numerical resolution of vortices in a shear layer, shed from a slat cusp: (a) without and (b) with the reduced dissipation approach.

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," AIAA Paper 2019-2405, 25th AIAA/CEAS Aeroacoustics Conference, Delft, the Netherlands, May 2019, DOI: 10.2514/6.2019-2405.

2) Ueno, Y., Isotani, K., Hayama, K., Takaishi, T., Ito, Y., Yokokawa, Y., Murayama, M., and Yamamoto, K., "Validation of Noise Reduction Design for Landing Gear in the FQUROH Flight Demonstration Project," AIAA Paper 2019-2506, 25th AIAA/CEAS Aeroacoustics Conference, Delft, the Netherlands, May 2019, DOI: 10.2514/6.2019-2506.

3) Murayama, M., Yokokawa, Y., Ito, Y., Takaishi, T., Yamamoto, K., Sakai, R., Hirai, T., and Tanaka, K., "Computational Analysis of Noise Reduction Results for Flap Side-Edges in the FQUROH Flight Demonstration Project," AIAA Paper 2019-2577, 25th AIAA/CEAS Aeroacoustics Conference, Delft, the Netherlands, May 2019, DOI: 10.2514/6.2019-2577.

- Invited Presentations

1) Yamamoto, K., "A Flight Demonstration Project for Airframe Noise Reduction Technologies, FQUROH," Asia Pacific International Symposium on Aerospace Technology (APISAT) 2019, Gold Coast, Australia, December 2019.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	3456
Elapsed Time per Case	297.6 Hour(s)

Resources Used

Fraction of Usage in Total Resources[*1](%): 2.59

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	22,822,086.70	2.77
SORA-PP	113,067.53	0.73
SORA-LM	4,432.49	1.85
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	66.10	0.06
/data	27,601.85	0.47
/ltmp	2,021.15	0.17

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	280.18	7.05

[*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.