Research on Airframe Noise Reduction Design (FQUROH-2)

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Responsible Representative

Takeshi Ito, Program Director of Aviation Technology, Aviation Technology Directorate

Contact Information

Takehisa Takaishi, FQUROH-2 Project Team (Airframe Noise Reduction Technology Project Team), Aviation Technology Directorate(takaishi.takehisa@jaxa.jp)

Members

Takehisa Takaishi, Mitsuhiro Murayama, Yasushi Ito, Takashi Ishida, Yoimi Kojima, Kazuomi Yamamoto, Kentaro Tanaka, Tohru Hirai, Gen Nakano

Abstract

Major airports are considering increasing the number of takeoffs and landings to meet the projected demand for air travel, enhance the international competitiveness of Japan's airports, and improve passenger convenience. It is essential to advance technologies that minimize airframe noise generated by high-lift devices and landing gear to reduce noise in the areas surrounding airports, even with the expected rise in takeoffs and landings. Our comprehensive approach includes developing a flight test plan using a commercial aircraft to demonstrate airframe noise reduction. Additionally, we have prepared an 8%-scale semi-span wind tunnel model of the NASA High-Lift Common Research Model (CRM-HL) for further demonstrations using a generic aircraft mode. These are part of our efforts to develop noise reduction technology practically. We used computational simulations to verify the feasibility of practical noise reduction concepts and design methods. This computational analysis, based on Large/Detached Eddy Simulations (LES/DES), is used to understand the mechanism of noise sources, predict noise levels, and design noise reduction devices.

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

Reasons and benefits of using JAXA Supercomputer System

The JSS3 has been used to understand the detailed noise generation physics and optimize noise reduction designs. The FQUROH project aims to accelerate the technology maturity of airframe noise reduction methods using advanced, large-scale, high-fidelity computational simulations on the JSS3's high-performance computing platform and to demonstrate the high-fidelity design technologies through flight tests. Computational simulations using the JSS3 have made it possible to design low-noise devices by understanding detailed physical phenomena that were difficult to obtain through wind tunnel testing alone. In addition, the JSS3's large hard disk and tape devices can store large amounts of data generated by unsteady numerical analysis for both short and long periods

of time.

- **Achievements of the Year**

Unsteady CFD simulations were performed to evaluate the noise generated by the slats on the leading edge of the wing, which is one of the main noise sources during the landing approach of passenger aircraft. In addition to the aeroacoustic analysis using a lattice Boltzmann method on Cartesian meshes, a Navier-Stokes method on hierarchical Cartesian meshes was also evaluated, and its basic verification was conducted. Figure 1 compares the computational results obtained on a manually-generated mesh (left figure) and adaptively-refined mesh (right figure) around the 30P30N three-element airfoil, which is widely used in high-lift noise prediction benchmark problems. The results indicate that the adaptive mesh refinement reduces pressure fluctuations caused in the slat wake by minimizing changes in grid spacing.

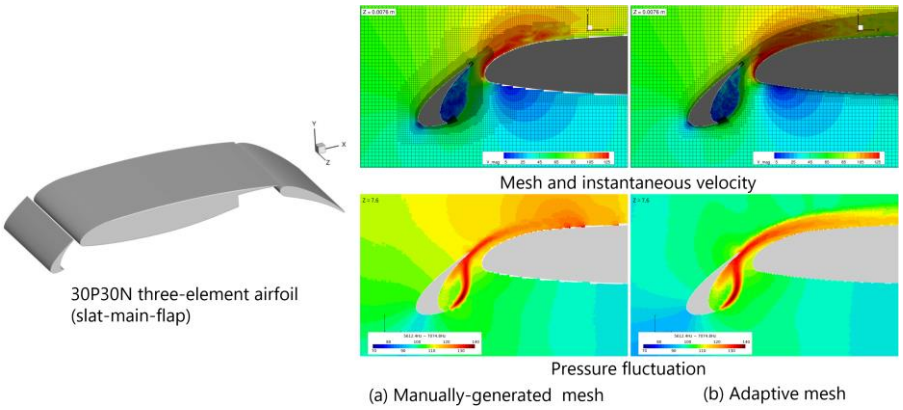

Fig. 1: 30P30N three-element airfoil geometry and computational mesh, instantaneous velocity, and pressure fluctuation around it

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1536
Elapsed Time per Case	180 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.29

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	7,045,984.24	0.32
TOKI-ST	227,879.84	0.23
TOKI-GP	6,397.00	0.10
TOKI-XM	240.01	0.12
TOKI-LM	4,221.33	0.30
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	100.87	0.07
/data and /data2	31,996.77	0.15
/ssd	1,147.43	0.06

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	813.35	2.66

[*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)	134.96	0.09

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