Research and Development on Airframe Noise Reduction Technology (FQUROH-2) #1

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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 activity evaluates a new advanced large-scale computational simulation method being developed.

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.

Achievements of the Year

A new method has been implemented for the unstructured solver FaSTAR to improve the CFD technology for evaluating the effectiveness of airframe noise reduction. The immersed boundary method (IBM) has been newly implemented to reduce the time required for unsteady flow simulations dramatically. This method models the boundary layer to eliminate the need for a high-density mesh on the boundary surfaces and ease the mesh generation process. In addition, a method for predicting far-field noise from unsteady flow simulation results with the IBM was implemented.

Reynolds-averaged Navier-Stokes (RANS) simulations were performed for 2D and 3D airfoils and full-aircraft configurations to evaluate the performance and effectiveness of the IBM for further development. Unsteady flow simulations using Delayed Detached Eddy Simulation (DDES) were conducted for a multi-element airfoil to verify the newly implemented features. Surface pressure fluctuations from the simulation results were used to predict far-field noise using the Ffowcs Williams-Hawkings (FW-H) method. The results were compared with those obtained with body-fitted meshes, and areas for further improvement were identified.

Publications

N/A

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1 - 2400
Elapsed Time per Case	39.5 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	152,533.67	0.01
TOKI-ST	10,706.05	0.01
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	11.72	0.00
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	50.50	0.03
/data and /data2	11,512.13	0.06
/ssd	573.72	0.03

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	406.68	1.33

*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)	11.59	0.01

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