Post-K Priority Issue 8D: Research and development of core technology to innovate aircraft design and operation

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Abstract

We develop a high-speed/high-precision computational program using a quasi-first principle method, which can faithfully reproduce the actual flight environment to understand the true nature of fluid phenomena. Specifically, we develop a high-precision compressible flow solver with geometric wall models and LES (Large Eddy Simulation) wall models based on hierarchical, orthogonal and equally spaced structured grids.

Ref. URL: http://www.postk-pi8.iis.u-tokyo.ac.jp/sub_d.html

Reasons for using JSS2

We need large computer like JSS2 because our calculations must be large scale computations. Moreover, JSS2 has a similar architecture to the our target computer called Post-K.

Achievements of the Year

We proceeded with the development of a compressible fluid analysis program FFVHC - ACE using a hierarchical, orthogonal and equally spaced structured grid method. In this fiscal year, a trial calculation for the aircraft of the actual detailed shape (JSM_CRM_LEG model) was performed using the immersed boundary method. Figure 1 is the computational grid for the JSM_CRM_LEG model. Figure 2 shows the object surface of the landing gear expressed in the flow solver. The reproducibility of the object surface is improved as the grid resolution improves. Figure 3 shows the vorticity around the JSM_CRM_LEG model, where Mach number is 0.2, the Reynolds number is 10^6, and attack angle is 7 degrees. The total number of grid points is about 800 million, of which the number of fluid points is about 600 million.

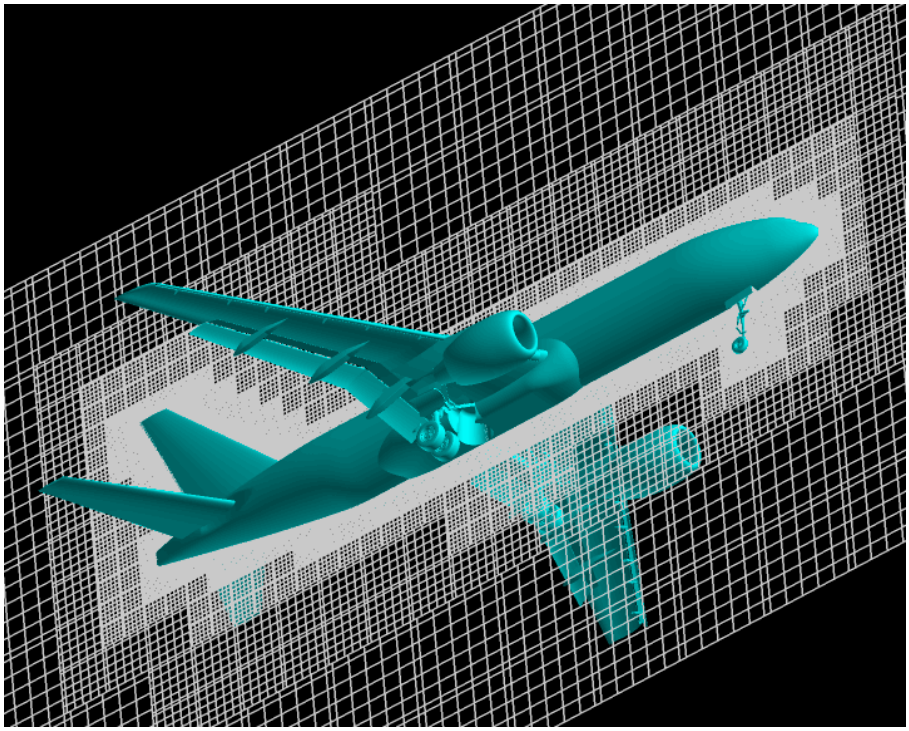

Fig. 1: The hierarchical, orthogonal and equally spaced structured grid around the JSM_CRM_LEG model.

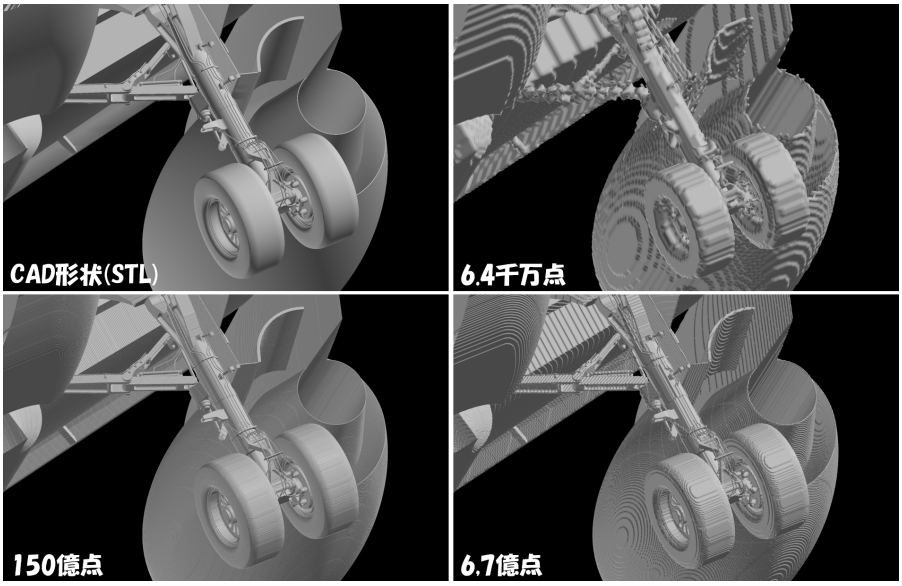

Fig. 2: Shape reproducibility of complicated geometry.

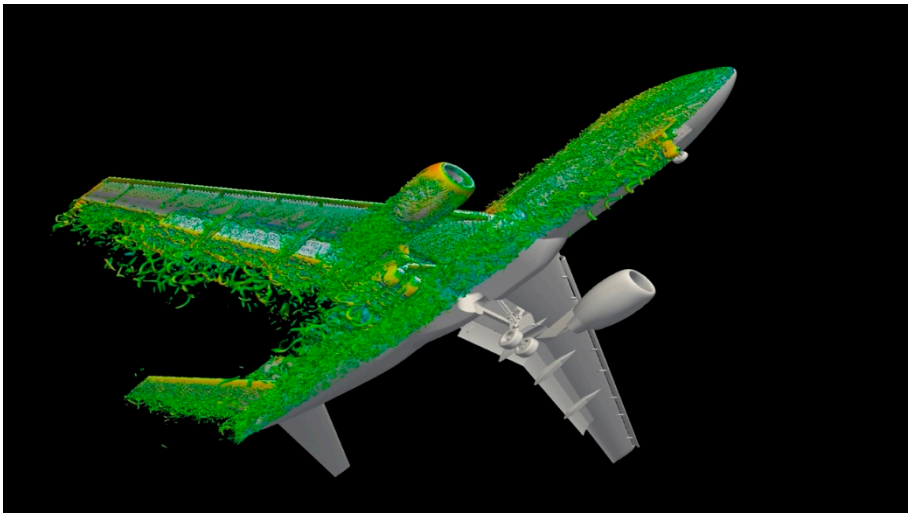

Fig. 3: Flow around the JSM_CRM_LEG model.
(Video. Video is available on the web.)

Publications

- Oral Presentations

R. Takaki, Toward the achievement of the aerodynamic characteristic evaluation for real configurations and real flight environments of aircraft, 4rd Symposium on Post-K computer Priority Issue 8.

- Other

Ryoji Takaki, How to make an aerospace vehicle with supercomputer !? - Roles of supercomputer in manufacturing -, 13th symposium to know K-computer in Mito - From K-computer to Post-K computer.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	256 - 600
Elapsed Time per Case	120 Hour (s)

Resources Used

Fraction of Usage in Total Resources[*1] (%): 3.88

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	36,154,361.50	4.43
SORA-PP	6,470.46	0.05
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	2,181.51	2.26
/data	33,258.50	0.59
/ltmp	12,472.17	1.07

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	36.60	1.28

*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.