MEXT Program for Promoting Researches on the Supercomputer Fugaku, Leading research on innovative aircraft design technologies to replace flight test

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Responsible Representative

Ryoji Takaki, Institute of Space and Astronautical Science

Contact Information

Ryoji Takaki(ryo@isas.jaxa.jp)

Members

Ryoji Takaki, Soshi Kawai, Yuichi Kuya, Hiroyuki Asada, Yoshiharu Tamaki, Hiroshi Koizumi, Masayuki Kakehi

Abstract

Realization of high-precision aerodynamic prediction by high-fedelity LES analysis around whole aircraft configulation for actual flight conditions.

Ref. URL: https://www.r-ccs.riken.jp/jp/fugaku/promoting-researches

Reasons and benefits of using JAXA Supercomputer System

It is possible to develop programs efficiently because JSS has the same architecture as the final target "Supercomputer Fugaku".

Achievements of the Year

The object shape is expressed as an algorithm in the analysis solver, in the method that combines the hierarchical cartesian grid method and the immersed boundary method (IB method). Therefore, some ingenuity or method is required for the surface integration required to calculate the force acting on the object, and physical quantity distribution on the object surface . Verification of the two-dimensional geometry was carried out, and it was found that sufficient accuracy was obtained by using the method proposed here. An example of verification with a two-dimensional thin wing is shown. The target was the thin airfoil NACA4402, which the IB method is not good at. The surface distribution of the pressure coefficient and friction coefficient near the front edge is shown in Figures 1 and 2. It can be seen that Level 10 and above results are in good agreement with the calculation results using a body-fitted grid(UPACS).

In addition, as part of the 1st Workshop on Cartesian Grid-based CFD, some verifications were conducted for simple geometories and good results were obtained in each task.

The method used here can also handle very thin objects. Figure 3 shows density and vorticity distributions of a

flow around a semicircle with a thickness of 0 that simulates a parachute.

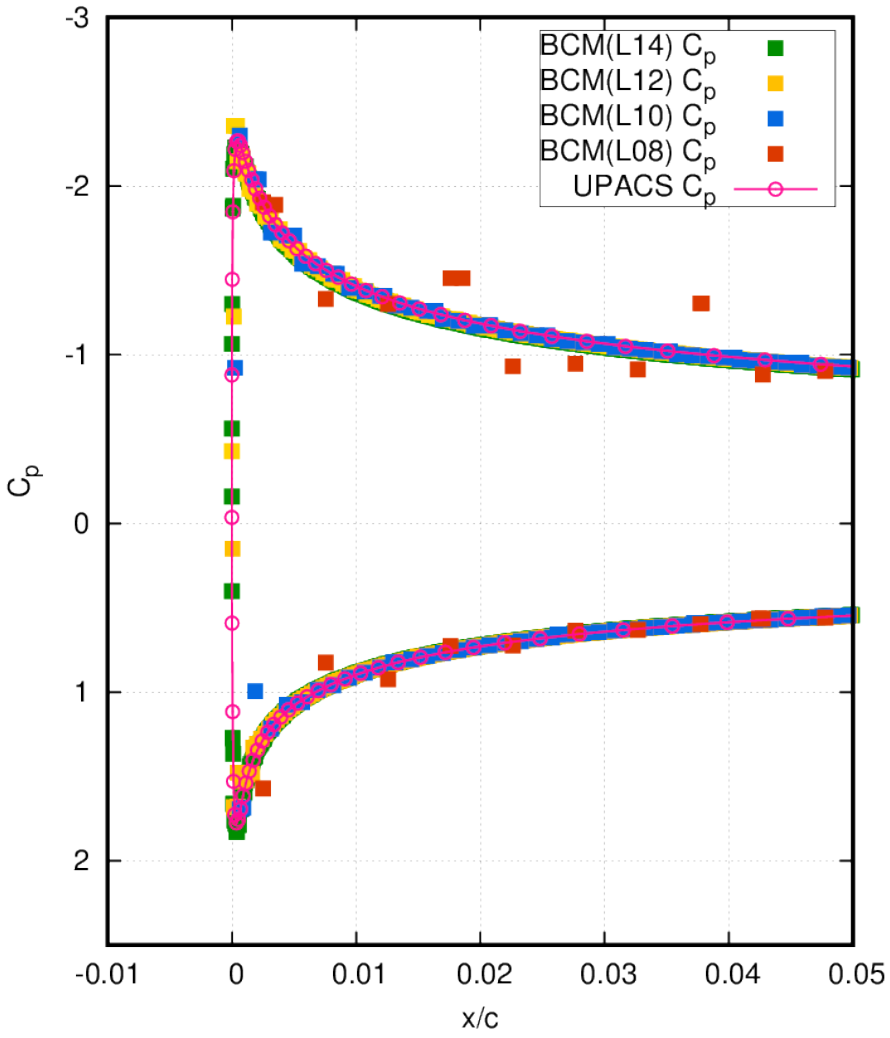

Fig. 1: The surface distribution of the pressure coefficient.

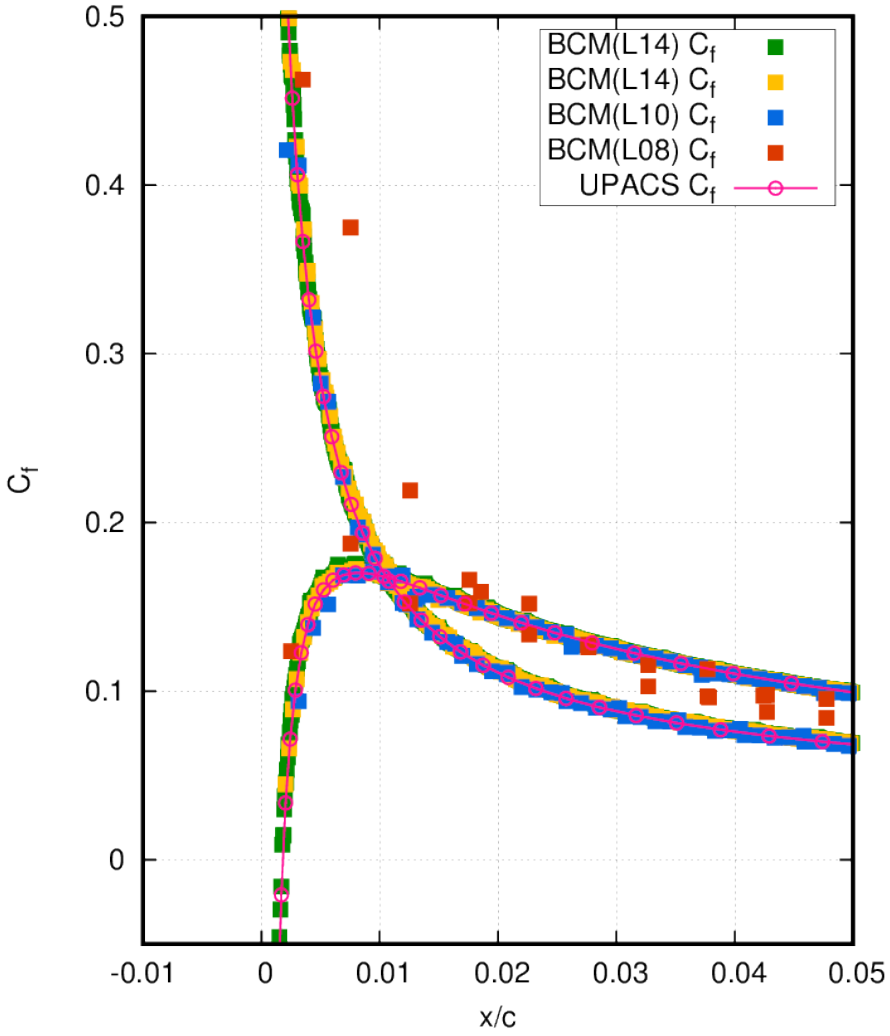

Fig. 2: The surface distribution of the friction coefficient.

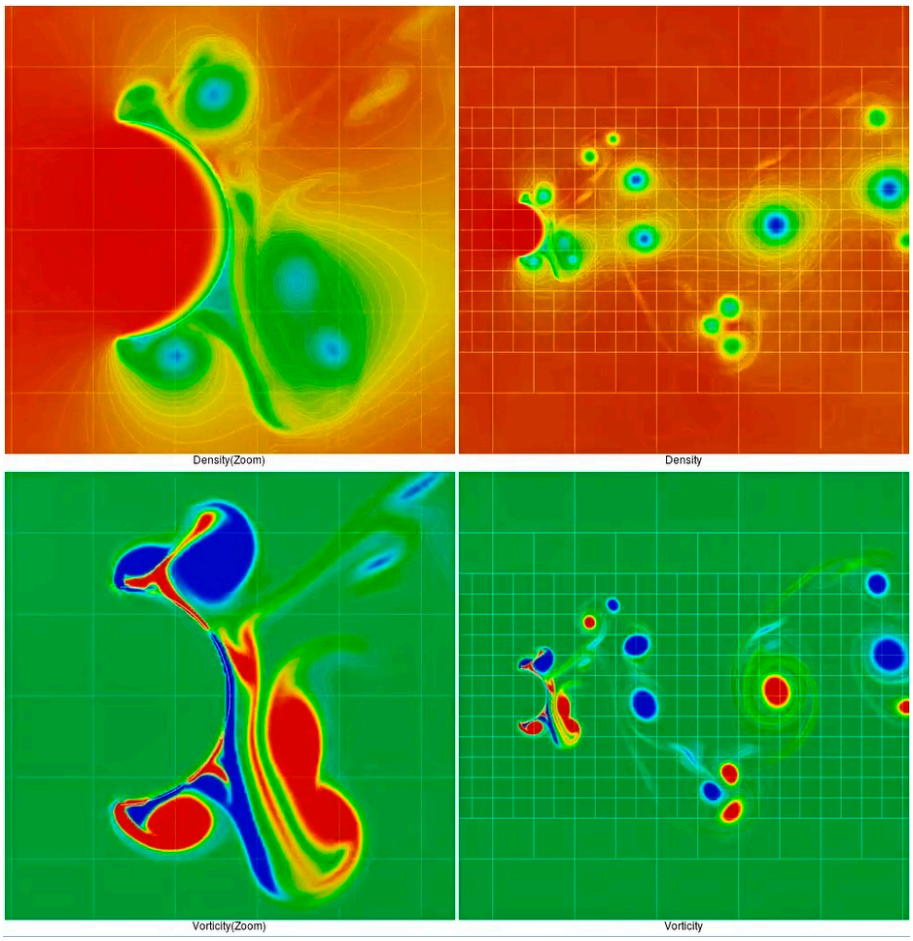

Fig. 3: Density and vorticity distributions of a flow around a semicircle with a thickness of 0. (Video. Video is available on the web.)

Publications

- Non peer-reviewed papers

1) Ryoji Takaki, Soshi Kawai, Yuichi Kuya, Yoshiharu Tamaki, "Verification of analysis accuracy on a two-dimensional thin airfoil surface in the immersed boundary method", pp173-180, Proceedings of Fluid Dynamics Conference/Aerospace Numerical Simulation Symposium 2020 Online, JAXA-SP-20-008, 2021.

2) Ryoji Takaki, Soshi Kawai, Yuichi Kuya, Yoshiharu Tamaki, "Accuracy verification of hierarchical cartesian grid method-Workshop on Cartesian Grid-based CFD -", pp77-88, Proceedings of Fluid Dynamics Conference/Aerospace Numerical Simulation Symposium 2020 Online, JAXA-SP-20-006, 2021.

- Oral Presentations

1) Ryoji Takaki, Soshi Kawai, Yuichi Kuya, Yoshiharu Tamaki, "Verification of analysis accuracy on a two-dimensional thin airfoil surface in the immersed boundary method", Fluid Dynamics Conference/Aerospace Numerical Simulation Symposium2020Online, 3C03.

2) Ryoji Takaki, Soshi Kawai, Yuichi Kuya, Yoshiharu Tamaki, "Accuracy verification of hierarchical cartesian grid method-Workshop on Cartesian Grid-based CFD -", Fluid Dynamics Conference/Aerospace Numerical Simulation Symposium2020Online, 3C05.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	1 - 24
Elapsed Time per Case	20 Hour(s)

Resources Used(JSS2)

Fraction of Usage in Total Resources[*1](%): 0.39

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	2,310,466.20	0.44
SORA-PP	1,698.16	0.01
SORA-LM	59.35	0.03
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	326.08	0.30
/data	10,477.82	0.20
/ltmp	2,964.52	0.25

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	2.48	0.08

[*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.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources[*1](%): 0.99

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	5,352,476.57	1.15
TOKI-RURI	10,279.18	0.06
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	376.03	0.26
/data	14,645.53	0.25
/ssd	202.13	0.11

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	2.48	0.08

[*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.