Research of unsteady flow simulation toward prediction of full flight envelope

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Abstract

The research related to unsteady flow simulation of the aircraft buffet phenomenon is conducted aimed for the prediction of full-flight envelope.

Ref. URL: http://www.aero.jaxa.jp/eng/research/basic/numerical/

Reasons and benefits of using JAXA Supercomputer System

A huge amount of computational resources is needed to simulate the aircraft buffet phenomenon which is high-Reynolds number and complex flow including flow separation.

Achievements of the Year

We have simulated low-speed and high-speed buffet toward CFD prediction of full flight envelope. We employed a lattice Boltzmann method(LBM) for the low-speed buffet. Combinig the LBM with a building cube method(BCM) enable large-scale computation. Figure 1 is a result of low-speed buffet simulation on NASA-CRM, where 400M cells are employed in the simulation. The small vortices at the separated shear layer are well resolved. Figure 2 is a result of gloabal stability analysis of high-speed buffet. The unstable modes related with the shock oscillation is obtained. The frequency of the unstable mode increases with the swept angle, which agrees with previous reports qualitatively.

Fig. 1: LBM analysis of low-speed buffet on NASA-CRM

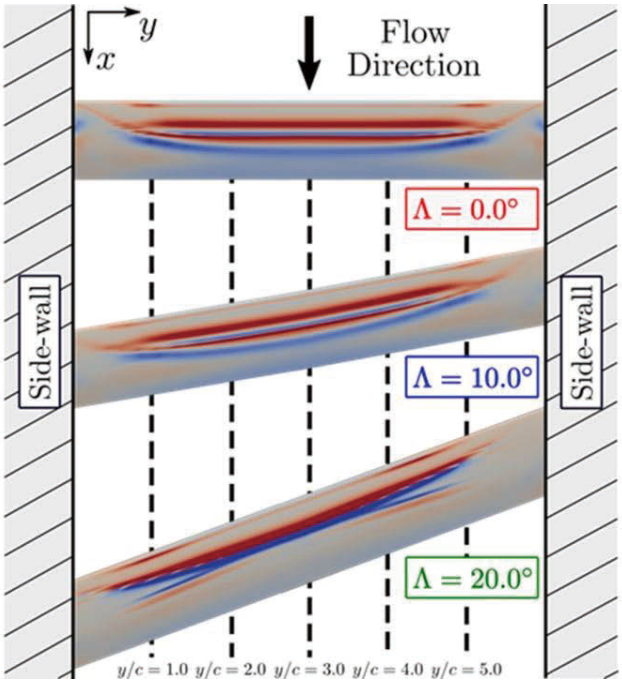

Fig. 2: Global stability analysis of high-speed buffet on swept wing

Publications

- Peer-reviewed papers

1) Andrea Sansica, Hashimoto Atsushi, Ohmichi Yuya, Global Stability Analysis of the JAXA H-ll Transfer Vehicle Re-Entry Capsule, IUTAM Transition 2019, submitted

- Non peer-reviewed papers

1) Andrea Sansica, Hashimoto Atsushi, Jean-Christophe Robinet, Supersonic Sphere Flow Unstable Bifurcations, 32nd International Symposium on Shock Waves

- Oral Presentations

1) Takashi Ishida, Daichi Asaoka, Masaharu Kameda, Unsteady flow simulation around an airfoil with low-speed and high angle-of-attack conditions by Lattice Boltzmann Method, 33th CFD Symposium

2) Takashi Ishida, Takahiro Yamamoto, Kenji Hayashi, Keita Nakamoto, Yuya Ohmichi, Masashi Kanamori, Takashi Aoyama, Introduction of JAXA's Research Activities on Elucidation and Prediction of Buffet Phenomena on Aircraft, The 51th Fluid Dynamics Conference/The 37th Aerospace Numerical Simulation

3) Andrea Sansica, Hashimoto Atsushi, Side-Wall Effects on the Global Stability of Swept and UnsweptWings at Buffet Conditions, The 51th Fluid Dynamics Conference/The 37th Aerospace Numerical Simulation Symposium

4) Ishida Takashi, Flow Simulation around 30P30N with BOXFUN Grid, APC-V

5) Hisato Takeda, Takahiro Yamamoto, Kenji Hayashi, Takashi Ishida, Ryotaro Sakai, Atsushi Hashimoto, Takashi Aoyama, Computation of 30P30N in Various Turbulence Models by FaSTAR Code, APC-V

- Poster Presentations

Takashi Ishida, Kazuyuki Nakakita, Masashi Kanamori, Yuya Ohmichi, Andrea Sancica, Kanako Yasue, Masataka Kohzai, Shunsuke Koike, Yosuke Sugioka, Research on prediction of buffet phenomena in ISSAC project, JAXA Aeronautical Symposium 2019

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	128 - 2048
Elapsed Time per Case	240 Hour(s)

- **Resources Used**

Fraction of Usage in Total Resources[*1](%): 6.14

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	54,477,608.38	6.62
SORA-PP	218,092.71	1.41
SORA-LM	12,151.02	5.07
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	633.93	0.53
/data	63,941.54	1.09
/ltmp	13,710.69	1.16

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	102.86	2.59

[*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.