Study on Aerodynamic Characteristics and Flow Fields for Mars Exploration Airplane

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Abstract

Recently, many kinds of research on unmanned aerial vehicles such as the Martian atmosphere and a high altitude one in the Earth's stratosphere have been conducted actively. These environments become that the atmospheric density and temperature are much lower. Then, the flight condition of the airplane is low Reynolds and high Mach numbers condition, and the aerodynamic data is insufficient for designing these vehicles. The applicants have been found that the separation flow of the condition is stabilized and the aerodynamic characteristics deteriorate. In particular, this tendency is more pronounced in thin airfoils. The purpose of this project is to clary the relationship at the low Reynolds and high numbers condition between aerodynamic and flow field for aerodynamic devices related to boundary layer control.

Reasons and benefits of using JAXA Supercomputer System

To conduct three-dimensional CFD, huge computational memories and costs are required. It is almost impossible to have a computation by the workstation at our laboratory. So it is necessary to conduct our research with a super-computer.

Achievements of the Year

In this year, numerical simulation of Mach numbers 0.20 (low subsonic speed and incompressible flow) and 0.74 (transonic speed and compressible flow) for the wing_grid (Fig.1), a wingtip device with multiple wing tip bifurcations and gap that mimic the shape of birds, were conducted as in the previous year. Then, the differences between these flow fields are discussed. Figure 2 shows the surface pressure around the wing_grid at the angle of attack 6 deg. with Mach numbers 0.20 and

0.74. In addition, the different colored streamlines of each wingtip are illustrated. The result suggests that the wingtip vortices generated from the wing_grid are observed from both Mach numbers 0.20 and 0.74. In particular. These results seem that the first wingtip vortex of the wing_grid is enhanced.

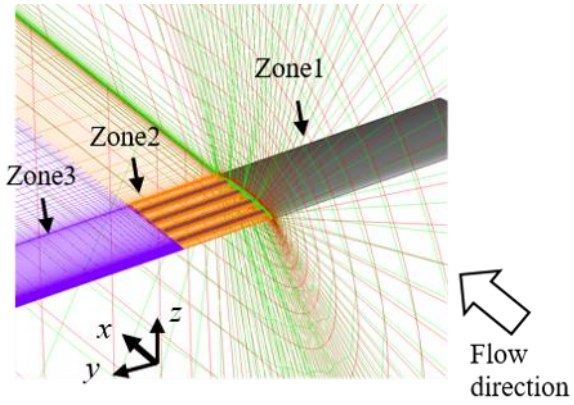

Fig. 1: Computational grid of the wing_grid

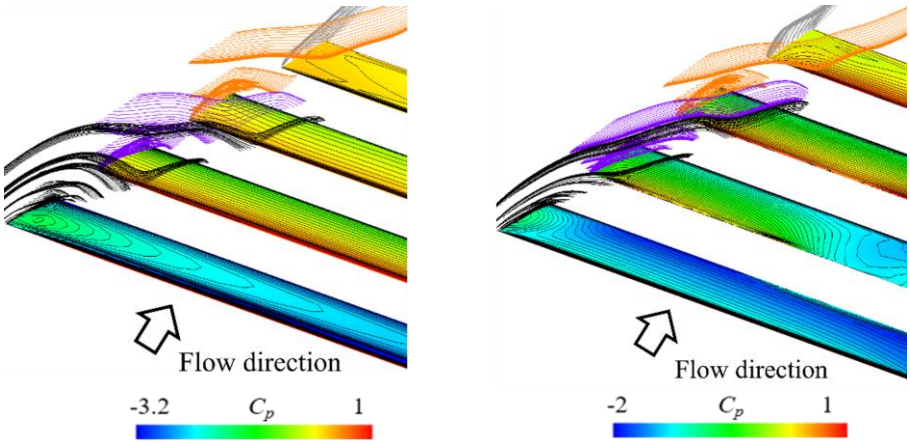

Fig. 2: Surface pressure coefficient with different colored streamlines near the trailing edge (angle of attack 6 deg)

Publications

- Peer-reviewed papers

Seiichiro Morizawa and Shigeru Obayashi, Evaluation of a Planar Wing with Wing Grid using CRM.65.airfoil, Bulletin of National Institute of Technology, Okinawa College, pp.1-14. (under review)

Usage of JSS

Computational Information

Process Parallelization Methods	N/A
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	1
Elapsed Time per Case	300 Minute(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.00

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	19,816.39	0.00
TOKI-ST	0.00	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	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	170.00	0.17
/data and /data2	3,446.67	0.04
/ssd	66.67	0.02

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	0.00	0.00

*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)	0.00	0.00

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