Study on Aerodynamic Characteristics and Flow Fields for Mars Exploration Airplane

Report Number: R19EACA18 Subject Category: JSS2 Inter-University Research URL: https://www.jss.jaxa.jp/en/ar/e2019/11544/

Responsible Representative

Seiichiro Morizawa, Lecturer, National Institute of Technology, Okinawa College

Contact Information

Seiichiro Morizawa(morizawa@okinawa-ct.ac.jp)

Members

Seiichiro Morizawa

Abstract

The discussion on the aerodynamic characteristics for a Mars exploration airplane was conducted. The atmospheric condition of Mars environment is quite different from that of Earth one. The flight condition of the airplane is low Reynolds number flow, and the aerodynamic data is insufficient for designing Mars airplan. So, study with CFD of the airplan was conducted for future Mars exploration. In this study, the effect of a clipped delta wing with and without dogtooth were investigated at a low Reynolds number flow (Re = 23,000).

Reasons and benefits of using JAXA Supercomputer System

In order to conduct three-dimensional CFD, a huge computatinal memories and costs are required. It is almost impossible to have a computation by the workstation at our laboratory. So it is nessessary to conduct our reseach with a super-computer.

Achievements of the Year

The lift-curve with dogtooth becomes slightly larger than that without dogtooth, but the maximum lift coefficient with dogtooth is small because the sudden drop in the lift-curve occurs at higher angle of attack and the stall of wing-tip is more pronounced. It is found that the leading-edge separations occurs in two positon, where are wing-root and dogtooth. However, it is difficult to discern them when the angle of attack is higher due to the acceleration of flow from dogtooth. By contrast, the drag-cure with dogtooth has almost the same as that without dogtooth, though there is a difference of the curve between these wings at higher angle of attack. The difference in magnitude relation of these wings is the oppised, and we have been currently analyzied the reason the difference.



Fig. 1: Wing geometries of clipped delta wing with and without dogtooth



Fig. 2: Difference in lift coefficient with and without dogtooth of clipped delta wings



Fig. 3: Difference in drag coefficient with and without dogtooth of clipped delta wings



Fig. 4: Difference of flow field with and without dogtooth of clipped delta wings

Publications

- Oral Presentations

 S. Morizawa, K. Tokura, and H. Kawazoe, "Aerodynamics Characteristics of Dogtooth on Clipped Delta Wing for Mars Airplane," 32nd International Symposium on Space Technology and Science, e-47, Fukui, Japan, 2019.

 N. Okamaoto, T. Unoguchi, H. Kawazoe, T. Matsuno, and S. Morizawa, "Aerodynamics Characteristics of a Mars Exploration Aircraft with the Delta Wing Deployed in Its flight," 32nd International Symposium on Space Technology and Science, e-44, Fukui, Japan, 2019.

- Poster Presentations

1) N. Okamoto, M. Kosaka, T. Unoguchi, S. Morizawa, H. Kawazoe and S. Obayashi, "Numerical Estimation of the Flight Range of a Gliding Mars Exploration Aircraft Based on Experimental Results," Sixteenth International on Flow Dynamics, CRF-68, Sendai, Japan, November 6-8, 2019.

Usage of JSS2

• Computational Information

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

• Resources Used

Fraction of Usage in Total Resources^{*1}(%): 0.02

Details

| Computational Resources | | | | |
|-------------------------|---------------------------------------|------------------------|--|--|
| System Name | Amount of Core Time (core x hours) | Fraction of Usage*2(%) | | |
| SORA-MA | 152,456.20 | 0.02 | | |
| SORA-PP | 146.52 | 0.00 | | |
| 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 | 243.19 | 0.20 | | |
| /data | 4,930.50 | 0.08 | | |
| /ltmp | 1,953.13 | 0.17 | | |

| 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.