Study on dynamic instability of a reentry capsule at transonic speed

Report Number: R18ETET12
Subject Category: Skills Acquisition System
URL: https://www.jss.jaxa.jp/en/ar/e2018/9169/

Responsible Representative

Takashi Takahashi (Aeronautical Technology Directorate)

Contact Information

Aeronautical Technology Directorate, Numerical Simulation Research Unit (ohmichi.yuya@jaxa.jp)

Members

Kenji Kobayashi

Abstract

Typical blunt bodies often show dynamic instability in subsonic and transonic regimes because of unsteady aerodynamic forces driven by complicate wake structures. In this study, we numerically simulated the flowfield around the capsule under the forced pitch oscillation motion, to investigate the flow structure around the oscillating capsule. Then, we applied the proper orthogonal decomposition (POD) to the obtained unsteady flowfield data.

Reasons for using JSS2

Large computational cost is required to simulate the unsteady wake of an reentry capsule.

Achievements of the Year

The unsteady flow around the reentry capsule was obtained by a detached eddy simulation. Figure 1 shows a comparison of the pitching moment history between experiment and the present numerical results. The amplitude of the moment coefficient shows good agreement with the experimental results. Then, by means of a proper orthogonal decomposition (POD), we extracted the coherent structures (Figure 3) as the POD mode from the obtained flowfield data (Figure 2).

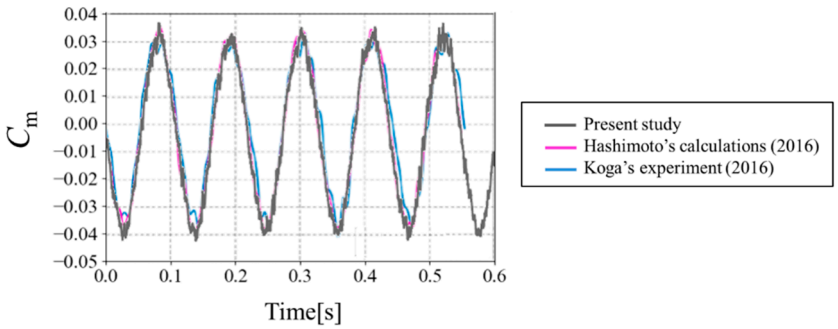

Fig. 1: Pitching moment history. (Hashimoto, A., Murakami, K., Aoyama, T., Tagai, R., Koga, S., Nagai, S., "Dynamic Stability Analysis of a Reentry Lifting Capsule with Detached Eddy Simulation," AIAA paper 2016-0552, 2016.)

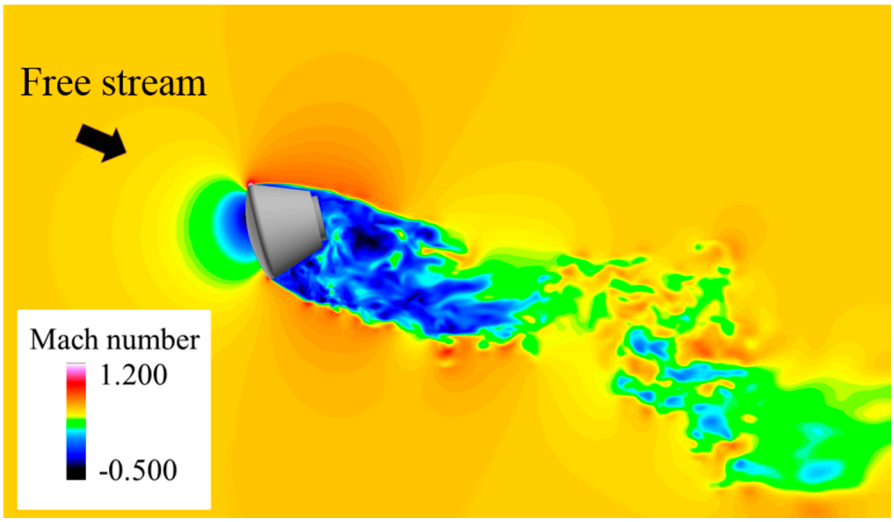

Fig. 2: Mach number distribution around the oscillating capsule.

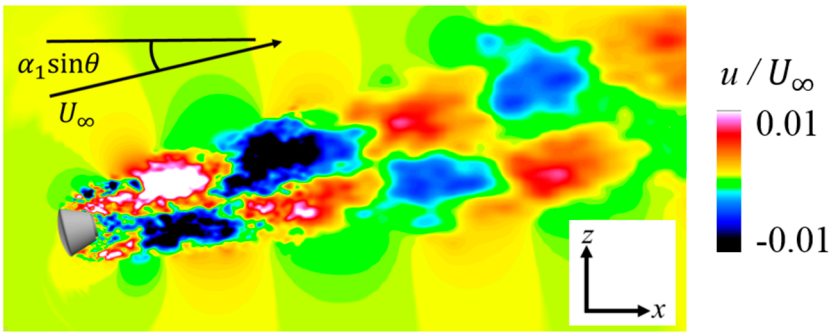

Fig. 3: The spatial distribution of the POD mode. 2D contour shows the distribution of velocity in the x-direction at y = 0.

Publications

- Oral Presentations

Kobayashi, K., Ohmichi, Y., Kanazaki, M., "Modal Decomposition Analysis of Subsonic Unsteady Flow Around An Atmospheric Entry Capsule with Forced Oscillation," AIAA Science and Technology Forum and Exposition 2019, San Diego, U.S.A, January 2019.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	1024
Elapsed Time per Case	900 Hour (s)

Resources Used

Fraction of Usage in Total Resources[*1] (%): 0.62

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2] (%)
SORA-MA	4,899,315.40	0.60
SORA-PP	48,405.94	0.39
SORA-LM	27,876.92	13.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	238.42	0.25
/data	42,480.49	0.75
/ltmp	976.56	0.08

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	17.33	0.61

[*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.