Development of High-fidelity Re-entry Safety Analysis Methods

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Abstract

High-fidelity re-entry safety analysis code LS-DARC is under the development in JAXA in order to realize the accurate EC predictions and the design-for-demise for the rocket upper statges and space-crafts. 6 Dof trajectory analysis, aerodynamics, heat flux, 3D thermal conductance can be considered by the coupling analysis code based on the reduced order models. Since models in LS-DARC is versatile and its turn-around time is very short, it has been applied wide range of aerospace engineering applications such as the research and development activities for the small re-entry capsule installed in HTV and the fly-back re-usable rocket.

Reasons for using JSS2

Probabilistic re-entry safety analysis based on the multi disciplinary coupling analysis with considering various uncertainty factors is essential. In addition consideration on the design parameter effect should also be considered. In addition, in-house computational environment is essential also for security reason. Consequently, JSS2 is essential.

Achievements of the Year

In this fiscal year, CFD analysis required to validate the heat flux and aerodynamic characteristics reduction model has been conducted for the LS-DARC development. For the integrated validation of the LS-DARC, the practical re-entry safety analysis has been conducted for the actual HIIB upper stage. As a result, accuracy improvement needs were found for the accurate EC predictions. In addition, analysis tourn-around time has been remarkably reduced, which is essential for the practical use. Schematic overview of models of LS-DARC and the example results of the surface heat flux is shown as Fig. 1.

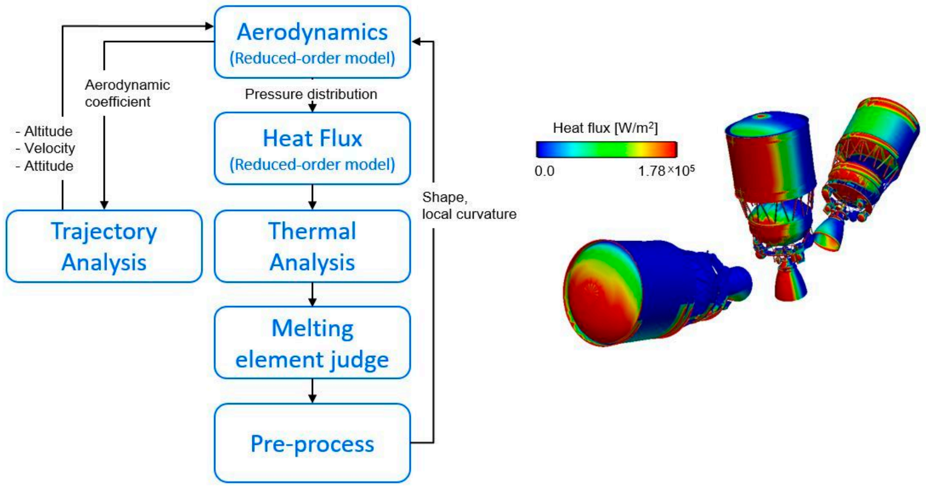

Fig. 1: Schematic overview of the multi-disciplinary high-fidelity re-entry analysis code LS-DARC, and surface heat flux distributions for HIIB upper stage

Publications

- Peer-reviewed papers

Fujimoto, K., Tani, H., Negishi, H., Saito, Y., Iizuka, N., Okita, K., Kato, A., "Uncertainty Quantification for Destructive Re-Entry Risk Analysis: JAXA Perspective," Stardust Final Conference, Conference, Springer book, pp.283-300, 2018.

- Non peer-reviewed papers

Keiichiro Fujimoto, Hideyo Negishi, Nobuyuki Iizuka, Yasuhiro Saito, Koichi Okita, "Quantitative Risk Analysis for Reliability and Safety issues in Aerospace Engineering," Safety Engineering Symposium 2018, 2018.

Keiichiro Fujimoto, Hideyo Negishi, Ryo Nakamura, Yasuhide Watanabe, Toshiaki Daibo, Koichi Okita, "CFD Research Needs for Re-entry Capsule Thermo-aerodynamics and Re-entry Safety Analysis," 32nd CFD Symposium, 2018.

Keiichiro Fujimoto, Hideyo Negishi, Toshiaki Daibo, Nobuyuki Iizuka, Ryuzo Shimizu, Koichi Okita (JAXA), "Development of High Fidelity Model-based Re-entry Safety Analysis Tool LS-DARC - Part 1," 8th Space Debris Workshop, 2018.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	FLAT 並列
Number of Processes	96 - 512
Elapsed Time per Case	400 Hour (s)

- **Resources Used**

Fraction of Usage in Total Resources*1 (%): 0.27

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	2,324,723.64	0.28
SORA-PP	106.38	0.00
SORA-LM	0.00	0.00
SORA-TPP	401.03	0.03

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	426.01	0.44
/data	25,939.49	0.46
/ltmp	15,598.34	1.34

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	0.31	0.01

*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.