Aeroacoustic simulation of launch vehicle at lift-off

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Abstract

It is required to predict and reduce the acoustic level of satellites caused by exhaust jet of rocket engines and transonic buffet. In this study, the lift-off acousitc analysis tool developed so far is coupled with the FEM tool to predict the acoustic level inside payload fairing, aiming to develop quiet launch vehicle.

Reasons for using JSS2

It is necessary to carry out billions of LES analysis, and large computing resources are essential to achieve the target frequency resolution.

Achievements of the Year

(1) Aero-vibro acoustic simulation for the prediction of harmful acoustic loading at lift-off of launch vehicle is developed. In this simulation technique, high-fidelity large-eddy simulation with computational aeroacoutics based on full-Euler equations is employed for computing jet aeroacoustics and their propagation to the outside of payload fairing. Acoustic field inside the payload fairing is computed by the coupled vibro-acoustic simulation based on finite element method. A simplified fairing model is used for the validation of the present method. An impact hammer test is conducted for validating the structural model. Then, accuracy of this method is validated by using the acoustic vibration test result with a subscale rocket engine.

(2) Aeroacoustic simulation based on hybrid LES/RANS is conducted to predict acoustic level around a SSTO at lift-off. (Fig. 2) It is found that the acoustic level is higher that the conventional expendatble launch vehicle with launch pad.

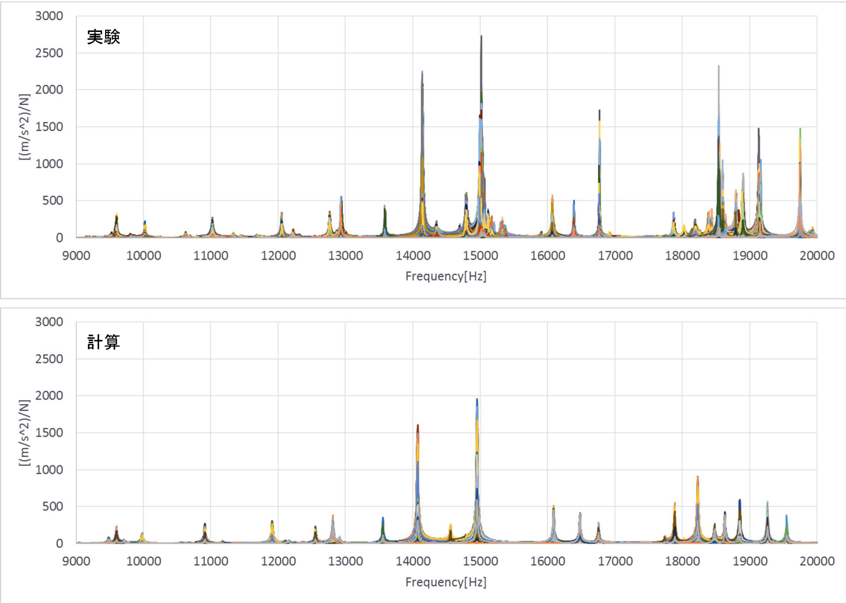

Fig. 1: Comparison of transfer function between experimental and numerical modal analysis

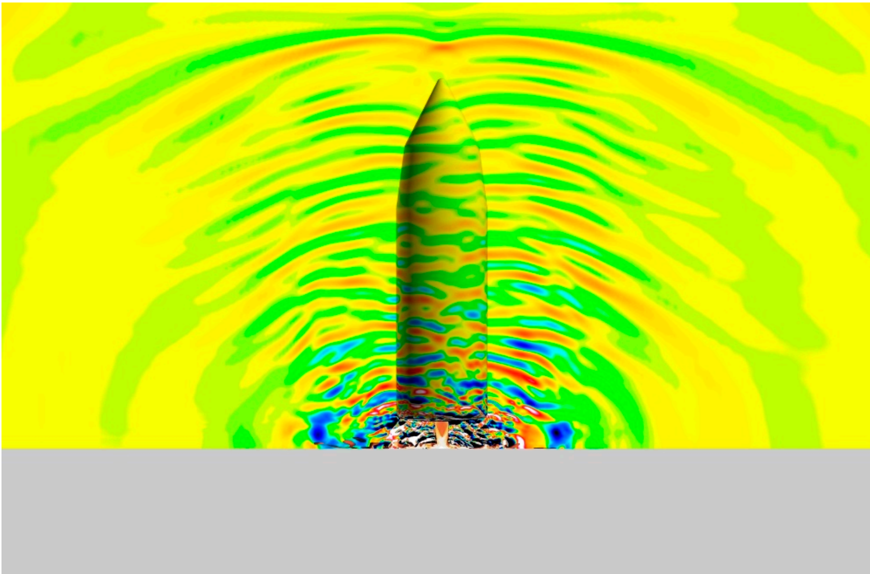

Fig. 2: Acoustic propagation of SSTO at lift-off

Publications

N/A

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	512
Elapsed Time per Case	800 Hour (s)

- **Resources Used**

Fraction of Usage in Total Resources[*1] (%): 0.81

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2] (%)
SORA-MA	6,736,350.24	0.82
SORA-PP	76,080.65	0.61
SORA-LM	1,576.29	0.73
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	5,139.61	5.32
/data	36,070.13	0.64
/ltmp	5,848.72	0.50

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	117.29	4.10

[*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.