JAXA-SUBARU Cooperative Research

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Abstract

The lift offset technology to improve aerodynamic performance of high-speed rotorcraft is investigated. Flaps on the fixed wing are installed to reduce the download in hover for the winged compound helicopter. In this study, these flaps are operated in opposite directions on the left and right sides in forward flight. These differential flaps generate a rolling moment on the airframe. The rotor is controlled to cancel the rolling moment of the airframe, resulting in a lift offset state. This study aims to demonstrate that differential flaps can improve the total lift-to-drag ratio of the rotor and the fixed wing through numerical simulations and wind tunnel tests.

Reasons and benefits of using JAXA Supercomputer System

There are many simulation cases, and the system is needed to get results efficiently. Large-scale simulation that requires much memory can be performed, and the results can be obtained efficiently.

Achievements of the Year

Simulations are conducted to evaluate the improvement of the aerodynamic performance using a simplified computational model constructed by a single main rotor and a winged-body based on the JAXA conceptual model of high-speed rotorcraft, to be wind-tunnel tested. The rotorcraft CFD tool, rFlow3D developed at JAXA, is utilized. Moving overlapped grid method is applied to simulate the motion of the main rotor blades. In order to obtain computational results efficiently, the flaps are modelled with partially overlapped grid to reduce the cost of the grid generation. Figure 1 shows the overlapping grid system used in the simulations. Structured grid is used. The overlapping grid system consists of the blade, winged-body, flaps, propeller nacelle, and inner/outer background grids.

The simulations are carried out based on the target conditions of the wind-tunnel tests. Figure 2 shows the flowfield around the rotorcraft by the numerical simulation. Highly complex flowfields are observed. The tip vortices from the blade tip flow behind the rotorcraft in a spiral shape. Tip vortices are generated from the fixed wing tips simultaneously. The numerical simulations support planning of the wind tunnel test and show improvement of the aerodynamic performance of the rotorcraft due to the lift offset technology.

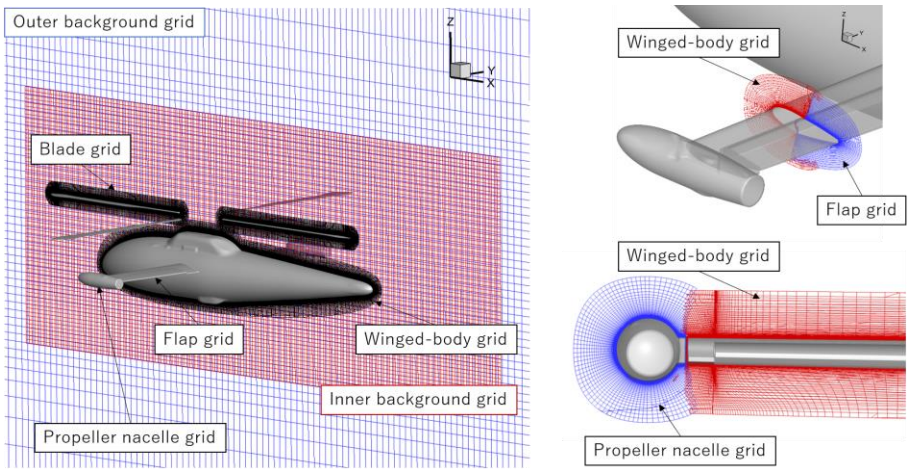

Fig. 1: Moving overlapped grid system used in the simulations

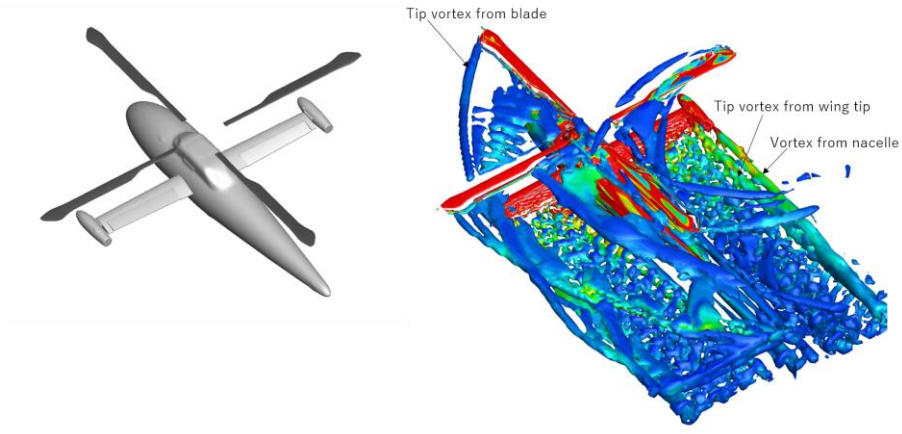

Fig. 2: Vortex flowfield around the rotorcraft

Publications

N/A

Usage of JSS

Computational Information

Process Parallelization Methods	N/A
Thread Parallelization Methods	OpenMP
Number of Processes	1
Elapsed Time per Case	720 Hour(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.86

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	9,239.64	0.00
TOKI-ST	5,767,523.80	7.10
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	460,774.27	9.67
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	2,162.81	2.15
/data and /data2	50,787.23	0.54
/ssd	6,763.94	1.75

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	10.76	0.07

*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)	0.77	0.00

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