Aerodynamic Study of Multirotor Drone

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Abstract

Cooperative researches with universities and research institutes funded by government on multirotor type drone and eVTOL aircraft are carried out, focusing on the aerodynamic performance, flight characteristics and the emission of noise.

Ref. URL: https://www.jss.jaxa.jp/en/rotorcraft/

Reasons and benefits of using JAXA Supercomputer System

The numerical simulations of multiple rotors require large amount of memories and high computing capability. Supercomputers are the MUST for such kinds of studies.

Achievements of the Year

The flowfields around a quadrotor drone are compared with quad rotors without the central fuselage. It is shown that the central fuselage blocks the upwash on the central portion of the quad rotors, redirects the flow to horizontal directions, thus increase the outwash velocity along the ground. Fig.1 shows the flowfields around the quadrotor drone in ground effect; while Fig. 2 shows the flowfields around quad rotors without the central fuselage. The outwash velocity profiles along the ground are shown in Fig. 3 and Fig. 4.

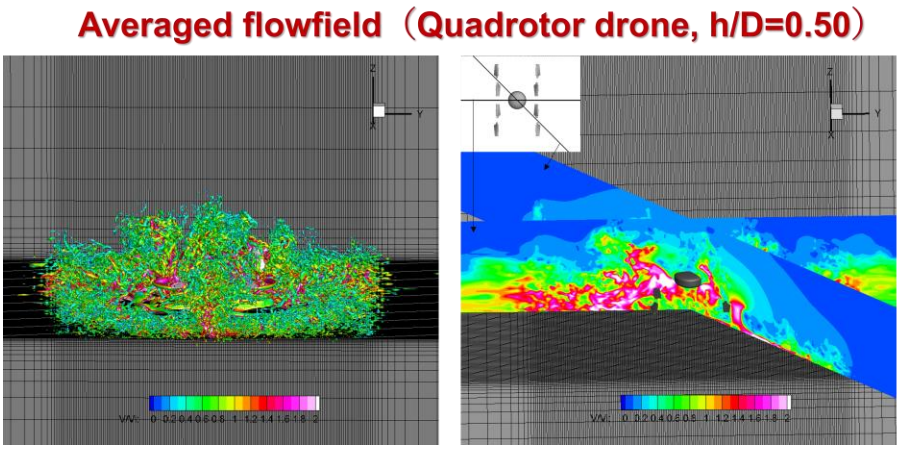

Fig. 1: Flowfield around a quadrotor drone hovering in ground effect

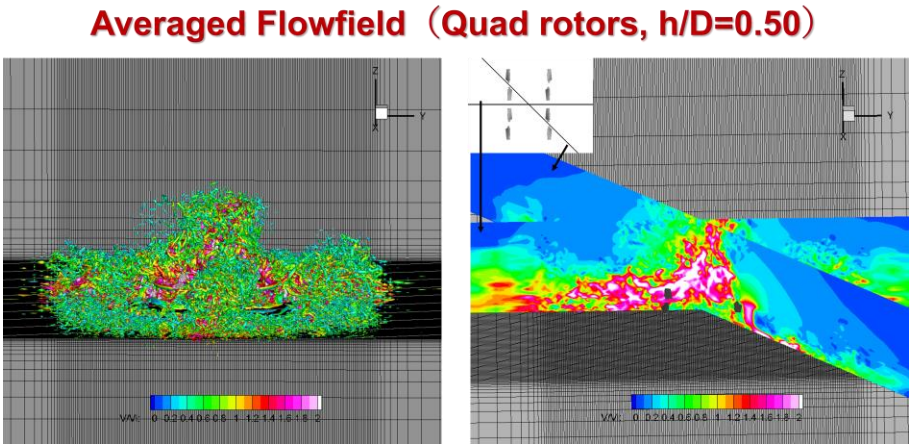

Fig. 2: Flowfield around quad rotors hovering in ground effect

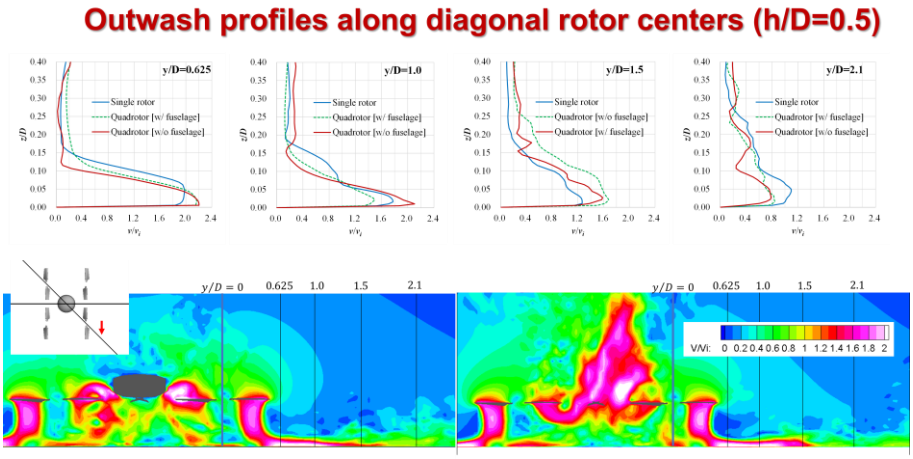

Fig. 3: Comparisons of velocity profiles on ground between a quadrotor drone and quad rotors along the section crossing the diagonal rotor centers

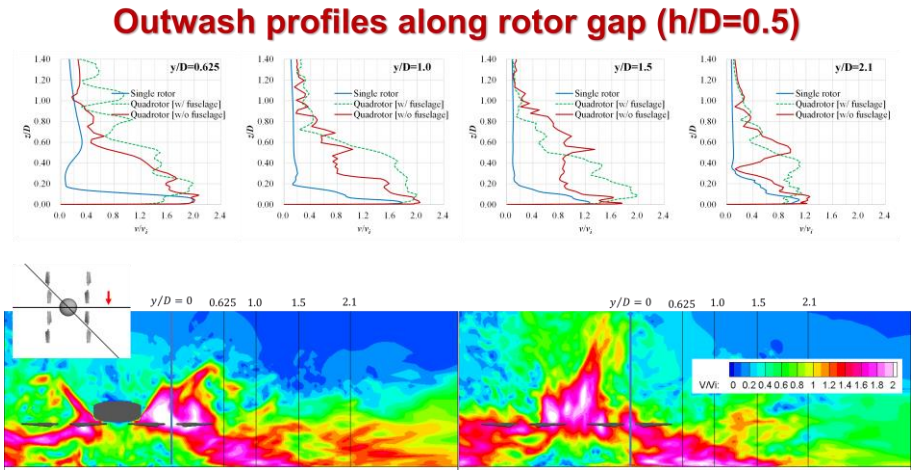

Fig. 4: Comparisons of velocity profiles on ground between a quadrotor drone and quad rotors along the gap of the rotors

Publications

- Peer-reviewed papers

1) Tanabe, Y., et al. (2021), Quadrotor Drone Hovering in Ground Effect, J. Robotics and Mechatronics, 33-2, 339-347.

- Non peer-reviewed papers

1) Yasutada Tanabe, Hideaki Sugawara, Shigeru Sunada, Koichi Yonezawa, Hiroshi Tokutake, NUMERICAL INVESTIGATION OF QUAD ROTORS IN GROUND EFFECT, 47th European Rotorcraft Forum (Virtual Conference), September 7-10, 2021.

2) Koichi Yonezawa, Kazuki Akiba, Hao Liu, Hideaki Sugawara, Yasutada Tanabe, Hiroshi Tokutake and Shigeru Sunada, Numerical Investigations of Ground Effect of a Quadcopter, 2021 Asia-Pacific International Symposium on Aerospace Technology (APISAT2021), November 15-16, 2021, Jeju, Korea & Online.

Usage of JSS

Computational Information

Process Parallelization Methods	N/A
Thread Parallelization Methods	OpenMP
Number of Processes	1
Elapsed Time per Case	1500 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.75

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	2,725,485.29	0.13
TOKI-ST	4,359,645.60	5.37
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	326.92	0.02
TOKI-TST	190,482.23	4.00
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	1,470.31	1.46
/data and /data2	25,087.23	0.27
/ssd	1,556.44	0.40

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	9.18	0.06

[*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)	87.68	0.06

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