Flowfield around blades with optimized airfoil for six-roter Mars helicopter

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Abstract

In this project, a study was conducted to find the optimum blade shape for a 6-rotor helicopter for Mars exploration, The optimization method by Efficient Global Optimization and the airfoil definition method by Class Shape Transformation were employed. The two-dimensional calculation by FaSTAR was used for the evaluation during the optimization, and rFLow3D was used to evaluate the performance as a rotor blade. The aerodynamic performance of CLF5605 airfoil adopted by Ingenuity at NASA JPL was referenced and compared, and the airfoil named TMU21k3-1, which improved the aerodynamic performance was obtained.

Reasons and benefits of using JAXA Supercomputer System

In order to effectively employ the JAXA-provided tools, FaSTAR and rFlow3D, it was necessary to run on the JAXA supercomputer, which has many application examples and is well-tuned.

Achievements of the Year

The optimization method by Efficient Global Optimization and the airfoil definition method by Class Shape Transformation were employed. The two-dimensional calculation by FaSTAR was used for the evaluation during the optimization, and rFLow3D was used to evaluate the performance as a rotor blade. Referring to the aerodynamic performance of CLF5605 airfoil adopted by Ingenuity at NASA JPL, we were able to obtain an airfoil TMU21k3-1 which achived better hovering perfomance than that of CLF5605 (Figs. 1 and 2).

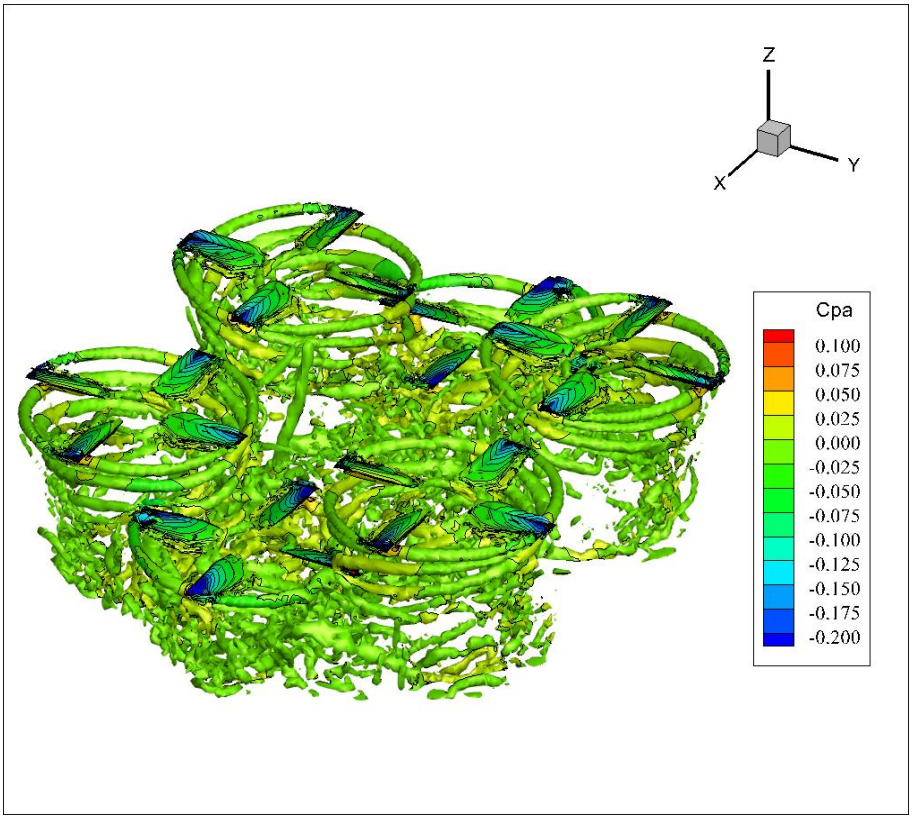

Fig. 1: Visualization results around 6-roter which employed the optimal airfoil, TMU21k3-01

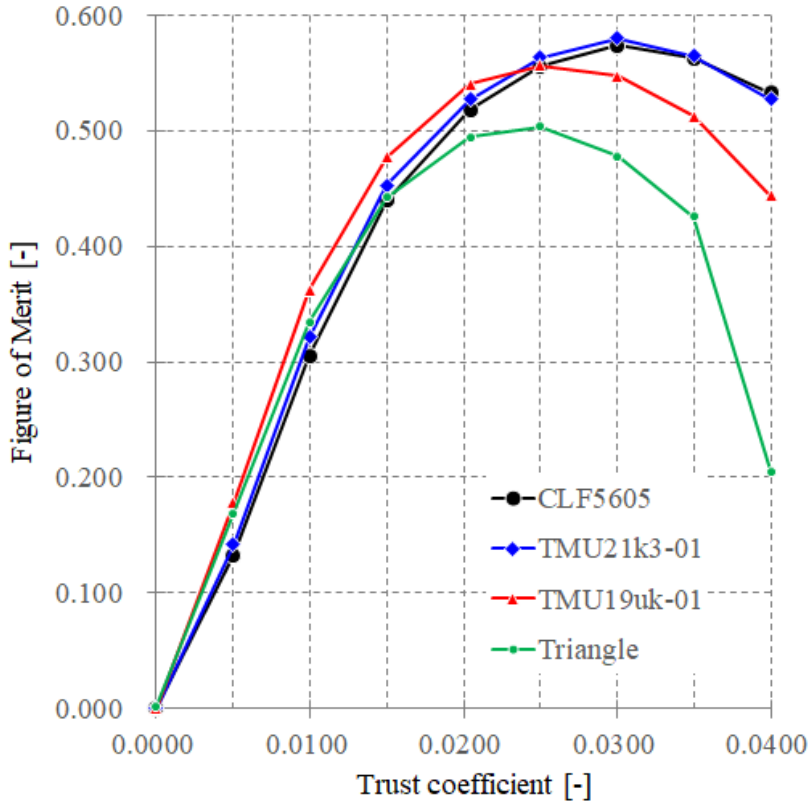

Fig. 2: CT-FoM diagram of the roter blade airfoil designed this year.The optimal design of the blade airfoil has resulted in a blade airfoil that outperforms the existing airfoil (CLF5605).Figure of Merit was calculated by 3D calculation using rFlow3D.

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	36
Elapsed Time per Case	96 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.31

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	445,107.73	0.02
TOKI-ST	1,935,150.66	2.38
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	583.66	0.04
TOKI-TST	322,004.80	6.76
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	2,155.31	2.14
/data and /data2	32,767.23	0.35
/ssd	1,668.94	0.43

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)	51.68	0.04

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