Three-Dimensional Global Multiobjective Aerodynamic Design Optimization of Wingtip Geometies

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Abstract

The objective is to demonstrate the effectiveness of a newly developed high DOF global multiobjective design optimization method, which does not require prior shape parameterization, by applying it to 3D aerodynamic shape optimization.

Reasons and benefits of using JAXA Supercomputer System

Since aerodynamic performance evaluation is necessary in the optimization process, the number of calculations is large, and each calculation is large-scale, large-scale parallel computation using a supercomputer is essential.

Achievements of the Year

We performed generative optimization of wing tip geometry for a low aspect ratio rectangular wing under low Reynolds number cruise conditions. An unstructured grid was automatically generated to evaluate the solution, and aerodynamic performance was evaluated using FaSTAR. A newly developed evolutionary algorithm was used for optimization, and a total of 4,800 solution evaluations were conducted for 160 individuals and 30 generations. Two objective functions, lift and drag coefficients, were used. As a result, a variety of solutions with a wide range of performance were obtained, including solutions that outperformed the baseline geometry. The aerodynamic performance of each solution was discussed by visualizing the flow field.

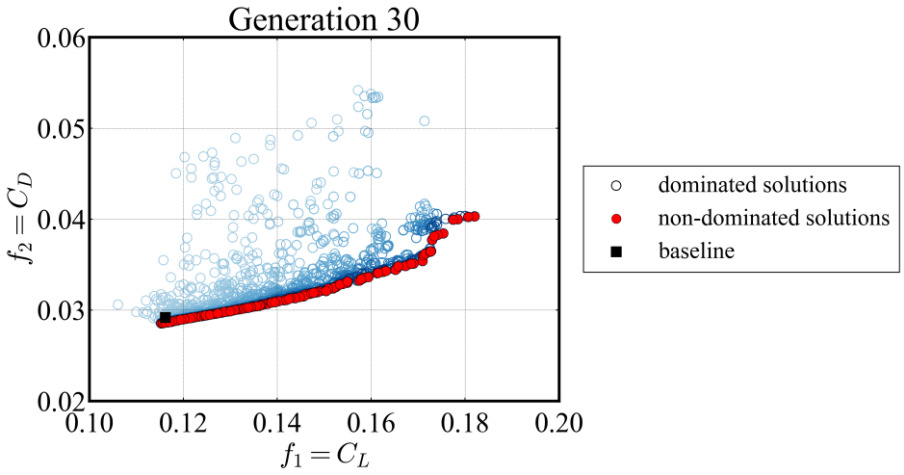

Fig. 1: Distribution of solutions in the objective function space obtained from 4800 solution evaluations

Fig. 2: Example of solution shape obtained (solution with small drag)

Fig. 3: Example of obtained solution shape (solution with large lift-drag ratio)

Publications

- Oral Presentations

Nimura, Naruhiko, and Akira Oyama. "Global Multiobjective Aerodynamic Optimization of Wingtip Design for Micro Aerial Vehicle." AIAA SCITECH 2024 Forum. 2024.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	144
Elapsed Time per Case	6.5 Hour(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.52

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	13,626,324.67	0.62
TOKI-ST	163,057.50	0.18
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
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	245.00	0.20
/data and /data2	5,070.00	0.03
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	0.00	0.00

*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)	6.49	0.00

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