Development of vortex generator layout design guidelines for improving aircraft performance

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Abstract

The installation of vortex generators (VGs) in an aircraft is mainly used as a solution to problems that require performance improvement during the flight test phase, and its placement is often determined by trial and error in flight tests. The objective of this research is to improve the current VG layout and design technology, which is only a quick solution to problems that occur in the flight test phase, so that it can be incorporated into aerodynamic design that actively utilizes VGs from the conceptual design phase.

Ref. URL: http://www.aero.jaxa.jp/eng/research/basic/application/

Reasons and benefits of using JAXA Supercomputer System

Computational simulations using the JSS reveal detailed physical phenomena of VGs, which is difficult only with wind tunnel tests, and enable to improve the design of the devices.

Achievements of the Year

To investigate Reynolds-averaged Navier–Stokes technologies required to predict the effect of VGs installed on a trailing-edge flap of a high-lift wing for the suppression of boundary layer separation, a two-dimensional infinite wing was chosen because computational cost was able to be minimized with high-resolution meshes. A 30P35N airfoil was used to obtain a large flow separation on the flap so that the effect of VGs was easily identified. Mesh generation guidelines have been obtained through this research to predict the effect of VGs, and have been applied to a three-dimensional

model, the JAXA high-lift research wind tunnel model OTOMO2, to evaluate the effectiveness of the mesh generation guidelines (Figure 1).

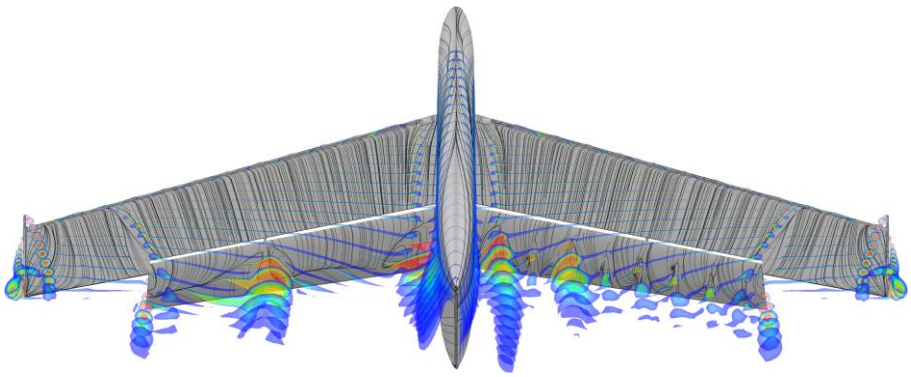

Fig. 1: Differences of surface streamlines and entropy distributoin on cross-sections between configurations without VGs (left) and with VGs on the flap (right)

Publications

- Peer-reviewed papers

Ichikawa, Y., Koike, S., Ito, Y., Murayama, M., Nakakita, K., Yamamoto, K., and Kusunose, K., "Size effects of vane-type rectangular vortex generators installed on high-lift swept-back wing flap on lift force and flow fields," Experiments in Fluids, Vol. 62, No. 8, July 2021, pp. 160, DOI: 10.1007/s00348-021-03198-4.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	324
Elapsed Time per Case	120 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 1.25

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	29,438,589.43	1.43
TOKI-ST	22,654.73	0.03
TOKI-GP	0.00	0.00
TOKI-XM	2,241.28	1.61
TOKI-LM	77.69	0.01
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	75.59	0.08
/data and /data2	3,997.16	0.04
/ssd	517.82	0.13

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	55.78	0.38

[*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)	530.73	0.37

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