Research on laminar fins system

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Abstract

The laminar flow vertical tail fins are designed and evaluated to establish practical technology for a natural laminar flow wing that will be applied to future subsonic aircraft. By investigating the influence of surface roughness on the flow field, we aim to establish criteria for surface roughness capable of maintaining laminar flow effects.

Ref. URL: https://www.aero.jaxa.jp/eng/research/ecat/igreen/

Reasons and benefits of using JAXA Supercomputer System

Designing laminar airfoils to reduce aircraft fuel consumption demands swift design processes along with numerous high-precision fluid flow analyses to scrutinize fine boundary layer flows. Surface roughness analysis necessitates more intricate examination compared to design requirements. The utilization of a supercomputer is imperative for executing these projects.

Achievements of the Year

To establish a manufacturing method for a laminar flow vertical tail, it is essential to define surface roughness specifications. In pursuit of this object, a highly accurate aerodynamic analysis was conducted using a multi-fidelity aerodynamic computational system that integrates various fidelity tools (RANS, direct numerical simulation, and stability analysis). The effects of surface roughness on turbulent transition were investigated, leading to the development of a new roughness index for turbulent transition. As illustrated in Figure 1, which depicts the effect of roughness on the flow field, a visualization of the leading edge of an airfoil with an inward-facing step is provided as one example. The height of the step varies, and it is observed that the greater the step height, the more turbulence is generated over a wider area from the leading edge of the wing. Thus, we constructed an index that accounts for the shape and magnitude of the roughness.

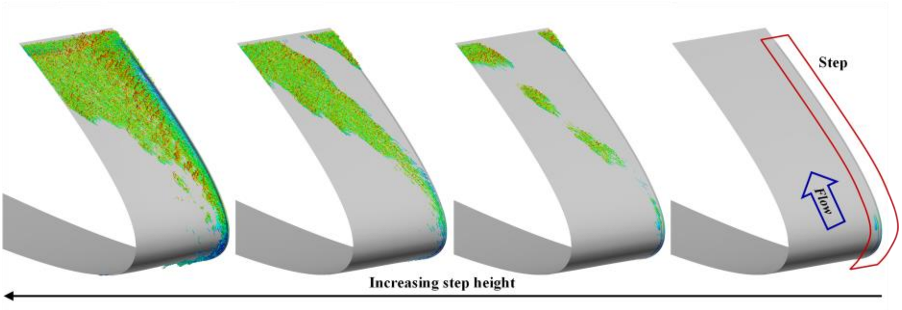

Fig. 1: Visualization of the turbulent transition occurring at the leading edge of an airfoil with an inward-facing step. The iso-surface and contours represent the vortex and kinetic energy, respectively. The step height increases from right to left.

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	48 - 10008
Elapsed Time per Case	55 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 3.18

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	117,316,994.88	5.30
TOKI-ST	130,068.06	0.14
TOKI-GP	0.00	0.00
TOKI-XM	10,604.74	5.81
TOKI-LM	79,127.07	6.03
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	754.39	0.63
/data and /data2	120,049.74	0.74
/ssd	9,538.00	0.90

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	29.57	0.11

[*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)	2,919.71	1.32

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