Innovative Green Aircraft Technology : High Efficiency and Low Noise Aircraft

Report Number: R24ETET15
Subject Category: Skills Acquisition System
URL: https://www.jss.jaxa.jp/en/ar/e2024/26981/

Responsible Representative

Atsusi Kanda, Aeronautical Technology Directorate, Aviation Enviromental Sustanability Innovation Hub

Contact Information

Dongyoun Kwak, Aviation Enviromental Sustanability Innovation Hub(kwak.dongyoun@jaxa.jp)

Members

Emilie Ramesh, Nozomu Hayabe, Yasushi Ito, Shinya Koganezawa, Dongyoun Kwak, Mitsuhiro Murayama, Takuto Masaki, Kazuhiro Takeoka

Abstract

The purpose of the iGreen research is to develop and mature a bunch of advanced and innovative technologies on aerodynamics, aeroacoustics, and structures to enable airframe design with higher environmental performances. In addition to verifying practical application of these technologies, we will also work on the development of elemental and system technologies.

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

Reasons and benefits of using JAXA Supercomputer System

CFD analysis are used for the understanding of aerodynamic characteristics and evaluation of the performance in the aircraft design phase. Huge calculation resources and costs were required for the high fidelity and quick response CFD analysis for the optimum aerodynamic design process on complex aircraft geometry. JSS3 can achieve those requirements, the cost and time are drastically saved on the CFD analysis.

Achievements of the Year

In this research, fundemental technologies to improve the environmental performance of subsonic aircraft, such as low fuel consumption and low noise, are studied in collaboration with universities. First, numerical analysis was conducted on a bump-shaped aerodynamic device that controls shock waves generated on the wing upper surface of a subsonic aircraft. The aerodynamic characteristics of the bump shapes were analyzed in terms of width, spacing, and chord locations(Fig.1), and design guidelines were obtained to reduce drag during transonic cruise flight. Second, The aerodynamic shape optimization of a Kruger flap for a natural laminar flow airfoil was performed to maximize the maximum lift coefficient during landing and the lift-to-drag ratio during takeoff. By optimizing the shape of the lower surface, a new configuration was developed that improved the lift-to-drag ratio during takeoff while maintaining the maximum lift during landing(Fig.2).

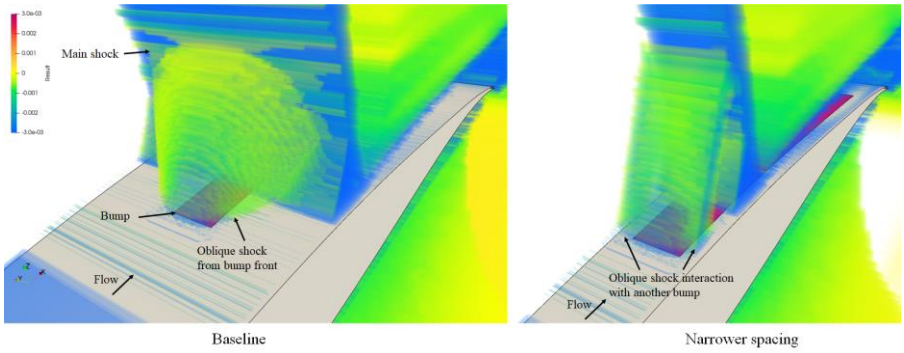

Fig. 1: Oblique shock formed around bump devices

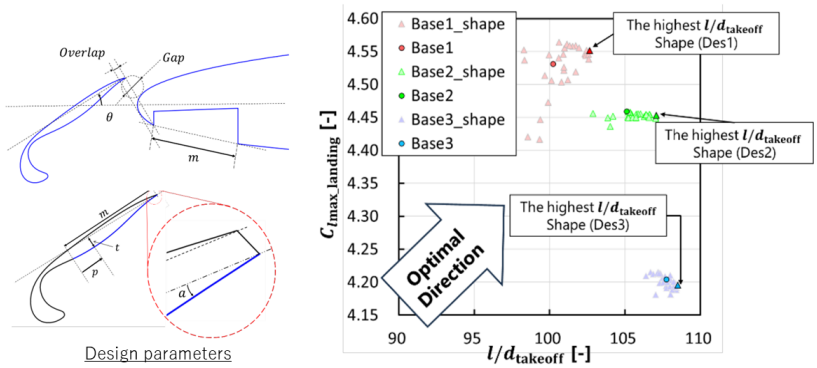

Fig. 2: Aerodynamic shape optimization of a Kruger flap for a natural laminar flow airfoil

Publications

- Oral Presentations

Nozomu Hayabe, Dongyoun Kwak:A Study on the Control of Normal Shock Wave over a Transonic Wing by Bump-shaped Aerodynamic Devices, 62nd Aircraft Symposium, 2B02, Fukui-shi, Oct.2024.(in Japanese)

Kazuhiro Takeoka, Masahiro Kanazaki, Yasushi Ito, Mitsuhiro Murayama, Kazuomi Yamamoto: Optimal Aerodynamic Design of Kruger Flap Placement and Shape, The 62nd Aircraft Symposium, Oct. 2024.(in Japanese)

Takuto Masaki, Masahiro Kanazaki, Yasushi Ito, Mitsuhiro Murayama, Kazuomi Yamamoto: Rapid Aircraft Fan Noise Propagation Analysis by Ray-tracing and Diffracted Sound Analysis Methods, The 62nd Aircraft Symposium, Oct. 2024.(in Japanese)

Nozomu Hayabe, Dongyoun Kwak:Research on Aerodynamic Devices for the Shock Wave Control on a Transonic Wing, AIAA Paper2025-0257, AIAA SciTech 2025, Orland, FL, Jan.2025.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	64 - 1024
Elapsed Time per Case	10 Hour(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.63

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	13,758,540.07	0.63
TOKI-ST	1,026,246.25	1.05
TOKI-GP	0.00	0.00
TOKI-XM	1,905.92	0.93
TOKI-LM	1,027.07	0.07
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	664.82	0.45
/data and /data2	89,493.89	0.43
/ssd	5,020.00	0.27

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	4.65	0.02

*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)	636.16	0.43

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