jh180032-NAJ

Daisuke Sasaki (Kanazawa Institute of Technology)

Cartesian-Based CFD/CAA Hybrid Method for Noise Prediction in Aerospace Fields

Background and Objective

Background

- Steady flow RANS solvers for aerospace engineering are matured
- Present and future challenging problems are unsteady turbulent flows and aerodynamically generated noise
- CFD/CAA approach (two step or hybrid approach)
  1. Unsteady turbulent flow field (CFD)
  2. Acoustic pressure field (CAA)
- Difficulty in predicting complex turbulent flows and enormous computational time required for high Re flows

Objectives

- CFD/CAA hybrid algorithm development and validation based on Cartesian mesh (IBM-based or cut-cell approach)
- Application of developed CFD/CAA hybrid method to aerospace problems
  - Fourth Aerodynamics Prediction Challenge (APC-IV)
- Efficient and portable parallel algorithm development for scalar and vector parallel computers

Research Institutes andMembers

CFD/CAA Algorithm Development and Applications

- Kanazawa Institute of Technology (D. Sasaki)
- Institute of Aerodynamics, RWTH Aachen University (M. Meinke)
- Tokai University (S. Takahashi)
- Advanced Manufacturing Research Institute, AIST (T. Misaka)
- Institute of Fluid Science, Tohoku University (S. Obayashi)
- Institute of Aeronautical Technology, JAXA (T. Ishida)
- RIKEN Advanced Institute of Computational Science (K. Onishi)

Efficient and Portable Parallel Algorithm Development

- Cyberscience Center, Tohoku University (R. Egawa, K. Komatsu)
- Information Technology Center, Nagoya University (M. Ogino)

Post-Process Implementation

- Intelligent Light (A. Toyoda)

Planned computational resources at Tohoku and Nagoya universities

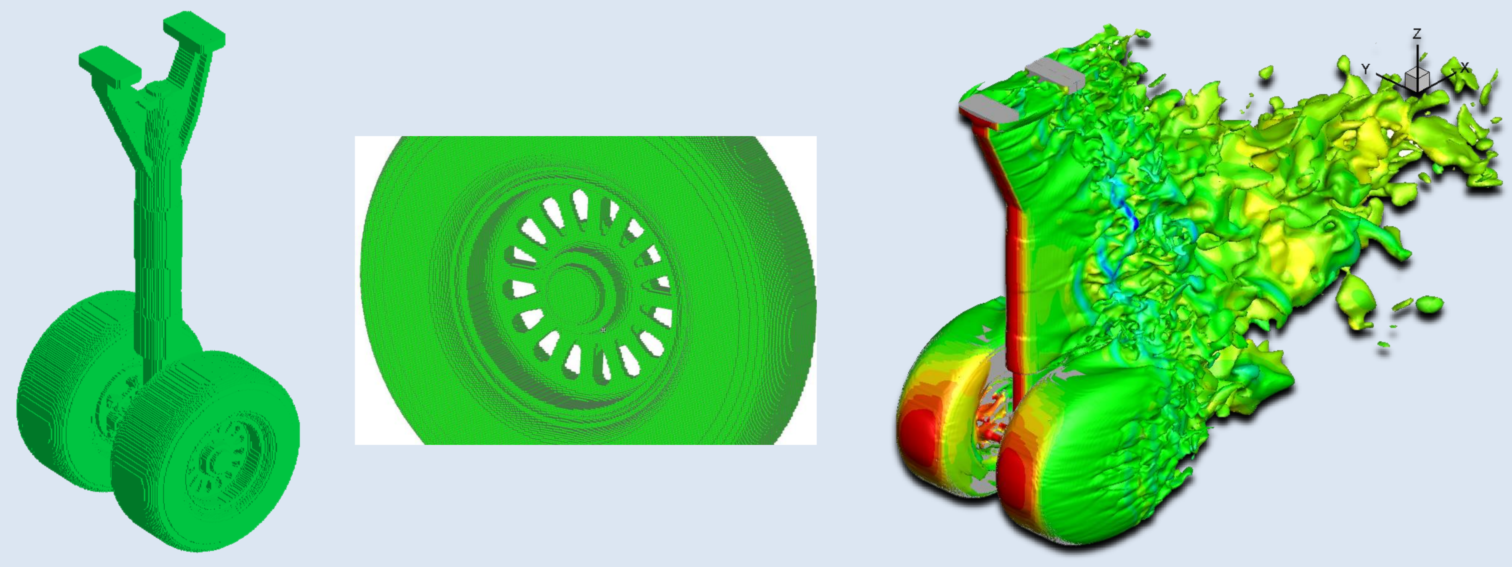
- Vector supercomputer (SX-ACE)
- Scholar parallel computers (FX-100, CX400, LX406Re2)
- 3D Visualization

Project Representative: dsasaki@neptune.kanazawa-it.ac.jp

Cartesian-mesh CFD

Characteristics of Cartesian-mesh CFD/CAA

- Fast and robust mesh generation
- Easy implementation of high order schemes
- Simple and efficient data structure
- Large computational time due to large-scale mesh



Flow simulation around an aircraft landing gear

Research Target

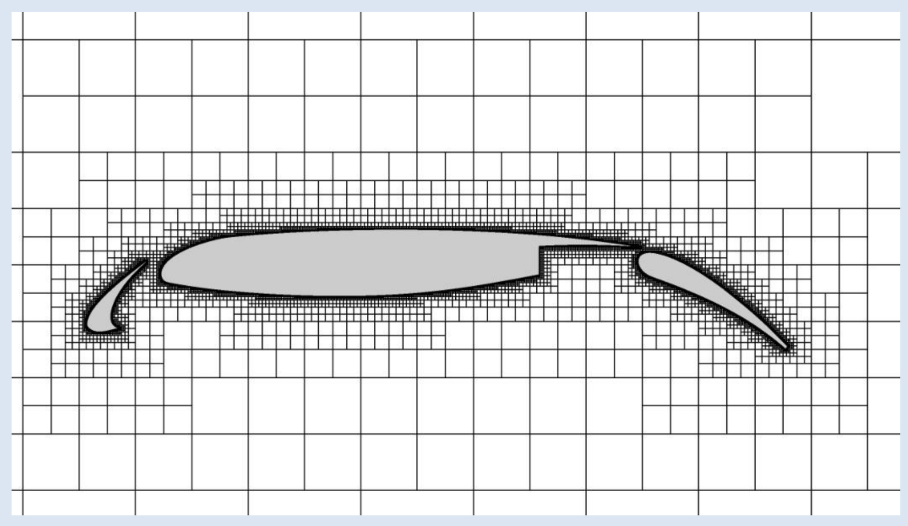
APC-IV Workshop: Slat Noise Prediction

Slat noise prediction of multi-element airfoil

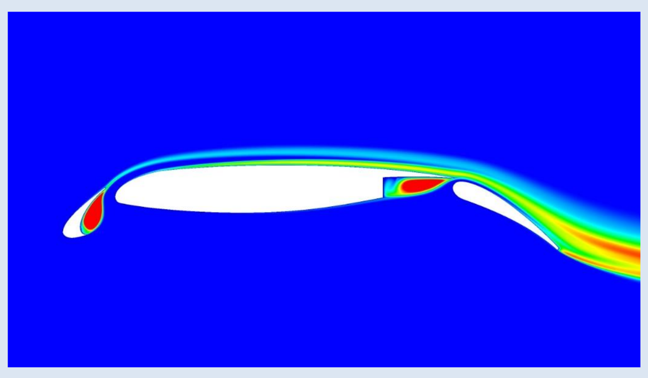
1. Aerodynamic prediction of 30P30N airfoil
2. Flap separation prediction of 30P35N airfoil
3. Noise prediction of 30P30N airfoil (near and far field)

Computational condition

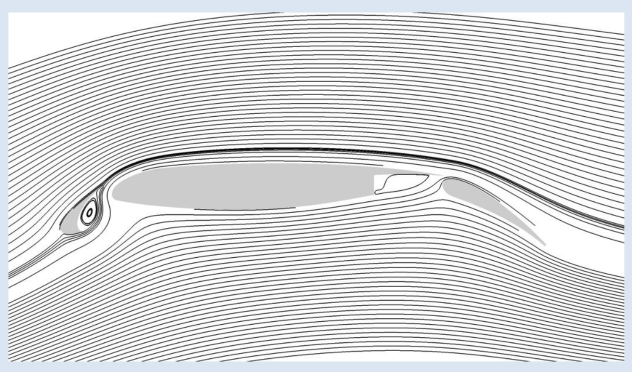
Flow Condition	Mach: 0.17 (Re: 1.71x10^6)
Angle of Attack	5.5, 9.5 (0,4,5.5,8,9.5,12,14,16,20,22,24,26)
Minimum Mesh Size	Extra Fine: 1.19e-5 Fine: 2.38e-5



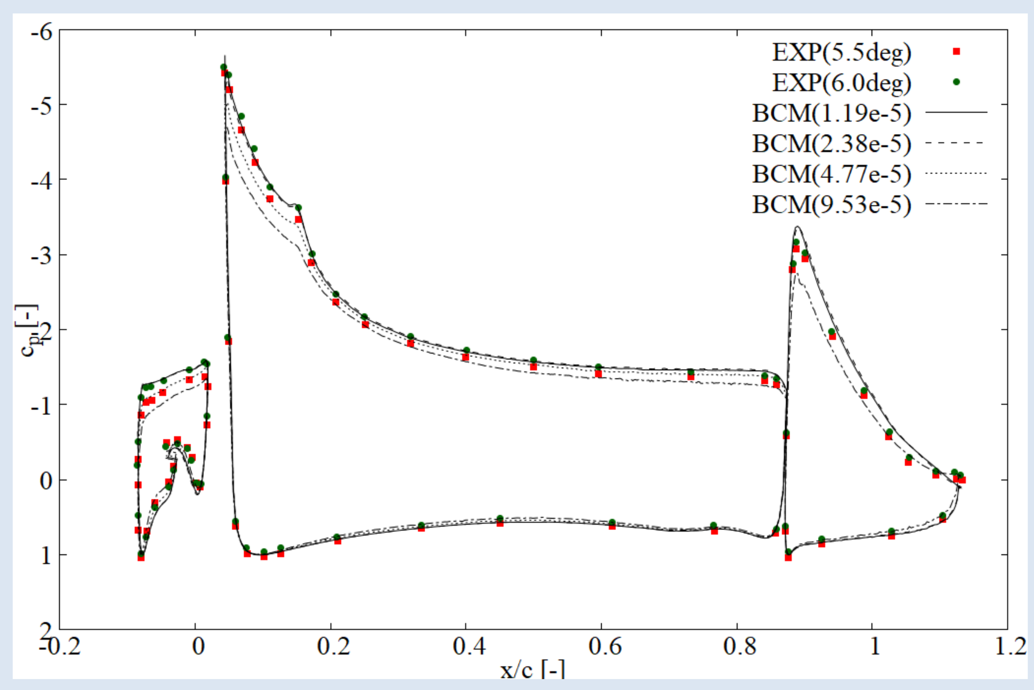
Mesh (Cube allocation)



Eddy viscosity distribution

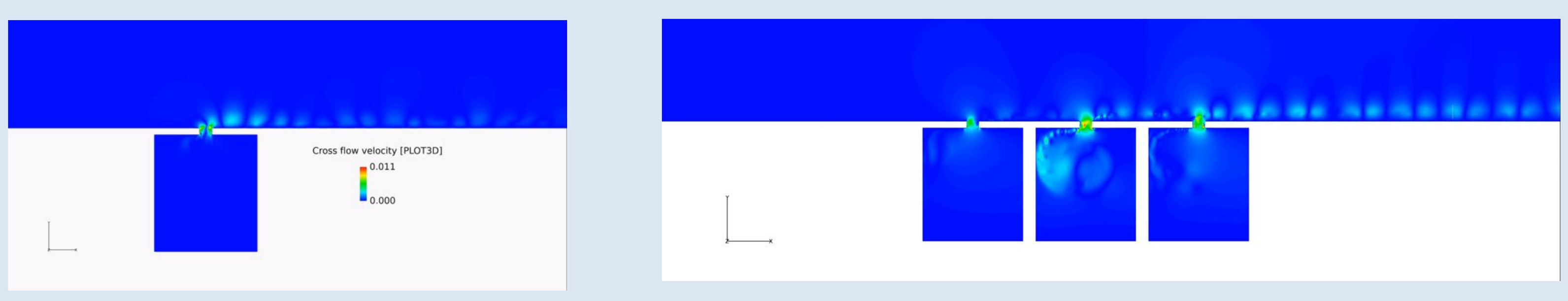


Streamlines



Pressure coefficient

Flow Prediction of Resonator under Grazing Flow for Acoustic Liner in Jet Engine



Comparison of cross flow velocity (Single-cell and three-cell models)