jh170029-NAJ

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Development of Cartesian-mesh CFD for Moving Boundary Problems in Aerospace Applications

Background and Objective

Background

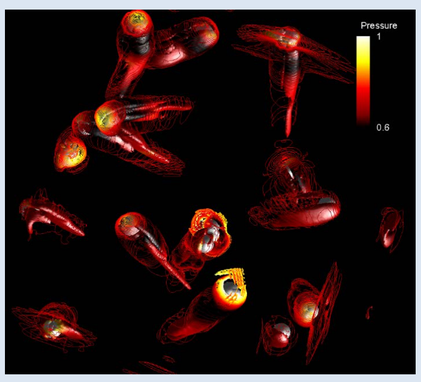
- Steady flow RANS solvers for aerospace engineering are matured
- Present and future challenging problems are unsteady turbulent flows with
  - moving surfaces
  - complex geometrical shapes

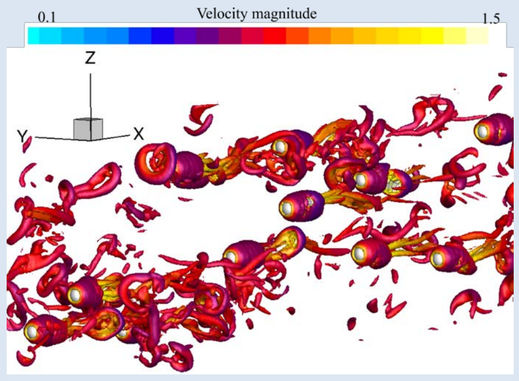
Objectives

- Development of Cartesian mesh CFD algorithm with immersed boundary methods for
  - efficient boundary representations
  - near-wall treatment for turbulent boundary layers
  - moving boundary problems
  - in-situ post-processing technique
- Improvement of parallel efficiency
- Validation through real-world problems

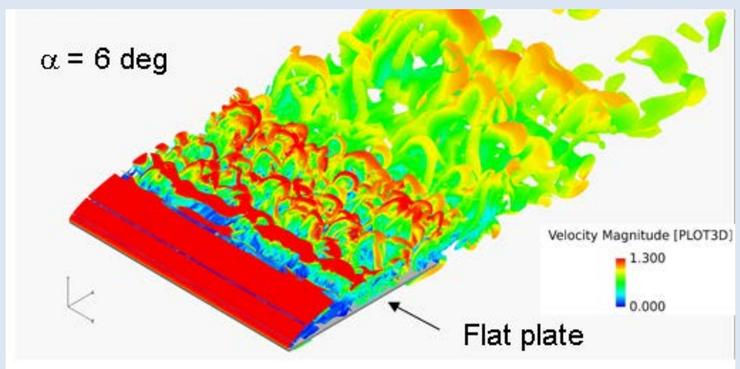
Research Target

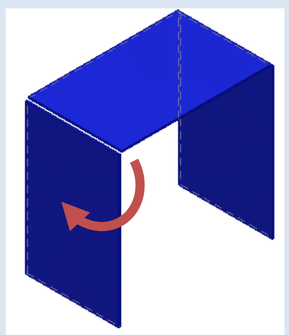
Gas-particle flows in exhaust plume of a rocket



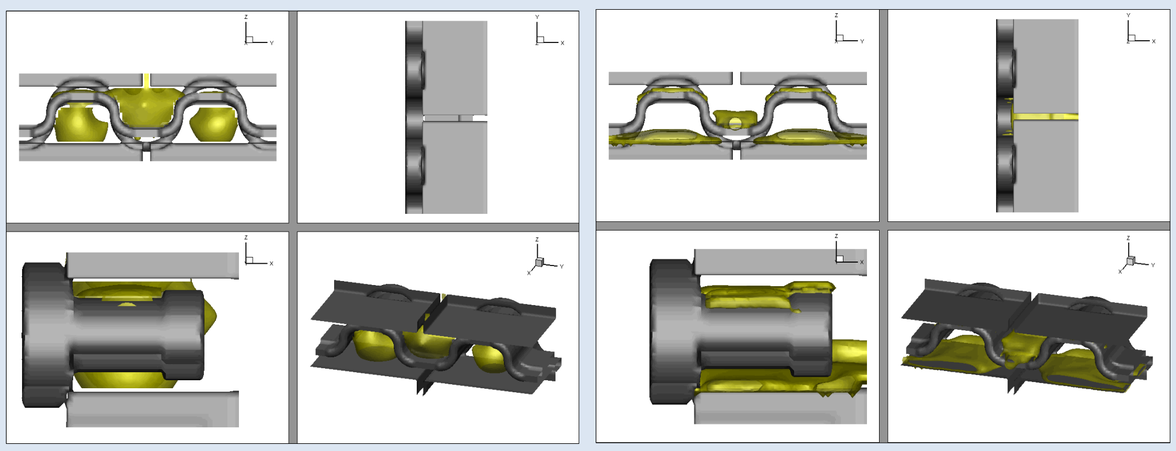


Deployment simulation of Mars exploration aircraft





Oil flow analysis around piston ring in engine



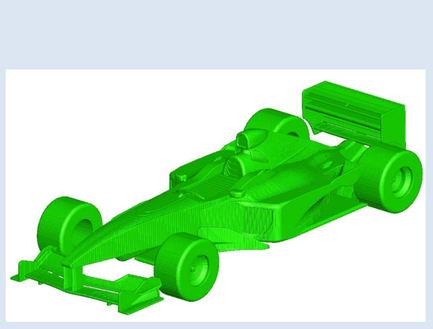
Cartesian-mesh CFD

Characteristics of Cartesian-mesh CFD

- Fast and robust mesh generation
- Easy implementation of high order schemes
- Simple and efficient data structure
- Easy handling of moving boundary

Challenge

- Staircase representation
- Difficulty in near-wall treatment
- Large computational time due to large-scale mesh



F1 racing car model (a few minutes for 1billion mesh)

Research Institutes and Members

CFD Algorithm Development and Applications

- Kanazawa Institute of Technology (D. Sasaki)
- Institute of Aerodynamics, RWTH Aachen University (M. Meinke)
- Tokai University (S. Takahashi)
- Institute of Fluid Science, Tohoku University (T.Misaka)
- 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

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