【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Engineering Ⅱ)

Title of Project : Research and Development of Next-Generation CFD for Peta-Flops Computers.

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Research Area : Integrated Engineering

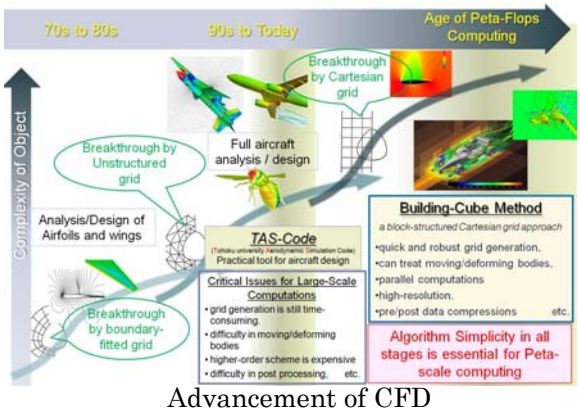
Keyword : Aerodynamics

【Purpose and Background of the Research】

This research is aimed at a development of next-generation computational fluid dynamics (CFD) that maximally utilizes the performance of the Peta-scale computers.

In the past developments of aeronautical CFD, there were two breakthroughs. The first was introduced by a boundary-fitted structured grid in the 70's. With this, computations of airfoils/wings became efficient and accurate, resulting a drastic improvement in jetliner performance. The second was introduced by unstructured grid in the 90's. With this, aerodynamic analysis and design of full aircraft configurations were highly advanced.

The unstructured-grid CFD, however, has several critical issues, such as a difficulty of implementing higher-order schemes, time-consuming grid generation for practical use, and a heavy load of post processing due to the irregularity of data. These will become more critical for near-future large scale computations. Another breakthrough in CFD is demanded.

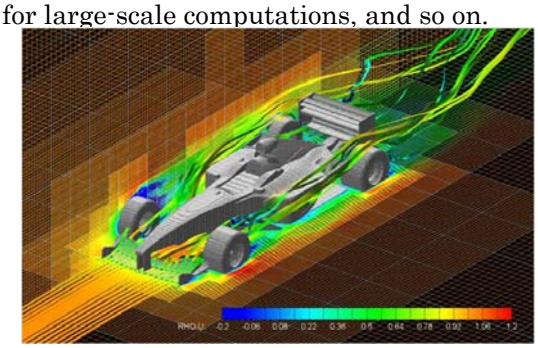


Advancement of CFD

This research is aimed at contributing to revolution and environmental suitability of fluid machines including aircrafts through a development of next-generation CFD for Peta/Exa-scale computers.

【Research Methods】

The core approach of the present next-generation CFD is based on a block-structured Cartesian grid, named Building-Cube Method. With this approach, several important advantages are obtained such as quick/robust grid generation, easy implementation of higher-order scheme, load reduction of post- processing for large-scale computations, and so on.



Large-scale computation using 0.2 billion mesh

【Expected Research Achievements and Scientific Significance】

It is expected to accurately predict airplane aerodynamics at takeoff/landing conditions that is still difficult by the current CFD. Aerodynamic noise is another important target of the present method. The flexibility of treating complex and deforming configurations also allows the advancement of optimization. Replacement of flight tests by CFD, the grand challenge of CFD named digital flight, will be reachable with the present study in future.

【Publications Relevant to the Project】

・T. Ishida, S. Takahashi, K. Nakahashi, "Efficient and Robust Cartesian Mesh Generation for Building- Cube Method", *J. of Computational Science and Technology*, Vol.2, No.4, 435-446, 2008.

・S. Takahashi, T. Ishida, K. Nakahashi, H. Kobayashi, K. Okabe, Y. Shimomura, T. Soga, A. Musa, "Study of High Resolution Incompressible Flow Simulation Based on Cartesian Mesh", *AIAA 2009-563, 47th AIAA Aerospace Sciences Meeting*, Jan. 2009.

【Term of Project】 FY2009-2013

【Budget Allocation】 164 ,800 Thousand Yen

【Homepage Address and Other Contact Information】

http:// www.ad.mech.tohoku.ac.jp/