GENERAL-PURPOSE COUPLING ANALYSIS PLATFORM IN PARALLEL ENVIRONMENTS

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ABSTRACT

Coupling phenomena are natural in a real world. However, coupling phenomena are often omitted in designing and manufacturing artifacts, because coupling analyses are still time-consuming and difficult tasks. We have been involved in developing various kinds of advanced computational mechanics simulation software which are able to solve large scale and complex shaped problems in parallel environments such as the Earth Simulator [1-4]. One of the authors has successfully performed one-way weak coupling analysis of fluid-induced vibration and noise in full-scale turbomachinery pump [5]. Then, we have been developing a general-purpose coupling analysis platform in parallel environments named REVOCAP_Coupler, and its pre-/post-processors named REVOCAP_Mesh and _Visual. The REVOCAP_Coupler is designed so as to enable various kinds of coupling analyses combining fluid, structure, thermal and electromagnetic codes, i.e. parallel CAE systems ADVENTURE [1, 2], parallel large eddy simulation (LES) codes for turbulent unsteady flow, FrontFlow/Blue [4, 6], FrontFlow/Red, parallel structural analysis code, FrontSTR, parallel electromagnetic analysis code, REVOCAP_Magnetic [7]. Most of the codes have already been implemented on the Earth Simulator. Keeping original performances of those codes, the REVOCAP_Coupler realizes parallel coupling simulations with large scale and complex-shaped models in a variety of ways as illustrated in Fig.1. The REVOCAP_Coupler is basically designed so as to deal with strongly coupled analysis as well as weakly coupled analysis owing to the employment of partitioned algorithms [8]. Using REVOCAP_Visual and an Interface Modeler, an interface model is easily constructed, which includes mapping information of interface data with different meshes and domain decompositions as illustrated in Fig.2. Socket is employed for parallel data communication, while MPI is used within each parallel solver. Fig.3 illustrates a whole process of the coupling analysis in a parallel environment. In the paper, we first describe a system architecture and core algorithms of the REVOCAP_Coupler. Then its performances in parallel environments are discussed in detail through solving a cooling problem of turbine blade with multiple holes.

REFERENCES

[1] http://adventure.q.t.u-tokyo.ac.jp

[2] S. Yoshimura, "Virtual demonstration tests of large-scale and complex artifacts using an open source parallel CAE system, ADVENTURE", *Journal of Solid State Phenomena*, Vol.**110**, pp.133-142, (2006).

[3] H. Akiba, S. Yoshimura, et. al., "Large scale drop impact analysis of mobile phone using ADVC on Blue Gene/L", Proceedings of SC06, CD-ROM, (2006).

[4] http://www.rss21.iis.u-tokyo.ac.jp

[5] Y. Y. Jiang, S. Yoshimura, R. Imai, H. Katsura, T. Yoshida and C. Kato, "Quantitative evaluation of flow-induced structural vibration and noise in turbomachinery by full-scale weakly coupled simulation", *Journal of Fluids and Structures*, Vol.**23**, pp.531-544, (2007).

[6] C. Kato, M. Kaiho and A. Manabe, "An overset finite-element large-eddy simulation method with applications to turbomachinery and aeroacoustics", *Trans. ASME, Journal of Applied Mechanics*, Vol.**70**, No.**1**, pp.97-108, (2003).

[7] S. Sugimoto, H. Kanayama, S. Asakawa, S. Yoshimura, "Time-harmonic eddy current analysis of a 44 million complex DOF problem with hierarchical domain decomposition method", *Transactions of JSCES*, Submitted for Publication.

[8] T. Yamada and S. Yoshimura, "Fluid-structure interaction analysis of flapping wing with line search partitioned approach", *Computer Modeling in Engineering and Sciences*, Accepted.
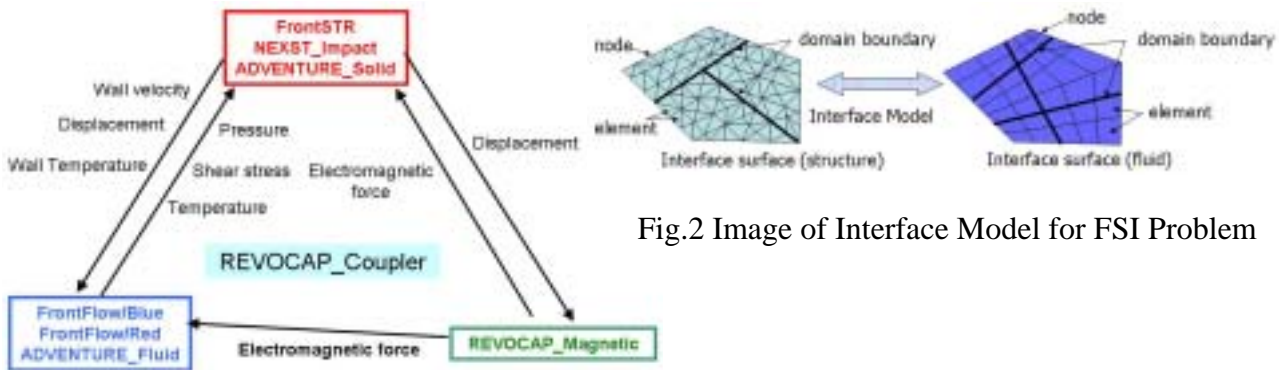
Fig.2 Image of Interface Model for FSI Problem
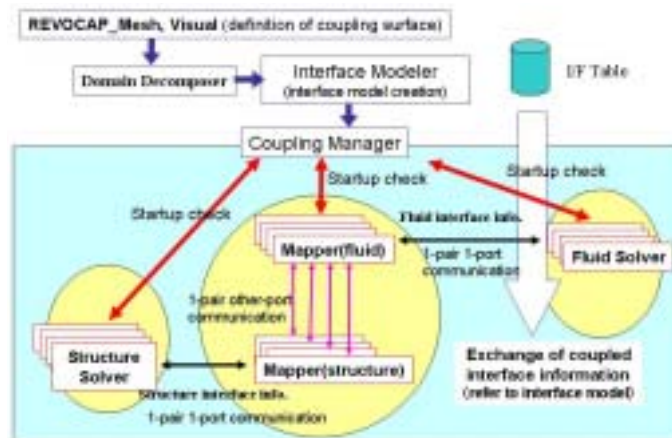
Fig.1 Coupling of Various Solvers on REVOCAP_Coupler

Fig.3 A Whole Analysis Process and Parallel Coupling with Mappers