Network-distributed aerodynamic analyses for the design optimization of WIG airfoils

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ABSTRACT

A network-distributed computing system was built using commercial software[1] and pc-platform for the optimal design of airfoils in ground effect. The aerodynamic analyses which take most of computational work during design optimization are divided into several lots and then allocated to associated PC sets through network. This is not a parallel process based on domain decomposition rather than a simultaneous distributed-analyses process using network-distributed computers.

The present analysis unit consists of three PCs in a set since a single evaluation of the Irodov's criterion[2] by finite difference requires three function evaluations while each evaluation needs a single pc-based aerodynamic analysis. The Irodov's criterion affects the static stability of airfoil in ground effect which plays a very important role in determining shapes of WIG(Wing In Ground Effect) airfoils. The number of design variables and selection of optimization algorithm are closely related to composing analysis jobs per lot. For example, for the design formulation of ten design variables[3] and SAO(Sequential Approximate Optimization)[4] with quadratic approximation, single design iteration requires 66 analysis sets where a single analysis set consists of three pc-based aerodynamic analyses. Hence these can be divided into 11 lot jobs if 6 analysis units consisting of 3 PCs(total 18 PCs) are available at once. The efficiency of computations can be maximized in this manner since it takes full advantage of PC resources with communication load minimized. However, parallel-computation formulation based on domain decomposition for optimization problem usually requires much more communication time and experiences unavoidable and increased load balancing burden in fine- or even coarse-grained computations mainly due to the aspect of repeated computations for optimization.

It was found that the network-distributed computing system[5,6] could become an alternative of efficient optimization framework instead of parallel processing system if analyses job could be divided and allocated in smart manner of minimizing communication load according to the selected optimization algorithm.

REFERENCES

[1] FLUENT Inc., (1998). "FLUENT 5 User's Guide".

[2] Irodov, R.D., (1974). "Criteria of Longitudinal Stability of Ekranoplan", Ucheniye Zapiski TSAGI, Vol. 1, No. 4, pp.63–74.

[3] Moon, J.–Y. and Joh, C.–Y., (2000). "Aerodynamic Shape Design Optimization Using NURBS", KSASS, Vol. 28, No. 8, pp. 8–15.

[4] Schmit, L. A. and Farshi, B., (1974) "Some Approximation Concepts for Structural Synthesis". AIAA Journal, Vol. 12, No.5, pp.692–699.

[5] Joh, C.–Y. and Lee, S.–K., (2004). "A Network-Distributed Design Optimization Approach for Aerodynamic Design of a 3-D Wing", KSASS, Vol. 32, No. 10, pp. 12–19.

[6] Joh, C.–Y., Kim, Y.–J. and Jung, H.–J., (2005) "A Study on the Efficiency of Aerodynamic Design Optimization Using Distributed Computation", JSASS-KSAS Joint Information Symposium on Aerospace Engineering, Nagoya Congress Center, JAPAN.