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Parallel Heat Transfer Analysis based on Multi-Frontal Solver considering Thermal Load Analysis

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Summary

This paper describes static and time transient heat transfer analysis developed for integrated analysis with thermal load analysis. As core solver of static and time transient heat transfer analysis code, domain-wise multi-frontal solver was used and in case of time transient analysis, generalized trapezoidal rule is implemented. Multi-frontal solver is based on domain-wise concept and the direct sub-structuring domain decomposition methods. Thus the solver doesn't need to assemble global stiffness matrix, whereas other direct solvers require assembling global stiffness matrix. IPSAP(Internet Parallel Structural Analysis Program) has been developed based on multi-frontal solver over a decade ago. IPSAP is able to solve linear static analysis and vibration analysis. In linear static analysis of IPSAP, thermal load analysis module is supported.

Temporal integration can be accomplished using the equation.

$$\{T\}_{n+1} = \{T\}_n + \Delta t \left\{ (1-\beta)\dot{T}_n + \beta \dot{T}_{n+1} \right\}$$

This equation contains a factor β that the analyst may choose. If the choice is $\beta = 0.5$, this equation is called the trapezoidal rule and have a unconditionally stable in linear problems; that is, numerical stability is guaranteed as Δt becomes indefinitely large.

Heat transfer analysis code is programmed considering parallel computation and has a powerful parallel computing performance as well as serial performance. On 16 CPUs, it has computing performance of 11 times compared with 1 CPU.

Finally, as carrying out static and time transient heat transfer analysis and thermal load analysis of IPSAP simultaneously, thermal-structure integration analysis will be able to be applied to structure design of real structure model, in example, satellite and semiconductor.

keywords: Domain-wise Multi-Frontal Algorithm, Parallel Computing, Thermal-Structure Integration Analysis

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