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A Parallel Computing Framework and a Modular Collaborative CFD Workbench in JAVA

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This paper addresses the growing usages of high performance computing in modern computational fluid dynamics to simulate the flow-induced vibrations of cylindrical structures necessary to enhance the Reactor Safety in Nuclear plants. The study is essential to prevent the damage of steam tubes causing an accident due to the release of reactor coolant containing radioactive materials out of the reactor system. After the accident of the SG tube rupture due to flow-induced vibration of the Mihama Nuclear Power Station Unit II, preventive measures of the recurrence of a SG tube rupture accident have been adopted. In this area of research, the computational efficiency is a major concern. The aim of this paper is to develop means for writing parallel programs and to transform shared-memory/sequential programs into distributed programs, in an object-oriented environment; thus facilitating programmers to develop parallel CFD codes to solve flow induced vibrations in Nuclear Reactors more quickly and efficiently thus preventing damages and shut-offs as well as accidents. In this approach, the programmer controls the distribution of programs through control and data distribution. The authors have defined and implemented a parallel framework, including the expression of object distributions, and the transformations required to run a parallel program in a distributed environment. The authors provide programmers with a unified way to express parallelism and distribution by the use of classes or packages storing active and passive objects. The distribution of classes/packages leads to the distribution of their elements and therefore to the generation of distributed programs. The authors have developed a full prototype to write parallel programs and to transform those programs into distributed programs with a host of about 12 functions. This prototype has been implemented with the Java language, and does not require any language extension or modification to the standard Java environment. The parallel program is utilized by developing a CFD workbench equipped with high end FEM unstructured mesh generation and flow solving tools enhancing easy analysis of fluid-induced vibrations of circular cylindrical tubes as well as other type of structures with an easy-to-use GUI implemented entirely on the parallel framework.

Summary

The central point of this project is the development of a parallel framework for developing FEM components ,FEM discretizations , adaptivity and multigrid solvers and their realization in a software package as shown, which directly includes tools for parallelism and hardware-adapted high-performance in low level kernel routines; completely platform independent. It is the special goal in this project to realize and to optimize the algorithmic concepts and to use them extensively for the solution and investigation of flow-induced vibrations or fluid structure interactions thus helping people to control Nuclear safety in plants .industrial zones etc.

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