理工学研究所
国際交流・公開研究セミナー

Dr. Alexander Popp（ドイツ ミュンヘン工科大学）が来日される機会に、最近その応用が注目されている計算力学手法の一つであるモルタル法について、基礎となる考え方とその数値流体力学および連成解析への応用に関してご講演をお願いしました。是非ご参集ください。

題　目： Mortar Methods for Computational Fluid Dynamics and Coupled Problems
講演者： Dr. Alexander Popp （ドイツ, ミュンヘン工科大学）
日　時： 2015年　9月　29日（火）　16:20 – 17:50
場　所： 中央大学　後楽園キャンパス 6号館 7階 6701号室

アブストラクト:

In the first part of this seminar, the coupling of computational subdomains with non-conforming discretizations will be addressed in the context of computational fluid dynamics (CFD) and stabilized finite element methods (FEM) for incompressible fluid flow. A mortar method using dual Lagrange multipliers is presented for handling the coupling conditions at arbitrary fluid–fluid interfaces. Recently, mortar methods have been successfully applied in nonlinear solid mechanics, for example to weakly impose interface constraints for finite deformation contact. The focus of this seminar is on both the mathematical foundation of mortar methods and the integration of a dual mortar approach into an existing FEM framework for CFD. In analogy to other problem classes, we exploit the fact that the dual mortar approach allows for an efficient condensation of the additional Lagrange multiplier degrees of freedom from the global system of equations. As a result, the typical but often-undesirable saddle-point structure of this system is completely removed. The proposed method is validated numerically for various three-dimensional examples, including a complex patient-specific aneurysm, and its accuracy and efficiency in comparison with standard conforming discretizations is demonstrated. In the second part of the seminar, we want to go beyond single-field CFD problems. First, the use of mortar methods for coupled multiphysics such as fluid-structure interaction (FSI) is highlighted. To be able to deal with non-conforming meshes directly at the FSI interface, we propose the integration of a dual mortar method into a general FSI framework based on the Arbitrary Lagrangian Eulerian (ALE) formulation. Finally, a special case of FSI problems is discussed: rotating structures embedded in ALE-based fluid domains What might seem like only a narrow part of all possible FSI problems, actually turns out to be one of great engineering interest (e.g. wind turbines). Recent work is presented that allows for arbitrarily shaped sliding interfaces within the fluid mesh. This, in turn, allows for a free rotation of structures without overly distorting the fluid elements. First qualitative results show that it is then possible to study arbitrary rotations of structures in fluids using the classical ALE formulation

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