COUPLING PROBLEM OF MULTIPHYSICS COMPUTATIONS ON FSI EXAMPLE WITH STRUCTURAL OPTIMIZATION

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The flow around body causes its strain. The numerical systems for analysis of that phenomena are intensively developed nowadays. The direction of development of fluid-structure interaction system is integration with the structure optimization. That problem involves three different fields: computational fluid-dynamics, structure analysis and optimization. The main aim is to build system which will coupled together the three above presented areas. The proposed system is a combination of both the aeroelastic and the structure optimization system developed at Division of Methods of Machine Design, Poznan University of Technology. The multiphysics system is based on loosely-coupled technique, meaning that each area is solved with separated, independent software. Therefore, a special procedures to exchange information between each problem are needed. It is done with coupling surface technique used by special prepared modules and tools. Due to difference in model description/discretization, different type of analysis, double coupling procedures are obligatory. The successful implementation of biomimetic optimization procedures into aeroelastic system will determine new topology design, which could not be estimated using static load on the surface of the structure only (Maute et al., 2004). It will allow to obtain better layout of inner structure than in the traditional optimization methods.

In this paper the two systems are coupled into one. First is the FSI system for aeronautical applications (Roszak et al., 2009) and the bio-inspired structure optimization system (Nowak, 2006). The second one is based on trabecular bone remodeling phenomena, where the strain energy density at the surface of the structure is constant. This system is able to compromise advantages of each shape, size and topology optimization methods. Hence, there are no restrictions and assumptions needed for optimal structure at the beginning of this process.

The main point of proposed multiphysics system is coupling method used to link each different field. The coupling surface is applied in this case – it is a part of structural model, which contains only the closest nodes (and connectivity matrix) to the boundary of structure and fluid. It allows to ensure proper nearest neighbor search and interpolation processes – it guarantees correct functionality of the system. The conservation of exchange quantities and efficiency of implemented procedures are also very significant.

Due to specific feature of presented multiphysics problem, some constraints for analyzed structure should be applied. These restrictions are helpful to control behavior of optimized structure. The future application of proposed system is to optimize aeronautical construction during fluid interaction. Therefore, the main assumption is to change only inner layout of construction. For instance, the main aim of wing is to produce lift force. Hence, the outer surface must be preserved.

In this paper the coupled method of biomimetic structure optimization process and fluid-structure interaction analysis is presented. The proposed idea is demonstrated at selected test case.

References

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