A thermo-fluid-structure interaction approach based on an immersed interface method and on a monolithic thermo-structure interaction approach

Abstract:
A coupled thermo-fluid-structure interaction approach, consisting of a finite volume scheme for the fluid and a finite element scheme for the thermo-structure interaction (TSI) problem, is proposed. Both schemes enable a fast, efficient and robust solution of the respective numerical problems. The compressible Navier-Stokes equations are solved on a Cartesian grid and a conservative immersed interface method is used to describe the flow boundaries. The fluid is solved by adopting a 5th order weighted essentially non-oscillatory (WENO) scheme for the discretisation of the convective fluxes. A 2nd order central difference scheme is used for the diffusive fluxes, while a 3rd order Runge-Kutta scheme is adopted for the integration in time. The TSI problem is based on separate discretisations of the structural and thermal fields, both using finite element technology. For the monolithic TSI problem, an iterative solver (GMRES) and a block Gauss-Seidel preconditioner with algebraic multigrid methods is used.
one-step-µ time-integration scheme is used for temporal discretisation. We present a loosely-coupled approach for the solution of the thermo-fluid-structure interaction problem, based on Dirichlet-Neumann partitioning. Special attention is given to the transfer of forces, temperatures and to the structural positions. The structural surface is represented by a level set function in the fluid code. The velocity and temperature field required for the coupling are interpolated from structural values on the zero-contour level set surface. Data transfer between the two codes is performed via message passing interface. The proposed method is tested for a cooling-process of a heated metal bar by mean of an external laminar boundary layer flow. Results show that the presented approach is able to handle the complexity of the three-field problem.

Stichworte:
Thermo-fluid-structure interaction; loosely coupled algorithm; immersed boundary method; monolithic thermostructure interaction

Dewey Dezimalklassifikation (Liste):
620 Ingenieurwissenschaften

Kongress- / Buchtitel:
Proceedings First ECCOMAS Young Investigators Conference

Kongress / Zusatzinformationen:
YIC2012

Jahr:
2012

Revied:
ja

Sprache:
en

Publikationsform:
CD-ROM / DVD

Semester (für SAP-Datenerfassung):
WS 12-13

Occurences:
Einrichtungen > Fakultäten > Fakultät für Maschinenwesen > Institut für Werkstoffe und Verarbeitung > Lehrstuhl für Numerische Mechanik (Prof. Wall) > Inproceedings > 2012

entries: