6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Variational space-time formulations for non-linear problems

Christian Hesch[1], Maik Dittmann[1], Stefan Schuß[1], S. Eugster[2], M. Favino[3] and Rolf Krause[3]

[1] University of Siegen, Paul-Bonatz-Straße 9-11, 57076 Siegen, Germany,
christian.hesch@uni-siegen.de, http://www.mb.uni-siegen.de/nm/
[2] University of Stuttgart, Pfaffenwaldring 9, 70569 Stuttgart, Germany
[3] Universita della Svizzera italiana, Via Giuseppe Buffi 13, 6900 Lugano, Switzerland

Keywords: *Non-linear mechanics, space-time elements, large-scale problems.*

In the present contribution, we introduce a new Galerkin based formulation for transient continuum problems, governed by partial differential equations in space and time, see [1] for details. Therefore, we aim at a direct finite element discretization of the space-time, suitable for massive parallel analysis of the arising large-scale problem. To be specific, a Bubnov-Galerkin approach with continuous finite elements in the whole space-time is used, i.e. we apply the same shape functions for the solution as well as for the test functional space.

We will present in detail the application to mechanical systems, using a direct discretisation of Hamilton's principle of varying action in the Hamiltonian framework. This approach has already been addressed in the fundamental papers of Emmy Noether within a continuous setting. This allows us to formulate the system in a variationally consistent way in the discrete space, hence we can demonstrate all necessary conservation properties of the different systems under consideration.

For two-dimensional problems in space, existing multigrid solvers for three-dimensional problems can be applied directly to solve the arising, massive large-scale problem. Eventually, we aim at further developments in structural mechanics as well as in optimal control, since the variationally consistent formulation in space and time allows for new designs of the discrete systems.

REFERENCES

[1] C. Hesch, S. Schuß, M. Dittmann, S.R. Eugster, M. Favino and R. Krause. Variational space-time elements for large-scale systems. Comput. Methods Appl. Mech. Engrg., 326:541-572, 2017.