Dual weighted residual method based error indicators for the local choice of the Finite Element

Andreas Rademacher[1] Dustin Kumor[2]

The contribution at hand deals with locking effects within the simulation of problems with local regions of nearly incompressible material behaviour and the possibility to cope with these difficulties by an adaptive choice of the finite element. Here, we consider the problem of linear elasticity, which is discretised with standard bilinear finite elements. It is a well known fact, that this kind of discretisation leads to locking phenomena in the case that Poisson's ratio is close to 0.5. The modification of the continuous bilinear form on the discrete level is one possibility to overcome the drawback of the initial formulation. We discretise the bilinear form by using a discrete divergence operator leading to the discretised bilinear form, which is realised by applying a one point Gaussian quadrature rule for the corresponding scalar product. This approach is known as selective reduced integration.

The discretisation error with respect to a user defined quantity of interest can be estimated applying the dual weighted residual (DWR) method. Since the discrete solution is computed by using a modified discrete bilinear form, the standard approach of the DWR method is not applicable and needs to be modified. We derive an error identity involving some additional terms due to the different bilinear forms and discuss the numerical approximation of it, which has to be handled with special care.

A further aim is to consider the adaptive local choice of the bilinear form to compute the element matrix. The adaptive choice of the bilinear form on element level describes a problem with model adaptive character. We use the DWR method to estimate the difference between the two arising discretisation errors. Finally, numerical results substantiate the accuracy of the presented error estimator and the efficiency of the adaptive algorithms.

References:

[1] D. Kumor, A. Rademacher: Goal-oriented a posteriori error estimates in nearly incompressible linear elasticity. In F. A. Radu, K. Kumar, I. Berre, J. M. Nordbotten and I. S. Pop, Editors, Numerical Mathematics and Advanced Applications, ENUMATH 2017, Springer, pp. 399-406, 2019

[2] D. Kumor, A. Rademacher: Goal oriented a posteriori error estimators for problems with modified discrete formulations based on the dual weighted residual method. Submitted to Journal of Numerical Mathematics

[1]Technische Universität Dortmund, Faculty of Mathematics, Chair of Scientific Computing (LSX)
Andreas.Rademacher@tu-dortmund.de

[2]Technische Universität Dortmund, Faculty of Mathematics, Chair of Scientific Computing (LSX)
Dustin.Kumor@tu-dortmund.de