Primary and Derived Variables with the Same Accuracy in Interval Finite Elements

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Keywords: *Interval; Uncertainty; Dependent Variables; Derived; Finite Elements.*

Abstract

One of the main challenges in interval computations is to minimize the overestimation in the target quantities. When sharp enclosures for the primary variables are achievable in a given formulation such as the displacements in Interval Finite Elements (IFEM) the calculated enclosures for secondary or derived quantities such as stresses usually obtained with significantly increased overestimation.

Usually, the derived quantities of the form $s = S(u)$ are dependent linearly or nonlinearly on the solution u of the uncertain system. One should follow special treatment in order to decrease the overestimation in the derived quantities see Muhanna, Zhang, and Mullen (2007), Neumaier and Pownuk (2007).

In this work we introduce a new formulation for Interval Finite Element Methods where both primary and derived quantities of interest are included in the original uncertain system as primary variables. The formulation is based on the variational approach and Lagrange multiplier method by imposing certain constraints that allows the Lagrange multipliers them-selves to be the derived quantities.

Numerical results of this new formulation are illustrated in a number of example problems.

References

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