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SECOND ORDER DENSITY BASED NONLINEAR TOPOLOGY OPTIMIZATION USING A HIGH LEVEL WEAK FORM LANGUAGE

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High level frameworks, based on a weak form language, aim at simplifying the finite element modelling of nonlinear problems, and they are available as both open-source and commercial software. The Generic Weak Form Language (GWFL) is the language used for this purpose in the open-source finite element library GetFEM [1]. The present work elaborates on a recently published topology optimization formulation which is expressed entirely in the GWFL, including the necessary adjoint analysis [2].

The automated derivation of the tangent system, available in GetFEM, remarkably simplifies the implementation of the proposed method, which comprises an adjoint analysis and an optimization procedure that retains second order information. The proposed formulation is defined as a nonlinear system of coupled PDEs

$$\begin{aligned} R_{\text{struct}}(\chi, u) &= 0 \\ R_{\text{adj}}(\chi, u; \lambda_u) &= 0 \\ R_{\text{opt}}(\chi, u; \lambda_u) &= 0 \end{aligned}$$

written in weak form in the GWFL. The design variable field χ, the continuum mechanics displacements field u, and the adjoint variable field λ_u are all found simultaneously by a monolithic Newton solution, using the consistent tangent matrix of the entire coupled system. This is a fundamentally different approach compared to a staggered solution of the system, where normally only first order information is used for performing design updates according to the third equation, which expresses optimality.

REFERENCES

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