A modular nonlinear stochastic finite element formulation for uncertainty estimation in contact mechanics.

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The Monte Carlo method has been widely used for the estimation of uncertainties in mechanical engineering design. However, while extremely flexible, this method remains impractical in terms of computational time and scalability. To bypass these limitations, other more efficient approaches such as the Galerkin stochastic finite element method (GSFEM) or the collocation method have been proposed. GSFEM, pioneered by Spanos and Ghanem [1], provides accurate statistics of the output, has the advantage of being sampling-independent and can be modular in terms of operations, albeit code intrusive. While linear elasticity has been extensively covered in the literature, the application of GSFEM to nonlinear mechanical behaviour remains relatively unexplored [2]. Our preliminary work focuses on a seamless and efficient modular framework avoiding the need to know a priori the material law. In particular, we i) make use of a hybrid formulation to capture discontinuous behaviours, illustrated here with a 3D application, and ii) extend the GSFEM to a generic half-plane contact problem where the distribution of shear and normal forces were determined, independently, by Cattaneo and Mindlin [3]. The contact is modelled through boundary conditions, where randomness of parameters, such as friction coefficient, is incorporated in the stochastic formulation. The evolution of output quantities (such as displacement) at the slip-stick transition is then investigated. The results show that the proposed framework is able to capture uncertainties in complex problems such as contact with a fraction of the computing cost of traditional methods.

REFERENCES


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