A COMPARISON OF DIFFERENT METHODS FOR CALCULATING TANGENT-STIFFNESS MATRICES IN A MASSIVELY PARALLEL COMPUTATIONAL PERIDYNAMICS CODE

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Abstract:
In order to maintain the quadratic convergence properties of Newton's method in quasi-static nonlinear analysis of solid structures it is crucial to obtain accurate, algorithmically consistent tangent-stiffness matrices. A goal of the study described in this thesis was to establish the suitability of an underexplored method for numerical computation of tangent-stiffness operators, referred to as "complex-step", and compare the new method with other techniques for numerical derivative calculation: automatic differentiation, forward finite-difference, and central finite-difference. The complex-step method was newly implemented in a massively parallel computational peridynamics code for the purpose of this comparison. The methods were compared through in situ profiling of the code for accuracy, speed, efficiency, and parallel scalability. The research provides data that can serve as practical guide for code developers and analysts faced with choosing which method best suits the needs of their application code. Additionally, motivated by the reproducible research movement, all the of the code, examples, and workflow to regenerate the data and figures in this thesis are provided as open source.

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