Fracture Analysis Using Reconfigurable Computing Systems

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Abstract:

The fracture mechanics analysis determines if the small flaws in structural components will grow into large enough cracks to cause them to fail catastrophically. An accurate finite element analysis is needed so that the strain-energy-release components can be calculated from the local forces and displacements around the crack tip. Complex fracture mechanics problems demand very high computing power. In this paper, we describe a novel approach of using reconfigurable computing for solving such problems. We have implemented FRACT3D, our own developed fracture mechanics code running on a host machine attached with a reconfigurable platform. This code has an equation solver block consisting mainly of Cholesky factorization, a computationally intense routine having complexity of (1/3)n^3 flops and forward-backward substitution steps. The Cholesky factorization and forward-backward substitution modules are developed as double precision hardware library elements. During FRACT3D execution, calls to the factorization or substitution routines on the reconfigurable hardware are made to provide acceleration. We have compared the performance of FRACT3D code when running exclusively on the host machine with the code running on the host and calling the Cholesky factorization/substitution steps implemented on the RCS. Results with the RCS enabled solution are encouraging and found to have speedup upto 16 times.