Peridigm: A New Paradigm in Computational Peridynamics

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Peridynamics is a nonlocal extension of classical solid mechanics suitable for modeling the failure and fracture of engineering materials. The classical theory of continuum mechanics is based on partial differential equations. These equations do not hold on crack surfaces and other singularities, as partial derivatives are not defined at discontinuities. In the classical theory, cracks are regarded as a pathological solution requiring special treatment. In contrast, the peridynamic theory is based on integral equations, for which discontinuous functions present no difficulty. By utilizing integral equations, the peridynamic theory avoids the need for the special techniques of fracture mechanics. In peridynamics, cracks are just another kind of solution and require no special treatment.

We provide an overview and introduction to Peridigm, a new open-source massively parallel code for computational peridynamics. We survey the capabilities of Peridigm, showing demonstration computations and highlighting several applications. We then discuss the numerical techniques used in Peridigm to solve the integro-differential equations of peridynamics, and end by presenting our current and future development directions.