Graduate Colloquium, Aerospace Engineering

WPI

Power of Accurate Differentiation through Integration: Peridynamic differential Operator

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Peridynamic (PD) differential operator (PDDO) converts the existing governing field equations from their local to nonlocal form while introducing an internal length parameter. The PDDO enables differentiation through integration. As a result, the equations become valid everywhere regardless of discontinuities. The lack of an internal length parameter in the classical form of the governing equations is the source of problem when addressing discontinuities. Although the PD theory is extremely suitable to model the response of structures involving crack initiation and propagation at multiple sites, with arbitrary paths, it is also applicable to other field equations involving phase change arising from corrosion and electrodeposition.

Furthermore, it is applicable to hyperbolic equations for which the solution does not smooth out with time and discontinuities persist such as a shock wave. Lastly, the PDDO enables the evaluation of derivatives of any order in a multi-dimensional space and provides a unified approach to transfer information within a set of discrete data, and among data sets. This presentation provides an overview of the PD concept, the derivation of the PDDO, and applications concerning data reduction and recovery, solutions to complex partial differential equations, failure prediction in structural materials under complex loading conditions.

Brief Bio: Erdogan Madenci has been a professor in the Department of Aerospace and Mechanical Engineering at the University of Arizona since 1989. Prior to joining the University of Arizona, he worked at Northrop Corporation, Aerospace Corporation, and the Fraunhofer Institute. Also, he worked at the KTH Royal Institute of Technology, NASA Langley Research Center, Sandia National Labs, MIT and the University of Oxford as part of his sabbatical leaves. He is the lead author of six books on Peridynamics (available in Chinese and Persian) and Finite Element analysis. He serves as the Editor-in-Chief of the Journal of Peridynamics and Nonlocal Modeling and an Associate Editor of ASME Open Journal of Engineering. He is a Fellow of ASME and an Associate Fellow of AIAA.