Abstract for 26 June 2017, Samui, Thailand

A Two-Scale Generalized Finite Element Method for Computational Fracture Mechanics Analysis

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The main feature of partition of unity methods such as *hp*-cloud and generalized or extended finite element methods is their ability of utilizing a priori knowledge about the solution of a problem in the form of enrichment functions. Linear combination of partition of unity shape functions can reproduce exactly any enrichment function and thus their approximation properties are preserved. Due to this reproducing property, the generalized finite element method has been applied to many classes of problems where a priori knowledge about the solution exists such as modeling of cracks, inclusions and microstructures. However, analytical derivation of enrichment functions with good approximation properties is mostly limited to two-dimensional linear problems. In this work, we propose a procedure to build enrichment functions to overcome this limitation. It involves the solution of local boundary value problems using boundary conditions from a global problem defined on a coarse discretization. The local solutions are in turn used to enrich the global space using the partition of unity framework. This procedure allows the use of a coarse and fixed global mesh for any configuration of local features and this enables efficient solution of problems with multiple local features. It is also appealing for problems with localized nonlinearities since computationally intensive nonlinear iterations can be performed on coarse global meshes. The parallel computation of local solutions can be straightforwardly implemented and large problems can be efficiently solved in massively parallel machines with this approach.

Experience:

Dae-Jin Kim is an Associate Professor in the Department of Architectural Engineering at Kyung Hee University, Korea. He received his B.S. and M.S. in Architectural Engineering from Seoul National University in Korea in 1998 and 2000, respectively, and his Ph.D. in Civil and Environmental Engineering from the University of Illinois at Urbana-Champaign in USA in 2009. He worked as a nuclear power plant structural engineer at AREVA NP Inc. between 2009 and 2010.

His research interests include the Generalized/Extended finite element simulations, massively parallel computation tools for large and complex structures, development of efficient steel-concrete composite systems and design and analysis of modular steel frame connections. His research group currently performs an intensive collaborative research with many industrial partners, especially structural steel product manufacturers in Korea.

To date, Dr. Kim has published more than 40 scientific articles and book chapters. He has papers featured on the ScienceDirect Top 25 Hottest Articles of Computer Methods in Applied Mechanics and Engineering and Engineering Fracture Mechanics. Two of his papers appeared on the list of the top five most downloaded articles of Computational Mechanics. He received the Best Teaching Award from the School of Engineering at Kyung Hee University in 2012, and the Prominent Young Researcher Award from the Computational Structural Engineering Institute of Korea in 2014. Since 2012, he has been actively participating in the International Multi-Conference on Engineering and Technology Innovation organized by Taiwan Association of Engineering and Technology Innovation and is currently a program committee member of the conference.