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GRANULAR AND MULTIPHASE FLOWS

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The Granular Science Laboratory

Prof. Glaucio Paulino

Donald & Elizabeth Willett Endowed Professor of Engineering

Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

Wednesday, Nov. 14, 2012 2:30 – 4:00 p.m.

Mechanical Engineering Center 224

Topology Optimization: Theory, Computations and Novel Applications

This presentation describes some recent advances in topology optimization. Some theoretical arguments are made with respect to classical density methods and implicit function methods (e.g. level set, phase-field). The implementation of such methods is addressed and a general topology optimization framework using unstructured polygonal finite element meshes is addressed. For large scale problems, the computational bottleneck of topology optimization is the solution of a large number of linear systems arising in the finite element analysis. When using iterative solvers, we observe that the linear systems in the sequence of optimization steps change slowly from one step to the next, and thus we can significantly reduce the number of iterations and the runtime of the linear solver by recycling selected search spaces from previous linear systems. Thus we discuss a version of the minimum residual method version with recycling (and a short-term recurrence) to make recycling more efficient for symmetric problems. The applications addressed involve diverse fields such as bio-inspired design of innovative building systems and design of patient-specific large craniofacial segmental bone replacements. Topological optimization for designing facial bone tissue replacements might improve current clinical methods and provide essential enabling technology to translate generic bone tissue engineering methods into specific solutions for individual patients.

Professor Paulino is the "Donald and Elizabeth Willett" Endowed Professor of Engineering at the University of Illinois at Urbana-Champaign (UIUC). He joined the Civil and Environmental Engineering Department (CEE) as an Assistant Professor in 1999, was promoted to Associate Professor in 2001, and to Full Professor in 2005. From 2009 to 2011 he was director of the "Mechanics of Materials" program at the National Science Foundation. He was also acting director of the "Nano and Biomechanics" program at NSF. His seminal contributions in the area of computational mechanics include development of methodologies to characterize the deformation and fracture behavior of existing and emerging materials and structural systems. His recent work spans topology optimization for large-scale multiscale/multiphysics problems. He has devoted significant efforts to increasing collaborative work between the scientific communities in mechanics and materials from the U.S. and developing countries through a series of workshops funded by the National Science Foundation, including events in Brazil (2002, 2003 and 2004), South Africa (2005) and Argentina (2006). His other honors include appointment as the Burton and Erma Lewis Faculty Scholar (2001), the Xerox Award for Faculty Research (2003), the MTS Visiting Professorship Chair in Geomechanics from the University of Minnesota (2004), the Walter L. Huber Civil Engineering Research Prize (2004) from the American Society of Civil Engineers, Visiting Professor appointments at the University of São Paulo (2004, 2005 and 2008), election as Chairman of the International Conference on Functionally Graded Materials (FGM 2006), and fellow of USACM (2011). His contributions to the permanent scientific literature include more than 150 scholarly publications in top peer-refereed international journals, and a new book on *The Symmetric Galerkin Boundary Element Method,* which has just been published by Springer-Verlag (2008). He has given many national and international invited, keynote, and plenary lectures, and has been a successful engineering consultant to several private and federal institutions. More information about his research and professional activities can be found at the following url: http://www.ghpaulino.com

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