PRISM
NNSA Center for Prediction of Reliability, Integrity and Survivability of Microsystems

PRISM Seminar Series – Spring 2010

PURDUE UNIVERSITY Discovery Park

"Fully-Conserving Integration Schemes in Lagrangian Mechanics"

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Thursday, April 8, 2010 at 11:00 A.M. in Birck - Room1001

Abstract: We present two integration schemes for Lagrangian mechanics, referred to as *energy-stepping* and *force-stepping* integrators, that are symplectic, momentum and energy conserving, time-reversible and convergent with automatic selection of the time-step size. All the momentum maps of the original system are exactly conserved by energy-stepping and are approximately conserved by force-stepping---exact conservation may additionally be achieved by recourse to Lagrangian reduction. In order to achieve these properties we replace the Lagrangian of the original system by a sequence of approximate Lagrangians that can be *solved exactly*. The energy-stepping scheme is obtained by replacing the original potential energy by a piecewise constant, or *terraced* approximation at steps of uniform height. The force-stepping scheme is obtained by replacing the potential energy by a piecewise affine approximation over a regular triangulation. By taking steps (triangulations) of diminishing height, an approximating sequence of energies is generated. The trajectories of the resulting approximate Lagrangians can be characterized explicitly and consist of intervals of piecewise rectilinear (parabolic) motion. Selected examples of application demonstrate the excellent long-term behavior of both integration schemes, their automatic time-step selection property, and the ease with which they deal with contact problems.
This work is in collaboration with Michael Ortiz (Caltech) and Bernd Schmidt (TUM).

Bio*:* Marcial Gonzalez is a graduate student in Aeronautics, with a minor in Materials Science, at the California Institute of Technology, under the supervision of Professor Michael Ortiz. His research interests include the development of numerical methods and theoretical models that provide new insight into the dynamic behavior of materials and structures. His Ph.D. research involves the development of fully-conserving time integration schemes that cope with the shortcomings of traditional time- integrators in Lagrangian mechanics. He is a Mechanical Engineer from the University of Buenos Aires, Argentina, and received a MS in Aeronautics from Caltech.

Prior to beginning his doctoral graduate studies, he worked five years as a research engineer at the Computational Mechanics Department of Tenaris R&D center in Argentina.