19th International Conference on Computational Statistics

Paris - France, August 22-27, 2010

COMPSTAT'2010 Book of Abstracts

Conservatoire National des Arts et Métiers (CNAM)

and

the French National Institute for Research in Computer Science and Control (INRIA)

Stochastic Newmark Schemes for the Discretization of Hysteretic Models

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Abstract. The need to study and to obtain digital solutions of stochastic nonlinear differential equations is a common situation in Seismic Engineering. This is the case for the hysteretic models. These models do not have an exact solution and can only be approximated by numerical methods. We discretize the solutions using the stochastic improved Euler scheme and the three parameter implicit stochastic Newmark schemes: a higher order and a lower order Newmark scheme. In the case of hysteretic models subjected to gaussian white noises, we were able to reduce the problem of approximating the solution to that of a linear system in each time step avoiding the Newton–Raphson method in the same time steps. This allowed us to save computational effort in the approximation of the response of the hysteretic system and was achieved by giving explicitly the value of one of the parameters in the equation of the Newmark scheme that corresponds to the hysteretic variable while keeping the equations of the displacement and velocity implicit. We compare the performance of these two implicit Newmark schemes. In the simulation study for the Bouc-Wen model, we compare the solutions produced for the specific choice of the parameters ($\alpha = 0.5$, $\beta = 0.5$) which are the values used by Roy and Dash(2005) in the case of linear systems. We conclude that the standard deviation of the displacement obtained from the proposed higher order Newmark scheme is larger than that obtained from the proposed lower order Newmark scheme. The proposed lower order Newmark scheme is computationally atractive to compete with the improved Euler scheme.

Keywords: Stochastic Differential Equations, Newmark schemes, Hysteretic models

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