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BOOK REVIEW

Christine Hrenya

Computational Granular Dynamics - Models and Algorithms, Thorsten Pöschel and Thomas Schwager, Springer, 2005

In this very readable text by Pöschel and Schwager, a host of methods available for the discrete-particle simulation of granular materials is covered. The introductory chapter (Chapter 1) provides the motivation for such simulations via an illustrative example that also emphasizes the complementary roles of experiments and physical understanding in the overall system analysis. The two most prevalent approaches to discrete-particle simulations, namely force-based (Chapter 2) and event-driven simulations (Chapter 3), are then discussed in great detail. The reader is first introduced to these methods conceptually, followed by a presentation of the corresponding algorithms in both equation form and C++ programs. Discrete Simulation Monte Carlo (Chapter 4) and rigid-body dynamics (Chapter 5) are covered to a slightly smaller extent in the following chapters. The final chapters on lesser-used techniques, specifically cellular automata (Chapter 6), bottom-to-top reconstruction (Chapter 7), and Brownian dynamics for the simulation of granular flows (Chapter 8), are more cursory in nature, but nonetheless serve as a basic introduction to the uninitiated reader. Instructive examples are presented throughout.

This book is expected to be of great benefit to those who are interested in developing their own discrete-particle simulations, but who have little, if any, previous experience. First, a series of C++ codes is given for each of the basic algorithms. The programs are written in a simple manner such that they are accessible to a reader familiar with basic programming, even without direct experience in C++. These programs, which are available for download at http://bio-inf.charite.de/cgd/, are modular in nature and thus can be mixed-and-matched to suit individual needs (sphere vs. triangular particles, simple collision search vs. accelerated search, etc.). Second, the authors provide valuable information on many of the subtleties associated with performing discrete-particle simulations: the challenges associated with applying DSMC to non-homogenous systems, the occurrence of inelastic collapse in event-driven simulations, the pros/cons of various force models, the non-intuitive behavior arising from a simplistic heated-wall boundary condition, etc. Information on some open issues does not appear - e.g., the practice and impact of using an artificially soft spring constant in soft-sphere models, the relative value of two and three-dimensional simulations - though the number of such omissions is few. One broader topic area that is not covered in the text is data extraction, namely the collection of velocity distributions, force chains, and constitutive quantities for continuum models (e.g., stress tensor), etc.

In summary, this work fills a void in the textbook treatment of discrete-particle simulations for granular flows. The text provides the reader with the basic knowledge and tools needed to perform simple simulations and to add complexity as needed. It is expected to be of pedagogical benefit for students as well as a valuable resource for researchers with interests and/or activity in this area.

C. Hrenya
Department of Chemical and Biological Engineering,
University of Colorado
E-mail: hrenya@colorado.edu