Abstract

Nuclear Science and Technology Division (94)

AUTOMATED VARIANCE REDUCTION APPLIED TO NUCLEAR WELL-LOGGING PROBLEMS

John C. Wagner
Oak Ridge National Laboratory,[*] P.O. Box 2008, MS-6170, Oak Ridge, TN 37831, USA

For submission to
ICRS-11
11th International Conference on Radiation Shielding
&
RPSD-2008
15th Topical Meeting of the Radiation Protection & Shielding Division of ANS
April 13–18, 2008
Callaway Gardens, Pine Mountain, Georgia, USA

The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-00OR22725. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

[*]Managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.

AUTOMATED VARIANCE REDUCTION APPLIED TO NUCLEAR WELL-LOGGING PROBLEMS

John C. Wagner
Nuclear Science and Technology Division, Oak Ridge National Laboratory,[*]
P.O. Box 2008, Oak Ridge, Tennessee 37831-6170, United States of America

Purpose: The Monte Carlo method is considered to be the most accurate method available for solving complex radiation transport problems. However, due to its nature, the Monte Carlo method is very computationally intensive for simulating deep-penetration problems. For difficult problems, such as nuclear well-logging tool simulations, some effective means of variance reduction must be used. The purpose of this paper is to apply the CADIS (Consistent Adjoint Driven Importance Sampling) methodology for automated variance reduction, as implemented in the ADVANTG (Automated Deterministic VAriaNce reducTion Generator) code, to representative models of neutron porosity and gamma-ray lithology-density tools and then evaluate the results. Additionally, the newly developed Forward-Weighted CADIS (FW-CADIS) method is applied to demonstrate its effectiveness for simultaneous optimization of multiple detectors (e.g., near and far detector responses) in a single simulation.
Methods and Materials: The ADVANTG code has been developed for general automated variance reduction based on three-dimensional discrete-ordinates adjoint functions and reliable variance reduction techniques. ADVANTG automatically generates consistent source biasing and mesh-based weight window lower bounds for MCNP(X). The FW-CADIS method is a newly developed variation of the CADIS method that involves a forward-weighted adjoint source to optimize global distributions (e.g., space-dependent dose and energy-dependent flux distributions), as well as semi-global distributions (e.g., response at multiple localized detectors).
Results: The computational speedups achieved for optimization of individual detector responses are dependent on which detector (near or far) was chosen for optimization; speedups of ~40/100 and ~400/3000 for the near/far detectors for the neutron and gamma-ray tools, respectively, were achieved. The FW-CADIS results demonstrate that significant speedups for both near and far detectors can be achieved simultaneously.
Conclusions: The FW-CADIS method can be used to simultaneously optimize the calculation of multiple detector responses, such as those needed in nuclear well-logging tool simulations.

[*]Managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.