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HYBRID GEOMETRY REPRESENTATIONS IN MONTE CARLO RADIATION TRANSPORT

Matthew Ryan Martin
Kansas State University
Leonard Lorence, Manager (Org. 15341) Brian Franke, Technical Advisor

Input geometry and detector definitions constitute the majority of the setup time for a Monte Carlo radiation transport simulation. Traditionally, Monte Carlo radiation transport codes define their input geometries and detectors through combinatorial geometry (CG) representations which are constructed from Boolean combinations of primitive geometries. CG representations allow for fast ray query and localization operations on the model, but are difficult to construct for complex topologies. Complex geometries are usually available in a Computer Aided Design (CAD) boundary representation (B-REP) format. However, ray shooting and localization operations B-REP geometries range from two to four orders of magnitude slower than the corresponding CG representation. Engine1 is a new radiation transport geometry engine that allows for any CAD, facetted, or CG representation to simultaneously exist in a simulation. Additionally, it allows for automatic detector subzoning by hybridizing surface representation topologies with volumetric unstructured meshes of convex polyhedral elements defined by the Exodus II format. Borrowing techniques from ray tracing and 3D game engine design, all of the geometric representations in the simulation are encapsulated in their axis aligned bounding box and stored in an efficiency grid structure. The efficiency grid structure allows for ray query times to scale logarithmically with the number of entities in the simulation. The end result is a geometry engine which, for example, can directly read PRO/ENGINEER, ACIS, Stereolithography, and CG geometries while volumetrically subzoning all representations with an unstructured Exodus II mesh.

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