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B2G4: A synthetic data pipeline for the integration of Blender models in Geant4 simulation toolkit.

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Particle simulation software is essential for the development and validation of theoretical prototypes in a myriad of physical appplications. The Geant4 simulation toolkit provides precise particle transport and matter interaction simulations in a controlled setting. The interpretation of simulated results is intimately linked to the level of detail represented in the simulation itself, including the ability of the simulation framework to create detailed geometries. Yet, rendering such highly detailed geometries is a daunting task in Geant4, where high-variance scenes must often be manually coded. Potential geometrical errors increase the time required for this coding procedure, and thus in-depth knowledge of the underlying simulation engine in Geant4 is needed.

This research proposes Blender2Geant4 (B2G4), a novel framework which transplants 3D scenes from Blender into Geant4 for synthetic data generation. This was achieved by synergizing the descriptive 3D modelling tools in Blender with the simulation capabilities of Geant4. The ability to import, arrange, and manipulate 3D objects in Blender permits the creation of highly detailed and varied scenes: users can easily create sophisticated geometries by using drag-and-drop placement, shape variance randomization, and intuitive material assignments. The suite of functionalities defined in B2G4 lexically translates geometry facets from Blender into a readable format for Geant4, enabling the automated export and import of scenes with minimal manual input. Hence, the B2G4 framework enables automated mass production of corrected 3D scene variations with precise annotations and geometrical consistency checks. The B2G4 framework is designed as an all-purpose geometry creation interface to reduce the complexity of simulation scenes in Geant4 for a variety of physical applications. The applicability of B2G4 in a muon tomography setup is highlighted with a set of procedurally generated 3D scenes.