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LARGE-SCALE MESHING AND DATA MANAGEMENT FOR THE COMPUTATIONAL TESTBED

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ABSTRACT

In an effort to improve synthetic thermal imagery for remote sensing technologies, a suite of closely coupled numerical simulators has been developed. This platform includes thermal and moisture transport finite element models, coupled with solar and vegetation models. It is well suited for simulations of specific controlled scenarios, in particular meteorological and time-of-day conditions, which otherwise might be difficult and time consuming to reproduce in the field. This suite serves as a compliment to, rather than a replace for, field and laboratory testing of remote sensors.

These numerical simulations have different requirements than some more traditional finite element simulations for the types and treatment of data. Hundreds of scenarios with different subsoil domains, as well as different configurations of vegetation, will be simulated. This requires the rapid and robust production of finite element meshes of the shallow subsurface for the moisture and thermal codes. The meshes need to include natural and manmade objects to achieve realism and relevancy, e.g. rocks and unexploded ordinance. This work will, in part, focus on the mesh generation process, which has been achieved by taking advantage of open source (black-box) mesh generation software, and a post-process, mesh smoothing technique to ensure quality elements in the final tetrahedral mesh. In addition, the process allows for the inserted objects to be either buried, flush with or protruding from the ground surface. A simple mesh repair operation around the objects is utilized to avoid poorly shaped tetrahedra in these regions. When desired, sub-surface soil regions can be assigned as a post-process step. This ability extends to statistically generated soil distributions using site-specific information obtained from soil samples.

A typical scene might be a (10m x 10m x 1m) domain with 1.5M tetrahedral elements, 300k nodes, and contain 20 or more objects. Various input data are needed to correctly assign geometry and material properties to the domain. This presentation will also focus on the process of moving from raw LIDAR data and object meshes to the final tetrahedral mesh, with attention given to the smoothing algorithm and the treatment of objects inserted into the domain.

Furthermore, the storage of simulation results becomes burdensome at this scale. This is true, as well, for the storage of material parameters such as the thermal properties for various metals and plastics which are needed as input for each simulation. These storage and management issue will also be addressed.

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