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ISSUES IN MULTI-SPECTRAL RAY TRACING FOR THE COMPUTATIONAL TESTBED

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ABSTRACT

The ray caster is a critical component of the computational suite to produce high-resolution synthetic thermal imagery of vegetated soil surfaces. The testbed is organized around the ray caster model, which directs the flow of energy among the entities of the model components. Direct and indirect solar energy is cast to all exposed surfaces and define the incident energy for the vegetation and ground models. Radiant energy emitted from surfaces is cast to neighboring surfaces. Reflected and emitted energy is cast to the sensor. The ultimate product of the ray caster is an ideal high-resolution near-surface image that is sampled by the (presumably lower-resolution) sensor model.

The ray caster carries information about the surface geometry of all entities in the test bed. The vegetation and ground models provide to the ray caster data in the form of three-vertex facets that define all surfaces and the materials that make up those surfaces. The ray caster assembles the facet data from each model component into a master description. The vegetation model depicts translucent leaves by facet pairs, whereby the portion of the energy not reflected can be transferred to the twin facet as transmitted energy. Data on direct and indirect solar loading, sun orientation, and down welling thermal loading is obtained from the meteorological data base and assembled in a light file. Also included in this file is the frequency content of the visible and thermal energy. The source files from these data as well as sensor-specific data such as view orientation and frequency bands of interest are provided to the ray caster in a scripting file.

The ray caster provides the energy flux to the other testbed components as a facet-based list. In turn, each component returns to the ray caster physical temperatures at the vertices of the facets. Reflected energy from the lighting pixel array is projected on a pixel array defined by the viewing (sensor) orientation. Energy is compiled into a pixel from a surface if it is exposed to both viewing array and lighting array. In this way, shadows are resolved to the resolution of the pixel size. Added to this energy is thermal energy emitted from the surface as computed from the temperature that is interpolated to the pixel location from the values at the facets vertices.

Properties for reflectance, transmittance, and emissivity are expressed by six spectral components. Energy transfer operations are performed band wise. Therefore, the ray caster logic contains no particular wavelength dependence. The physical meaning of each band is controlled by the values contained in the material property and light files. Greater or lesser frequency resolution can be obtained within particular bands depending on these data.