A data-driven approach for efficiently storing, evaluating, integrating and sampling spherical and hemispherical datasets

Adam Goodenough and Scott Brown (presenter)
Digital Imaging and Remote Sensing Laboratory
Rochester Institute of Technology
Rochester, NY

The radiative transfer community frequently utilizes hemispherical and spherical weighting functions, including surface bi-directional reflectance distribution functions (BRDF) and bi-directional transmission distribution functions (BTDF) and volume scattering phase functions (SPFs). Although measured data is considered a gold standard, this data is difficult to use directly and is usually fit to either physics-inspired parametric models (e.g. micro-facet distribution models including Cook-Torrance, Maxwell-Beard, etc.) or basis function representations (e.g. spherical harmonics, Zernike polynomials, etc.). However, these representations have computational limitations in the context of numerical radiation propagation. What is sought is a way to represent arbitrary hemispherical and spherical weighting functions and provide a unified framework for efficiently performing four key tasks: (1) *direct evaluation* of the representation to retrieve weights for arbitrary incident and exitant geometries, (2) *integration of* the weights for arbitrary solid angles, (3) *sampling* of the underlying probability function exactly, and (4) *storing* the function compactly so that multiple functions can be represented without massive memory requirements. This presentation will outline a data-driven approach to representing arbitrary hemispherical and spherical weighting functions that leverages a geometric construct we refer to as *spherical quad-trees* (SQTs). A detailed overview of the methodology for how to create and utilize SQTs will be discussed and the use of SQTs for applications including BRDF and SPF data will be presented.