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Parallel Monte Carlo Sampling Scheme for Sphere and Hemisphere*

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Abstract. The sampling of certain solid angle is a fundamental operation in realistic image synthesis, where the rendering equation describing the light propagation in closed domains is solved. Monte Carlo methods for solving the rendering equation use sampling of the solid angle subtended by unit hemisphere or unit sphere in order to perform the numerical integration of the rendering equation.

In this work we consider the problem for generation of uniformly distributed random samples over hemisphere and sphere. Our aim is to construct and study the parallel sampling scheme for hemisphere and sphere. First we apply the symmetry property for partitioning of hemisphere and sphere. The domain of solid angle subtended by a hemisphere is divided into a number of equal sub-domains. Each sub-domain represents solid angle subtended by orthogonal spherical triangle with fixed vertices and computable parameters. Then we introduce two new algorithms for sampling of orthogonal spherical triangles.

Both algorithms are based on a transformation of the unit square. Similarly to the Arvo's algorithm for sampling of arbitrary spherical triangle the suggested algorithms accommodate the stratified sampling. We derive the necessary transformations for the algorithms. The first sampling algorithm generates a sample by mapping of the unit square onto orthogonal spherical triangle. The second algorithm directly compute the unit radius vector of a sampling point inside to the orthogonal spherical triangle. The sampling of total hemisphere and sphere is performed in parallel for all sub-domains simultaneously by using the symmetry property of partitioning. The applicability of the corresponding parallel sampling scheme for Monte Carlo and Quasi-Monte Carlo solving of rendering equation is discussed.

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