Fast Image Based Lighting for Mobile Realistic AR

Abstract

This is the supplemental material for the article "Fast Image Based Lighting for Mobile Realistic AR".

CR Categories: I.3.3 [Computer Graphics]: Picture/Image Generation—Display Algorithms I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality; H.5.1 [INFORMATION INTERFACES AND PRESENTATION]: Multimedia Information Systems—Artificial, augmented, and virtual realities;

Keywords: augmented reality, real-time rendering, image-based lighting, environment acquisition

1 Shadow generation

1.1 Sphere decompostion

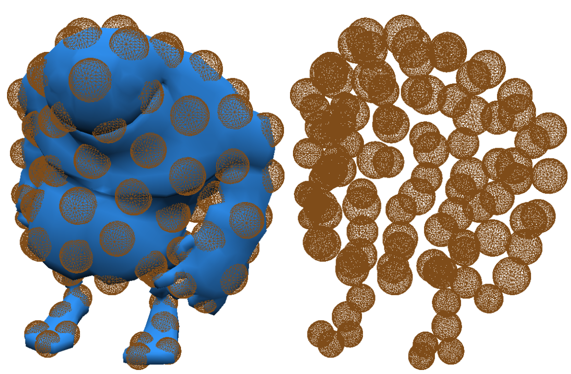

Figure 1: *Sphere decomposition of 3D objects (*100000 *samples,* 100 *spheres)*

Decomposing a geometry with approximating spheres has been largely tackled in the discrete geometry literature, for instance to reconstruct implicit surfaces from point clouds. Although, since we do not seek any reconstruction, we chose to apply a simpler method that is sufficient for shadow projection. First, the surface of the object is sampled relatively to triangle's surface. The resulting points are organized into clusters with a simple K-Means algorithm. Then, a sphere is created for each cluster on the object surface by minimizing the distance between the sphere's center and the points belonging to the corresponding cluster. Figure 1 shows examples of sphere decomposition with this method.

1.2 Occlusion and shadow computation

In this part, we will assume that the local geometry around the virtual object may be approximated by a horizontal plane. The virtual object lies onto this plane, and shadows will be projected on it. To compute soft shadows, one has to evaluate environment visibility for every point of the horizontal plane. To evaluate shadowing, one will have to evaluate these quantities:

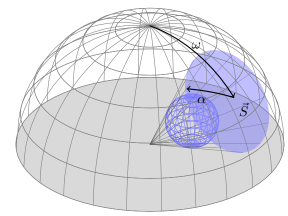

Figure 2: *Sphere obstruction*

$$\mathcal{E}_{ambient}(p,\vec{n}) = \frac{1}{\pi}\int_{\mathcal{H}^2(\vec{n})} \mathcal{L}_{glob}(\vec{\omega}) \times \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega}$$

$$\mathcal{E}_{shadow}(p,\vec{n}) = \mathcal{E}_{ambiant}(p,\vec{n}) - \frac{1}{\pi}\int_{\mathcal{S}(p)} \mathcal{L}_{glob}(\vec{\omega}) \times \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega}$$

with $\mathcal{H}^2$ being the hemispherical domain and $\mathcal{S}(p)$ being the visible part of the sphere from the current point. The shadowing factor $\mathcal{F}(p)$ is then obtained by taking the fraction of these two quantities:

$$\mathcal{F}(p) = \frac{\mathcal{E}_{shadow}(p,\vec{n})}{\mathcal{E}_{ambient}(p,\vec{n})} = 1 - \frac{\int_{\mathcal{S}(p)} \mathcal{L}_{glob}(\vec{\omega}) \times \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega}}{\int_{\mathcal{H}^2(\vec{n})} \mathcal{L}_{glob}(\vec{\omega}) \times \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega}} \tag{1}$$

which may be simplified in:

$$\mathcal{F}(p) = 1 - \frac{\mathcal{L}_{glob}(\mathcal{S}(p))}{\mathcal{L}_{glob}(\mathcal{H}^2(\vec{n}))}\left(\frac{1}{\pi}\int_{\mathcal{S}(p)} \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega}\right) \tag{2}$$

The solid angle lying on each sphere is given by :

$$\int_{\mathcal{S}(p)} \vec{\omega}.\vec{n}\,\mathrm{d}\vec{\omega} = \cos(\omega)\sin^2(\alpha) \tag{3}$$

where α is the half angle in which the sphere is seen from the current point and ω is the angle between the normal of the horizontal plane and the center of the sphere projection (see figure 2). Therefore, $\mathcal{F}(p)$ may be obtained with:

$$\mathcal{F}(p) = 1 - \cos(\omega)\sin^2(\alpha)\frac{\mathcal{L}_{glob}(\mathcal{S}(p))}{\mathcal{L}_{glob}(\mathcal{H}^2(\vec{n}))} \tag{4}$$

Figure 3 shows some results of our shadowing technique applied on the same object with different environment maps (not shown for clarity purpose). One may see that shadows exhibit different shapes.

2 Image-based lighting

This section will show some results showing the difference between Plausible Blinn-Phong shading method of McGuire and ours, where all faces of the cube-map are contributing to the diffuse component. To exhibit this property, a specific cube-map built with a single color on each face is used to light a diffuse object. One may see on figure 4 that using McGuire's technique leads to discontinuities, while ours blends the contribution of each face seamlessly.

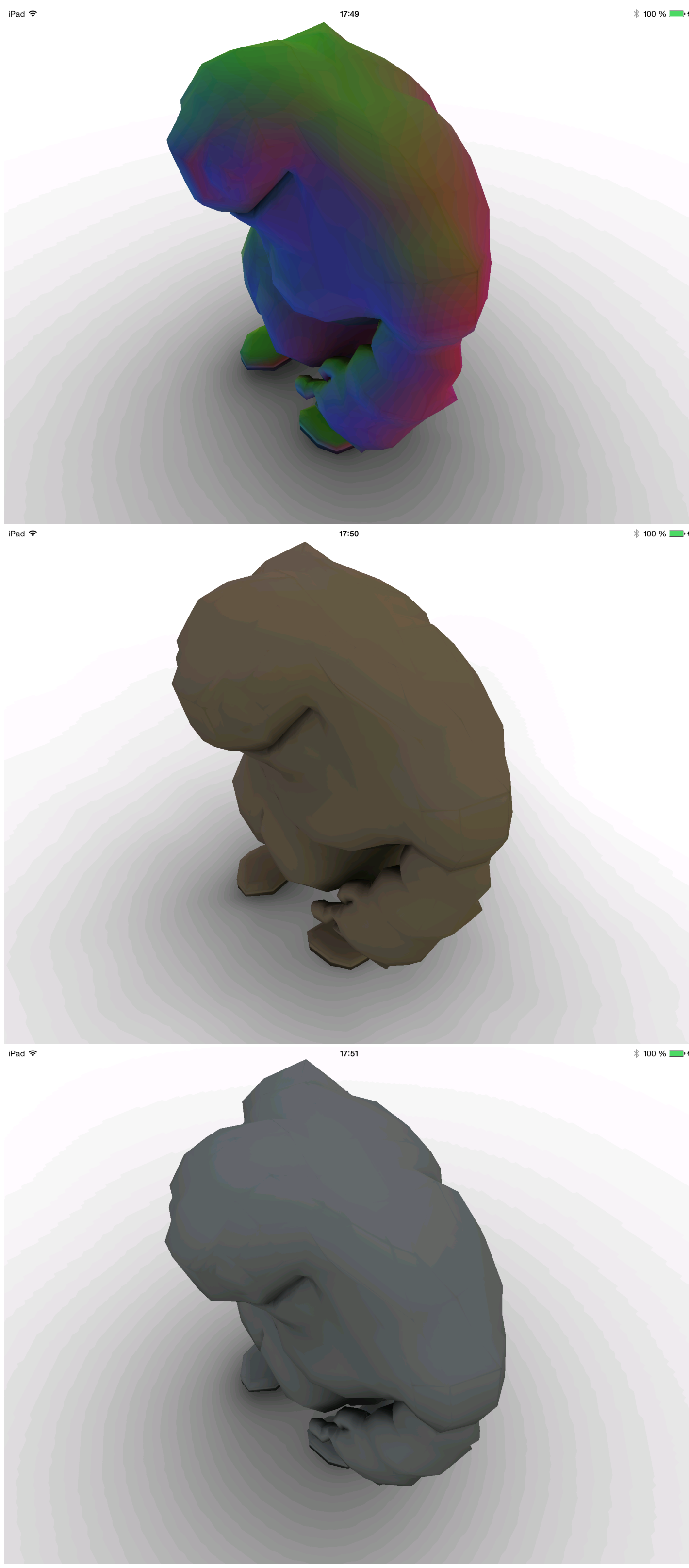

Figure 3: *Shadow generation results*

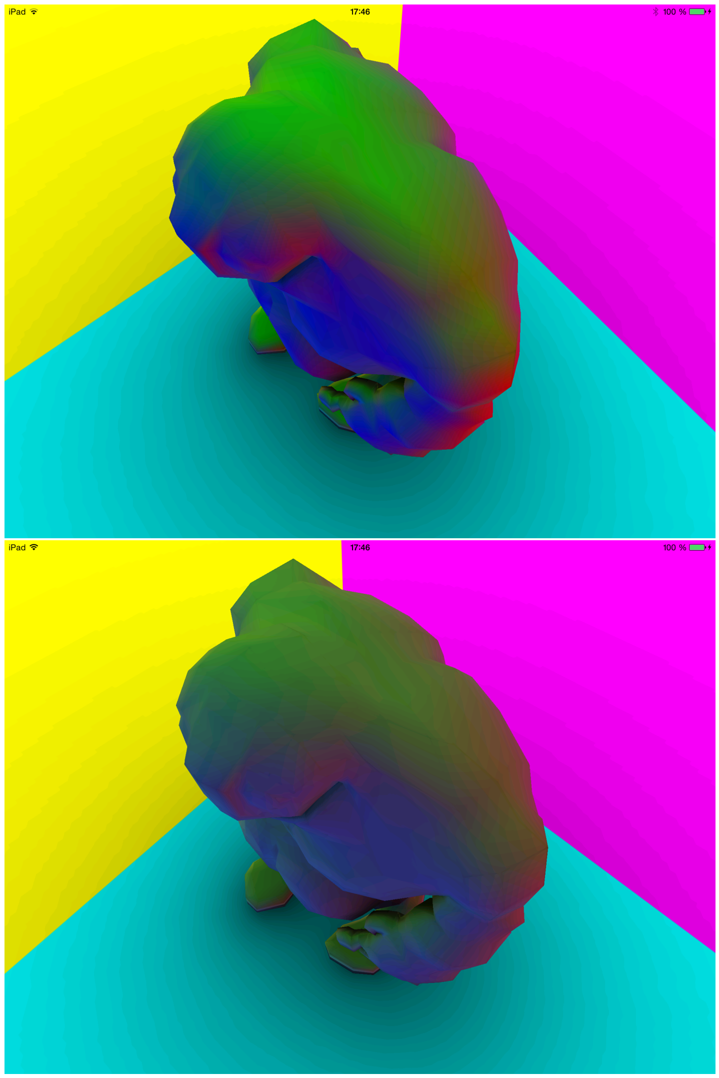

Figure 4: *Comparison between McGuire Plausible Blinn-Phong(top) shading and ours(bottom).*