1. Introduction

This poster introduces a novel weighting function of bilateral upsampling for specular surfaces. High-resolution rendering with expensive shaders (e.g., global illumination) is a considerable problem for real-time applications such as video games. Therefore, some bilateral upsampling based methods such as spatio-temporal upsampling [Herzog et al. 2010] were proposed to alleviate the computational burden. The main challenge of these upsampling techniques is to optimize a weighting function in order to estimate a pixel value by appropriately prioritizing samples. We propose an efficient weighting function based on a specular lobe similarity. This function is simple and has no additional storage cost. Moreover, it has no user-specified parameters. Thus it can be easily integrated with general upsampling techniques.

2. Geometry-Aware Upsampling

A surface normal continuity is generally used for evaluating a geometric similarity, which is well suited for diffuse surfaces because the shading results depend on the normal vectors. However, for specular surfaces, we have to take into account not only the normal vectors but also the eye directions and the specular sharpness to generate accurate results, since specular lobes are determined by them.

3. Weighting Function for Specular Surfaces

A weighting function should evaluate a similarity of the reflected radiance between the current pixel $i$ and the sampled pixel $j$, which is the inner product of the incident radiance and the reflection lobe. Assuming that the incident radiance distributions of two pixels are identical, the difference of the reflected radiance is determined by only the reflection lobes. Therefore, we introduce a weighting function $w_{ij}$ representing the specular lobe similarity as given by computing the inner product of the two specular lobes.

Since the shape of the specular lobe depends on the BRDF model, and there is not always an analytical solution of the inner product, this poster approximates the lobes by using spherical Gaussians (SGs). As described in [Wang et al. 2009], a specular lobe is approximated with an SG. The inner product of two SGs is analytically obtained. Hence, we define the weighting function as the inner product of the normalized SGs.

We here employ voxel cone tracing [Crassin et al. 2011] with spatio-temporal upsampling as an experimental example, since voxel cone tracing is known to be computationally expensive to render specular surfaces. In the image using the normal based weighting function, there are some blurring and flickering artifacts due to estimation errors. On the other hand, our method enables higher-quality upsampling without parameter tuning. Our approach adaptively reduces blurring and flickering artifacts depending on specular sharpness and eye directions.

Future Work

Our approach is limited to isotropic BRDFs which can be approximated by a single SG. However, this is not a problem for voxel cone tracing which also approximates BRDFs by a Gaussian lobe. In addition, we can introduce anisotropic BRDFs using several SGs with sacrificing time. Our weighting function is also applicable for geometry aware blurring (i.e., specular lobe aware blurring). In future work, we would like to investigate the effectiveness of such filtering.