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Lace Curtain: Modeling and Rendering of Woven Cloth Using Microfacet BSDF - Production of a Catalog of Curtain Animations

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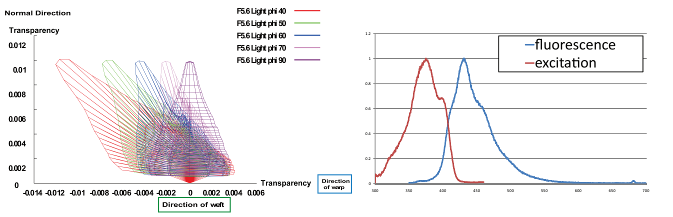
1 Introduction

The need for rendering woven fabrics arises frequently in computer graphics. Woven fabrics have a specific appearance, luster, and transparency. We have proposed a BTDF model using the Henyey-Greenstein Function (HGF)[Uno et al. 2008]. However, since the HGF is a phenomenologically based model, to make the model more accurate, a physically based model is introduced. This paper proposes a new microfacet BTDF model for woven fabrics. we embed a multi-band structure with a fluorescent property into the model, and the results of the rendering show the powerful influence of fluorescence on the appearance of the visible band.

2 Physically based model for woven cloth

2.1 Measurements of woven cloth

We measured the BTDF and the fluorescence property of the four woven fabric samples. The BTDF measurements were conducted by using a BRDF instrument (Fig.1a)[Uno et al. 2008]. The excitation property and the fluorescence property of woven cloth (Fig.1b) were obtained by a Jobin YvonSpex FluoroMax-2 spectrophotofluorometer.



(a)Measured BTDF (b)The excitation and fluorescence property

Figure 1: Measurements of woven cloth

2.2 Woven cloth microfacet BTDF model

To choose the best-fit model for approximating the BTDF of fabrics, we compared the approximate curves calculated from six typical models (Phong, Ward, Ashikhmin-Shirly, Cook-Torrance, HGF, and GGX[Walter et al. 2007]) with the measured BTDF curves. The results showed that the GGX, a physically based model, fit the BTDFs most precisely. Therefore, we proposed a new woven cloth microfacet BTDF model on the basis of the GGX adding parameters such as the density of threads, the absorbing/scattering coefficients, the twisted structure of yarn and the woven structure in the woven cloth. Thus, this model can be thought as BSDF because of the introduction of scattering.

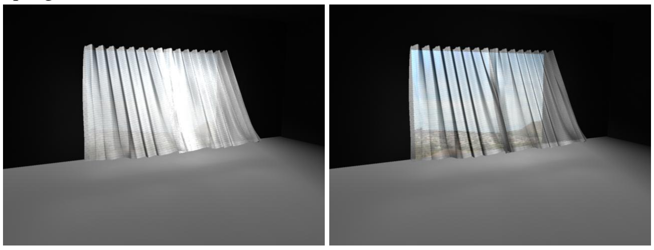
2.3 Multi-band BTDF

We calculated the fluorescent color and the fluorescence intensity from the excitation spectrum and the fluorescence spectrum obtained by measurement, using XYZ/RGB color coordinate, and found each component value of the multi-band BTDF that consists of RGB bands.

3 Rendering

3.1 Woven cloth microfacet BTDF model

Here, the results of the rendering based on the previous HGF-based model and the new microfacet-based model are compared in Figure2. We introduced Global Illumination and performed the ray tracing and photon mapping by using Maya's Mental Ray shader plug-in.



(a)Previous HGF-based model (b)New microfacet-based model

Figure 2: The results of rendering.

3.2 Multi-band BTDF

The results of the rendering based on the multi-band BTDF without or with fluorescent property under sunlight (Illuminant D65) are compared in Figure 3. We found that the influence of the ultraviolet radiation in sunlight on color appearance was greater than we expected.

(a)Without fluorescence property (b)With fluorescence property

Figure 3: Results of the rendering based on the multi-band BTDF

4 Real-time rendering of the BTDF

A real-time rendering algorithm of this BTDF model was implemented by using a combination of OpenGL and Nvidia's Cg.

5 Conclusion

We proposed a new woven cloth microfacet BTDF model on the basis of the GGX, and a multi-band BTDF model for including fluorescent properties. We are planning to generate a catalog of curtain animations that can express various types of woven fabrics under arbitrary light conditions.

References

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