SHADING MODEL OF THATCHED GRASS BLADE

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Abstract

Currently, Shading of thatched grass blade is lack of physically characteristic. This paper presents a new shading model for rendering a thatched grass blade. In our method, we used a microfacet BRDF (Bidirectional Reflectance Distribution Function) on the upper side. In contract, BSSRDF (Bidirectional Scattering Surface Distribution Function) is used on the lower side. For evaluation, we compare our method to real photograph and previous methods. Our result shows that a thatched grass blade can capture all physical reflectance and scattering function. And it is intuitive to adjust.

Keywords: Physically Based Rendering, BRDF, BSSRDF, Natural Rendering

Introduction

Thatched grass mostly found either in countryside or urban. It composed of a huge a mount of dried grass blade. Almost of thatched grass uses to be a roof tile, wall until architecture decoration. It has been long relationship among Asian culture. To the best of authors' knowledge, there has been no existing work to date about physically shading for rendering thatched grass blade.

Thatched grass has been used in many application, animation, game, and simulation respectively. Previously, almost papers were focus on ecosystem [1,2] with huge amount of grasses; their rendering is not based on physical appearance of grass blade.

Our thatched grass modeling is based on [3]. However, their work was not using the physical shading of thatched grass blade in rendering. They used only BRDF. In this paper, is the combination of BRDF (the reflectance on upper side) and BSSRDF (the scattering on lower side) base on [16]. With our shading, it can capture all physical appearance of thatched grass blade. And apply to another kind of grass with a little adjustment.

Literature Review

A physically shading model has been researched for long time. BRDF(Bidirectional Reflectance Distribution Function.) is the function that describe the ratio of the differential radiance reflected and the differential irradiance incident at point X on hemispherical coordinate.[4]. BRDF model itself has many attributes. Such as, Helmholtz Reciprocity(The incident and excitant are changeable by unchanged the value of BRDF.), Energy Conservation (The existence radiance is not more than incident radiance). Torrance and Sparrow[5] were proposed the first a microfacet BRDF model. Otherwise, they model can use only with isotropic material. A BRDF model of Ward's and Duer's [6,7] are produced based on the BRDF model of Cook-Torrance[8]. However, their shading model is not physically plausible and microfacet distribution function is not normalize. Ashikmin and Shirley[9] proposed a framework for a microfacet BRDF with further develop by Ashikmin and Premoze [10] but it is not on physical plausible because they ignored the $\cos\theta_h$ term. A halfway vector model disk is use in shading model of Edwards et al.[11] however this shading ignores the reciprocity. Currently, Kurt et al [12] purposed a microfacet BRDF model that can use on isotropic and anisotropic material. They shading model based on physically plausible.

BSSRDF (Bidirectional Scattering Surface Distribution Function) is the function to describe the diffuse and scattering of a slab object. It has been used in skin[13], milk, leaf or any translucent material[14]. A dipole approximation of light diffusion, It uses to simulated subsurface-scattering (SSS) was introduced by Jensen et al [15]. Donner and Jensen[16] further improve the multipole based on dipole model. Quantized-Diffusion was introduced by Eugene D'Eon and Geoffrey Irving[17]. They improve the diffuse theory that better than classical diffuse theory, use in dipole or multipole. Our purpose method is based Ralf Habel et al[18]. They use Cook-Torrance model to describe the reflectance. However, the specular of this model is not on physically plausible. And they method need the 3D scanner for scanning a leaf's shape and many texture maps for the characteristic of grass, that is not intuitive.

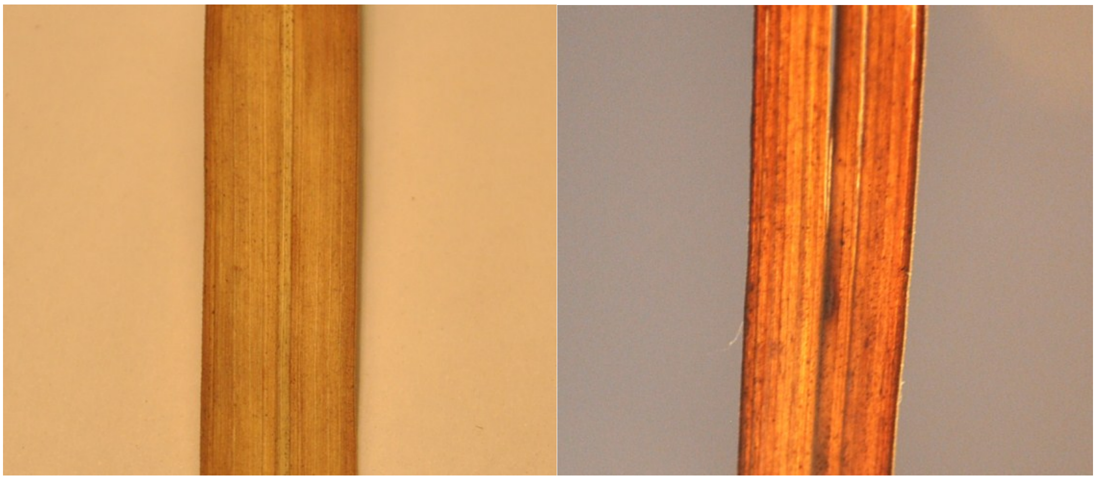


Figure 1 (Left) Show the reflectance of thatched grass blade. (Right) The lower side of thatched grass blade, it is translucent.

Methodology

The main characteristic of thatched grass blade, it is involved with specular [19] when combined each blade together. Our shading model mainly consists of 2 parts. Firstly, The upper side of thatched grass. We used BRDF for describe the reflectance of light by using Kurt et al[12]. His method used the simple term of pure lambert and combined with a single specular term.

$$fr(x, \omega_i, \omega_o) = \frac{kd}{\pi} + \frac{ksF(\omega 0 \,.h)D(h)}{4(\omega 0 \,.h)((\omega i \,.n)\,(\omega o \,.n))^{\alpha}} \quad (1)$$

kd is the coefficient of diffuse, *ks* is the specular reflectivity. And $F(\omega_o.h)$ is the Schlick 's [20] formula approximate of Fresnel term. With this method, it is more physically accurately when compare the result with others shading [12].

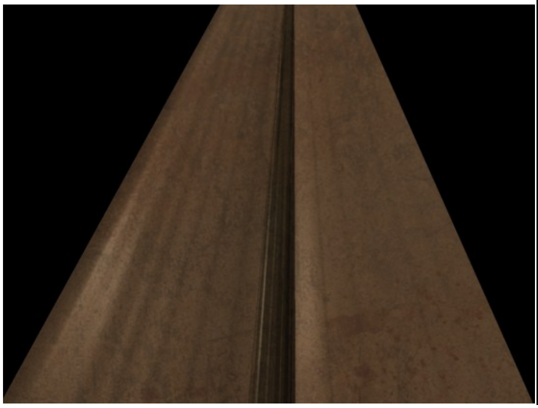
Secondly, The lower side composed of diffuse and scattering. We used the multiple BSSRDF of [18]. Finally, the radiance that we got from the upper and lower side is.

$$L_o = S(x_i, \omega_i, x_o, \omega_o) + fr(x, \omega_i, \omega_o)$$

$S(x_i, \omega_i, x_o, \omega_o)$ is the scattering function (BSSRDF) and $fr(x, \omega_i, \omega_o)$ is the reflectance function (BRDF). In a work of [3], they used bump map for control the width and the height of a second vein. Otherwise, It cannot use in our method. We used the displacement mapping instead.

Results

We implemented and developed a shading model of thatched grass by using renderman language on a PC with a 3.6 GHz Pentium i7 processor and a Redeon HD4670 graphics card, and used 3Delight for the Renderman Shader compliant and renderer. The Fig2. shows the upper side of thatched grass blade. The lower side shows in Fig3



$\theta_i = 30$

$\theta_i = 45$

$\theta_i = 60$

Figure 2 The upper side of thatched grass blade with various angles.

Figure 3 The lower side of thatched grass blade.

Discussion and Conclusion

Our shading model shows the physical appearance of thatched grass. In our method, we used BRDF Model on the upper side to describe the reflectance of thatched grass blade. In addition, the lower side used a multipole BSSRDF for capturing the diffuse and translucency of thatched grass. When compared the qualitative of our method with photograph and previous method. Our method is look more natural and bases on physical of thatched grass blade.

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