連続フレーム画像を用いた反射成分の分離法

The Separation of Reflection Components from Image Sequence

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1. Introduction

The reflection of objects can be described computationally by Torrance-Sparrow model [1]. The reflection generally consists of two main components of diffuse and specular reflection. The estimation of these two components is very important for texture mapping to regenerate new images from different view directions. In this report we describe how to estimate the diffuse component and specular component. The experimental results show that this method is a prospective approach for separating reflection components.

2. Reflection Model

The reflection from a 3D point under some illumination is described by the following model, which is used for estimating the diffuse component and specular component:

$$I = K_d \cos \theta_i + K_s \frac{1}{\cos \theta_r} e^{-\alpha^2 / 2\sigma^2} \qquad (1)$$

Where $I = (I_r, I_g, I_b)$ represents the reflection in three channels; θ_i is the angle between the surface normal and the light source; θ_r is the angle between the normal and the view direction; α is the angle between normal and the bisect of the light source direction and the view direction; σ is the standard deviation of a facet slope of the model. K_d, K_s are the constants for the diffuse and specular components.

3. Separation of Reflection Components

In order to separate the diffuse and specular components, we take the image sequence of object from different angles, changing light direction and view direction. The 3D points are traced in different images to acquire the reflections viewed in different angles in three channels. Then we have a $n \times 3$ matrix, which can be written as the following equation according to the reflection model:

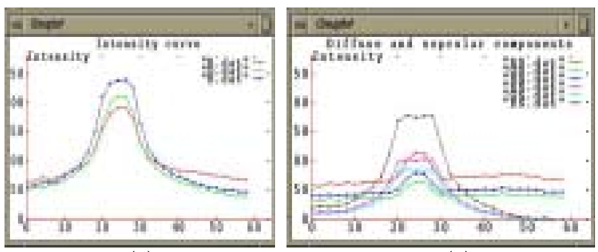
$$I_{n\times 3} = G_{n\times 2} \cdot K_{2\times 3} \qquad (2)$$

Where matrix $I_{n\times3}$ is the measured reflection values in three channels. Geometry factor $G_{n\times2}$ represents the intensity values of diffuse and specular components with respect to the light source and view direction. In matrix $K_{2\times3}$, the second row is the color vector of light source, which is measured directly by a calibration approach. The first row is computed by searching a color vector from the reflection intensities, which has largest angle with the color vector of light source in RGB space.

When matrix $I_{n\times3}$ and matrix $K_{2\times3}$ is known, the matrix $G_{n\times2}$ can be estimated by the least squared method. Then the reflection can be separated into diffuse component and specular component by multiplying the estimated geometry factors with each row vector of matrix $K_{2\times3}$.

4. Experimental Results

In order to verify the validity of the above approach, we had taken a sequence image of an object that is put on a rotary table with two flat illuminations. Then we form a texture image by arranging the middle vertical line of object in image. This texture contains specular component that should be separated out. In order to do so, we had acquired the correspondent reflection data of each point from different angle by rotating the table [2]. The reflection data is used for separation by applying the approach described before. After separating out the specular component, only the diffuse component is used for texture mapping to the 3D model. Figure 1(a) shows the reflection value of one point from different angles and (b) shows the diffuse and specular components.



(a) (b)

Fig. 1. Reflection components

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REFERENCES

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