Reflectance Estimation of Human Face from a Single Shot Image

Kazuki Okami* Naoya Iwamoto Akinobu Maejima Shigeo Morishima†

Waseda University

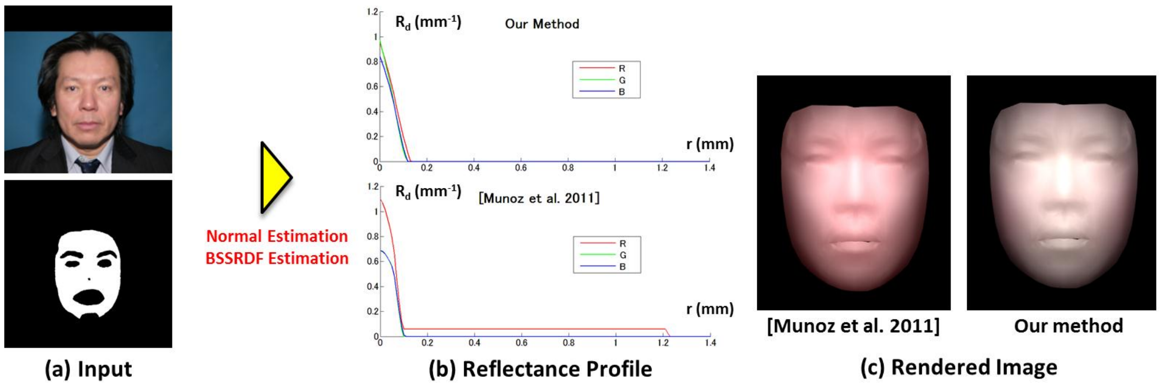

Figure 1. *Our work flow*

1. Introduction

Simulation of the reflectance of translucent materials is one of the most important factors in the creation of realistic CG objects. Estimating the reflectance characteristics of translucent materials from a single image is a very efficient way of re-rendering objects that exist in real environments. However, this task is considerably challenging because this approach leads to problems such as the existence of many unknown parameters. Munoz et al. [2011] proposed a method for the estimation of the bidirectional surface scattering reflectance distribution function (BSSRDF) from a given single image. However, it is difficult or impossible to estimate the BSSRDF of materials with complex shapes because this method's target was the convexity of objects therefore, it used a rough depth recovery technique for global convex objects.

In this paper, we propose a method for accurately estimating the BSSRDF of human faces, which have complex shapes. We use a 3D face reconstruction technique to satisfy the above assumption. We are able to acquire more accurate geometries of human faces, and it enables us to estimate the reflectance characteristics of faces.

2. Our Approach

Our proposed method is composed of two estimation processes.

Normal Estimation: We apply the 3D face reconstruction method proposed by Maejima et al. [2008] to acquire accurate information of human face geometries. This method, which is based on the deformable face model, creates a 3D human face model from a single frontal face image.

BSSRDF Estimation: On the basis of the dipole diffusion approximation [Jensen et al. 2001], multiple subsurface scattering is expressed as follows:

$$L(x_{out}, \omega_{out}) = \frac{1}{\pi} F_t(\eta, \omega_{in}) \int_A R_d(r)\, E(x_{in}) dA(x_{in}) \qquad (1)$$

We estimate the BSSRDF model from the given single frontal face image using Munoz's method, which is based on the previously recovered object shape, and represented color and light information. R_d is called the diffuse reflectance function, which is the only unknown factor in equation (1), and it is approximated by a linear combination of a set of piecewise constant functions. This approximation is derived using the Quasi-Minimal Residual (QMR) method. Then, this approximated function is optimized to continuous, differentiable, monotonically decreasing function.

* e-mail: kazuki-o-paper@ruri.waseda.jp

† e-mail: shigeo@waseda.jp

3. Work Flow

First, as the input in Figure 1-(a), we use a single image of the frontal face and a mask image to remove parts that can lead to errors, such as eyes, lips, beards.

Next, a surface normal, irradiance, and texture color at each vertex are calculated from the known light information, camera position, and the normal estimation.

Finally, we estimate the reflectance characteristics using the BSSRDF estimation.

4. Result and Discussion

The reflectance characteristics of the input face by using Munoz's method and our method are shown in Figure 1-(b). The rendered objects using each estimated reflectance profile are shown in Figure 1-(c). Munoz's results show an overly reddish hue as the face of the input. In contrast, we can render more similar hue of input human face using our estimation result.

As future work, it is necessary to handle unknown environments to extinguish environmental constraints such as light sources. At present, we use a known light source for comparison purposes that require accurate light information. Furthermore, we will add a new feature to express local characteristics of the human face.

References

JENSEN, H. W., MARSCHNER, S. R., LEVOY, M., AND HANRAHAN, P. 2001. A practical model for subsurface light transport. In *Proc. SIGGRAPH 2001*, 511-518.

MAEJIMA, A., AND MORISHIMA, S. 2008. Fast Plausible 3D Face Generation from a Single Photograph. *ACM SIGGRAPH ASIA 2008, Poster, maejima.pdf*.

MUNOZ, A., ECHEVARRIA, J. I., SERON, F. J., LOPEZ-MORENO, J., GLENCROSS, M., AND GUTIERREZ, D. 2011. BSSRDF Estimation from Single Images. In *Proc. Computer Graphics Forum* 30, 2, 455-464.

SIGGRAPH 2013, July 21 – 25, 2013, Anaheim, California.

ACM 978-1-4503-2261-4/13/07