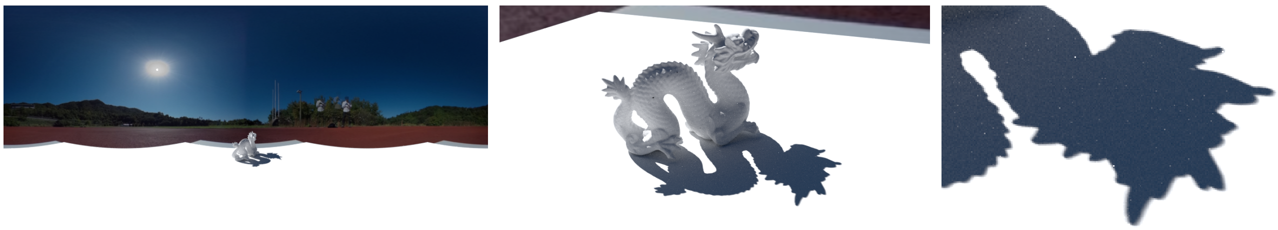
Generation of Omni-directional HDR Light Probe Images Based on the Intensity Distribution Model around the Sun

Daito Kakeya
Hiroshima City University

Masashi Baba
Hiroshima City University

Shinsaku Hiura
Hiroshima City University



(a) (b) (c)

Figure 1: (a) an omni-directional image rendered using the reconstructed HDR light probe image, (b) a perspective image, (c) close up image of the shadow area of (b).

CCS CONCEPTS

•**Computing methodologies** →*Image-based rendering;* 3D imaging; Reconstruction;

KEYWORDS

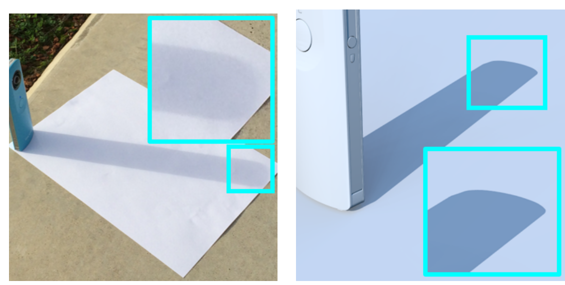
image-based lighting, omni-directional image, lighting environment estimation

ACM Reference format:
Daito Kakeya, Masashi Baba, and Shinsaku Hiura. 2017. Generation of Omni-directional HDR Light Probe Images Based on the Intensity Distribution Model around the Sun. In *Proceedings of SIGGRAPH '17 Posters, Los Angeles, CA, USA, July 30 - August 03, 2017,* 3 pages.
DOI: 10.1145/3102163.3102224

1 INTRODUCTION

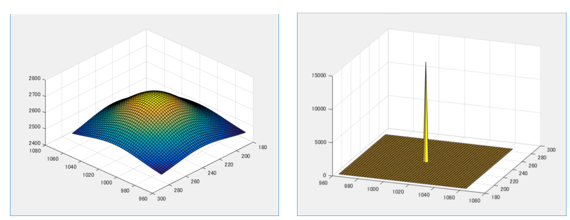
When synthesizing CG images with real image as a background, it is necessary to estimate the lighting environment such as intensities and directions of light sources from real images. In previous study[Baba et al. 2016], except for the high intensity area such as the sun, light source information was estimated by concerning pixels of the captured image as light sources having corresponding intensities[Debevec 1998]. For a high intensity area, the intensity of the light source was estimated from the ratio of the intensity of the shadow area and the sunshine area[Sato et al. 2003]. However, since the sun is used as one parallel light source, there is a problem that it can express only a sharp shadow and it can not be reproduced as an HDR light probe images. Figure 2(a) shows a real image. Figure 2(b) shows a rendering result by the conventional method. In the Figure 2(b), the penumbra of the upper part of the shadow can not be expressed and the shadow boundary is clear comparing with the real image.

SIGGRAPH '17 Posters, Los Angeles, CA, USA
 978-1-4503-5015-0/17/07…$15.00
DOI: 10.1145/3102163.3102224



(a) Real image (b) Rendering results

Figure 2: Comparison of shadowing



(a) Sky intensity distribution model around the sun (b) Sun intensity distribution model

Figure 3: Intensity distribution model

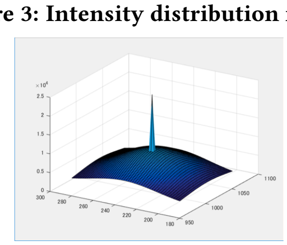


Figure 4: Around the sun intensity distribution model

(a) View from above (b) The bottom of the shadow (c) The upper part of the shadow

Figure 5: Evaluation of shadowing

2 PROPOSED METHOD

In this study, we represente the intensity distribution inside the high intensity areas such as the sun using the radial basis function. Since the area occupied by the sun in the high intensity area is small, there will be an intensity gap between the sun and the sky around the sun if one intensity distribution model is used. Therefor we create a model having two intensity distribution models. One is for the intensity distribution of the sky around the sun, and the other is for the intensity distribution of the sun. After estimating the intensity distribution model, we generate an Omni-directional light probe image with detailed intensity distribution information.

2.1 Sky intensity distribution model around the sun

We fitted the radial basis function of equation (1) by the least squares method based on the intensity information of the sky around the sun.

$$L_{sky}(x, y) = k \exp(-\beta(x - \mu_x)^2 - \gamma(y - \mu_y)^2)) + c \tag{1}$$

where (x, y) is the image coordinate, $L_{sky}(x, y)$ is the intensity value. $k, \beta, \mu_x, \mu_y, \gamma, c$ are parameters to be estimated. Figure 3(a) shows the sky intensity distribution model around the sun.

2.2 Sun intensity distribution model

In the previous study[Baba et al. 2016], the total amount S of the sun's intensity was estimated. In this study, the intensity distribution of the sun is expressed by the equation (2).

$$L_{sun}(x, y) = h \exp(-\alpha((x - \mu_x)^2 + (y - \mu_y)^2))) \tag{2}$$

where, α was estimated from apparent diameterod of the sun. h was analytically obtained by the total amount S of the sun's intensity. Figure 3(b) shows sun intensity distribution model.

2.3 Around the sun intensity distribution model

We expressed the intensity distribution around the sun by equation (3) by combining the above models.

$$L(x, y) = L_{sky}(x, y) + L_{sun}(x, y) \tag{3}$$

Figure 4 shows around the sun intensity distribution model.

2.4 Update intensity distribution of HDR light probe image

High intensity area of HDR light probe image is updated according to the intensity distribution model around the sun. Based on the generated HDR light probe image, image-based lighting is performed.

3 RESULT AND CONCLUSION

Image-based lighting was performed using the generated HDR light probe images. In this study, we created a scene with a THETA model on the plane and rendered it. Figure 5 shows rendering results. Figure 5 (a) is a image viewing from above. Figure 5 (b) is a close up image of the shadow near the object. The clear umbra was confirmed. Figure 5 (c) is a close up image of upper part of the shadow. The boundary of the shadow is blurred and the penumbra was confirmed. Therefore, we could confirm that the shadowing close to the real image was performed.

REFERENCES

Masashi Baba, Kesuke Haruta, and Shinsaku Hiura. 2016. Estimating lighting environments based on shadow area in an omni-directional image. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference, SIGGRAPH '16, Anaheim, CA, USA, July 24-28, 2016, Posters Proceedings.* 88:1–88:2. DOI: http://dx.doi.org/10.1145/2945078.2945166

Paul Debevec. 1998. Rendering Synthetic Objects into Real Scenes: Bridging Traditional and Image-based Graphics with Global Illumination and High Dynamic Range Photography *(SIGGRAPH '98).* ACM, 189–198. DOI: http://dx.doi.org/10.1145/280814.280864

Imari Sato, Yoichi Sato, and Katsushi Ikeuchi. 2003. Illumination from Shadows. *IEEE Trans. Pattern Anal. Mach. Intell.* 25, 3 (March 2003), 290–300. DOI: http://dx.doi.org/10.1109/TPAMI.2003.1182093