Accelerating computation of Appearance from Motion by using Omni-Directional Camera

Ryota Domon[1], Yuto Hirasawa[1], Shoji Yamamoto[2], Hiroshi Kintou[3], Norimichi Tsumura[1]
[1] Chiba University, [2] Tokyo Metropolitan College of Industrial Technology, [3] Nikon Corporation
E-mail: d.0402.r@gmail.com

1. Introduction

Three-dimensional (3D) printing technology has made a big development in this decade. Fused deposition modeling (FDM) method become major method of 3D printing technology. Especially, various materials, such as metal, ceramic, and food, can be utilized for FDM method by mixing the raw materials with chemicals. Because of such improvement, there are many applications such as arts and industrial products. Various appearance reproducibility induce appearance control for 3D printing. To control the appearance in 3D printing, many researches related with appearance would be able to apply. However, to measure the appearance, method or instruments which are currently used are large scale and high cost. Moreover, it is difficult for non-expert user to measure the appearance of the object. The rapid reproduction is also important characteristics of 3D printings. Therefore, the measurement system which is commercially available, rapid and compact, is required for handling the appearance.

In this paper, we propose a rapid and compact measurement system equipped with 3D printing system. Based on the appearance from motion proposed by Dong et al.[1], we increase the availability of the method by adding the lighting condition of measurement. In order to add the lighting information, we adopt the omni-directional camera.

2. Method

Our proposed method is similar to the one proposed by Dong et al.[1]. We follow their major part of techniques and acquisition properties such as surface reflectance and acquisition scheme. In order to add that technique to rapid measurement, we capture environmental image (shown in Fig.1) with Ricoh Theta 360 degree view camera as lighting information. For the radiometrical linearity and color correction with single exposure camera which captures measurement target object, we compensate the environmental image with high dynamic range acquisition method proposed by Debevec et al.[2] and Munsell Color Chart. Another modification from Dong et al. is microfacet theory. They acquired reflectance lobe by fitting with the measured value for each rotated angle, but we employ the microfacet reflectance model in order to acquire the reflectance by less optimization computation. We employ Beckmann model and GGX model.

3. Acquisition Result

Figure 2 shows the result of measurement by using gonio-photometer and our proposed method. Blue line in the Fig. 2 is measured by gonio-photometer, and red line and

Figure 1

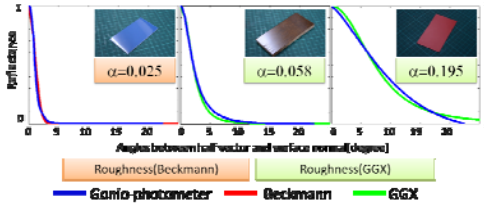

Figure 2

green line in Fig. 2 are Beckmann distribution model and GGX distribution model respectively. It is apparent that microfacet reflectance of each of the subjects are estimated accurately compared to gonio-photometer as a ground truth. Another purpose of our proposed method is reduction of computational cost. Our proposed method uses environmental map for incident lighting component, the computational cost is simply reduced. It is not to be required to estimate the incident light component, we can estimate the each surface reflectance independently. Therefore, parallel computing technique is easily applied in our proposed method and it can accelerate estimation process dramatically. We calculate the computational cost of both our proposed method and previous one, and found that ours achieve ten times faster.

4. Conclusion and future work

In this paper, we present a reflectance measurement method with the lighting component derived from omni-directional camera. Although our method is simplified from the previous study, we can demonstrate the superiority of using omni-directional camera. We measured relatively simple object for verifying the performance of our proposed method. From the practical point of view, it is needed to evaluate the target object with more complex shape.

Acknowledgements

This research was partially supported by Kaken, 24500267, and Brain and Information Science on SITSUKAN, 25135707.

References

[1] Dong, Yue, et al. ACM Transactions on Graphics (TOG)33.6 (2014): 193.
[2] Debevec, Paul E.,et al. ACM SIGGRAPH 2008 classes. ACM, 2008.