17p-D5-9

Experimental Demonstration of Spectral Estimation in Digital Holography

Peng Xia[1], Yasunori Ito[1], Yuki Shimozato[1], Tatsuki Tahara[1], Takashi Kakue[1], Yasuhiro Awatsuji[1], Kenzo Nishio[1], Shogo Ura[1], Toshihiro Kubota[2], and Osamu Matoba[3]

[1] Kyoto Institute of Technology, [2] Kubota Holography Laboratory Corporation , [3] Kobe University
E-mail: awatsuji@kit.ac.jp

1. Introduction

With the development of industry, agriculture, medicine and so on, the measurement of spectrum reflectance distribution of object becomes more and more important, especially in spectral photometer field [1]. We presented the improvement of color reproduction in color digital holography [2]. In the previous report, all of known reflectances of a Macbeth color checker were trained to improve the overall color reproduction of object.

In this paper, we demonstrate spectral estimation of object, whose spectral reflectance has been unknown, in digital holography. The effectiveness of the proposed method was confirmed by an experiment.

2. The Proposed Technique

The principle of the proposed technique is shown in Fig.1. In this technique, multiple lasers operating at different wavelengths such as red, green, blue (R, G, B) are used to record the complex amplitude of the object, and the corresponding monochrome-reconstructed image for each wavelength can be reconstructed. After that, the intensity distributions of these reconstructed images are used to estimate the continuous spectrum reflectance distribution of object by spectral estimation method [3].

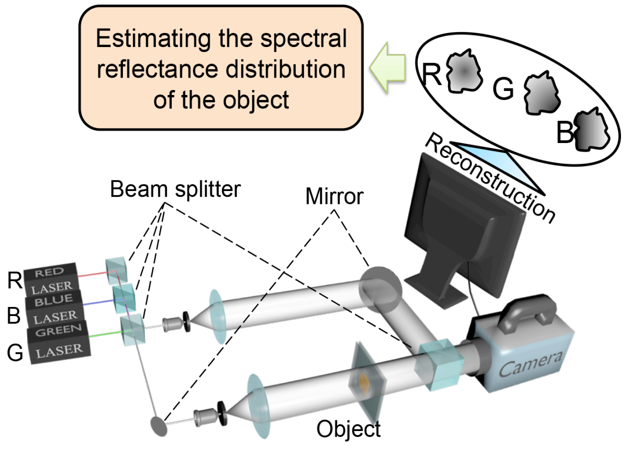

Fig. 1. Principle of the proposed technique.

3. Experiment

We conducted an experiment to demonstrate the proposed technique. The object was a Mini Color Checker Chart with 24 colors and the size is 57.0 mm × 82.5 mm as shown in Fig. 2, and each color was numbered. The object was located 470 mm away from the CCD plane. Three lasers operating at 473 nm, 532nm, and 633 nm were served as the light sources. A monochrome CCD camera with 2456(H) ×2058(V) pixels was used. When we estimated the spectral reflectance distribution of one color which was arbitrarily chosen as an object whose spectral reflectance distribution was unknown, the other 23 colors were used for the training set. We arbitrarily chose the spectral reflectance distribution of one color (No.3) for the object whose spectral reflectance distribution is estimated, and compared the estimated result with the true values, which are given by the manufacturer. The experimental result is shown in Fig.3. As seen from the figure, the spectral reflectance was successfully estimated, and the proposed technique was experimentally confirmed.

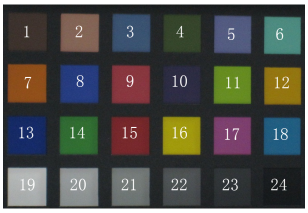

Fig. 2. Photograph of the object.

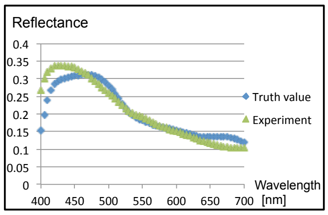

Fig. 3. Experimental result (No.3 color).

4. Discussion

The curves of the spectral reflectance distributions obtained in experiment were greatly similar to that generated by the true values. However, there exist some dissatisfactory components in the 400nm-450nm bands, 480nm-520nm bands, and 650nm-700nm bands. This is because only three laser lines that are operating at 473nm, 532nm, and 633 nm were used to estimate the spectral reflectance distributions of the object. To improve the estimation accuracy, more laser lines may have to be used.

5. Conclusions

We have demonstrated that the spectral estimation of an object by digital holography. The effectiveness of the proposed method has been experimentally confirmed. It will contribute to high-precision 3D measurement and spectroscopic measurement of object, such as blood measurement, living cell measurement, and so on.

This study was partially supported by Grant-in-Aid for JSPS Fellows from the Japan Society for the Promotion of Science (JSPS), and by the Funding Program for Next Generation World-Leading Researchers GR064 of JSPS.

References

[1] T. Inoue, K. Itoh, and Y. Ichioka, Opt. Lett. **16** (1991) 934.
[2] P. Xia, *et al.*, Appl. Opt. **50** (2011) H177.
[3] H. Haneishi, *et al.*, Appl. Opt. **39** (2000) 6621.