液晶レンズを用いて DFD 方法で深度マップの測定

Depth Measurement via DFD Using Liquid Crystal lens Imaging System

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Liquid crystal (LC) lenses have electrically tunable focal lengths, and efforts are being made to perform focusing or zooming function using them in imaging systems, not relying on any mechanical movements of lenses. It is possible to design a system having an LC lens that the image size on the imaging sensor remains unchanged even though the focal length of the LC lens is changed, and such a system is very convenient for acquiring scene information, depth for example. Depth can be estimated via depth from focus (DFF) using an LC lens [1], but one has to take a stack of images for the calculation, which is a time consuming process. Here, we report deriving depth map via depth from defocus (DFD) method [2] using an LC lens imaging system from two images taken at different focal lengths of the LC lens.

The LC lens used in this work is reported in [3]. The frequency of the two voltages is 800 Hz, and the thickness of the LC (MLC 6080 from Merck) layer is 30 μm. The voltages applied on the cell tune the optical power of the lens approximately from -3.9 to 4.4 m^{-1}. Figure 1 shows the setup of the experiment. The LC lens is attached to a camera module of 8 mm focal length. Two images are taken at the maximum positive and negative powers, as shown in Fig. 2. Figure 3 shows the depth map of the scene obtained via DFD from the two images in Fig. 2.

Fig. 1 experimental setup

Fig. 2 two images

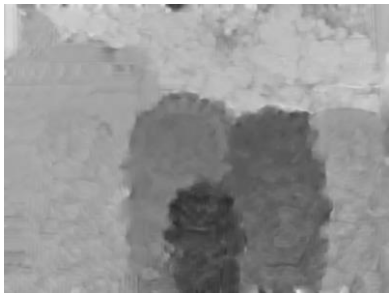

Fig. 3 depth map

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[1] M. Kawamura, et al., *Proc. of SPIE* **8828** (2013) 88280Q-1. [2] M. Watanabe, et al., *Int. J. Comput. Vis.* **27** (1998) 203. [3] M. Ye, et al., *Jpn. J. Appl. Phys.* **49** (2010) 100204.