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偏光板を利用しない液晶レンズの結像方法（その二）

Imaging by Liquid Crystal Lens without Polarizer (Part II)

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A polarizer is generally necessary when a liquid crystal (LC) lens is used in an imaging system. The polarizer greatly decreases the amount of incident light received by the image sensor and makes the system difficult to be used in low-light situation. We have proposed a polarizer-free imaging (PFI) technology to solve the problem [1, 2]. Two images I^{l} and I^{nl} are captured when the LC lens is in the lens and non-lens states, respectively, and a final image I is deduced from I^{l} and I^{nl}. Here, we report an improved PFI method using two images obtained in two different lens states of the LC lens to generate a final image of high contrast.

Let image $\mathrm{I_{target}}$ be the image captured by the image sensor after the focus tuning by the LC lens. Since there is an ordinary wave that is not modulated by the LC lens, $\mathrm{I_{target}}$ is of low contrast. A new image $\mathrm{I_{target}^{new}}$ is generated using an additional image $\mathrm{I_{reference}}$ that is captured before the focus tuning, that is, $\mathrm{I_{target}^{new}} = (\mathrm{I_{target}} - \alpha \mathrm{I_{reference}})/(1-\alpha)$, where α is an adjustable parameter. It is proved theoretically that the contrast of $\mathrm{I_{target}^{new}}$ can be close to that of the image captured by the imaging system using a polarizer. The advantage of the PFI technology is that all available light is made use of in image formation. The proposed method is verified experimentally. The structure of the LC lens is described in detail in [2, 3]. The thickness of the LC layer in this work is 50 μm. The image $\mathrm{I_{target}}$ is captured at voltages V_2 = 11 V and V_1 = 18 V, and the image captured at V_2 = 16 V and V_1 = 18 V is used as the reference image $\mathrm{I_{reference}}$. $\alpha = 0.6$ is used in the calculation. The images are shown in Fig. 1. We can see that image $\mathrm{I_{target}^{new}}$ of high contrast is obtained even when no polarizer is used.

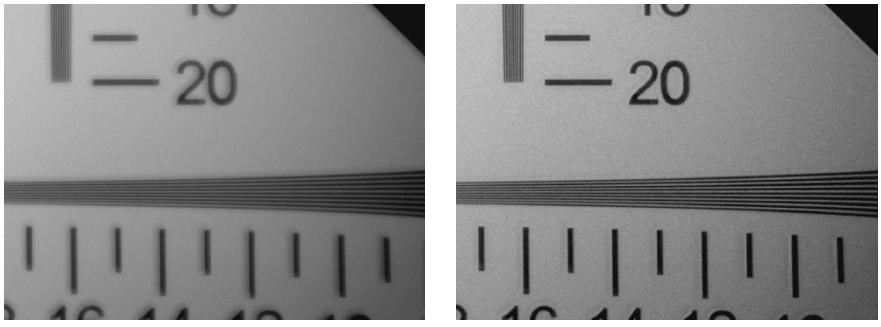

Fig. 1 The images $\mathrm{I_{target}}$ and $\mathrm{I_{target}^{new}}$.

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[1] 包瑞 他, 第 61 回応用物理学会春季学術講演会講演予稿集（2014　青山学院大学）, 18a-F10-6.

[2] R. Bao, *et al*., SID Intl Symp. Digest Tech. Papers,1465-1468 (2014).

[3] M. Ye, *et al*., *Appl. Opt.* **43** (2004) 6407.