

偏光板を利用しない液晶レンズの結像におけるノイズ除去

Denoising for Polarizer-free Imaging of Liquid Crystal Lens

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Recently, we have reported polarizer-free imaging (PFI) methods [1] [2] for an imaging system that uses an LC lens of single nematic LC layer as focusing element. By PFI method, the non-modulated ordinary wave is removed by imaging in non-lens state of the LC lens [1], or significantly reduced by utilizing an out-of-focus reference image acquired during focusing [2]. PFI generates images of high contrast, but also raise the image noise; the noise variance of the final image generated by PFI is $(1 + \alpha^2)/(1 - \alpha)^2$ times larger than that of the original images, where α is an adjustable parameter used in PFI. The noise level rises dramatically as α exceeds 0.6.

This report presents a denoising method specially designed for the images generated by PFI, namely PFI denoising. The salient noises and textures in the image generated by PFI can be accurately detected by taking into account the correlation between the original in-focus and the out-of-focus reference images. Different denoising filters are then successively applied to different image regions including salient noises, smooth regions and texture regions, so that the image contrast will not be degraded by performing denoising. Good performance of PFI denoising is demonstrated by experimental results. Figure 1 shows the images before and after PFI denoising. Noise reduction can be clearly observed and there is little decrease in image contrast after denoising.

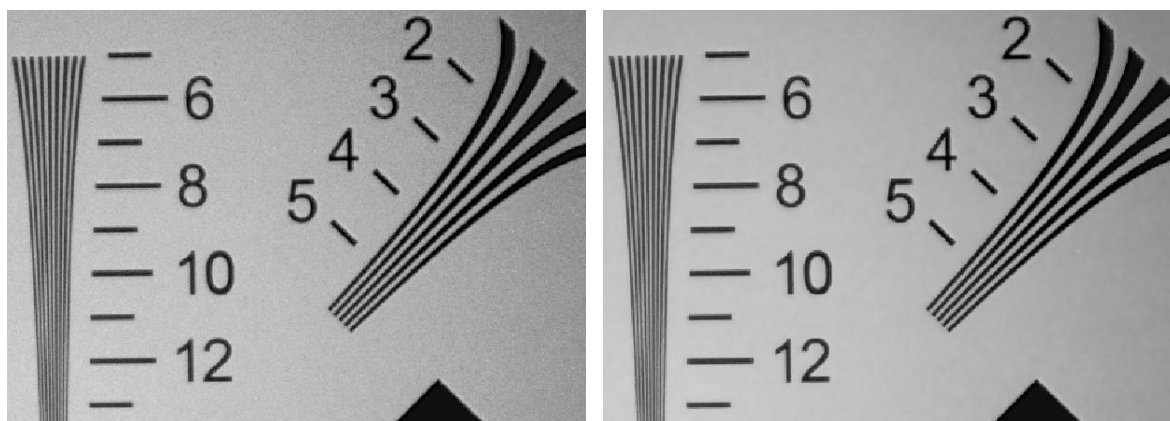


Fig. 1 images before and after denoising

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[1] R. Bao et al, Polarizer-free imaging of liquid crystal lens, *Opt. Express*, 22, 16, 19824–19830 (2014).

[2] C. Cui et al, Polarizer-free imaging of liquid crystal lens using reference image, 21st International Display Workshops IDW, LCT 2-3, Niigata, Japan, (2014).