Fourier Ptychographic Algorithm Based on Stochastic Gradient Descent Method for Optimal Synthesis of Computer-generated Holograms

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In augmented reality (AR), three-dimensional (3D) displays are one of the essential technologies. In 3D display, the accommodation effect, motion parallax, and occlusion must be fully implemented. Digital holography, which controls volumetric waves in space, is suitable to implement 3D displays. Recently, RGB-D image [1], layered depth image [2] are used to reconstruct 3D objects in digital holography. Since all the above methods quantize the depth level, it is not enough to reconstruct objects with a continuous depth level. Of course, if the quantized level is constructed very closely, it may seem continuous, but it requires a lot of computation resources. In this presentation, we proposed a Fourier ptychographic computer-generated hologram (FPCGH) algorithm [3] based on sophisticated gradient descent (SGD). We calculated the gradient of loss function with respect to hologram pixels. The motion parallax and accommodation effect could be obtained by the dense multi-view image composition and SGD based Fourier ptychographic optimization.

Figure 1(a) shows the scheme of FP-CGH synthesis. Large-scale spherical surface comprises the far-field domain, which is represented by the k-domain. The angular spectrum of optical field is represented in the k-domain. When observing a 3D object, we can experience motion parallax in which the 3D object is visible corresponding to the position of the eyeball, and naturally recognize the depth difference between the objects. If so, if there are images with motion parallax applied to each eyeball position, depth information of 3D objects can be obtained without a depth-map. If we assume that the identical image is perceived both when viewing a 3D object and when observing far-field CGH, because far-field CGH and the object are interconnected via Fourier transform and inverse Fourier transform. Consequently, far-field CGH should possess the Fourier spectrum of the image corresponding to the position of observer within each local area. Unlike holographic stereograms [4], which are limited to discrete positions in the Fourier domain for observer's observation.

Figure 1(b) shows FP-CGH observed from different observation direction. It is natural that a different image appears when the position of eye-lens aperture is moved. Accommodation effect is expressed in response to the focus, this is because Fourier spectrums of adjacent sub-images are densely overlapped.

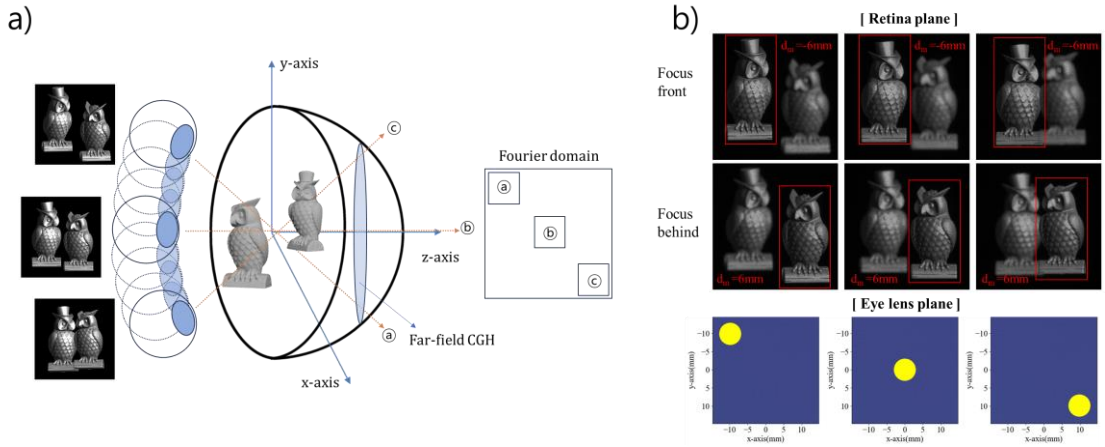

Fig. 1 (a) Optical model of FPCGH. (b) FPCGH observation simulations using cascaded Fresnel transform corresponding to position and focal length of eye-lens.

References

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