Transparent 3D Display using Gabor super-lens

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Transparent autostereoscopic 3D display can be used to create attractive visual effects by combining the displayed 3D image with some real objects, visible through the display. The known approach to slim form factor transparent 3D display is based on transparent 2D display with parallax barrier [1]. Application of lenticular array instead of parallax barrier would increase both brightness of stereoscopic image and transmissivity of the see-through 3D display. However, the lenticular array works like one-dimensional diffuser and all objects behind it look dramatically blurred. We have found a method to overcome this problem.

To solve the problem we propose to apply second (additional) lenticular sheet placed upon the rear side of the transparent OLED, aligned parallel with the first one and confocal with it. Thus the light-emitting layer of the OLED display is sandwiched between two lenticular sheets. Two confocal lenticular sheets constitute the optical system known as Gabor super-lens.[2].

For symmetrical Gabor super-lens the lens equation, derived in [3] reduces to the simple statement that the real image of an object appears at the same distance from the lens as the distance to the object. Image of the object, placed behind the super-lens appears floating in space in front of the lens. Floating 3D images are displayed with reversed depth. Objects, placed at the distance similar to the viewing distance cannot be seen clearly. More distant objects and scenes appear mirrored.

We have fabricated dual side 4-views 3D display, with optimum viewing distance 500 mm using 18.4 degrees slanted geometry of the lenticula. Resolution of each view is 90x64 pix. Front and rear lenticules are aligned parallel to each other. Transmissivity of the display with two lenticules is measured as 0.55, that is practically the same as the transmissivity of the OLED panel itself. The effect of Gabor super-lens in transparent 3D display is shown in Fig.1

Fig. 1. Transparent OLED display with lenticula destroys the background text (left). The display with Gabor super-lens displays the background image floating in front (middle). Multiview 3D image (color rings) can be superimposed with floating image of the background 3D object (right)

The displayed multiview 3D images can be seen at both front and rear sides of the transparent display. Distant objects also can be seen throgh the transparend display, but they appear mirrored. Application of such 3D display in advertizing and entertainment visual equipment could be of great interest.

References

1. M. Gross, US Patent Appl. 20120314017, (2012).
2. D. Gabor, UK Patent 541753, (1940).
3. G. Hembd-Solner, R. F. Stevens, M. C. Hutley, J. Opt. A: Pure Appl. Opt. 1 ,64-102 (1999).