Enhancement of viewing angle performance for a film-type patterned retarder stereoscopic display using lenticular lens array

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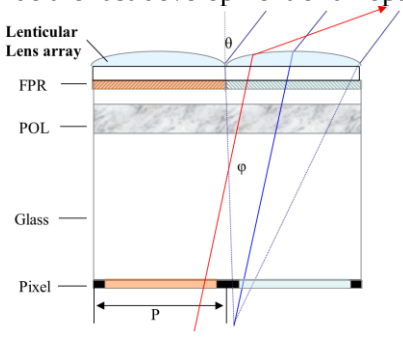
We proposed a novel method to enhance the viewing angle characteristics of a film based patterned retarder 3D display(FPR 3D) using a lenticular lens array. Fig 1-a) illustrates a brief concept of the proposed technology. A lenticular array with a horizontal direction is attached on the conventional FPR 3D panel, so as to increase the vertical viewing angle. Each lens is aligned to the corresponding pixel in the horizontal direction. Using this lens technique, the light from a vertically oblique angle is successfully controlled to reduce the 3D crosstalk by converting the light from a neighborhood pixel to a high angle component. By an inverse ray tracing, it was analyzed that the viewing performance is closely related with the focal length of the lens array.

We analyzed the off-axis focal surface of a lens inside a refractive media using a wave optical approach. And, the relationship between 3D viewing angle and the lens characteristics was found by applying the geomertical properties of 3D FPR panel, as shown in the following equation. The theoretical relation between the viewing angle and a lens parameter was depicted in Fig.1-c). Using this relation, the required lens thickness for the given 3D panel could be readily predicted.

$$d\Delta n \approx \frac{P}{8}\frac{1+CT_r}{1-CT_r}\left(\theta_c-\theta_0\right)+O\left(\theta_c^{\,2}\right), \quad \theta_0 \equiv 2n\frac{B/2+\mu_0}{L}$$

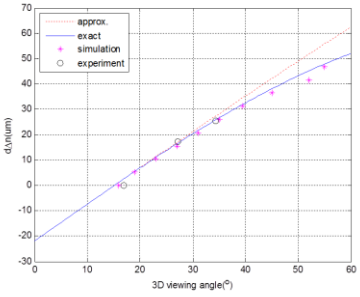
A standard 47” FPR 3D panel was fabricated for this experiment. The lenticular lens array was made by a micro-molding process, which is the typical fabrication method of a prism sheet in Back-light unit. The lenticular array could be laminated on the FPR 3D panel using the current process for alignment of the patterned retarder film(FPR). Typically, the lenticular array is consisted in three layers: lens layer, base film layer and adhesive layer. The birefringence property of each layer is the most important factor in fabrication of a lenticular array. In order to eliminate a birefringence effect, the material for the base film was selected with Acryl or TAC instead of PET. We have developed three different types of lenticular films, as shown in Fig. 1-b). And, 18.5" panel with the pixel size of 47" FHD was fabricated to verify the characteristics of the proposed structure. As shown in Fig.1-c), the lenticualr lens array could enhance not only 3D viewing angle in the verical direction, but also the luminance and crosstalk at a normal direction. By applying lens technique, we have successfully enhanced 3D vertical viewing angle of FPR panel and confirmed the relation between lens characteristics and its viewing angle. This study can provide the fast development of an optimum lens for the various FPR 3D panels.



a)

Lens type	A-type	B-type	C-type
Thickness (um)	30um	50um	63um
Shape	spherical	spherical	non-spherical
Refractive index of lens	1.57	1.51	1.51
Base film thickness(um)	38um	80um	80um
Base film material	Acrylic	TAC	TAC

b)



c)

Fig. 1. a) The proposed concept, b) the developed lens array and c) the comparison between theoretical analysis and experimental results

References

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