Paper No S9.3: 3-D Grayscale Images Generation on Optically Rewritable Electronic Paper

W. Zhang, J. Sun, A. K. Srivastava, V. G. Chigrinov, and H. S. Kwok

Partner State Key Laboratory (PSKL) on Advanced Displays and Optoelectronics Technologies, Department of Electronic and Computer Engineering, Hong Kong University of Science & Technology, Clear Water Bay, Hong Kong, E-mail: Derek19890615@gmail.com

Abstract

Optically Rewritable Electronic Paper (ORW E-Paper) is based on the optically addressed bi-stable display which needn't any power to display the image after being uploaded. In this article, we disclose an easy and practical method to generate 3-D grayscale images on the ORW E-Paper by using a grating mask and printed transparent films and written by polarized blue LED light.

1. Introduction

Optically Rewritable (ORW) technology is a modified method of azo-dye photo-alignment that possesses traditional high azimuthal anchoring energy and has a unique feature of reversible in-plane aligning direction reorientation. It gives possibilities to deposit all electronic elements separately from plastic card and for changing information on display using 450 nm LED light direct writing on display by optical method. Written information on display can be saved for long time without any extra power supply [1].

Several methods to generate 3-D patterns on ORW E-Paper have already been proposed. In this letter, we show a method which has high potential to display 8 bits grayscale 3-D images on ORW E-Paper [2].

2. 3-D Grayscale Images Display

2.1. Grayscale Generation

Based on the working principle of inkjet printers, dots sizes are controlled to perform different gray levels: the larger dot size, the darker of the pixel is shown on the paper. Grayscale images can be printed by this kind of binary methods which could be good masks for writing patterns on ORW E-Paper by blue led light (shown in Figure 1).

2.2. 3-D Effect Generation

The concept is based on the generation of two opposite handedly circularly polarized light for the two different images for left and right eye of the observer. In this respect, two domains with twist angle $+45°$ and $-45°$, with respect to the easy axis of the optically passive alignment layer, have been created. Thus the light passing through these domains followed by quarter-wave plate (QWP) becomes right-handed circularly polarized (RCPL) and left-handed circularly polarized light (LCPL) that can be discriminated by the polarizing glasses.

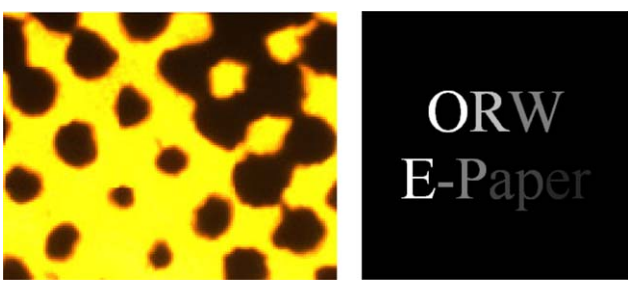

Figure 1. Dots on ORW E-Paper & grayscale image mask.

Figure 2. 3-D effect with polarizing glasses.

After passing through the QWP, the output light takes the form:

$$\vec{E_{out}} = \begin{pmatrix} 1 & 0 \\ 0 & \exp\left(-i\frac{\pi}{2}\right) \end{pmatrix} \begin{bmatrix} cos\theta \\ sin\theta \end{bmatrix} = \begin{bmatrix} cos\theta \\ -isin\theta \end{bmatrix}$$

When $\theta = \pi/4$, $-\pi/4$ and 0, the output light is $\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -i \end{bmatrix}$ (LCPL), $\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -i \end{bmatrix}$ (RCPL), $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ (linearly polarized light), respectively.

3. Methodology

We can start to write the 3-D image on the cell following steps below:

1. Expose the cell under the polarized LED light at $+45°$ with the mask to write left eye image on the ORW E-Paper cell;
2. Erase the cell to $0°$ with 100 μm grating in order to write right eye image at odd columns. Now we keep left eye image at even columns.
3. Expose the cell to $-45°$ with grating (period 100 μm) and image mask (with a little bit shifted to the even columns pattern) together to rewrite right eye image at odd columns on the ORW E-Paper cell.

Therefore, when we are wearing the polarizing glasses, right eye can only see the right circular polarization of light as the right glass only analyze right circular polarization and vice versa. As left and right eyes obtain similar but position shifted images simultaneously, our brain will generate the 3-D perception (shown in Figure 2).

4. Acknowledgements

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5. References

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