A Panel Hot-plugging Driving System for R2R Cholesteric LCD

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Abstract
To realize the advantages of e-Paper, driving systems should be separated from panels to keep its superiority in thin, light, and flexible. For this purpose, this paper develops a panel hot-plugging driving system for R2R cholesteric LCD. Its performance is verified by implementing an e-Badge application. Satisfactory results are obtained.

1. Introduction
The objectives of this paper are to realize the features of e-Paper and to reduce the driving system cost borne by each e-Paper panel. To realize the advantages of e-Paper, driving systems should be separated from e-Paper panels to keep its superiority in thin, light, and flexible. Furthermore, this separation can share out the driving system cost between hundreds of e-Paper.

Due to paper-like look and ultra-low power consumption, Ch-LCD is widely investigated in recent years [1-5]. Roll-to-Roll process is an economical method to reduce Ch-LCD cost [6]. Ch-LCD has the bi-stable property and is usually used in low power applications such as e-Paper and e-Book [7]. Planar and focal-conic textures are two stable states of Ch-LC. The planar texture can reflect a range of light bandwidth to display a specific color. The focal-conic texture can transmit most of light through the panel [8-9]. Besides, Ch-LC has an unstable state called homeotropic texture. Applying a large enough electric field, the focal-conic texture (FC state) of a Ch-LC can be transferred to the homeotropic texture (H state). After the electric field is quickly released, the homeotropic texture of the Ch-LC will be relaxed to the planar texture (P state) through transient planar texture (P* state). If a low electric field is applied afterward, the planar state will be transformed to the focal-conic state. The necessary applied voltages for required state transitions should be determined according to the R-V curve of the Ch-LCD, as shown in Figure 1.

Fig. 1. Reflectance vs. voltage (R-V) curve of a R2R Ch-LCD

In a traditional Ch-LCD driving system, a panel is integrated with a system. To Ch-LCD e-Paper, this approach reduces its flexibility, increases its thickness, and raises its weight. Furthermore, one panel will have to bear the total cost of its driving system. In order to reduce the system cost per panel, increase flexibility, decrease thickness, and lower weight, this paper develops a panel hot-plugging driving system for R2R cholesteric LCD (Ch-LCD). Its driving and separation performance is verified by applying the system to implement an e-Badge application.
Satisfactory results are obtained experimentally on R2R Ch-LCD as e-Badge.

2. Panel Structure

Figure 2 is the sectional diagram of the standard developed R2R bistable cholesteric display. The displays were produced by using a narrow-width R2R laser etcher to segregate the bottom electrode of ITO on PET, and a narrow-width continuous-coating machine to precisely deposit and dry the cholesteric liquid-crystal droplets, dispersed in a water soluble binder layer (CH-LC), and a dark layer (DL), and by screen printing thermally cured conductive, polymer thick film inks to form the top conductors (Ag) and interconnect pads (Ag). The resolution of this panel is about 30dpi.

For hot-plugging a R2R Ch-LCD panel into its driving system, this paper designs a FPC to transfer row electrodes and column electrodes into the same side (as the figure 3). Furthermore, for easy, fast, and reliable hot-plugging, this paper designs some positioners on the FPC. The FPC is bounded on the back of a R2R Ch-LCD. The FPC bonded R2R Ch-LCD can now become capable of hot-plugging where the active area is 3.5”x4.5”.

3. System Design

The R2R ChLC display writer system structure is showed in Figure 4. The writer system includes three parts: (1) power Module (2) Driving Module (3) Tcon Module.

(1) Power Module:
This module supports the digital and analog power for this system. A switching circuit rises the low voltage to high voltage about 160V for analog power.

(2) Driving Module:
The driving IC is used Supertex HV3418 and this module will generate the high voltage waveform for Two-Level DDS driving.

(3) Tcon Module:
The Tcon will control all the system timing and receive the image source from PC through the USB interface.

In addition, the user can operate the writer by a GUI on PC. The GUI can help user catch the image with the webcam and type the information which user want to show on panel.

All the driving processing is showed in Figure 5.
Dynamic driving schemes are adopted in the driving system and the updating time for one frame can be shorter than 500ms. A pre-clear driving is for getting better contrast ratio.

4. Results

Figure 6 shows the complete R2R Ch-LCD Hot-plugging System. The panels in Figure 7 can be hot-plugged into its driving system, as shown in Figure 8. The panels and the driving system in can be combined to form an e-Badge system. The e-Badge can be applied as ID cards used in company or conference for identification, as shown in Figure 9. The average contrast ratio of the e-Badge is 4.92.

5. Conclusion

The dynamic driving system for hot-pluggable R2R Ch-LCD can realize the advantages of e-Paper: thin, light, and flexible. Furthermore, this separation can share out the driving system cost between hundreds of e-Paper. The fast frame updating time is less than 500ms. One of the applications is the proposed e-Badge that can be used in a company or conference for identification.
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6. References


