Chapter 1

Introduction

1.1 Motivation and Objective

Thin-Film Transistor (TFT) liquid crystal display (LCD) is the most widely used in display system. Orientation of the LC molecules can be modified by externally-controlled electric field across the LC layer, and then the resultant polarization state of the LC layer changes consequently. As light passes through the molecules, these changes in polarization state result in different brightness/ darkness patterns that produce images on the screen. In convention design of pixel structure, three sub-pixels, red (R), green (G), and blue (B), composed of single pixel. Under suitable viewing conditions, division of sub-pixels is in distinguishable and light from each set of R/G/B sub-pixel is regarded as emitting form single pixel. Spatial color formation (SCF) mechanism claims this concept and has been widely implemented in current LCDs. The whole structure of conventional color TFT LCD using SCF is shown in Fig. 1-1.

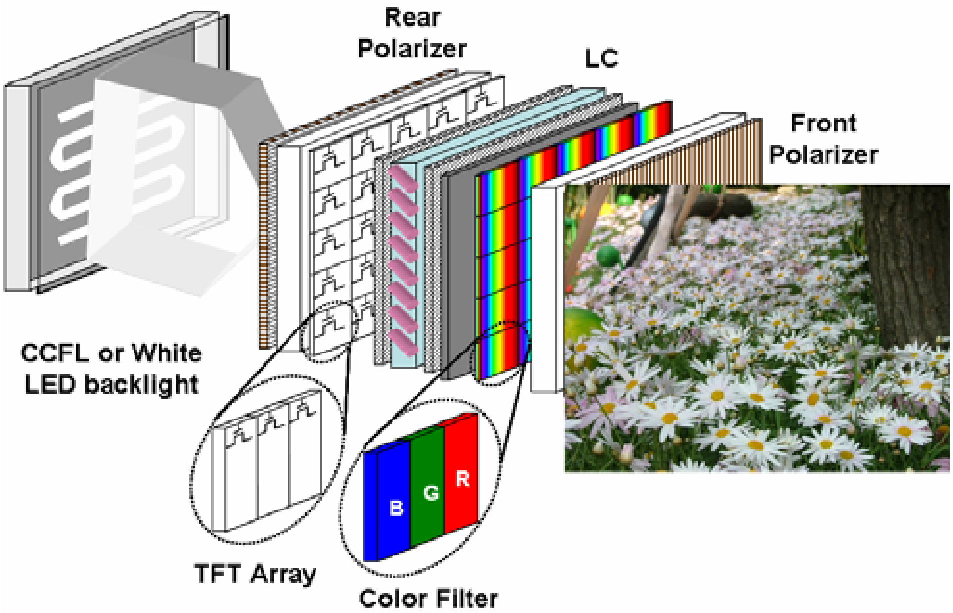

Fig. 1-1. Structure of Color TFT LCD.

TFT LCDs are prized for several important advantages. For example, TFT LCDs can easily achieve high image brightness, offering brightness approximately twice that as CRT on average. This is particularly important for viewing in daytime, high light areas. Therefore, LCD will easily appear brighter than CRT in these conditions. On the other hand, LCDs have made great strides to narrow the gap on contrast. Contrast is important for viewing in low light situations and ensuring that black tones appear black, and is most important for gaming and movie playback. Third, although CRTs still hold the advantage in regards to color purity and quality, LCDs, however, have again made great improvements as well, and now offer bold, brilliant colors in many cases. For gaming or movie watching, as well as professional-level image editing, this difference can range from slightly to significantly noticeable, especially in a side-by-side comparison. Finally, an obvious advantage for LCD monitors of their main selling points is, LCD monitors can weigh as little as 8 pounds for the smaller screen sizes, and are often just 6-8 inches deep, including the depth of the base stand. CRT by comparison can easily weight 40-50 pounds, are often over 15-inches deep, and are very inconvenient for moving. It goes without saying that LCD helps free up a tremendous amount of desk space. As the consequence, TFT LCDs are rapidly displacing competing CRT technology, and are commonly available in small and large sizes.

TFT LCDs have been global popularized to display various kinds of information because of its flatness and lower power consumption. However, the information have been become a more high quality and a more high resolution, therefore LCDs are required a higher resolution display pixel. To make a high density display pixel in usual color filter type TFT LCD is difficult, because a pixel consist with 3 sub-pixels in red, green, and blue colors. Therefore, the main problem is to reduce the pixel size to achieve more high resolution.

In contrast to the field sequential color (FSC) displays, each frame is temporally divided into R, G, B or more color fields. By sequentially displaying these R, G, B, sub-frames fast enough, a full color frame is perceived. With FSC displays, it is possible to obtain a large spatial resolution in a small and thin size at low cost. Therefore, FSC formation mechanism is widely used in all kinds of information displays for the high resolution.

In contrast to the advantage of FSC method, however, an intrinsic visual artifact, Color Break-Up (CBU), has shown to degrade visual quality. The illustration of the CBU was shown in Fig. 1-2.

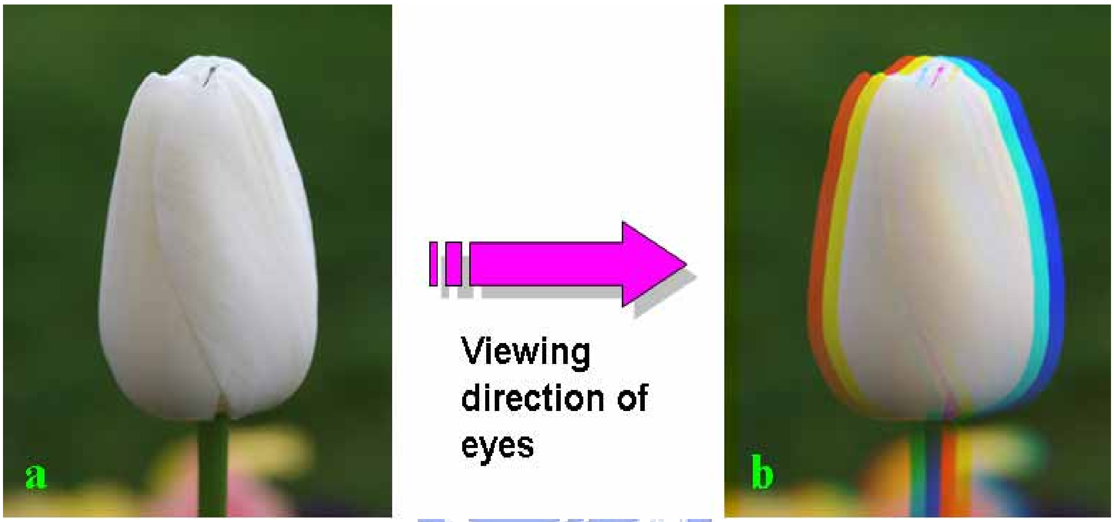

Fig. 1-2. a) A stationary image in FSC display. b) Perceived one with CBU by eyes motion.

For improving the image quality in FSC display, CBU has been investigated to realize the mechanism, classification and corresponding solutions in the past decade. Two categories of approaches were proposed to describe CBU qualitatively and quantitatively, one by psychophysical experiments [1-7], and the other by precise recording with high-speed camera [8]. In addition, several methods also have been reported to improve the CBU in FSC display [9-14]. Even so, only qualitative judgments were set by the former methods, and analytic results measured in a short time for specific image conditions were obtained by the latter, but the resultant view of perception is rarely presented.

Therefore, it is worth searching for a model to predict entire image with CBU effect, and to verify the result by means of a convenient apparatus, such as Digital Still Camera (DSC). It is anticipated that reasonable arguments from the model can simulate CBU in new FSC display, such as FSC LCD, and can contribute to reduce CBU artifact. The applications of the visual model and the psychophysical experiment on display devices are the main topic of this thesis.

1.2 Organization

This thesis is organized as follows. In Chapter 2, the principle of the FSC LCDs, the properties of human vision, and the prior arts of CBU are described. In Chapter 3, the proposed model of physical analysis will be presented. Moreover, the device of the experimental flows and experimental systems used to verify the simulation result will also be described. Then, the visibility of CBU will be found out by performing psychophysical experiment in Chapter 4. In Chapter 5, the minimum frame rate predicting and experimental results of CBU suppression will be given. Finally, conclusions and future works are summarized in Chapter 6.