Modified Half-V Switching Ferroelectric Liquid Crystal Displays (FLCDs) for Quasi Impulsive Driving

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We propose modified concept that enables LCDs quasi-impulsive operations, and demonstrated a prototype AM-LCD that is suitable for displaying moving pictures combined with ' 2-Domain Half-V shaped switching mode' FLCD.

Introduction

The development of new AM-LCDs has accelerated in recent years and their use has spread not only in notebook PCs, but also in desktop monitors. The next most important target for the application of AM-LCDs will be TV displays because of their enormous market. However, more improvements are demanded for LCDs to supersede cathode ray tubes (CRTs) in the monitor market and TV applications and so on.

Moving picture quality is an important issue for AM-LCDs. However, motion pictures shown in these conventional LCD panel lose their clearness and become blurred. Such blurring is an artifact on picture quality and is a serious problem hindering the use of AM-LCDs as TV display. Many researchers indicated two causes for these phenomena.

1) Slow LC response time
(Including pixel capacitance variation)

2) Hold type driving

In order to solve these problems, a novel ferroelectric liquid crystal (FLC) mode for AM-LCDs was proposed, which is capable of analogue gray scale by external voltage and fast response based on the ferroelectric effect. **[1]** This mode is called ' Half-V shaped switching mode' from the profile of the optical response in applying field.

In this work, we propose modified concept that enables LCDs quasi-impulsive operations, and demonstrated a prototype AM-LCD that is suitable for displaying moving pictures combined with ' 2-Domain Half-V shaped switching mode' FLCD.

Quasi-Impulsive Driving

It is pointed out that the hold-type operation of AM-LCDs is responsible for the blurring images. **[2]** Conventional LCD in hold-

type method displays an image for a frame period. (see **Fig. 1**) Each time the image changes, the brightness also changes in a step-by-step sequence. Even if LC response time becomes fast enough, inconsistency between eye movement and static images in every frame remains in every frame. In hold-type operation, the viewer sees the old image overlapping the new one, which results in a blurring of image profile.

The CRT, however, is an impulsive-type display. An image is produced by the irradiation of a single electron beam onto fluorescent-coated pixels that emit light. The pixels emit light only for one instant within each frame, so there is almost no visual overlap between images.

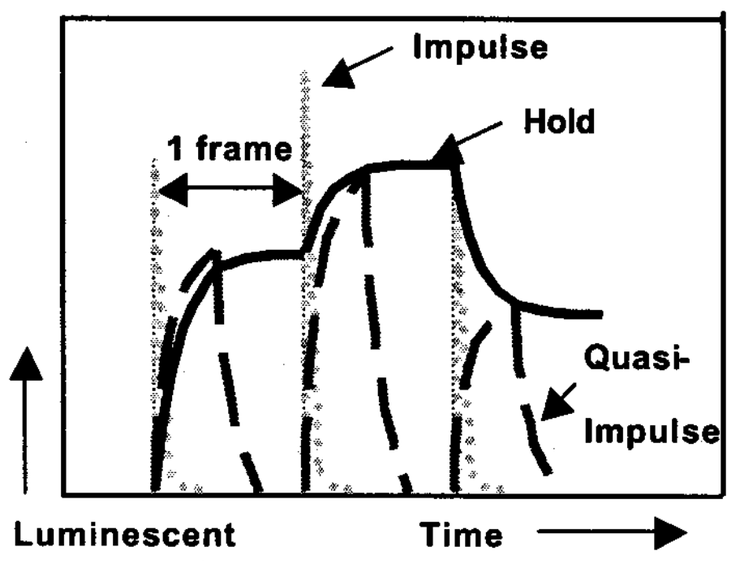

Fig. 1. Temporal responses of displayed light

Most manufacturers, in an effort to make the LCD panel closer to an impulse design, have been developing a "Quasi-impulse-type," which provides a period where no image is displayed during each frame period. The quasi-impulse-type can be implemented by writing black data to the screen for a period, or by merely turning off the backlight for a time during each frame. **[3]**

Modified method for Quasi-Impulse

Fig. 2 shows the characteristics of transmittance vs. applied voltage of the FLCD showing half V-shaped switching. It was proposed that it is possible to obtain excellent moving images since the simple scheme of AC symmetric driving inevitably give a 50% reset period on opposite voltage application.

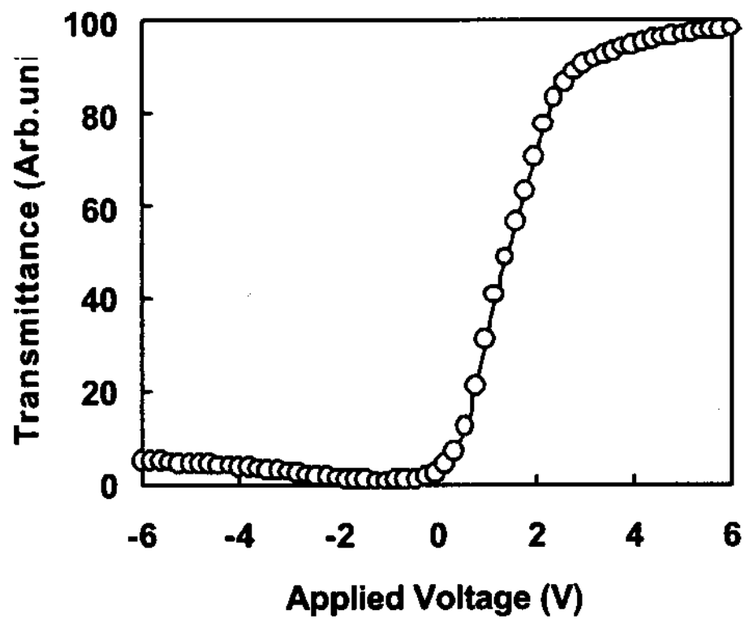

Fig. 2. V-T characteristics

Under the driving scheme of dot polarity inversion, however, above-mentioned quasi-impulsive operation is not achieved due to mono-domain alignment of half V-shaped switching FLCD mode. As shown in **Fig. 3**, conventional dot polarity inversion scheme of applying inversed polarity voltages between neighboring dots only deteriorated brightness of LCD panel without improving moving images because quasi-impulsive operation is not achieved. Although frame polarity inversion scheme is applicable for quasi-impulsive operation, the flicker visibility

and crosstalks increase so much that frame polarity inversion scheme scarcely be applied LCD panels.

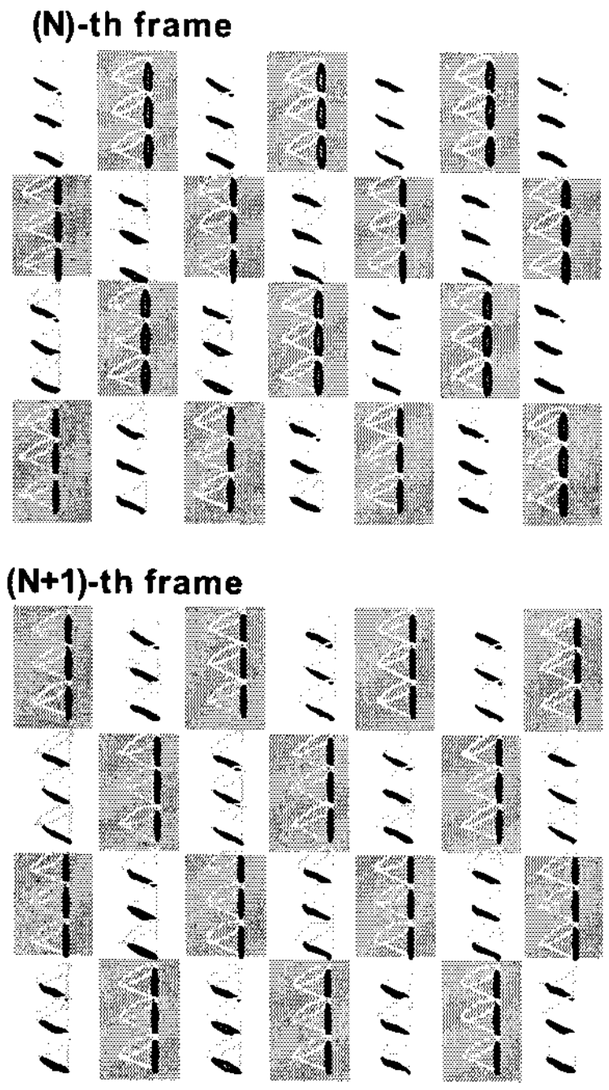

Fig. 3. Dot polarity inversion scheme using mono-domain alignment of half V-shaped switching mode FLCDs

In order to achieve quasi-impulsive operation for excellent moving images, we propose ' 2-Domain Half-V shaped switching mode' FLCD that has symmetrical profiles of the optical response in applying field between neighboring columns. To obtain the uniform alignment with 2-domain during cooling process from isotropic to Smectic $\tilde{C}^*$ (SC^*), an electric field of a low DC voltages should be applied only near the phase transition temperature from Ch (N^*) to SC^*. As shown in **Fig. 4**, we obtain the uniform alignment with 2-domain between neighboring columns. When positive field is applied, (N)-th column parts show transmittance. When negative field is applied, on the contrary, (N+1)-th column parts show transmittance.

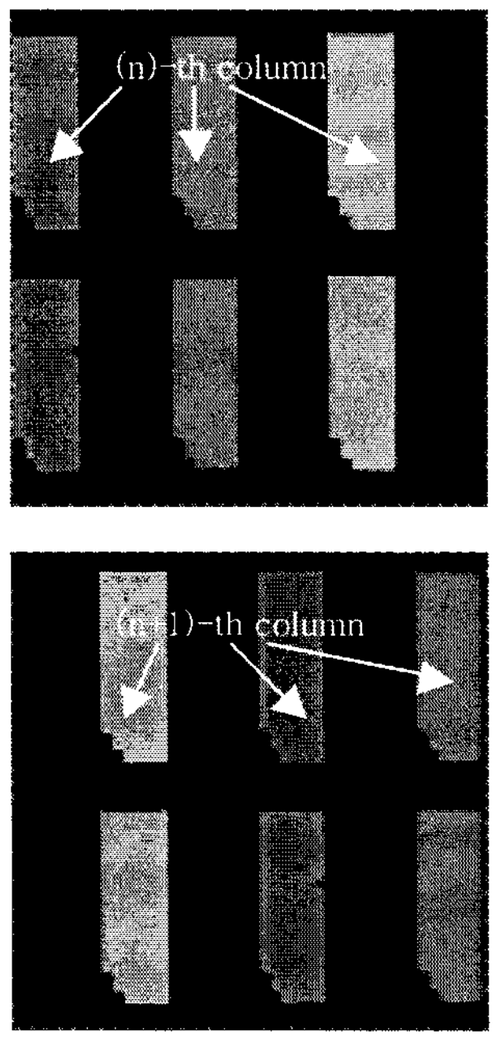

Fig. 4 Microphotographic textures of uniform alignment with 2-domain, under the positive field, and negative field, respectively.

Fig. 5 shows an example of ' 2-Domain Half-V shaped switching mode' FLCDs that we proposed. As above mentioned, we made ' 2-Domain Half-V shaped switching mode' FLCD that has symmetrical alignments between neighboring columns, namely, (N)-th and (N+1)-th column. By applying this concept and scheme of column polarity inversion, we achieved ' 2-Domain Half-V shaped switching mode' FLCD with quasi-impulsive operation. The improvement of moving image quality has been observed. As quasi-impulsive operation is applied, however, the 30 Hz flicker caused by polarity inversion is more

visible resulting in degradation of image quality. Therefore, a detailed study of increasing the frame rate in order to prevent flicker component is in process and will be explained in a forthcoming publication.

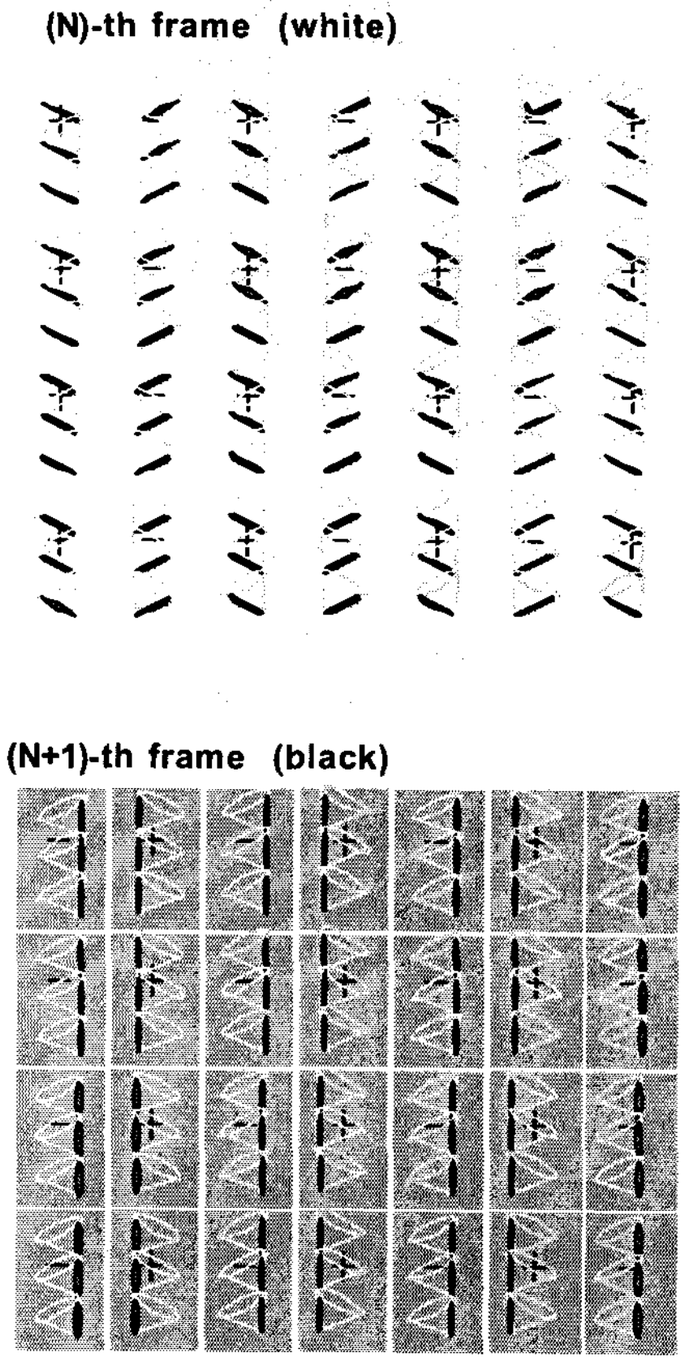

Fig. 5. An example of ' 2-Domain Half-V shaped switching mode' FLCDs

Conclusions

We propose modified driving method that enables LCDs quasi-impulsive operations, and demonstrated a prototype AM-LCD that is suitable for displaying moving pictures combined with ' 2-Domain Half-V shaped switching mode' FLCD. Using the proposed method and fast response LC cell, improved motion image quality can be observed with AM-LCDs. Multimedia AM-LCD-TVs can be realized with this technology.

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Reference

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