P-128: Development of OCB mode with impulsive driving scheme for improving moving picture quality

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Abstract
In general, contrary to the CRTs with impulsive emission, liquid crystal displays have motion artifacts such as blurring, ghost image, decrease of dynamic CR(contrast ratio), and stroboscopic motion due to hold type driving method. In this paper, to improve motion picture quality of LCDs, impulsive driving method of black data insertion was applied to the OCB mode which is well known for its fast LC response time and wide viewing angle properties. Subject evaluation was carried out with CRT, TN, SIPS(Super IPS), and impulsive driving OCB. Moving picture image quality near CRT was obtained in impulsive OCB driving mode

1. Introduction
Recently, the demand for LCD TV is increasing exponentially in the large area FPDs(flat panel display), supported by the advent of HDTV broadcasting and the progress of FPDs. Among the terms desired, such as brightness, response time, contrast ratio and viewing angle, the need for excellent moving picture quality is on the rise.

Due to the hold type driving, LCDs are known to have blurring, ghost image, decrease of dynamic CR, and jerky motion.[1-3] These motion artifacts cannot be avoided on account of the eye-trace integration; a perceived image is a temporal continuous image integration with eye movement which are synchronized with motion picture.[4]

To reduce the motion artifacts, various methods are proposed such as improvements of LC response time, cyclic resetting by LC switching, back light blinking, double frame rate displaying method and over driving technique.[3] Fast LC response time and over driving technique cannot guarantee the CRT-like moving picture quality when displayed in hold type manner. Double frame rate method requires fast LC response time (under ~8ms), the processing of motion-compensated field interpolation of the input video signal, and the double frame rate driving of LC. In back light blinking fast LC motion (under ~8ms) is needed and the perfect line-by-line LC switching can not be obtained even when the backlight is scanned.

In this paper we report the improvement of motion picture quality of OCB mode by applying cyclic resetting method and along with the results of subjective quality assessment.

2. Results and Discussion

2.1 Impulsive driving method
To apply cyclic resetting method to LCD, liquid crystal should response to data signal in less than half frame. Considering the LC response saturation, when applying the black data between data signal the response time should be under 5ms to maintain the black level.

Figure 1 and 2 show the diagram of impulsive OCB mode T-con board and impulsive driving method using OE(output enable) signal. The input signal is transferred in dual signal. We used two FPGA ICs and the former FPGA IC controls front 5 drive ICs and the latter FPGA IC controls back 5 drive ICs. There are two methods realizing impulsive driving with cyclic resetting, one is using 120Hz driving; during half frame data signals are scanned and during the remaining half frame the black signals are scanned. The other is using 60Hz driving; with STV(gate control signal) and OE(output enable, OE1, OE2, OE3) signal data signals are scanned in the first half of display and black signals are scanned in the second half of display. As shown in figure 4, white : black duty ratio of 1 : 1 can be obtained when writing the data signal in the first gate line, writing black signal in the (n/2)+1th gate line. Likewise 2 : 1 duty ratio can be obtained when writing the data signal in the first gate line, writing black signal in the (n/3)+1th gate line.

Impulsive driving carries reduction of gate on time, so the charging capability reaches the limit. We increased the TFT W/L ratio from 6.7 to 15 to secure enough charging capability of >95%(through HSpice simulation).

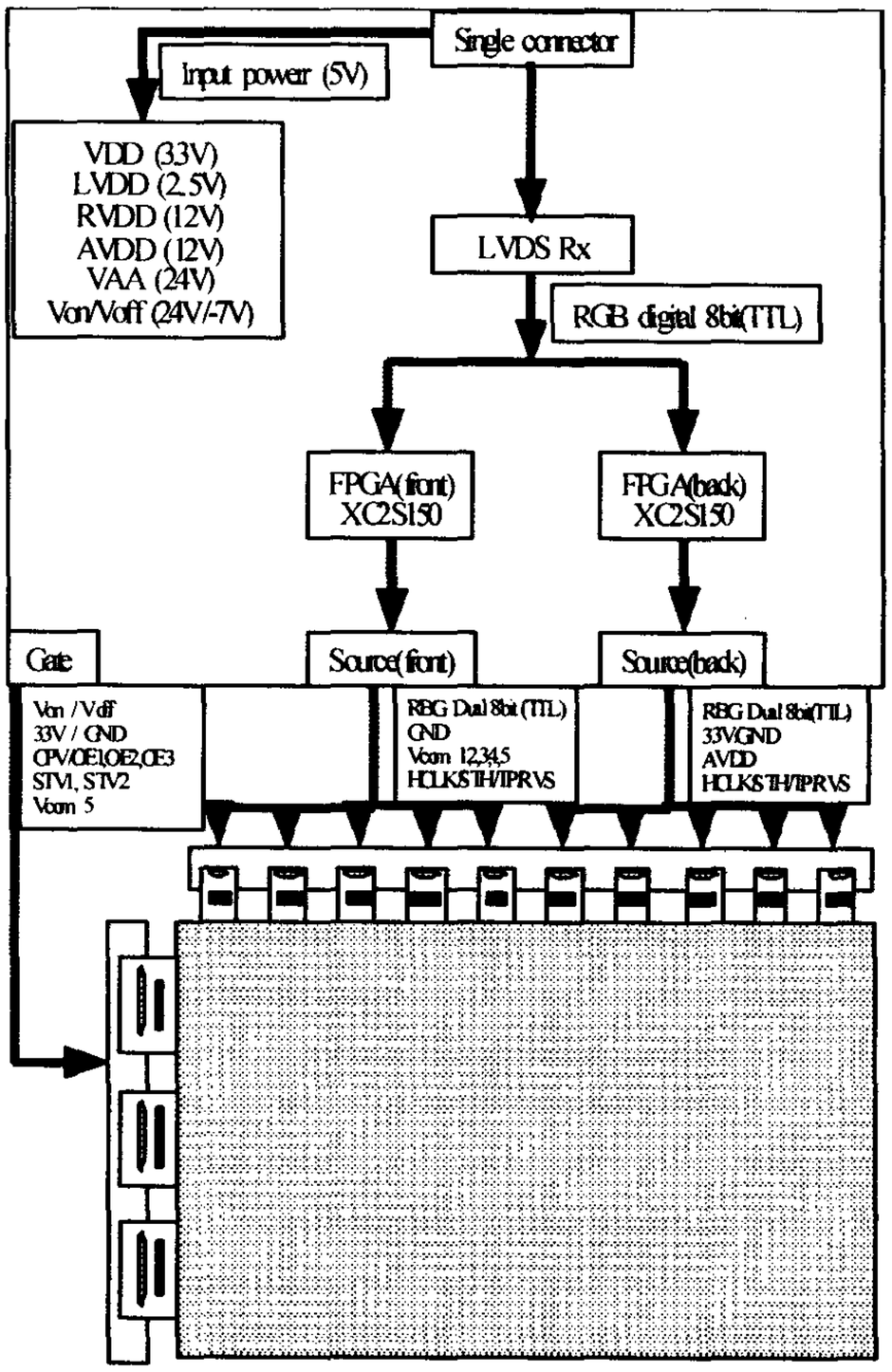


Figure 1. Diagram of impulsive OCB mode T-con board

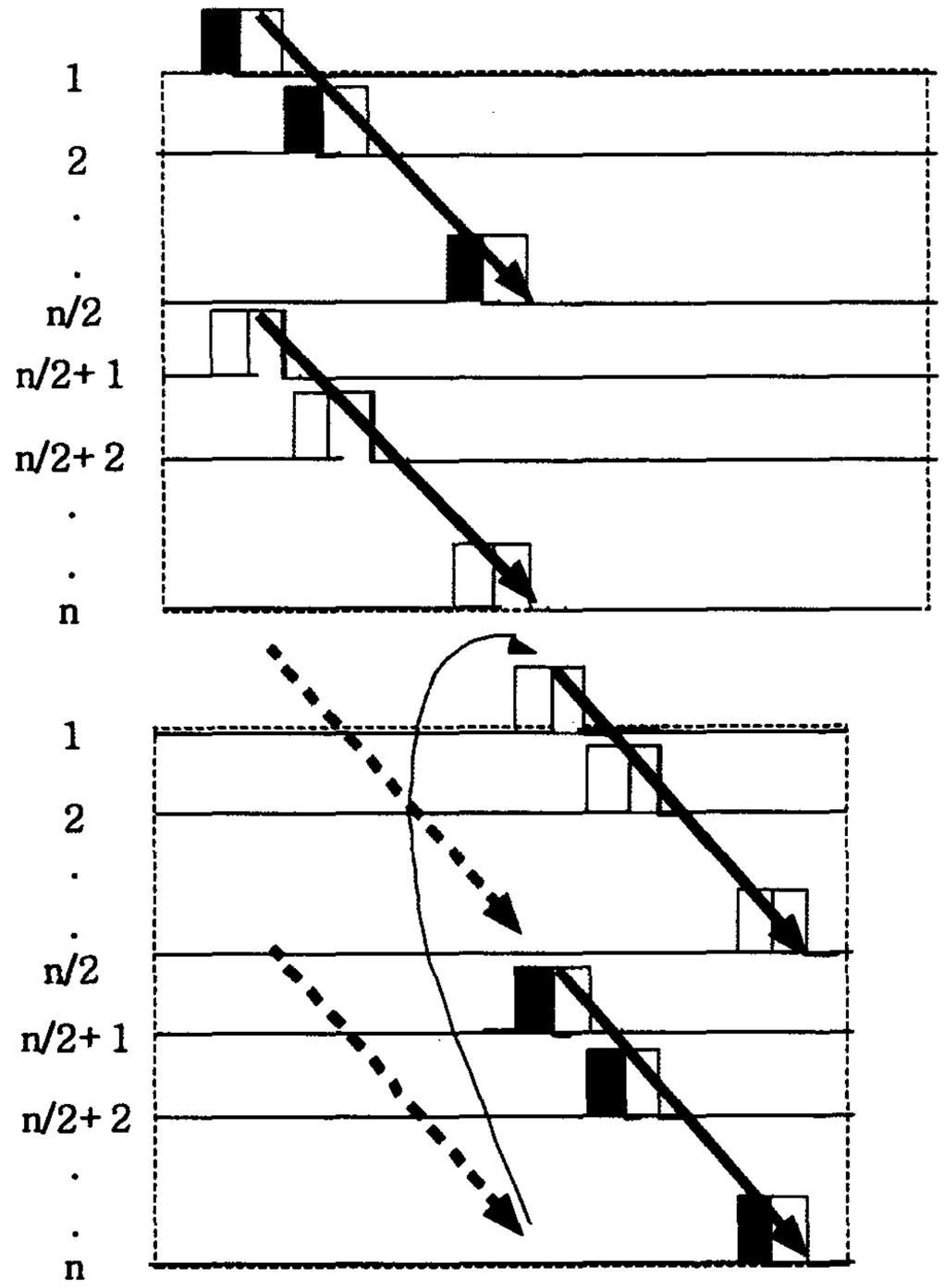


Figure 2. Impulsive driving method using output enable signal (blue line : black(blank) data, red line : data signal)

2.2 Specification

Subjective evaluation was conducted for motion picture quality on CRT, TN, SIPS (super IPS), and impulsive driving OCB mode in order to compare the motion picture qualities.

Table 1 shows the specification of the sample LCDs and CRT. The size of the sample LCDs is 17 inch with WXGA definition (1280 x 768) and the size of CRT is 19 inch. The white luminance of CRT was measured when all the display area was white.

	Response Time (ms)	Color Reproduction	White (cd/m^2)
CRT	<1	~72%	90
TN	~21	65%	400
SIPS	~22	72%	500
Impulsive OCB	~6	72%	600

Table 1. Characteristics of sample LCDs and CRT.

2.3 Subjective evaluation

In our subjective evaluation, we chose two patterns; moving box and moving train(fig. 3). The former is for the evaluation of moving character and the latter is for the evaluation of moving picture. To eliminate the size effect, LCDs with same size and definition(17" WXGA) were used except 19" CRT.

The comparison between the motion picture quality of LCDs and CRT were evaluated subjectively using the following five grade impairment scales. Degradation of quality of the test motion picture is,

5 : imperceptible

4 : slightly perceptible

3 : perceptible but not annoying

2 : annoying

1: very annoying

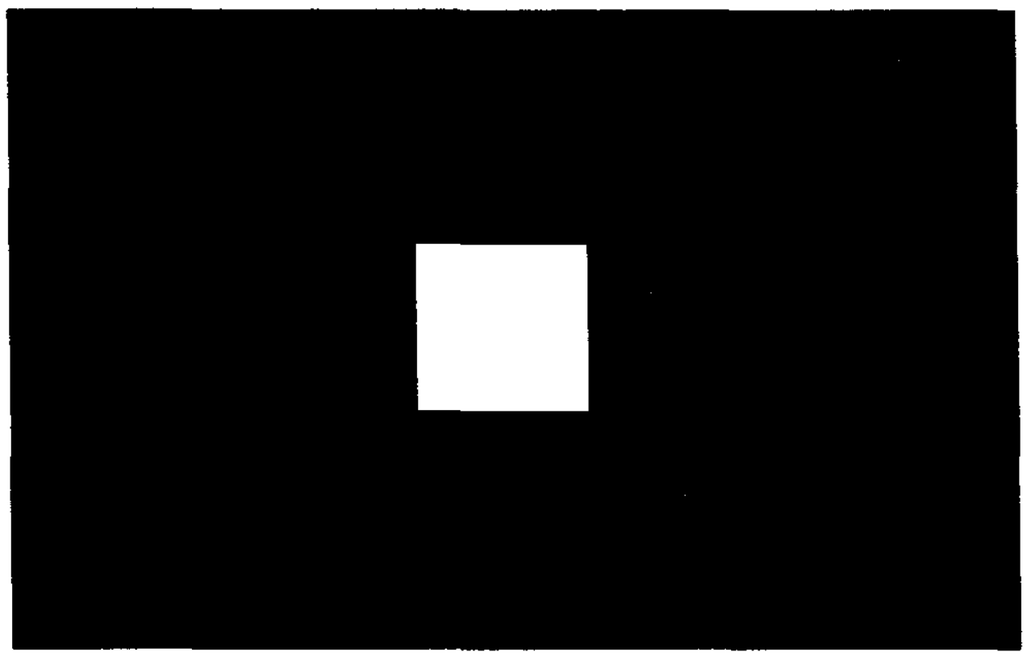


Figure 3. Reference picture used in subject evaluation of moving picture quality.

We operated 4 displays(CRT and TN, SIPS, impulsive OCB mode LCDs) simultaneously and evaluated the moving picture quality impairment compared with CRT(reference) using 5 grade impairment scale. In CRT, still picture was used as reference.

The viewing distance was around 6 screen heights and subject evaluation was operated in office condition. Test participants were not informed about the LCD mode(blind test) in order to do justice.

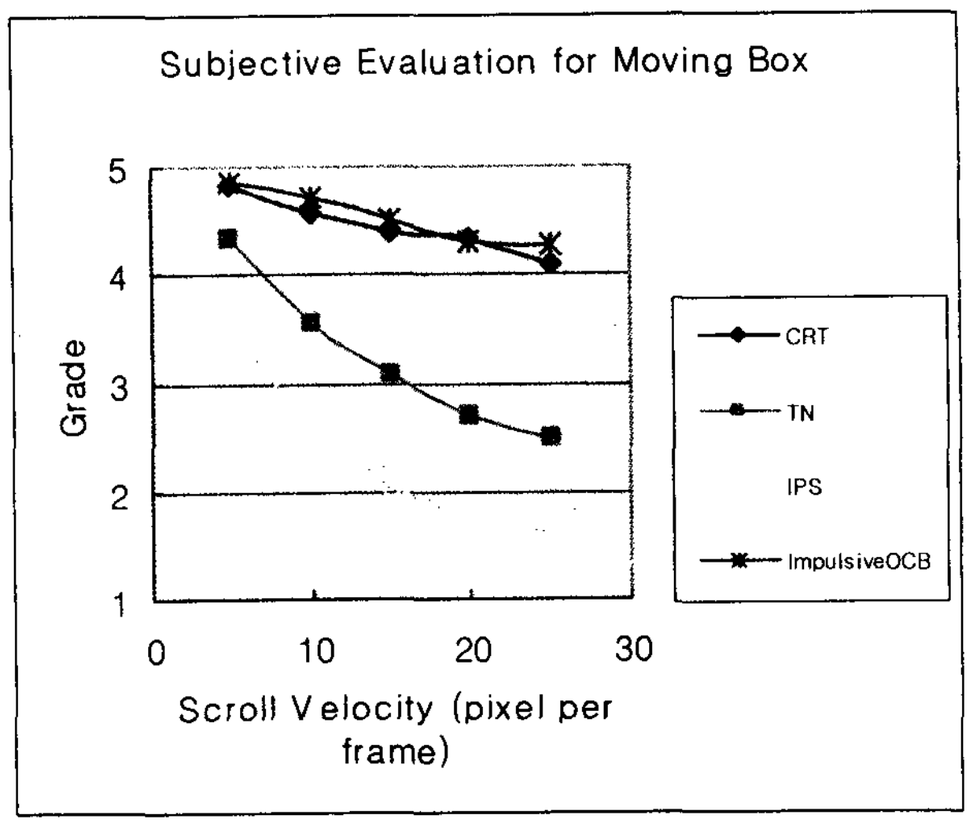
A still picture was used as a reference picture (Figure 3). A moving picture was generated using pattern generator by scrolling the reference picture from right to left at a constant velocity (5, 10, 15, 20, 25 pixel/frame).

2.4 Evaluation results

In subjective evaluation, 47 test participants evaluated motion picture quality of moving box and moving train according to the five-grade scale. Statistic analysis results are shown in Fig. 4.

Generally the scroll velocity of images commonly appeared in TV broadcasting is about 10ppf(pixel per frame), and the scroll speed of violent action like sports is about 15~20ppf.

In CRT the subject evaluation grade of moving picture is around 5 regardless of the scroll velocity, but in subject evaluation for moving box, the grade decreases with an increase of scroll velocity. This is thought to be due to the screen persistence time of CRT.



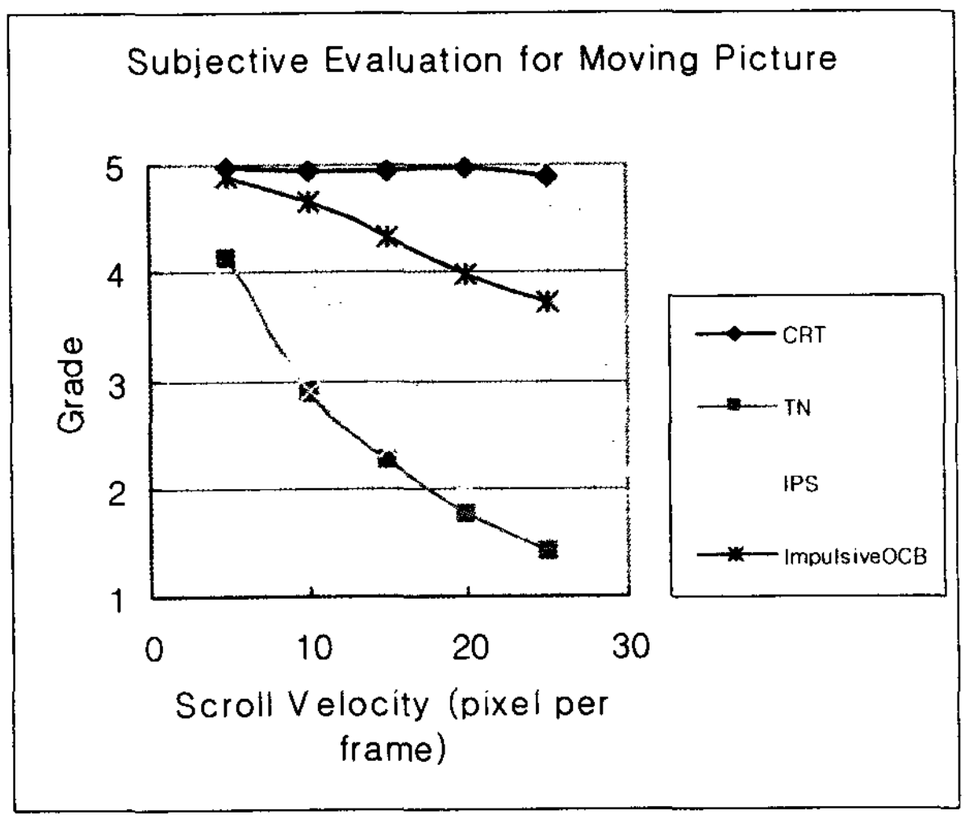


Figure 4. Evaluation results for moving box(up) and moving picture(down).

The averaged subjective scores show a monotonous decrease in motion picture quality with an increase of scroll velocity. It is obvious from the results that impulsive OCB mode has an excellent moving picture image quality; impulsive OCB mode is equally matched with CRT in moving box pattern. In moving box pattern the impairment grade was in inverse proportion to the length of tailing or blurring. Generally, grade 4.5 is called threshold of perception for deterioration and grade 3.5 is sometimes called limit of acceptance. In evaluation of moving picture impulsive OCB mode showed around 4.5 impairment scale to 12 ppf and over near 4.0 impairment grade up to 20 ppf. The rest hold type LCDs, TN and SIPS showed poor impairment grade(under 3.0) even in 10 ppf.

To obtain perfect motion picture quality, it is generally known that test display should acquire over 4.5 impairment scale(threshold of perception for deterioration) in subjective evaluation. Other hold type LCDs could not reach the threshold of perception for deterioration in moving picture quality. We could confirm that we should apply impulsive driving in LCD to have CRT-like moving picture quality.

3. Summary

We applied impulsive driving method of cyclic resetting to OCB mode and the motion picture quality was greatly improved. Subjective evaluation was conducted for motion picture quality on CRT, TN, SIPS, and impulsive driving OCB mode in order to compare the motion picture qualities and we obtained CRT-like motion quality in impulsive OCB mode.

4. Acknowledgements

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5. References

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