Fast Response Driving of TFT LCD for Motion Picture

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Abstract

We reported the algorithm of driving scheme that enhances moving picture property by improving gray-to-gray response time. Here, we report result of simulation for estimation of driving voltage to reduce response time, and experimental result. We investigated optimization of algorithm so that minimum size of LUT can support to reducing the gray-to-gray response time within 1 frame period, and with single algorithm it is possible to apply the algorithm to various kinds of LC material. So in our system there is no external EEPROM.

1. Introduction

LCDs have begun to be used in displaying TV moving pictures and fast-moving objects generated by the PC graphics systems. However, one of drawback of the LCD performance for the motion picture is slow response time. The response time in LCD tends to be slower in grayscale. Therefore it is concerned about the loss of contrast whenever the picture moves.

In order to resolve this issue, the overdrive method looks to become the key technology for LCD TV and other display for multimedia. To accelerate the response time, the voltage data is to be modified by adding the additional voltage data which corresponds to the quantity of change in voltage data according to time. In overdrive system, it is normal to use additional EEPROM for LUT(Look Up Table). In LUT, there are absolute voltage data which corresponds to the difference in image data values.[1),2)]

However, there are some points for mass production. If several kinds of LC material would be used, the contents of LUT must be modified. In mass production, downloading the data to EEPROM needs several seconds, so it decreases the efficiency of production. Above all, adding of EEPROM increases the material cost. Large size of LUT makes the logic of controller complex, so it might be needed to use EDRAM(Embedded DRAM) within controller. It also increases the cost.

Because of above reason, we tried to make the LUT simple and not to use EEPROM. And, we investigated the possibility of applying one algorithm to the several LCs which have different properties.

2. Experimental

Figure 1 shows the system diagram of experiment. In this system, we used ALTERA 10K100 FPGA as controller, and HY57V643220CT as frame memory.

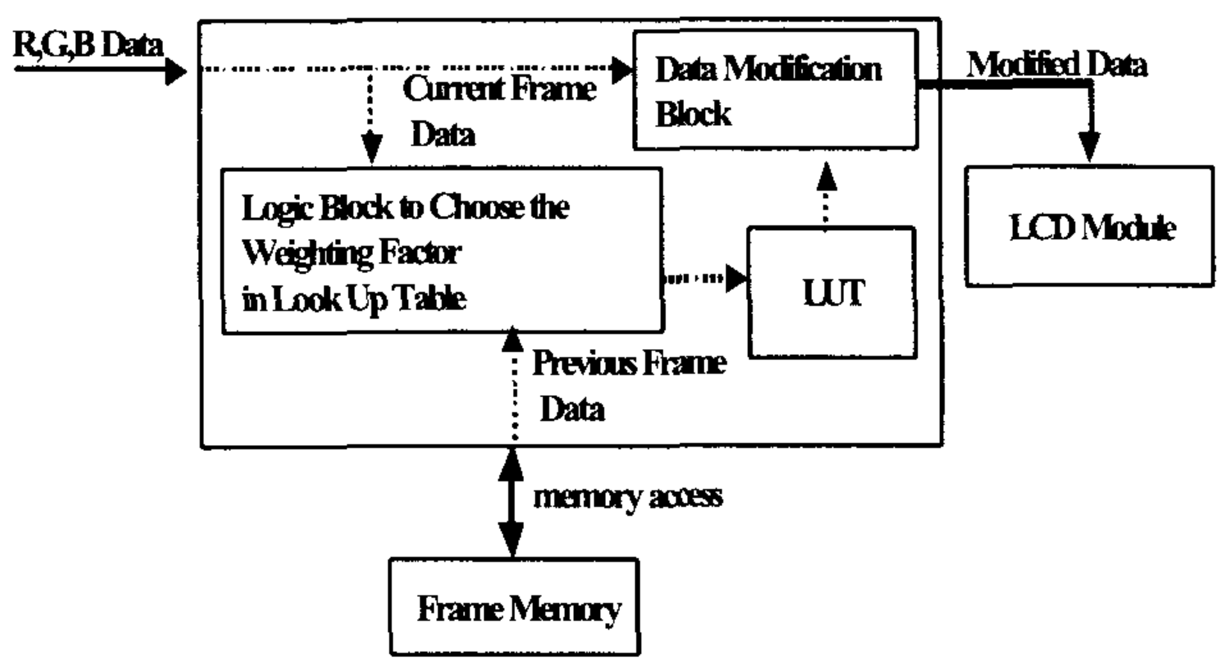


Figure 1. Block diagram of driving system

We tried to do modeling of pixel capacitor as the function of voltage. On the basis of theoretical modeling, we tried to set up the overdrive system. With modeling and real experimental data, we made one algorithm, which can be expressed in the form of LUT. The LUT is composed of the ratios of modified gray data (which means overdrive data) and current field gray data. The size of LUT was optimized to be minimum which can support full gray data.

So the LUT can be deposited within the controller, not at the external EEPROM.

We applied one algorithm to several kinds of LC in TN mode which has different material property each other.

We also made one algorithm for FFS mode, and applied to FFS module.

3. Results and discussion

Fig 2 shows the experimental result for TN mode. At this result, we could confirm that one algorithm can be applied to different kind of LC which has different material property each other.(for example, elastic , dielectric property).

Most important property for response time is supposed to be viscosity. For fast response time between black and white, the viscosity of LC is recommended to be the range of 60 ~ 100 (mPa.s). We considered the LC of this range for algorithm.

We considered the dynamic nature of LC capacitance. In the Active Matrix (AM) driving method, it is assumed that constant charge is maintained. However, voltage applied to a pixel capacitor will change as the capacitance of LC changes.

In the n^{th} frame, V_n is applied to a pixel, which was at V_{n-1} previously. After charging, the voltage changes to V_f eventually. From the charge conservation law,

$$V_n = \frac{C(V_f)}{C(V_{n-1})} \times V_f \qquad (1)$$

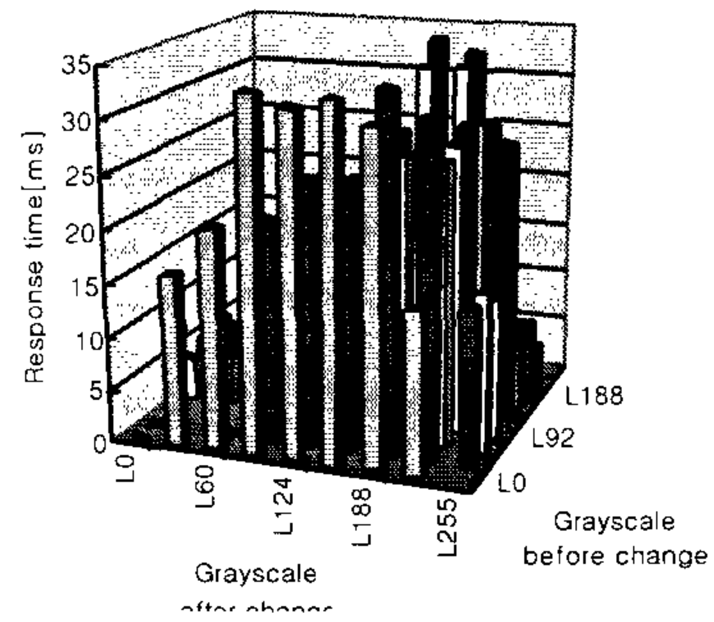
In order for the pixel to reach the desired voltage level V_n, the following V_{over} should be applied instead of V_n.

$$V_{over} = \frac{C(V_n)}{C(V_{n-1})} \times V_n \qquad (2)$$

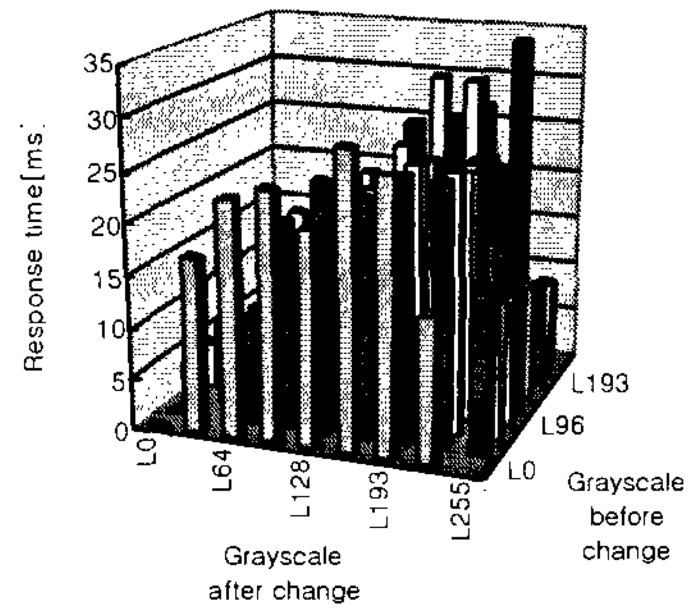
LC Name	Δe	K11	K33
A-Type	6.8	11.1	14.8
B-Type	4.9	10.21	15.59

Table 1. Material property of LC (TN mode)

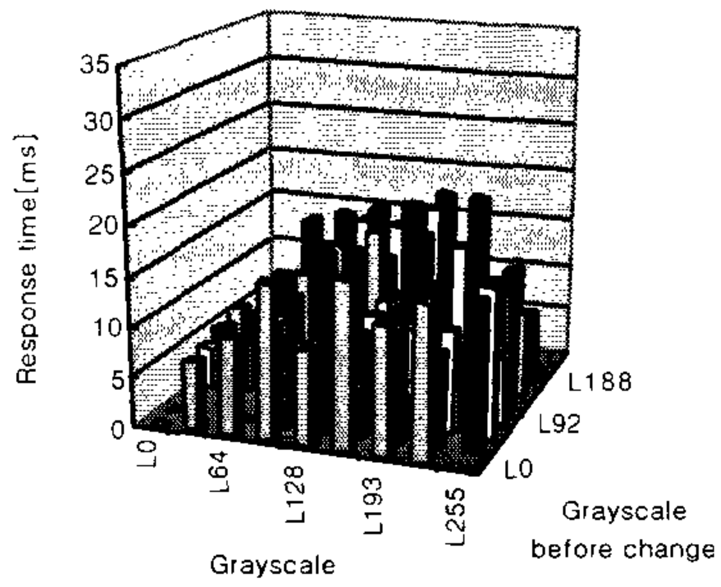
a) A-Type TN LC (Conventional Drive)



b) B-Type TN LC (Conventional Drive)



c) A-Type TN LC (Over Drive)



d) B-Type TN LC (Over Drive)

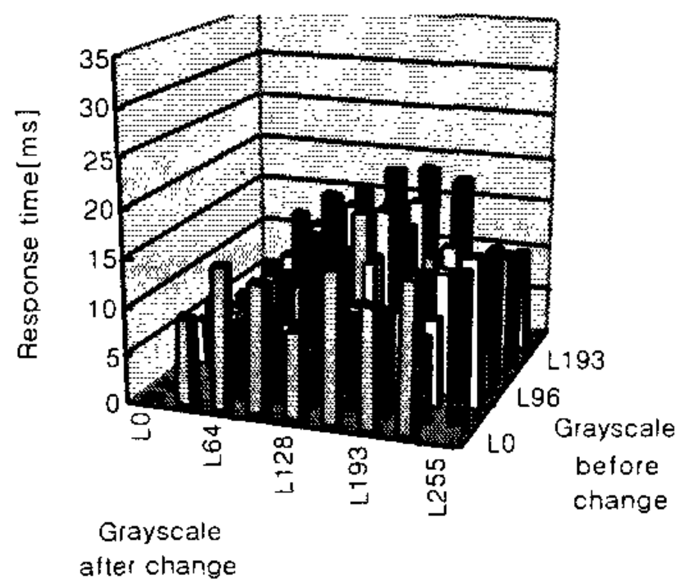
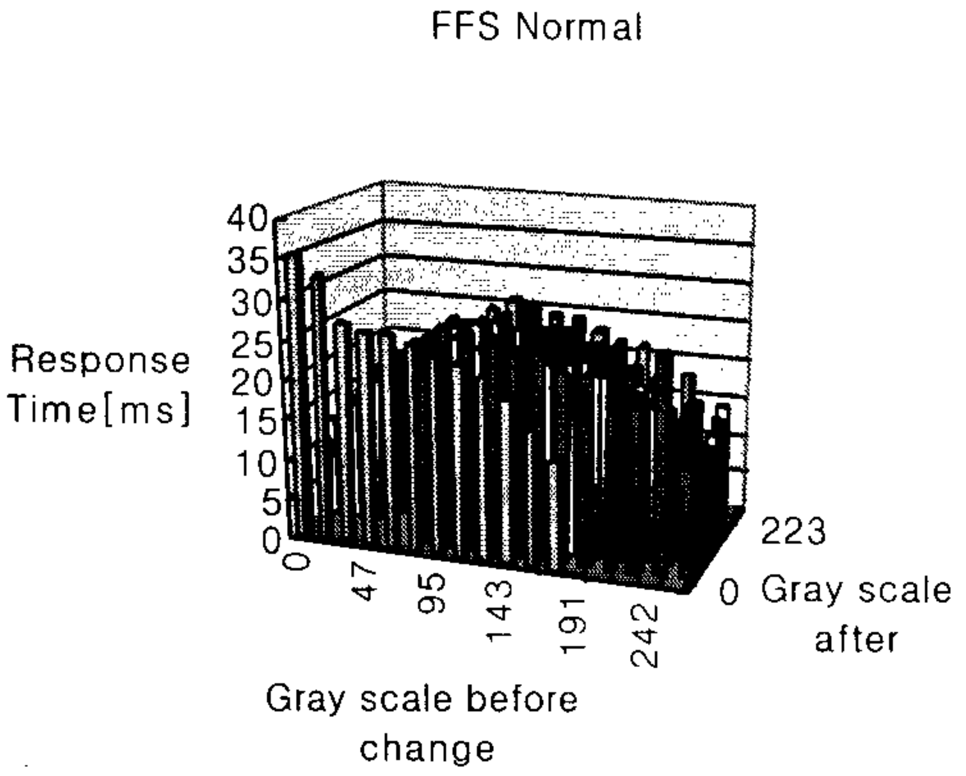


Figure 2. The response time betwe scale(TN mode)



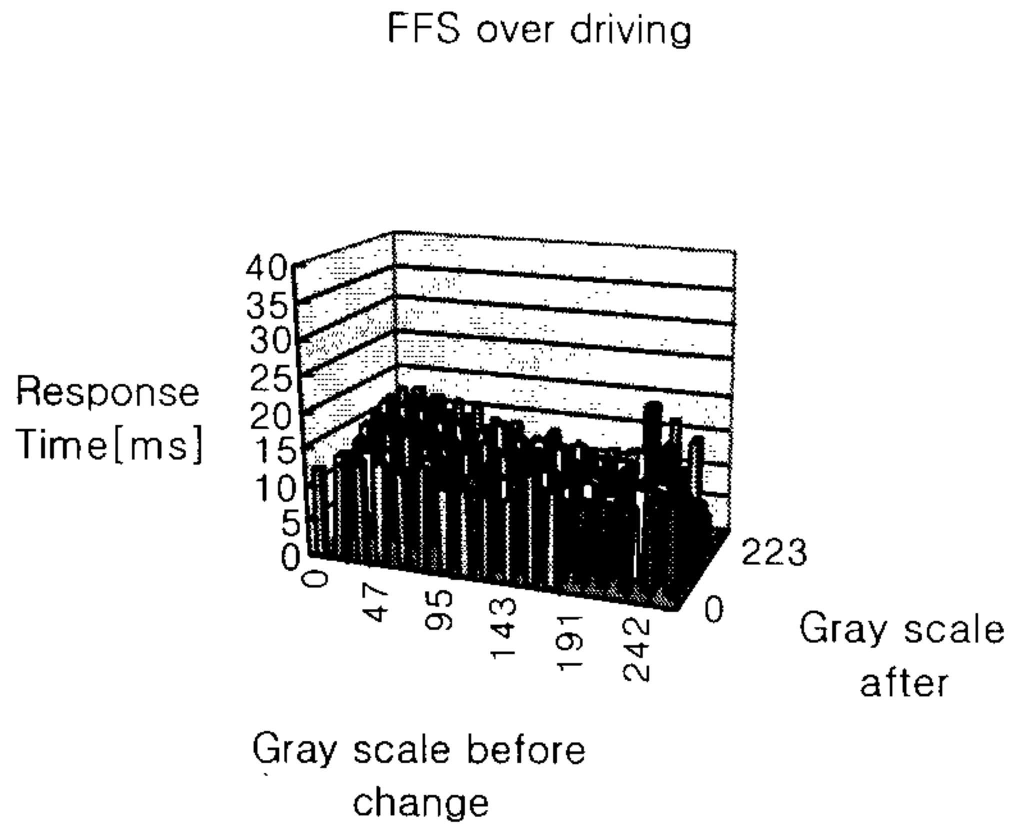


Figure 3. The inter-gray response time (FFS Mode)

Table 1 shows the material property of LC used in this experiment. Figure 3 shows the experimental result for FFS mode.

With the help of theoretical equation (2) and experimental data of inter-gray response time, we could established optimized algorithm for each mode.

We also investigated the influence of frame rate on response time of this method. From 60Hz to 75 Hz, we compared the inter-gray response time, and could confirm that it is possible to use one algorithm for the frame rate range of 60~75Hz.

4. Conclusion

In this paper we demonstrated that with one algorithm it is possible to reduce gray-to-gray response time within one frame period for several TN mode LC. The influence of temperature will be inspected ASAP. And for FFS mode, we investigated the optimum algorithm and demonstrated the result.

5. References

[1] B-.W.Lee,D.Sagong,and G.Jeong,*SID 2001 Digest*,41.51(2001)

[2] K.Nakanishi,S.Takahashi,H.Oura, T.Matsumura,S.Miyake,K.Kobayashi, *SID 2001 Digest*,29.3(2001)

[3] S.H. Lee, S.M. Lee, and H.S.Park, *SID 2001 Digest*,29.2(2001)