A Method of Reducing EMI in LCD Timing Controller using Efficient Data Compression and Data Transition

Min Kyu Kim, Song-Jae Lee, ChangGone Kim, SinHo Kang
LG Display Co., Ltd., 1007, Deogeun-ri, Wollong-myeon, Paju-si, Gyeonggi-do, 413-811, Korea
TEL:82-31-933-7592, e-mail: mkurim@lgdisplay.com

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Abstract

This paper proposes an efficient data compression for the conventional method of reducing EMI in a 10 bit LCD timing controller (TCON). In addition, we develop a new method to reduce EMI in a LCD TCON through repeated data on adjacent blocks. The novel technique reduced EMI by 10 dB for a 52" FHD 10it LCD TV.

1. Introduction

TFT-LCD has been highlighted as the leader of flat display systems by rapid technology progress and successful commercialization. TFT-LCD has many good features for flat displays such as excellent color reproduction, high contrast ratio, and high luminance. In order to improve the quality of moving image on a TFT-LCD, overdriving (OD) technique is used [1]. The OD method uses memory devices for saving an image data. It also uses a data compression to reduce a memory size. As a result of using storage devices, it has an increased EMI problem in a LCD TCON.

2. Data Transition Minimization (DTM) Algorithm

The DTM algorithm presents the method of reducing EMI which is generated by OD technique in LCD [2], [3]. This algorithm converts the data, which is transferred into and out of a memory device, to minimize the data transition with comparing previous data to current data. It needs one flag signal to reconstruct the converted data in DTM algorithm. The conventional DTM algorithm uses the BTC method for compression. After compressing, the data transfer into a memory. Figure 1 shows the concept of the compression method on DTM algorithm. Then, in order to minimize the data transition, DTM method is applied. Figure 2 shows the concept of DTM method.

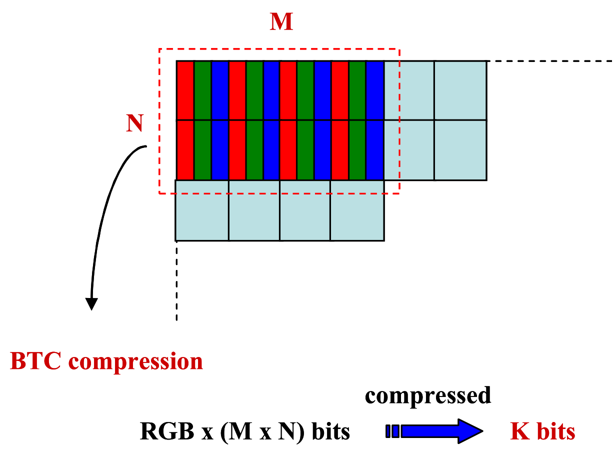


Fig. 1. The concept of the compression method

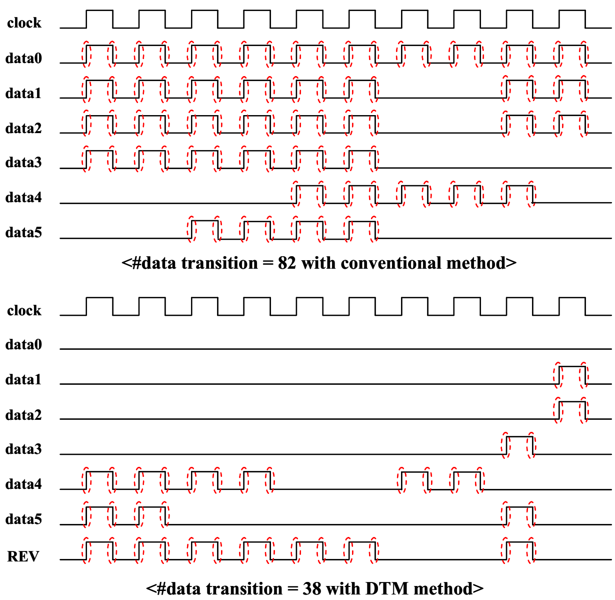


Fig. 2. The Concept of DTM algorithm

The current data is compared to a previous data having L bit to identify the number of bit transitions from a low value to a high value or vice versa. The present data is inverted when the number of transitions is greater than L/2. As shown figure 2, the data transitions are decreased, in spite of an additional flag bit. Figure 3 shows the total block diagram of LCD TCON with DTM algorithm.

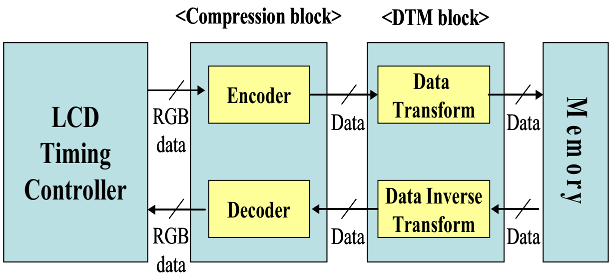


Fig. 3. The total block diagram of LCD TCON with DTM algorithm

3. Advanced DTM (ADTM) Algorithm with an Efficient Data Compression Method

This paper suggests an advanced DTM method for reducing EMI and an efficient data compression method for applying to high depth color LCD model. Figure 4 presents the block diagram of the proposed algorithm. The compressor block uses a BTC method to compress the data. If it uses the conventional BTC method on the DTM, it needs to compress more or to use a specialized memory device instead of common one. However, first suggestion could make a quality of image degraded. Second one is caused to increase the cost and couldn't be used widely. Therefore, we suggest an efficient compression method to maintain the image quality and use on common memory devices. We have a quantize block to compress image data additionally. The quantize block makes the mean value, RGB_LSB_mean, which are average of R_mean/G_mean/B_mean's lower R bits. Then, the lower R bits of R_mean/G_mean/B_mean are discarded. In spite of truncation, the data loss is much less because of having the mean value. Consequently, we can get the idle bits for using DTM method through a quantize block.

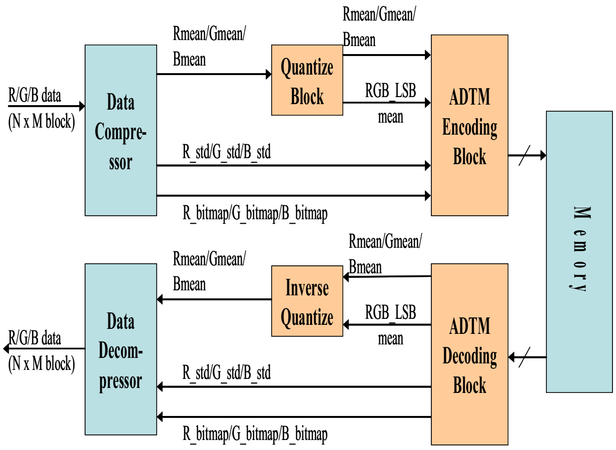


Fig. 4. The block diagram of ADTM with efficient compression

ADTM encoding block takes the compressed data. Then, it stores them until the next compressed data enter into. Comparing the data of previous block with the one of current block, if all bits of data are same, the data of present block will be converted into zero. At this, in order to reconstruct the data, the flag bit which is one remaining idle bit is only converted into one. In this case, the all data do not make transitions except for one flag bit. The data of neighboring blocks are usually same in the image data. So ADTM algorithm is an effective method to reduce EMI and power consumption in the LCD. Figure 5 shows a rough block diagram of ADTM method. If the data of current block are not same as the one of previous, it takes a conventional DTM method to minimize the data transition.

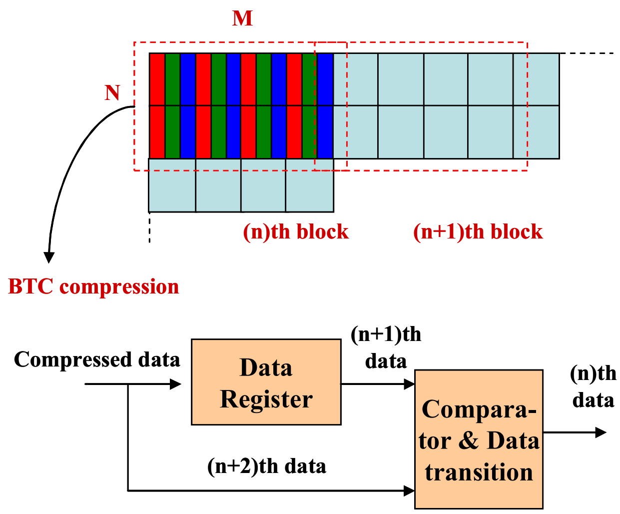


Fig. 5. The block diagram of ADTM method

4. Results and discussion

To compare the proposed compression method with a conventional one, we measured the PSNR by designing the algorithm with programming C. Figure 6 presents two compressed image of conventional and proposed method. Table 1 shows the PSNR result of a conventional compression and proposed one method. As shown table 1, the proposed method does not almost have data loss and gets the additional 4 idle bits for using ADTM algorithm. We implemented the proposed algorithm on the Cyclone II FPGA by performing placement and routing with Altera Quartus II. We measured the EMI of the proposed algorithm and conventional one by driving a 52" FHD 10bit LCD TV with FPGA control board at 3m chamber. We used the two kinds of images which are H-character and color bar images. The result of EMI measured is shown in figure 7. ADTM could reduce EMI in general and by 10dB maximally. As shown figure 7, EMI results are not good generally. But it is caused by using FPGA. If we implement the proposed method on ASIC, EMI is decreased on the whole. We also measured a power consumption using FPGA board. Table 2 shows the power consumption of FPGA chip at the VCC of FPGA board. We had a result of decreasing a power consumption overall because that ADTM algorithm could minimize data transitions.

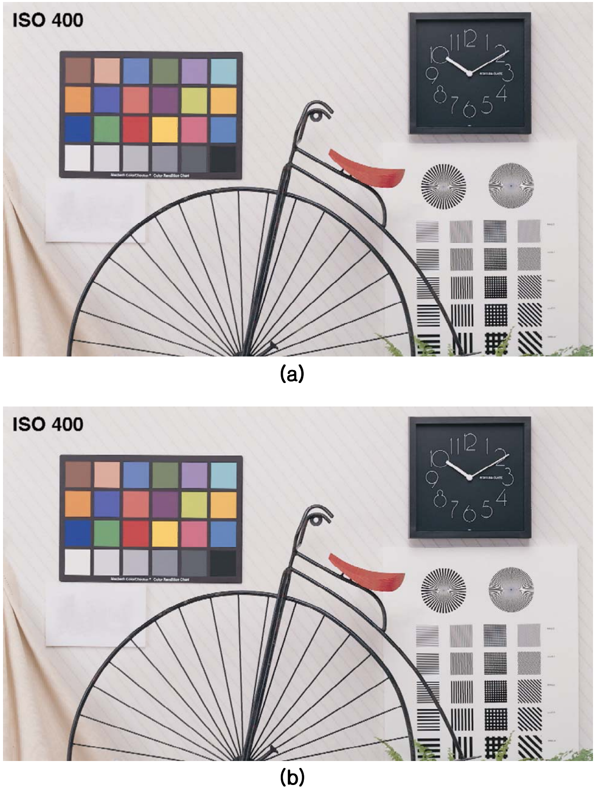


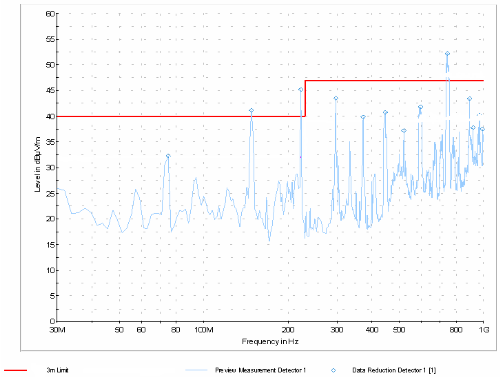
Fig. 6. Compressed images (BIKE 1) (a) the proposed method (b) the conventional method

5. Summary

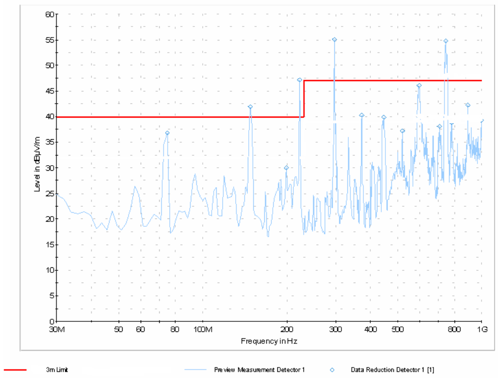
This paper presented an efficient compression and advanced data transition method for reducing EMI on LCD timing controller. Our proposed algorithm can reduce EMI and power consumption with minimizing the data transition of between LCD TCON and memory. This would make a great contribution to a LCD in digital machine including EMI and power consumption problem. The proposed method can also deal with a future high depth color LCD model with the efficient proposed compression algorithm.

TABLE 1. PSNR of compression results

Image	PSNR	
	Conventional	Proposed
BIKE1	29.76	29.26
BIKE2	31.53	30.05
FLOWER	35.44	34.11
FRUIT	32.86	31.23
PORT	35.67	33.45



(a)



(b)

Fig. 7. EMI result (with color bar image) (a) the proposed method (b) the conventional method

TABLE 2. Result of measuring power consumption

Pattern	Normal method (mW)	ADTM Method (mW)	Note
Full White	2366	2108	−258 (10.9% ↓)
Vertical 1 Line	2330	2079	−251 (10.8% ↓)
Horizontal 1 Line	2317	2154	−163 (7.0% ↓)
1 Dot	2333	2145	−188 (8.1% ↓)
Bike 1 Image	3108	3009	−99 (3.2% ↓)
Fruit Image	3135	2049	−86 (2.7% ↓)
Music Image	3175	3085	−90 (2.8% ↓)

6. References

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