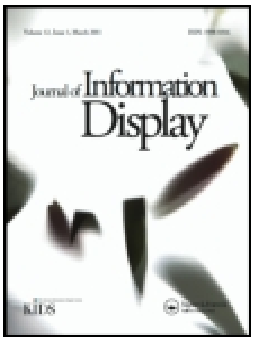

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A sub-field rearrangement driving method for reducing dynamic false contour in plasma display panels

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A Sub-field Rearrangement Driving Method for Reducing Dynamic False Contour in Plasma Display Panels

Seung-Yong Lee[**] **and Byong-Deok Choi**[*]

Abstract

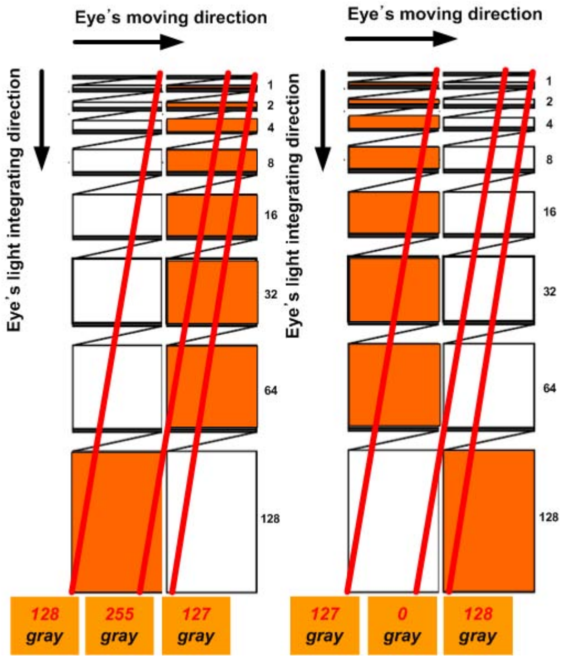
A sub-field rearrangement driving method has been proposed to reduce a DFC (Dynamic False Contour) phenomenon in plasma display panels. The proposed driving method expresses 256 gray levels with 16 sub-fields, while conventional one uses only 8 sub-fields. Notwithstanding the increase in the number of sub-fields, the display time is similar to the conventional 8 sub-fields driving method by appropriate choosing selective writing and selective erasing for sub-fields.

Keywords : PDP (plasma display panel), DFC (dynamic false contour), driving method

1. Introduction

PDPs usually displays 60 frames or more per second and each frame is composed of multiple sub-fields to generate gray scales. Each sub-frame typically emits binary-weighted amount of light, so gray scales can be expressed by choosing and combining sub-fields, because the light averaged out over a frame time is perceived to human eyes. However, the light from chosen sub-fields to express a gray scale can be unevenly distributed over a frame time. That is, a gray scale can be distorted to become brighter or darker as illustrated in Fig. 1. This is called dynamic false contour, or simply DFC, and many driving methods have been reported to address this issue [1-7].

This paper presents a driving method using sub-field rearrangement that shows more reduced DFC phenomenon compared to previous 12 sub-field driving method [5]. It is common knowledge that the more number of sub-fields each frame is composed of, the more reduced DFC can be expected. However, it also leads to a decrease in the display time. However, with the proposed driving method, the display time can be kept the same even with the increase in the number of sub-fields by appropriately combining selective write addressing and selective erase addressing for sub-fields.



(a) (b)

Fig. 1. Dynamic false contour phenomenon with the eye movement (a) when eyes move from a 128-gray pixel to a 127-gray pixel, the perceived gray-level changes from 128-gray to 255-gray and turns into 127-gray and (b) when eyes move from a 127-gray pixel to a 128-gray pixel, the perceived gray-level changes from 127-gray to 0-gray and turns into 128-gray.

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2. Proposed Sub-field Rearrangement

The conventional ADS (Address Display Separated) driving method constitutes a frame with 8 sub-fields for 256 gray scale expression, where each sub-filed emits the binary-weighted amount of light, and consists of reset period, address period and sustain period as shown in Fig. 2. The reset period initializes the pixel state by erasing the data of the previous sub-field, the address period selects pixels to be discharged, and the sustain period determines the gray scales of the selected pixels by repeating the discharge.

Fig. 3 illustrates the concept of the proposed sub-field rearrangement. A frame is composed of 16 sub-fields, and those sub-fields have the sustain periods with the time ratio of 1 - 1 - 1 - 2 - 2 - 4 - 4 - 16 - 16 - 16 - 32 - 32 - 32 - 32 - 32 - 32, where the time ratio determines the gray scale of the sub-field so that any gray level can be expressed by combining the sub-fields. During the reset period of the first sub-field, all the pixels are initialized. Then the selective writing is used during the address period with the sustain period following for light emission. The second and the third sub-fields, on the other hand, use the selective erasing addressing. It should be noted that the turn-on pixels in the first sub-field are erased in the second or the third sub-fields according to the image data, and the second and the third sub-fields do not need the reset period, the fourth sub-field, the selective writing addressing is used again, that is, a sub-field with a different time ratio from that of the previous sub-field uses the selective writing addressing, and the following sub-fields with the same time ratio uses the selective erasing addressing.

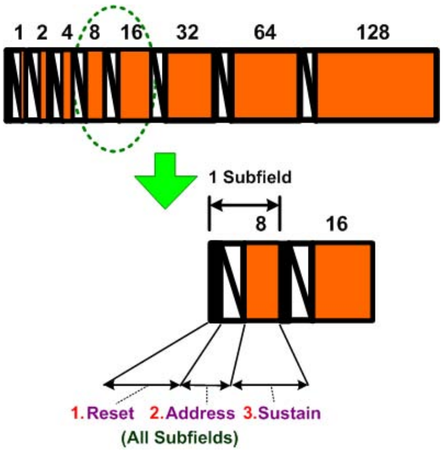

Fig. 2. Sub-field arrangement of conventional ADS driving method.

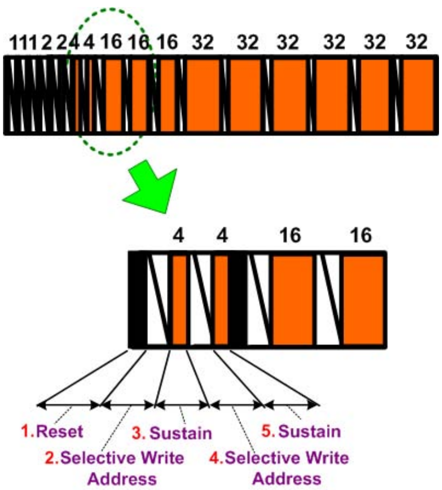

Fig. 3. Sub-field rearrangement of proposed driving method.

To illustrate the proposed sub-field rearrangement, let us look at an example of sub-field configuration for displaying 36th gray level in the proposed driving method as shown in Fig. 4. It is found that the sixth, eighth and ninth sub-fields discharge pixels. The sixth sub-field uses the selective writing addressing, and the seventh sub-field addresses the pixels by the selective erasing and emits no light. Note that it does not need the reset period for the selective erasing, because the selective erasing is performed on the turn-on pixels in the sixth sub-field. The eighth sub-field uses the selective writing addressing again with the

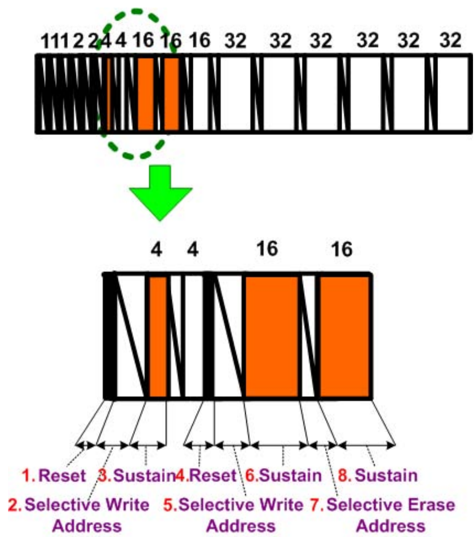

Fig. 4. Example of 36-gray expression in proposed driving method.

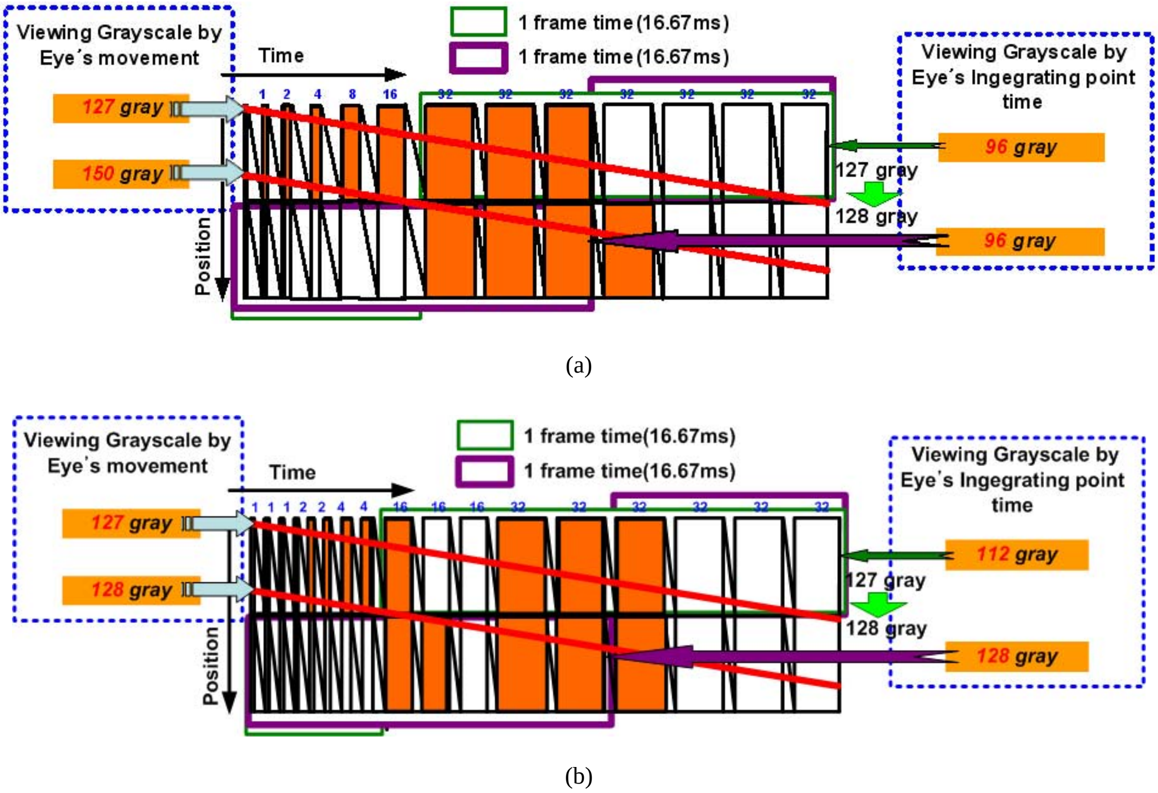

Fig. 5. Explanation of dynamic false contour phenomenon in time domain when the gray level changes 127 to 128 (a) in previous 12-sub-field driving method and (b) proposed driving method.

reset period, while the ninth sub-filed continues to discharge the pixels turned on in the eighth sub-field by selective erasing addressing. The sixth, eighth and ninth sub-fields have the time ratio of 4, 16 and 16, respectively, thus combining these sub-fields to express 36th gray level.

Fig. 5 (a) and (b) analyse and compare the DFC phenomenon for one frame time (16.67ms) in the previous 12 sub-fields driving method with the sustain periods having the time ratio of 1 - 2 - 4 - 8 - 16 - 32 - 32 - 32 - 32 - 32 - 32 - 32 [5] and the proposed sub-field rearrange driving method. Because human eyes perceive a gray level as they continuously integrate the light form a display device, we can assume a time window moving with time in Fig. 5. When the displayed gray level changes from 127 to 128, there exists a moment during which time the integrated light corresponds to the 96th gray level as shown in Fig. 5 (a). This is an unwanted gray level that cause the DFC phenomenon to occur. The proposed sub-field rearrangement method also suffers from a similar situation. The112th gray level falsely occurs while the gray level changes from 127 to 128. However, the difference between the real and false gray levels is reduced from 32 gray levels (128th-96th gray level) to 16 gray levels (128th-112th gray level), alleviating the DFC phenomenon as much as possible.

3. Display Time Analysis

Tables 1, 2 and 3 summarize the sub-field configuration

Table 1. Sub-field Configuration of Conventional ADS Driving Method [1]

Conventional ADS	Subfield #	1st	2nd	3rd	4th	5th	6th	7th	8th
	Grayscale	1	2	4	8	16	32	64	128
	Driving Sequence	R W S	R W S	R W S	R W S	R W S	R W S	R W S	R W S

R(Reset): 8 period, W(selective Write address): 8 period

Table 2. Prior 12-Sub-field Rearrange Method [5]

12-Subfield	Subfield #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
	Grayscale	1	2	4	8	16	32	32	32	32	32	32	32
	Driving Sequence	R W S	R W S	R W S	R W S	R W S	R W S	E S	E S	E S	E S	E S	E S

R(Reset): 6 period, W(selective Write address): 6 period, E(selective Erase address): 6 period

Table 3. Proposed 16-Sub-field Rearrange Method

	Subfield #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
Proposed	Grayscale	1	1	1	2	2	4	4	16	16	16	32	32	32	32	32	32
	Driving Sequence	R W S	E S	E S	R W S	E S	R W S	E S	R W S	E S	E S	R W S	E S	E S	E S	E S	E S

R(Reset): 5 period, W(selective Write address): 5 period, E(selective Erase address): 11 period

Table 4. Comparison of Display Time

	Conventional ADS		12-Subfield		Proposed	
Scan Time(ms)	Single	8.16	Single	7.85	Single	8.27
	Dual	4.08	Dual	3.93	Dual	4.14
Display Time(ms)		12.59		12.74		12.53

R(Reset) 300us S.W(Selective Write) 1.5us S.E(Selective Erase) 0.6us

Conventional ADS

R=300us, SW=1.5us
R x 8 subfields = 300us x 8=2.4ms
SW x 8 subfields x 480 lines = 1.5us x 8 x 480 =5.76ms
Single Scan = R + SW = 2.4ms + 5.76ms = 8.16ms
Dual Scan = Single Scan / 2 = 4.08ms
Display Time(ms) = 1 field – Scan = 16.67 – 4.08 = 12.59

12-Subfield

R =300us, SW = 1.5us, SE = 0.6us
R x 6 subfields = 300us x 6 = 1.8ms
SW x 6 subfields x 480 lines = 1.5us x 6 x 480 = 4.32ms
SE x 6 subfields x 480 lines = 0.6us x 6 x 480 = 1.73ms
Single Scan Time = R + SW + SE = 1.8ms + 4.32ms + 1.73ms = 7.85ms
Dual Scan = Single Scan / 2 = 7.85ms / 2 = 3.93ms
Display Time(ms) = 1 field – Scan = 16.67 – 3.93 = 12.74

Proposed

R =300us, SW = 1.5us, SE = 0.6us
R x 5 subfields = 300us x 5 = 1.5ms
SW x 5 subfields x 480 lines = 1.5us x 5 x 480 = 3.6ms
SE x 11 subfields x 480 lines = 0.6us x 11 x 480 = 3.17ms
Single Scan Time = R + SW + SE = 1.5ms + 3.6ms + 3.17ms = 8.27ms
Dual Scan = Single Scan / 2 = 8.27ms / 2 = 4.14ms
Display Time(ms) = 1 field – Scan = 16.67 – 4.14 = 12.53

and the driving sequence for gray scale expression in the conventional ADS method, 12-sub-field driving method [5] and the proposed 16-sub-field driving method, respectively. From these tables, we can calculate the total reset, address and display time of each driving method. The results are given in Table 4. The comparison of the display time between those three driving methods reveals that the proposed 16-sub-field driving method has similar display time to the conventional ADS driving method, even though the proposed 16-sub-field driving method has the most number of sub-fields among these three driving methods. This can be attributed to two facts. First, the proposed driving method has only five reset periods, while the ADS driving method has eight reset periods, and the 12-sub-field driving method has six reset periods. This is because the proposed driving method appropriately combines the selective writing and the selective erasing address periods. Second, the proposed driving method uses the selective writing address only five times while the conventional ADS driving method uses the selective writing address eight times during one frame.

4. Simulation Results

To verify the impact of the proposed driving method, we performed simulations on the DFC phenomenon of the driving methods mentioned above. Fig. 6 shows an original image used for the simulations. To observe the DFC phenomenon, we assume that the original image moves right by one pixel in the next frame, so that each pixel sees a change of a gray level. Now we can calculate the perceived gray level of each pixel by averaging the light throughout the two frames as the time window moves as illustrated in Fig. 5. Fig. 7 shows that the DFC phenomenon occurs in the conventional ADS driving method. Fig. 8 shows the DFC phenomenon is a little bit reduced in the 12-sub-field driving method, and Fig. 9 shows the result of the proposed 16-sub-field driving method,

Fig. 6. Original image.

Fig. 7. Dynamic false contour in conventional 8-sub-field ADS driving method.

Fig. 8. Dynamic false contour in previous 12-sub-field driving method [5].

Fig. 9. Dynamic false contour in proposed 16-sub-field driving method.

where we can find that the DFC phenomenon is, although it is not perfect is reduced furthe.

5. Conclusions

We have proposed a new sub-field rearrangement driving method for reducing the DFC phenomenon in PDPs. It is wellknown that the more sub-fields are used, the less DFC phenomenon occurs, but this occurs at the expense of decrease in the display time. The proposed driving method uses 16 sub-fields to reduce the DFC phenomenon, but it has the similar display time of 12.53 usec as the conventional 8-sub-field ADS driving method, and 12-sub-field driving method, both of which have the display time of 12.59 usec and 12.74usec, respectively. This is achieved by appropriately arranging the selective writing and the selective erasing addresses with a smaller numberof reset periods. Through simulations, we were able to confirm that the proposed driving method can contribute to reducing the DFC phenomenon in PDPs.

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