Equalizing pulse with error diffusion technique using Look-up-Table and subfield pattern for reducing dynamic false contour

Ki Ho Seo, Ki Woong Whang

School of Electrical Engineering & Computer Science, Seoul National University, Seoul, Korea, 82-2-880-7253

kihoss@pllab.snu.ac.kr

Abstract

We reported the method for the relatively simple equalizing pulse to reduce dynamic false contour. Equalizing pulse is determined by look-up-table and moving direction and velocity of the image. Used look-up-table is a few. If image moves to right or left, necessary LUT is only one for the velocity of 1 pixel/tvfield to right or left. This technique makes the process simple after obtaining motion information.

1. Introduction

Subfield method is used to express 256 gray scale in plasma display panels(PDPs). It is good for still image, but it makes serious disturbance when expressing moving images[1]. It is called 'dynamic false contour(DFC)'. DFC occurs in the area in which the luminance changes smoothly. And the state of the most significant bit(MSB) is changed in that area. Among proposed techniques, equalizing pulse technique[2] is reported to be effective in reducing DFC. DFC occurs when the state of MSBs is changed. In the fig. 1a, image moving velocity is 1 pixel/tvfield to right and left. The original information is 127 and 128. But the eye integrates stimuli along the arrows and the DFC occurs between two pixels. DFC depends on image moving velocity and direction. DFC gets broader as image moves faster, and has opposite amount when image moving direction is opposite like fig. 1a. Equalizing pulse technique modifies the information of pixels to give almost same integration result with the original one. In fig. 1b, opposite adjacent DFC appears. In that case, DFC gets less visible.

We suggest relatively simple technique for determining the amount and the position of equalizing pulse. It needs motion vector and one look-up-table(LUT). Our technique makes the calculation after getting motion information simpler.

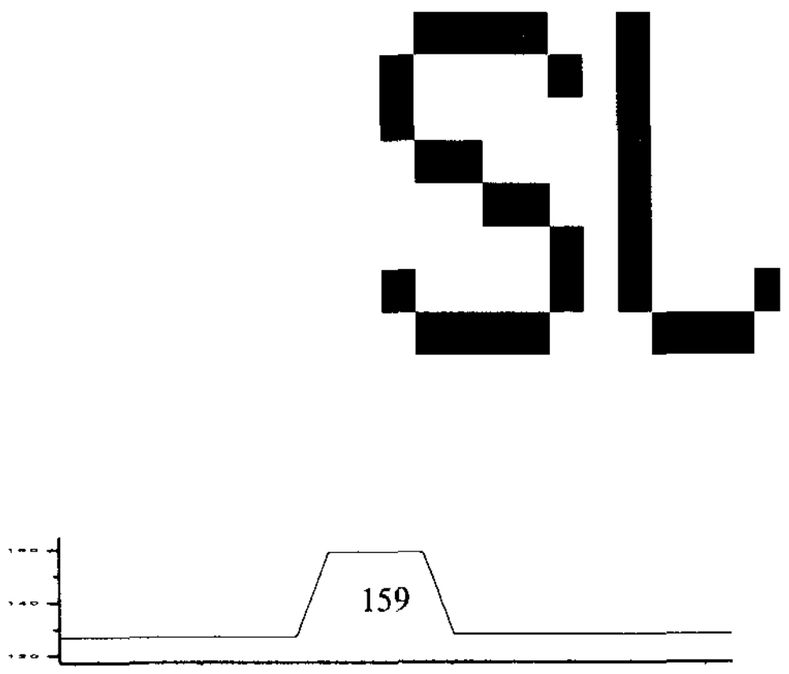

Fig. 1a. Dynamic false contour

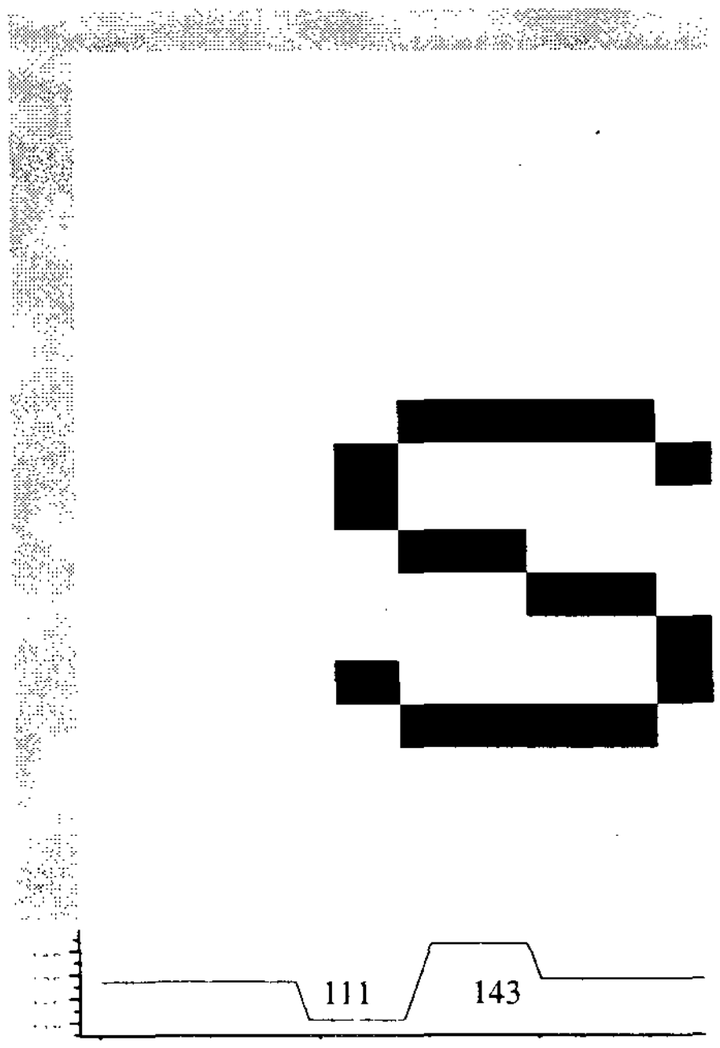

Fig. 1b. After modification

2. Proposed technique

2.1. Preparation for the process

Serious DFC occurs when the state of MSB changes. So it is known that it is possible to predict the position of serious DFC in advance. If image moves to left of right, it can predict DFC position to check the difference of the number of MSB turned on. If the difference with left or right pixel is one, it is possible that the spot becomes DFC. If the difference is more than one, the spot is real edge rather than DFC. And the change of the number of MSB turned on is also checked for the process after this.

Equalizing pulse technique induces additional noise if motion information is false. To reduce the danger of false process, we don't modify the state of MSB.

2.2. Making LUT

Used subfield pattern is 1 2 4 8 16 32 32 32 32 32 32 32 32. If the image moves to right, equalizing pulse is added to only left pixel in this process. If the image moves to left, equalizing pulse is added to only right pixel. The LUT has three columns. Two columns are original luminance information of neighboring two pixels. There are one difference of MSB(32) between them. The third column is modified luminance of left pixel that makes least mean square error. Assumed moving velocity is 1 pixel/tvfield to right only. Because opposite moving direction makes opposite DFC, one LUT is sufficient.

2.3. Adding equalizing pulses and additional diffusion proper to subfield pattern

If the image moving velocity is 1 pixel/tvfield to left of right, it is sufficient to modify one of the checked pixels by consulting LUT. But it is insufficient when the image moves faster. DFC gets broader as the image moves faster, so modifying one pixel is insufficient. In the faster case, additional equalizing pulses are added to the pixels in the modified pixel's direction. Namely, if the image moves to right, additional equalizing pulses are added to left pixels. The amount of additional equalizing pulses is determined mainly by the amount of pulses of 1 pixel/tvfield.

Total amount of equalizing pulse is velocity times the modification of 1 pixel/tvfield. Because doubled velocity makes almost doubled DFC like fig. 2, doubled modification reflects necessary modification almost. Additional modification amount is diffused to adjacent pixels to reduce DFC like fig. 3. Diffusion kernel is different by motion direction and the change of the number of MSB turned on. In fig 3, X and Y pixel have one different MSB turned on. If moving velocity is 2 pixel/tvfield to right, twice amount of modification of velocity 1 pixel/tvfield is applied to X pixel. If moving velocity is 3 pixel/tvfield, same modification of 2 pixel/tvfield is applied and same modification amount is applied to pixel Z. Though the moving velocity is same, modification amount and range is somewhat different according to the change of the number of MSB turned on.

Modifying is limited not to change the state of the MSB. If the state of MSB is changed by additional diffusion, it may induce another noise there.

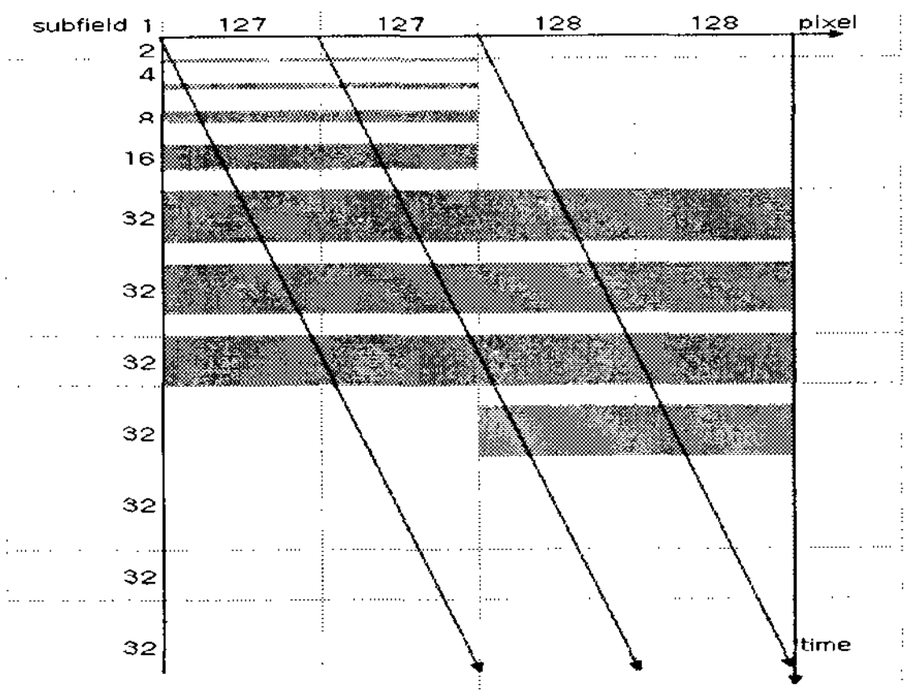

Fig 2. Dynamic false contour of velocity 2 pixel/tvfield

			Z	X	Y
			Z	X	Y
		Z	X	Y	
		Z	X	Y	
	Z	X	Y		

Fig 3. Range of modification

Because subfields to modify are in the beginning of tvfield, one-directional modification can reduce DFC without inducing another noise. The result of this process may not be the most optimized solution, and another solutions are

reported[3][4][5]. But this process needs simple LUT. This process needs relatively simple calculation.

3. Result

Fig. 4a, 4b are the original ramp image and the simulation result without any process. Fig. 4c is the result of above process. Assumed velocity is 4 pixel/tvfield to right. There is more DFC in the bright area, we give more equalizing pulse in that area.

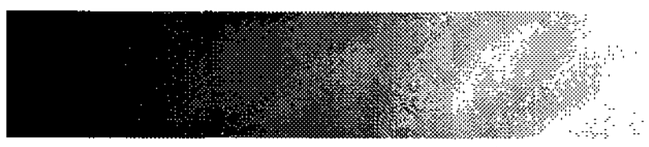

Fig. 4a. Original image

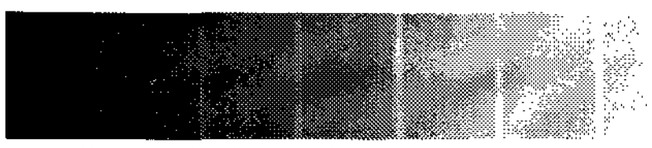

Fig. 4b. Result without any process

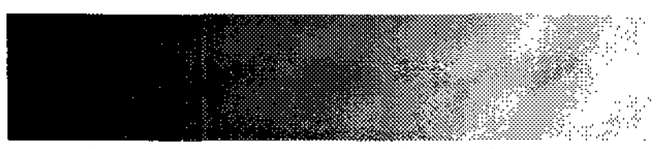

Fig. 4c. Result after above process

Fig. 5~8 shows whole process. Original image is Fig. 5 After checking the number of MSB which is turned on, the pixels to add equalizing pulse are determined. Calculation for getting motion vector is applied those black pixels. If checked pixels are determined not to move, no modification is added to those pixels.

Checked pixels reflect DFC well in fig. 7 Equalizing pulse by LUT is given to black pixels and adjacent pixels of fig. 6 by consulting LUT and motion vector. For horizontal movement, necessary LUT is only one. But more LUT may be necessary for arbitrary direction. LUTs for some directions, will help to reduce DFC. Fig. 8 is the result after whole process. The visibility of DFC is much reduced.

Fig. 5. original image

Fig. 6. Checked pixels to add equalizing pulse

Fig. 7. Simulation result without any process

Fig. 8. Result after whole process

4. Summary

The principle of equalizing pulse had been described in the past. Our technique uses look-up-table for specific subfield pattern to carry out that principle. Our technique reduces dynamic false contour through simple calculation and don't need big memory for look-up-table.

5. References

[1] S. Mikoshiba, SID Digest, pp. 384-386, 2000

[2] Y. Zhu, et al., "A motion-dependent equalizing-pulse technique for reducing gray scale disturbance on PDP", SID '97, pp. 221-224, 1997.

[3] Y. Zhu, et al., "An extended equalizing pulse technique for reducing gray scale disturbance of PDPs below the minimum visual perception level", Asia display '98, pp. 1075-1078, 1998.

[4] R. van Dijk, T. Holstag, "Motion compensation in plasma displays", IDW '98, pp. 543-546, 1998.

[5] J. Ryeom, et al, "An image data rearranged sub-field method for reducing dynamic false contours in PDPs", IDW '98, pp. 547-550, 1998.