Reduction nonlinearity of output luminance using modified ADS driving method in SMPDP

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Abstract

One of the factors deteriorating PDP image quality is the nonlinearity and nonuniform of output luminance as a function of input gray level. A novel method using modified ADS driving scheme is proposed to decrease this nonlinearity. It optimizes the reset pulse and adjusts the subfields, makes the relation of output luminance and input gray level almost linear. This method can be applied to general commercial PDPs.

1. Introduction

Plasma display panel (PDP) has been promised to be an attractive solution for high-definition television (HDTV) and home-theater applications. While the manufacturing cost is now the primary concern, there is also some significant research activities focused on improving the panel performance such as the efficacy, contrast and image quality.

A novel AC PDP structure with shadow mask (SMPDP) was presented to introduce another way of low cost PDP[1][2]. It can derate the manufactory process of barrier rib and replace with a metal plate with many small holes, which was called the shadow mask in the CRT industry. A typical sandwich structure of SMPDP is illustrated in figure 1, which shows a single pixel containing three discharge subpixels.

Ideally, SMPDP has linear output luminance response to digital-valued input[3]. However, the actual SMPDP has nonlinearity output luminance regarding to the input gray levels, especially in ADS (address and display period separated) method. Figure 2 shows measured luminance for the first 21 gray levels, obtained by measuring a commercial AC PDP[4]. The luminance does not vary monotonously. It depends on the time-interval of the light-emitting pulses, and also on the previous emission period. In addition, luminance levels are found to vary for each display pulse in a subfield due to gradual accumulation of space and wall charges.

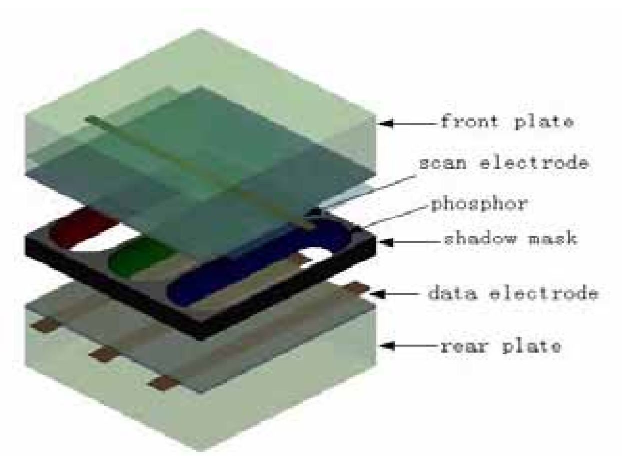


Figure 1 Sandwich structure of single SMPDP pixel containing three discharge cells

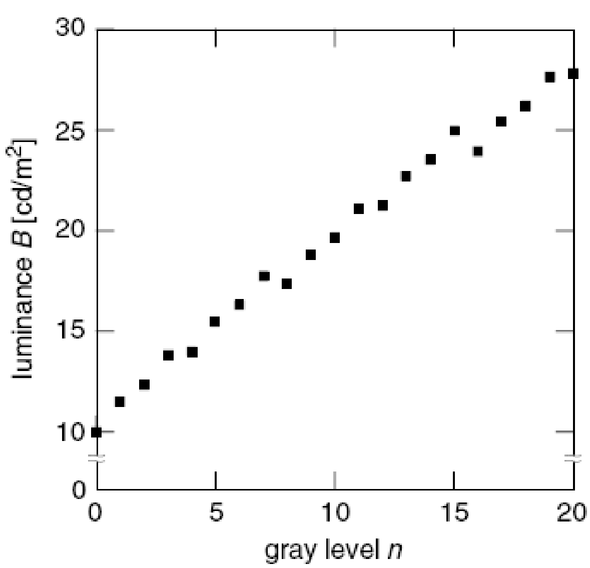


Figure 2 Magnified view of measured B(n) on an AC-PDP, B(0)=10cd/m2. The luminance level does not vary monotonously

2. Driving scheme in SMPDP

SMPDP uses address, sustain and reset pulse in ADS driving method to represent 256 gray levels[1][2]. Each frame is composed of 8 sub-fields and each subfield is divided into three distinct periods, e.g. address, sustain and reset, it is shown in figure 3. The address period ignites pixels which will emit light in sustain period according to the image information. The sustain period applies power to the pixels which have been ignited in address period for display light emission. The reset period establishes necessary conditions for reliable addressing in next subfield.

It assumes that, there is no output luminance for the reset and address pulse, just have irradiance for sustain pulse. Thus, the relation between output luminance and input gray level is linear. In fact, the light emission from the reset and address pulses can not be neglected, which may have high output luminance comparing to a single sustain pulse[5], and that the influence of reset pulse on next subfield can not be neglected too, which may decide the stability of emission between subfields. Therefore total output luminance of one frame is not proportional to the number of the sustain pulses.

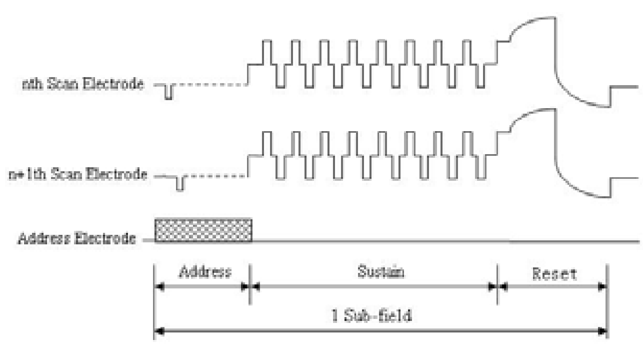


Figure 3 Driving waveform of SMPDP during a single sub-filed

3. Modified ADS driving method

3.1 Optimization of reset pulse

The ramp waveform has recently been used before address period for plasma display. The reset period establish two necessary conditions for reliable addressing. The first is a well established wall voltage for all pixels and the second is adequate priming of the address discharge.

During the process of applying ramping up and down voltage between electrodes in a reset period, the discharge can be controlled for each cell regardless of cell structure or conditions.

Figure 4 illustrates the detailed ramp waveform of 25 inch SMPDP. Where the V_{pu} is 100V, the V_s is 170V and the V_{pd} is 65 V.

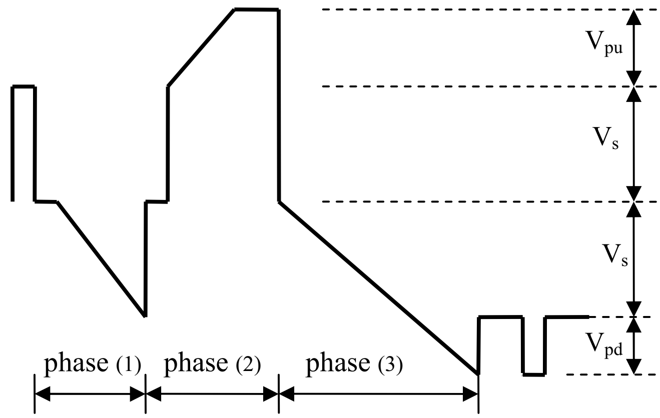


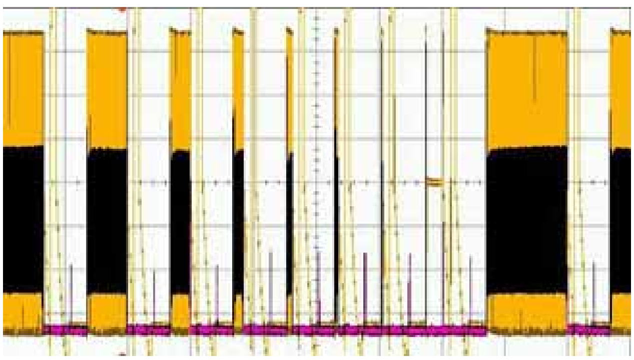
Figure 4 Reset waveform applied in 34 inch SMPDP

As shown in figure 4, we change the conventional reset period which use priming waveform after the sustain period[6], add a new negative erasing pulse to establish a primary stable wall voltage. The whole reset period can be divided into three phases, phase (1) is the added new negative erasing pulse, phase (2) and phase (3) make up of the conventional reset period. The ON cells in preceding sub-field have a fixed wall voltage when entering into the reset period, while the OFF cells have an unknown wall voltage. After the first ramping down in phase (1), the cells whose wall voltages are above zero will have a similar wall voltage. During the phase (2), the strong discharge occurs inside the cells whose wall voltages are below zero at first, and then a similar wall voltage above zero will established after ramping up. Now all cells' wall voltage are above zero. During the phase (3), as soon as the gas voltage reaches V_b, weak discharge will occur inside the cell, after the second ramping down phase, the similar wall voltage of all cells will be established.

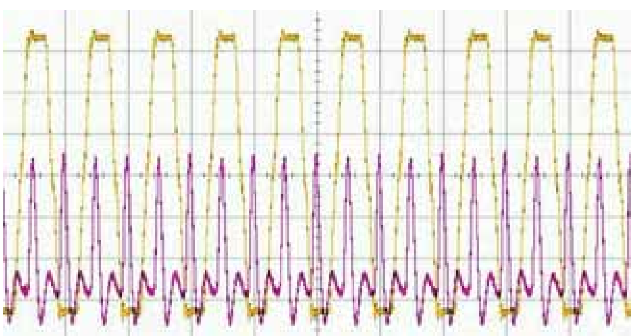
After the optimization of reset pulse, the influence between subfields decreases to a low level, it almost can be neglected. The emission of next address period can work normally, so the relation between irradiance and sustain pulse will be linear. Figure 5, which is screened from the oscillograph, shows the emission in address and sustain period with optimized reset pulse.

X-axis denotes the time, y-axis denotes the voltage. Yellow curves denotes the driving waveform, pink curves denotes the emission waveform, which are measured by Agilent infiniium 54832B DSO.

Figure 5(a) shows the relation between driving waveform and the emission of each subfield in one frame, we can conclude that the emission in address period of each subfield is appropriate and steady. Figure 5(b) shows the relation between sustain waveform and the emission in sustain period, we can conclude that the emission in each sustain pulse is similar and steady, so the irradiance intensity in sustain period is linear to the number of sustain pulses.



(a) Emission in address period



(b) Emission in sustain period

Figure 5 Emission in address and sustain period

3.2 Modification of subfields

In conventional ADS driving method, the TV field (16.7ms) is divided into 8 subfields and the number of sustain pulses for each subfield are 2^n $(0 \le n < 8)$. It may introduces dynamic false contour (DFC), and also deteriorate the linearity of image quality[7]. On the basis of split MSB bit into two parts[8], we split two bits into four parts, figure 6 illustrates the scheme of splitting subfields.

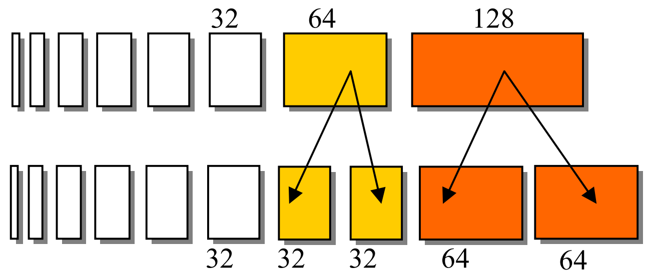


Figure 6 Scheme of splitting subfields

In 25 inch SMPDP, we use 166 KHz sustain frequency, and the number of sustain pulses for white point is 512 pairs. During experiment, we also have noticed that there is a phenomenon of nonlinearity between output luminance and input gray level, if we adopt the method of splitting subfields mentioned above. To minimize the nonlinearity of output luminance, we adjust the number of sustain pulses in four subfields, and do some sequence adjustment of subfield on the basis of scheme figure 6 shown.

Figure 7 shows the modification of subfields. We split conventional SF7 with 128 sustain pulses into new two subfields with 48 sustain pulses and 80 sustain pulses, and also split conventional SF8 with 256 sustain pulses into new two subfields with 112 sustain pulses and 144 sustain pulses. After splitting the conventional SF7 and SF8, and adjusting the number of sustain pulses, we make some adjustment in sequence of subfields, just as shown in figure 7.

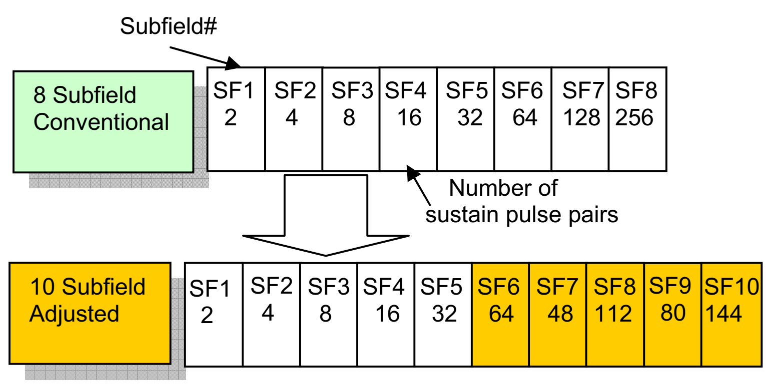
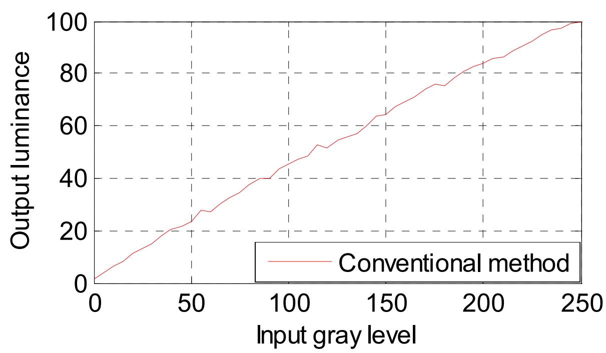


Figure 7 Modification of subfields

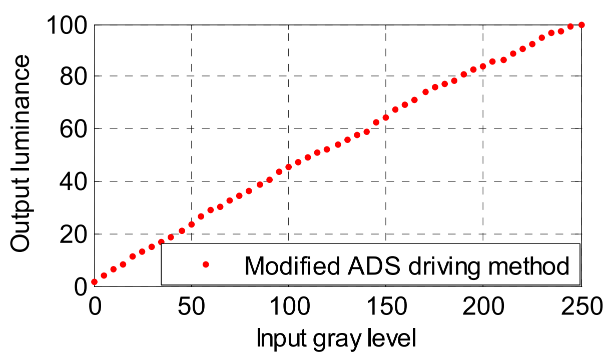
4. Experimental results

The performance of the proposed modified ADS driving method was evaluated by comparing the result images with those of the conventional system[2][6][8]. For the experiments, we use CA210 luminance measuring device to measure a 100×100 pixels white square on the center of 25 inch SMPDP in darkroom environment. The result of measurement is shown in figure 8.

Obviously, in figure 8(a), we can find that the relation between output luminance and input gray level is nonlinear, and there is a luminance collapse occurs on three input gray levels, so the image quality is deteriorated. Figure 8(b) shows the result using modified ADS driving method, we can find that the relation between output luminance and input gray level is almost linear, and there is no luminance collapse, the image quality is improved.



(a) Conventional method



(b) Modified ADS driving method

Figure 8 The relation between output luminance and digital-input with two methods

5. Conclusions and impact

The proposed modified ADS driving method focused on the optimization of reset pulse, the splitting and the sequence adjustment of subfields, and the number of sustain pulse adjustment in one subfield. The experiment indicated that this method could decrease the nonlinearity of output luminance. In result, we obtained an output luminance linearly response to input gray level.

The linearity of luminance is very important for image quality on digital display panel. Although contiguous 208-subfield scheme[4] is promising, it can not be applied to the most commercial PDPs using ADS scheme. The method which is proposed in this paper can decrease the nonlinearity of luminance in SMPDP. The proposed method was realized by the optimization of reset waveform and the adjustment of subfields. There is no need to add additional circuit, so it can be applied to general PDPs.

6. Acknowledgements

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7. References

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