New Driving Scheme for White Color Balancing of Plasma Display Panel Television

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I. ABSTRACT

A new driving-scheme is used for balancing white colors of plasma display panel-television (PDP-TV) by independent luminance control of the red, green and blue colors. White colors of eight subfields can be clustered within a region, which is not resolvable in terms of visual perception.

II. INTRODUCTION

Plasma Display Panel (PDP) is a promising candidate for use in large area (>40-inch) full-color wall-mounted digital televisions. One of the important issues for realizing the high quality PDP-TV is to improve an image quality including, dynamic false contours [1], and white color balancing [2]. The problems related to white color balancing in PDP-TV are inherently due to the differences in the visible emission and decay characteristics among the red (R), green (G), and blue (B) phosphor layers [3]. This causes the deviation of the white colors from the black-body locus when displaying a 256 color gray level, resulting in deteriorating a color image quality of a 42-inch PDP-TV. In a PDP-TV system, since a 256 gray level is realized by proper combination of eight subfields shown in Fig.1, we have measured the decay and saturation characteristics of the red, green, and blue phosphor layers with eight subfields [3]. Our experimental result illustrates that the white color changes as the subfield varies from SF1 to SF8, indicating that the white color balancing for a good color quality is required if the white color difference, $\triangle uv$ from the reference white color on black-body locus is greater than 0.002 in (u, v) units [4].

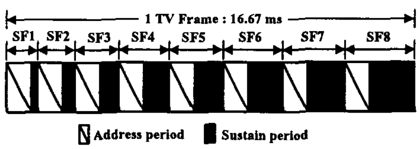

Fig. 1. Arrangement of subfields in 1 TV frame.

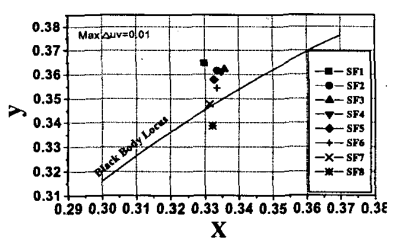

Fig. 2. Variation in white colors with 8 subfields before compensation.

The displacements of the white color chromaticities from the black-body locus as a variation of eight subfields are expressed in the CIE color coordinates of Fig. 2. The measured data of Fig.2 show that the maximum white color difference $\triangle uv$ between SF1 and SF8 is 0.01, which is much greater than 0.002. Thus, the white colors need to be compensated for white color balancing.

Accordingly, this study proposes a new driving method, which can control the luminance ratio among the red, green, and blue colors by applying various auxiliary address pulses independently to the red, green, and blue cells during a sustain-period. Through this proper control of the luminance ratio, the minimum perceptible white color difference ($\triangle uv<0.002$) is obtained irrespective of the variation in the subfields from SF1 to SF8.

III. WHITE COLOR BALANCING

The cell structure of PDP-TV consists of three cells that emit the red, green, and blue lights and the sustain and address pulses are applied to the three electrodes through the sustain and address drivers, as shown in Figs. 3 (a) and (b). As illustrated in the timing diagram of the voltage pulses in Fig.4, in the conventional driving method, no address voltage is applied during a sustain-period, and the sustain pulses are commonly applied to the sustain electrodes through the sustain drivers X and Y in Fig.3. Thus, the luminance difference among the red, green, and blue cells inevitably occurs as a variation of the subfield due to the different emission and decay characteristics of the R, G, and B phosphor layers.

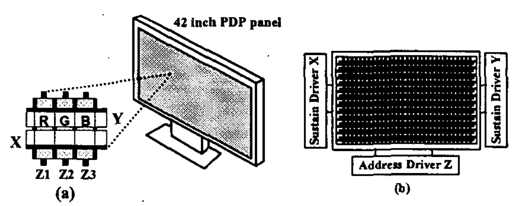

Fig. 3. Cell structure of 42-inch PDP-TV (a) and sustain/address drivers for applying the sustain and address pulses.

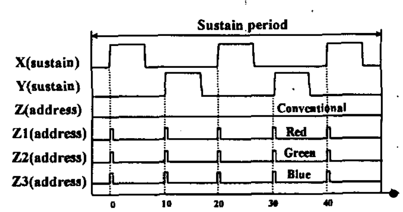

Fig. 4. New driving scheme for balancing the white color relative to the conventional driving scheme during sustain-period.

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Consequently, to compensate the luminance difference among the red, green, and blue cells during a sustain-period, a new driving method which can adjust the luminance ratio is needed, as illustrated in Fig. 4. In the new driving method, various short address pulses are simultaneously applied to the address electrodes through the address driver Z during a sustain-period to compensate the luminance difference among the red, green, and blue cells. The pulse width of sustain pulses are 8 μsec at 50 KHz, whereas the pulse width of the auxiliary short address pulses are fixed at 500 nsec. However, the amplitudes of the short address pulses are varied at intervals of 20 V from 20 V to 120 V to adjust the luminance ratio among the red, green and blue lights according to the variation of the subfields from SF1 to SF8, even though the sustain pulses have a constant amplitude of 180 V. These data libraries are used to choose the appropriate luminance and spectra for the white color balancing.

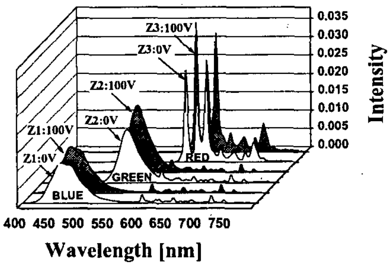

Fig. 5. Visible spectra of red, green, and blue lights emitted from PDP cell with a variation of auxiliary voltage pulse in subfield of SF8.

The flow chart for the white color balancing with eight subfields is shown in Fig.6. First, the variation of the white colors from the PDP-TV is measured with eight subfields. Next, it is checked whether the △uv of the measured white color values relative to the reference white color is below 0.002 or not. If the △uv of the measured white color values relative to the reference white color is above 0.002, the white color should be compensated according to the procedure of the flow chart for white color balancing. Then, the luminance ratio among the red, green, and blue lights necessary for the white color balancing is determined. After selecting the red, green, and blue spectra necessary for the white color balancing from the data library, the CIE color coordinates, x and y are calculated from the red, green, and blue spectra using the color mixing program in which the x and y coordinates are obtained by the mathematical calculation procedure through the combination of the standard color matching function and the measured red, green, and blue spectra. If the value of △uv between the compensated white colors and the reference white color is smaller than 0.002, then compensation process terminates. Otherwise, a repeated processing of the loop is started, as shown in Fig. 6. Within the loop, new color coordinates instead of the previous color coordinates are calculated using the color mixing program after rearranging the red, green, and blue spectra from the data library. Therefore, this compensation process needs several iterations until the value of △uv is below 0.002. Finally, when the compensation process is completed, the amplitudes of the three short address pulses applied to the red, green, and blue cells are determined relative to the eight subfields, respectively.

As a result of using the flow chart adopting the new driving scheme for the white color balancing, the x, y coordinates of the balanced white colors with eight subfields are displayed in Fig.7. The white color difference △uv in each subfield relative to the reference white color (x=0.3404, y=0.3543) on the black-body locus is obtained below 0.002, implying that the minimum perceptible white color difference required for the white color balancing relative to the reference white color on the black-body locus can be achieved irrespective of the variation in the subfield from SF1 to SF8.

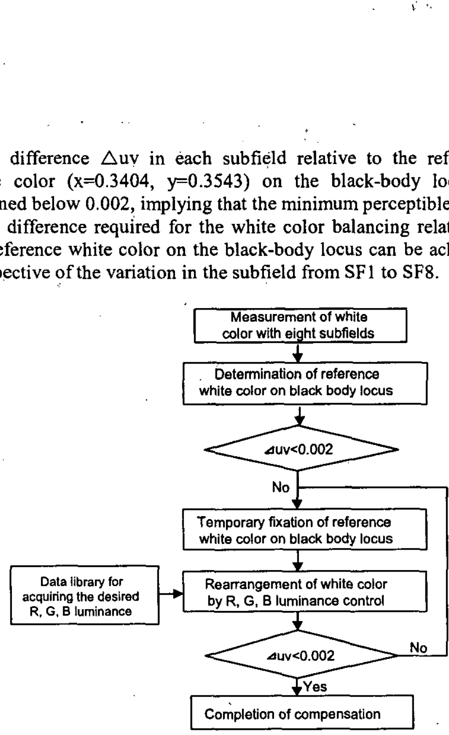

Fig. 6. Flow chart for white color balancing.

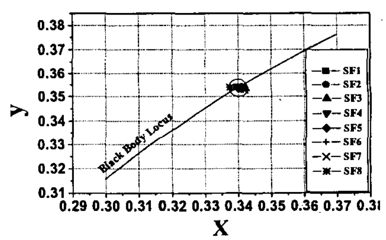

Fig. 7. White color balance with 8 subfields by new driving method.

IV. CONCLUSION

The balanced white colors with eight subfields are obtained using the new luminance compensation driving method. The white color difference △uv below 0.002 shows that the minimum perceptible white color difference for a high image quality is achieved irrespective of the variation in the subfields from SF1 to SF8.

V. REFERENCES

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