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行政院國家科學委員會補助專題研究計畫 ■成果報告 □期中進度報告

廣色域攝影機設計之研究

計畫類別：■個別型計畫　□整合型計畫
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共同主持人：
計畫參與人員：陳韋辰，余冠生

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中文摘要

一般攝影機的頻譜響應是由 ITU-R BT.709 色彩標準所推演所得，使得攝影機能夠紀錄適合於顯示器重現影像色彩的信號。然而由 ITU-R BT.709 色彩標準所推演的理想頻譜響應是物理上不能實現的。理想頻譜響應必須做修改使得攝影機頻譜響應能夠實現，但是由於理想頻譜響應含有很大的旁帶，使得實際的攝影機之色彩校正並不很精確。本計畫成果提出一種設計能夠紀錄更精確影像色彩攝影機的方法。我們發現由一個使用單頻光為三原色的廣色域顯示器所推演得到的理想頻譜響應之旁帶很小。我們使用GretagMacbeth ColorChecker 校正攝影機，其頻譜響應是由此理想頻譜響應修改所得。結果顯示色彩校正誤差可以跟著旁帶的降低而縮小。雖然這攝影機的頻譜響應是由廣色域顯示器推演所得，它也可以應用於使用色彩飽和度較低三原色的顯示器，比如符合 ITU-R BT.709 色彩標準的顯示器。由於所推演的理想頻譜響應決定於單頻光三原色的波長，我們可以選擇適當的三原色波長推演適合的頻譜響應，使實際可得的染色材料能夠應用於製作高色彩紀錄精度攝影機使用的彩色濾光片。

關鍵字：色差公式，色彩辨別橢圓，廣色域顯示器。

Abstract

The spectral responses of conventional cameras are derived from the ITU-R BT.709 color standard so that the cameras are able to record the signals that are suitable for the display to reproduce image color. However the ideal spectral responses derived from the ITU-R BT.709 color standard are not physically realizable. They are modified so that camera spectral responses can be practically implemented. The chromaticity calibration of practical cameras is not very accurate because of the large side lobes of the ideal spectral responses. A method to design a camera that is able to record more accurate image color is shown. It is found that the amplitudes of side lobes of derived ideal spectral responses from a wide-color-gamut display with monochromatic primaries can be significantly reduced. The camera with practical spectral responses modified from ideal spectral responses is chromatically calibration with GretagMacbeth ColorChecker. The result shows that the chromaticity calibration error can be reduced accordingly. Although the camera spectral responses are derived from a wide-color-gamut display, it also can be applied to the displays with less saturated primaries, e.g. ITU-R BT.709 primaries. Because the derived ideal spectral responses depend on the wavelengths of monochromatic primaries, we may choose proper primary wavelengths to derive suitable spectral responses for available dye materials used in the color filters of the cameras with high-color-accuracy recording capability.

Keyword: camera spectral response, wide-color-gamut camera, wide-color-gamut display

1. Introduction

Digital image plays an important role in this information era owing to the advance of cameras and displays. Cameras are image input devices and displays are image output devices. Nowadays, both are popular and penetrate our daily life. Imaging systems based on CCD or CMOS cameras have been widely used in professional and consumer applications owing to their high resolution, high quantum efficiency, wide spectral response, acceptable signal-to-noise ratio, linearity, fast response, small size, durability and low cost [1]. There are color filters in the cameras for capturing color images. Absorption materials and interference films can be used to implement color filters [2]. Absorption color filters are durable and low cost but their transmission spectra are limited by available absorption materials. The transmission spectrum of an interference color filter can be tailored but its cost is high and its transmittance is low for wideband application. Therefore, absorption color filters are used in conventional cameras. The spectral responses of a camera are the product of the transmittances of color filters and the CCD or CMOS spectral response. Theoretically, if the spectral responses of a camera exactly fit the CIE color matching functions $\bar{x}$, $\bar{y}$ and $\bar{z}$ as are shown in Fig. 1 [2], the tristimulus values of image color can be accurately measured and recorded by the camera. The output signals of the camera can be generated according to the tristimulus values and the chromaticity characteristics of a display, e.g. ITU-R BT.709 color standard [3]. The chromaticity triangle and D65 white point of the ITU-R BT.709 color standard are shown in Fig. 2. Thus, the image color can be accurately recorded and reproduced if the image color lies within the color gamut of the display. However, such an ideal camera is not yet realized because it is difficult to implement the matched spectral responses. It is noticed that, from Fig. 1, we can see that four color filters are required for the ideal camera because there is a side lobe in blue region for the color matching function $\bar{x}$. For conventional cameras, three color filters in red, green, and blue are preferred without sacrificing camera resolution. The other difficulty arises from lack of proper color filters.

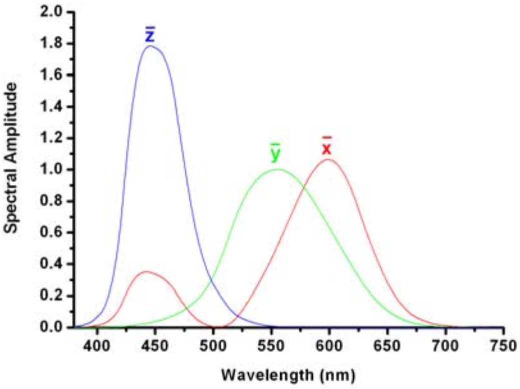

Figure 1: CIE color matching functions $\bar{x}$, $\bar{y}$ and $\bar{z}$.

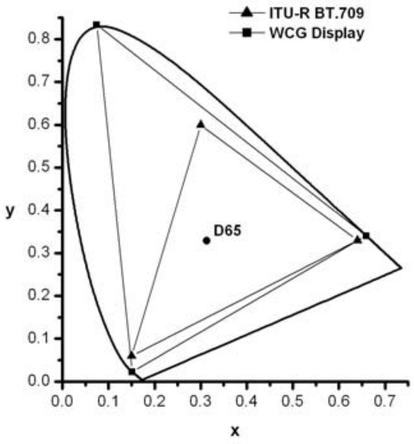

Figure 2: Chromaticity triangles of the ITU-R BT.709 standard display and the WCG display with monochromatic primaries. D65 white point is also shown.

The spectral responses of conventional cameras are derived from the ITU-R BT.709 color standard as is shown in Fig. 3 and will be explained in the next section [4]. The derivation is designed so that the camera raw signals (R_d, G_d, B_d) can be directly applied to an ITU-R BT.709 standard display for

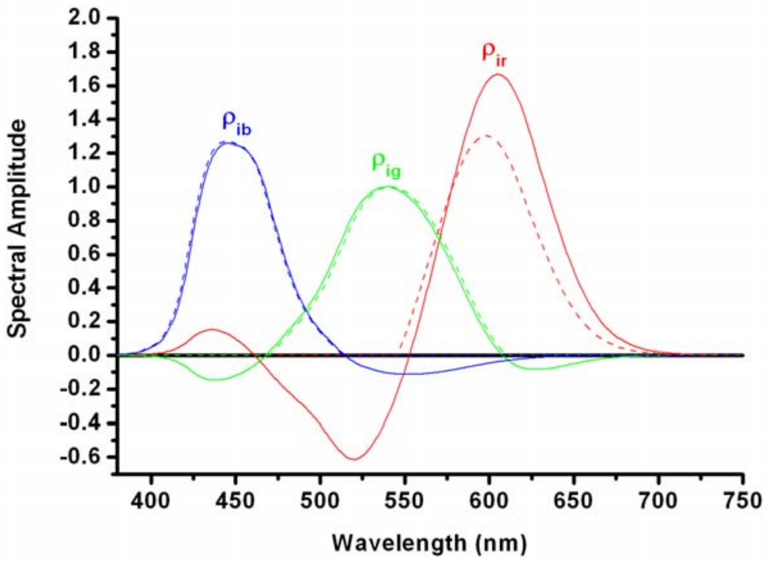

Figure 3: Ideal spectral responses of red (ρ_{ir}), green(ρ_{ig}) and blue (ρ_{ib}) channels derived from the ITU-R BT.709 standard display. The corresponding hypothetical spectral responses are shown with dashed lines.

reproducing image color. However, as is shown in Fig. 3, there are negative side lobes for the ideal spectral responses. Although camera spectral response is non-negative, we can apply a 3×3 matrix to the camera raw signals for calibration so that the camera output signals (R_c, G_c, B_c) can be applied to an ITU-R BT.709 standard display for reproducing image color. We take the red channel as an example to explain the calibration method. A set of hypothetical spectral responses of positive value is shown in Fig. 3 with dashed lines. It is noticed that the wavelengths of peak hypothetical spectral responses are slightly shifted from the corresponding ideal spectral responses, respectively, and the relative peak amplitude of the hypothetical spectral responses are also slightly different from that of the ideal spectral responses for minimizing the error of the calibration method shown in the following. For the ideal spectral response of red channel shown in Fig. 3, there are a positive side lobe in blue region and a negative side lobe in green region. The calibration matrix is equivalent to taking the hypothetical spectral response of blue channel as the positive side lobe of the ideal spectral response of red channel in blue region and taking the inverted hypothetical spectral response of green channel as the negative side lobe of the ideal spectral response of red channel in green region. In mathematical expression, $R_c = c_{rr}R_d - c_{rg}G_d + c_{rb}B_d$, where c_{rr}, c_{rg} and c_{gb} are positive values and they can be calculated by regression. The training samples for regression can be prepared with preferred color charts, e.g. GretagMacbeth ColorChecker. The calibration methods for green and blue channels are similar. Such a calibration method is widely used in either video camera or digital still camera (DSC) today. However, the calibration method is not very accurate even if high order terms are included in regression mainly because the practical spectral responses of blue and green channels much differ from the positive side lobe in blue region and the negative side lobe in green region of the ideal spectral response of red channel, so are for green and blue channels.

In this paper, we propose a method to design a camera that is able to record more accurate color image. The basic idea is to reduce the amplitudes of side lobes of derived ideal spectral responses so that the calibration error due to side lobes is reduced accordingly. We found that the amplitudes of side lobes can be significantly reduced for the ideal spectral responses derived from a wide-color-gamut (WCG) display with monochromatic primaries. Although the camera spectral responses are derived from a WCG display, it also can be applied to the displays with less saturated primaries, e.g. ITU-R BT.709 primaries.

2. Color Device Model

The color device model of a three-primary display can be represented by a 3×3 chromaticity matrix and three tonal transfer curves (TRCs) for red, green, and blue primaries [3,4]. TRCs convert input signals into linear signals that are proportional to primary luminance. The linear signals are normalized and are designated as R, G and B for red, green, and blue primaries, respectively, in which $0 \le R, G, B \le 1$. The output CIE XYZ tristimulus values of the display can be written as

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} a_r x_r & a_g x_g & a_b x_b \\ a_r y_r & a_g y_g & a_b y_b \\ a_r z_r & a_b z_g & a_b z_b \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}, \tag{1}$$

where (x_r, y_r), (x_g, y_g), and (x_b, y_b) are the color coordinates of red, green, and blue primaries, respectively; z_r=1-x_r-y_r, z_g=1-x_g-y_g , z_b=1-x_b-y_b; a_r, a_g, and a_b are the relative maximum luminances of red, green, and blue primaries, respectively, and

$$\begin{bmatrix} a_r \\ a_g \\ a_b \end{bmatrix} = \begin{bmatrix} x_r / y_r & x_g / y_g & x_b / y_b \\ 1 & 1 & 1 \\ z_r / y_r & z_g / y_g & z_b / y_b \end{bmatrix}^{-1} \begin{bmatrix} x_w / y_w \\ 1 \\ z_w / y_w \end{bmatrix}, \tag{2}$$

where (x_w, y_w) are the color coordinates of white point and z_w=1-x_w-y_w. Equation (1) assumes that the luminance of white point is unit.

The color device model of a three-color-filter camera is more complicated than that of a display. In general the spectral response of a detector is a function of wavelength, incident light intensity, and spatial coordinates [5, 6]. We assume the spectral responses have been calibrated so that they are functions of wavelength only and the camera raw signals (R_d, G_d, B_d) can be written as

$$R_d = \int S(\lambda) \rho_r(\lambda) d\lambda, \tag{3a}$$

$$G_d = \int S(\lambda) \rho_g(\lambda) d\lambda, \tag{3b}$$

$$B_d = \int S(\lambda) \rho_b(\lambda) d\lambda, \tag{3c}$$

where $S(\lambda)$ is the spectral power density of incident light; $\rho_r(\lambda)$, $\rho_g(\lambda)$ and $\rho_b(\lambda)$ are the spectral responses of red, green and blue channels, respectively. The tristimulus values of the incident light are

$$X = K_m \int S(\lambda) \bar{x}(\lambda) d\lambda, \tag{4a}$$

$$Y = K_m \int S(\lambda) \bar{y}(\lambda) d\lambda, \tag{4b}$$

$$Z = K_m \int S(\lambda) \bar{z}(\lambda) d\lambda, \tag{4c}$$

where K_m= 683 lm/Watt is the maximum luminous efficiency. If we assume (R, G, B)= (R_d, G_d, B_d) in Eq.(1) and substitute Eqs.(3)-(4) into Eq.(1), we have the ideal spectral responses that linearly relate tristimulus values and camera raw signals

$$\begin{bmatrix} \rho_{ir}(\lambda) \\ \rho_{ig}(\lambda) \\ \rho_{ib}(\lambda) \end{bmatrix} = K_m \begin{bmatrix} a_r x_r & a_g x_g & a_b x_b \\ a_r y_r & a_g y_g & a_b y_b \\ a_r z_r & a_b z_g & a_b z_b \end{bmatrix}^{-1} \begin{bmatrix} \bar{x}(\lambda) \\ \bar{y}(\lambda) \\ \bar{z}(\lambda) \end{bmatrix}, \tag{5}$$

where $\rho_{ir}(\lambda)$, $\rho_{ig}(\lambda)$ and $\rho_{ib}(\lambda)$ are the ideal spectral responses of red, green and blue channels, respectively. Figure 3 shows the ideal spectral responses of the camera derived from Eq.(5), in which (x_r, y_r)= (0.64, 0.33), (x_g, y_g)= (0.3, 0.6), (x_b, y_b)= (0.15, 0.06) and (x_w, y_w)= (0.3127, 0.329). As is discussed in the last section, the tristimulus values and camera raw signals are not linearly related for physically realizable spectral responses due to the side lobes of the ideal spectral responses and limited available absorption materials for color filters. We assume a set of hypothetical spectral responses for studying the calibration error due to the mismatches between the physically realizable spectral responses and ideal spectral responses. The hypothetical spectral responses are

$$\rho_r(\lambda) = \gamma_r Trunc\left[\rho_{ir}(\lambda - \Delta\lambda_r)\right], \tag{6a}$$

$$\rho_g(\lambda) = \gamma_g Trunc\left[\rho_{ig}(\lambda - \Delta\lambda_g)\right], \tag{6b}$$

$$\rho_b(\lambda) = \gamma_b Trunc\left[\rho_{ib}(\lambda - \Delta\lambda_b)\right], \tag{6c}$$

where γ_r, γ_g and γ_b are the gains of red, green and blue channels, respectively, that normalize the signals for white balance; the function $Trunc[\bullet]$ sets the amplitude of the side lobes of an ideal spectral response to be zero; $\Delta\lambda_r$, $\Delta\lambda_g$ and $\Delta\lambda_b$ shift the peak wavelengths of the spectral responses of red, green and blue channels, respectively.

Tristimulus values and camera raw signals can be empirically related with the following equations [7]

$$\begin{aligned} T(R_d, G_d, B_d) = a_0^T &+ \sum_{k=1}^{P} a_{rk}^T R_d{}^k + \sum_{k=1}^{P} a_{gk}^T G_d{}^k + \sum_{k=1}^{P} a_{bk}^T B_d{}^k \\ &+ \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{rglm}^T R_d{}^l G_d{}^m + \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{gblm}^T G_d{}^l B_d{}^m + \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{brlm}^T B_d{}^l R_d{}^m \text{, } T= X, Y, Z, \end{aligned} \tag{7}$$

where a_0^T is a constant representing offset value; *P* and *Q* are positive integer; and the coefficients a_{ik}^T and c_{ijlm}^T (i, j= r, g, b; k= 1, 2, …P; l, m= 1, 2, …Q) are constants. In this paper we assume the offset values to be zero for simplicity. The gray balance can be maintained under the following constraints

$$a_{r1}^T + a_{g1}^T + a_{b1}^T = T_w, \tag{8}$$

$$\sum_{k=2}^{P} a_{rk}^T + \sum_{k=2}^{P} a_{gk}^T + \sum_{k=2}^{P} a_{bk}^T + \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{rglm}^T + \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{gblm}^T + \sum_{l=1}^{Q}\sum_{m=1}^{Q} c_{brlm}^T = 0 \text{, } T= X, Y, Z, \tag{9}$$

where X_w, Y_w, Z_w in Eq.(8) are tristimulus values of white point. Under the above assumption and constraints, the degree of freedoms for the coefficients in Eq.(7) is M= 3×[3×(P+Q^2)-2]. Given a set of training samples, the coefficients in Eq.(7) can be calculated by regression.

The tristimulus values predicted by Eq.(9) can be substituted into Eq.(1) for calculating the camera output signals which are also the input signals of the display for reproducing image color. In Eqs.(1)-(2), the color coordinates of primaries and white point are of the display to show the image color. The display may follow the ITU-R BT.709 color standard or is a WCG display. However, if tristimulus values are not included in the color gamut of the display, the calculated signals will be clipped. For such a case, the technique of color gamut mapping is required [9,10].

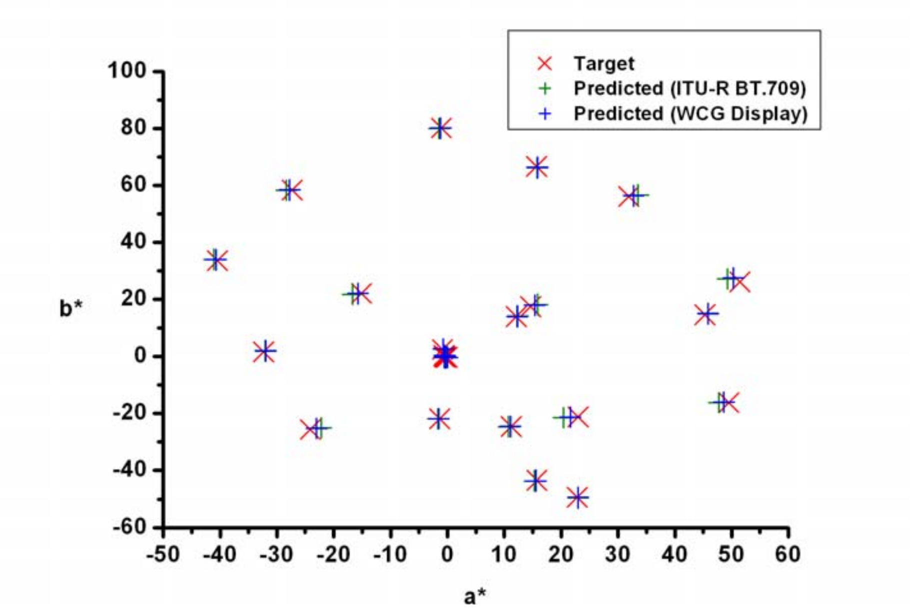

Figure 4: Target and predicted color coordinates of 24 training color patches by the use of optimized hypothetical spectral responses derived from ITU-R BT.709 standard display and the WCG display with monochromatic primaries.

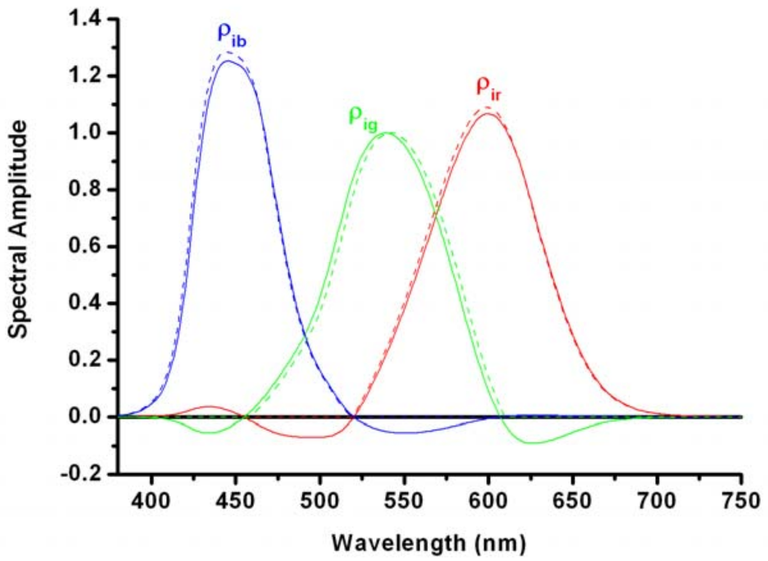

Figure 5: Ideal spectral responses of red (ρ_{ir}), green(ρ_{ig}) and blue (ρ_{ib}) channels derived from the WCG display with monochromatic primaries. The corresponding hypothetical spectral responses are shown with dashed lines.

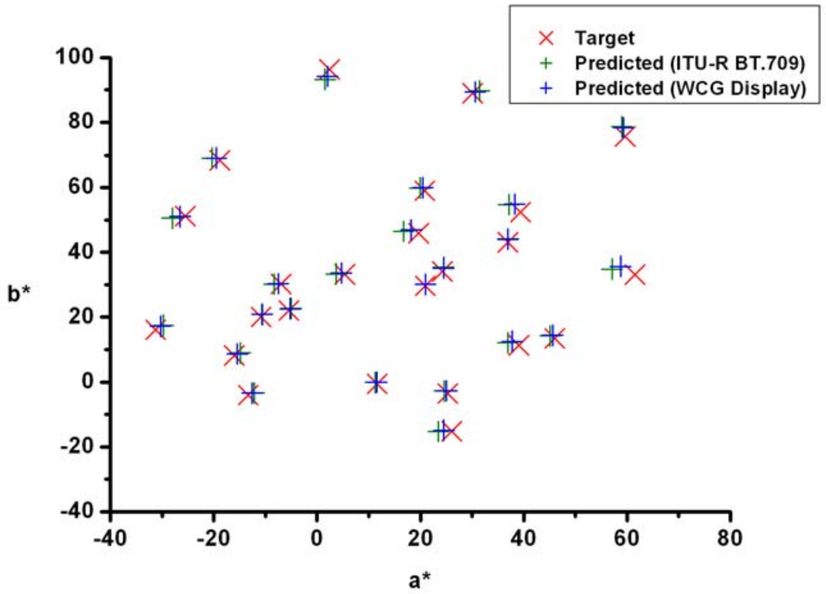

Figure 6: Target and predicted color coordinates of 24 test color patches by the use of optimized hypothetical spectral responses derived from ITU-R BT.709 standard display and the WCG display with monochromatic primaries.

3. Design Method and Result

There are 24 color patches in GretagMacbeth ColorChecker. The spectral reflectance of each color patch is measured. The product of the measured reflectance and the spectral power density of D65 illuminant is taken as the spectral power density $S\left(\lambda\right)$, in which the brightness of D65 illuminant is set so that its stimulus value Y is unit. The calculated spectral power density is called the normalized spectral power density. The tristimulus values of training samples are calculated from Eq.(4) with normalized spectral power densities. The calculated tristimulus values are called the target tristimulus values. The camera raw signals are calculated from Eq.(3) with the normalized spectral power densities and the hypothetical spectral responses given by Eq.(6). Because there are only 24 color patches with GretagMacbeth ColorChecker, we take P=2 and Q=1 so that the degree of freedoms M= 21 and is less than 24. The color difference between the tristimulus values predicted by Eq.(7) and target tristimulus values of a color patch is calculated with CIEDE2000 [8]. The parameters $\Delta\lambda_r$, $\Delta\lambda_g$ and $\Delta\lambda_b$ in Eq.(6) are optimized for the minimum average color difference of the 24 color patches.

The optimized hypothetical spectral responses derived from ITU-R BT.709 color standard are shown in Fig. 3 with dashed lines. We can see that the spectral response of red channel is shifted to shorter wavelength and its peak amplitude is significantly increased; the spectral response of green channel is slightly shifted to longer wavelength; the spectral response of blue channel is slightly shifted to shorter wavelength and its peak amplitude is slightly increased. The target and predicted color coordinates of 24 training color patches are shown in Fig. 4. The average color difference ΔE_{00} = 0.45.

We take the WCG display with monochromatic primaries given in [12] as an example to show the improvement of calibration error by deriving the camera responses from its primaries. The primary wavelengths are 607 nm, 520 nm and 455 nm for red, green and blue primaries, respectively. Figure 5 shows the ideal spectral responses derived from the WCG display. We can see that the amplitudes of side lobes are significantly reduced. It is noticed that the ideal spectral responses of red and green channels are zero at blue primary wavelength 455 nm. Similar results are found at green and red primary wavelengths. The simultaneous zero crossing at 455 nm is owing to the color matching $\bar{z}$ at this wavelength can be constructed by the ideal spectral response of blue channel along. For the case shown in Fig. 3, the color matching function at every wavelength has to be constructed by at least two ideal spectral responses. The side lobes of ideal spectral responses can be regarded as the response oscillation around zero value. Because of the simultaneous zero crossing, the oscillation amplitudes of the ideal spectral responses for the WCG display are less than the display with less saturated primaries.

The optimized hypothetical spectral responses are shown in Fig. 5 by dashed lines. We can see that the spectral responses of red and blue channels are slightly shifted to shorter wavelength and the spectral response of green channel is slightly shifted to longer wavelength. The peak amplitudes of the spectral responses of red and blue channels are slightly increased. The target and predicted color coordinates of 24 training color patches are also shown in Fig. 4. The average color difference $\Delta E_{00} = 0.25$. From Fig.4, we can see color shifts are reduced by the use of the optimized hypothetical spectral responses derived from the WCG display.

We prepared the other 24 test color patches. Figure 6 shows the target and predicted color coordinates of 24 test color patches by the use of optimized hypothetical spectral responses derived from ITU-R BT.709 standard display and the WCG display. The average color differences $\Delta E_{00} = 0.97$ and 0.68 by the use of optimized hypothetical spectral responses derived from ITU-R BT.709 standard display and the WCG display, respectively. We can also see color shifts are reduced by the use of the optimized hypothetical spectral responses derived from the WCG display.

4. Conclusions

The spectral responses of conventional cameras are derived from the ITU-R BT.709 color standard so that the cameras are able to record the signals that are suitable for the display to reproduce image color. However the ideal spectral responses derived from the ITU-R BT.709 color standard are not physically realizable. They are modified so that camera spectral responses can be practically implemented. The chromaticity calibration of practical cameras is not very accurate because of the large side lobes of the ideal spectral responses. A method to design a camera that is able to record more accurate image color is shown. It is found that the amplitudes of side lobes of derived ideal spectral responses from a wide-color-gamut display with monochromatic primaries can be significantly reduced. The chromaticity calibration method for the camera with practical spectral responses modified from ideal spectral responses is shown, in which the color patches of the GretagMacbeth ColorChecker with D65 illuminant are used as the training samples. The result shows that chromaticity calibration error can be reduced accordingly. Although the camera spectral responses are derived from a wide-color-gamut display, it also can be applied to the displays with less saturated primaries, e.g. ITU-R BT.709 primaries. Because the derived ideal spectral responses depend on the wavelengths of monochromatic primaries, we may choose proper primary wavelengths to derive suitable spectral responses for available dye materials used in the color filters of the cameras with high-color-accuracy recording capability.

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1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

□ 達成目標

■ 未達成目標（請說明，以 100 字為限）

　□ 實驗失敗

　□ 因故實驗中斷

　■ 其他原因

說明：原計畫目標之理論部分已完成，另一目標為自行組裝廣色域攝影機以實驗驗證，由於所申請經費被大幅刪減，遠不足以購買所需要的設備與耗材，因而放棄此實驗部分。

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

在當今資訊社會中，各種大大小小的攝影機(含數位相機)已深入每個人的日常生活，因此攝影機所記錄的影像品質相當重要。本計畫成果主要在攝影機的頻譜響應之設計。傳統攝影機的頻譜響應來自 ITU-R BT.709 色彩標準，已行之多年，本計畫成果提出一種新的設計觀點，使得攝影機能夠紀錄具有精確影像色彩的信號。雖然這攝影機的頻譜響應是由廣色域顯示器推演所得，它也可以應用於使用色彩飽和度較低三原色的顯示器，比如符合 ITU-R BT.709 色彩標準的顯示器。我們預期本研究成果具有相當高的應用價值，特別是台灣為攝影機主要設計與製造國家，未來將很有助於台灣相關產業的發展。

行政院國家科學委員會補助團隊參與國際學術組織會議報告

99 年 6 月 22 日

報告人姓名	溫盛發	服務機構	中華大學	職稱	教授
會議正式名稱	中文：資訊顯示器學會 2010 國際學術會議				
	英文：Society for Information Display (SID) 2010 International Symposium				
會議時間	自 99 年 5 月 24 日至 99 年 5 月 28 日	地點（國、州、城市）	美國，華盛頓州，西雅圖		

報告內容應包括下列各項：

一、參加會議經過

二、與會心得

三、考察參觀活動（無是項活動者省略）

四、建議事項

五、其他

一、參加會議經過

國際最著名的顯示器學術組織 SID 每年五月底舉辦學術會議，是世界規模最大的顯示器學術會議，今年(2010)是第 48 屆在美國華盛頓州西雅圖華盛頓州會議中心舉辦。由於顯示器產業蓬勃發展，參與人數眾多。今年 SID2010 有 523 篇論文發表，其中口頭報告論文 322 篇。與往年相比，今年大會較突出的特色是 3D 顯示器，觸控螢幕，與節能的綠色技術。歷屆會議的主角其實是國際知名大公司，如韓國的 Samsung，美國的 3M，日本的 Sony，與荷蘭的 Philips 等。耀眼的成果多來自這些大公司，這也反應出顯示器技術的現實。也就是這些大公司的資源充沛，比較有能力負擔新技術開發成本。學術界的資源不如大公司，研究成果自然沒有大公司出色。可以這樣說，學術界的研究成果主要在點的突破，大公司的研究成果除了點也能做線的突破，最終是落實到產品，由大公司做全面性的成果收割。這些大公司之間的消長，今年特別顯著。前幾年 Sony 聲勢還很顯著，這兩年大不如前。台灣的友達以往還積極參與，但這兩年也已差很多了。Samsung 是持續積極參與的面板與顯示器製造商，聲勢浩大，與其產業地位相符。

42" World's Slimmest LED LCD Module

- Size : 42 Inch
- Outline Dimension : 986.0(H) X 602.9(V) X 2.6(D) X 30.0(B) mm
- Weight : 3.6Kg
- Resolution : Full HD (1920 X 1080)
- Luminance : 450 nit
- Color Depth : 10bit(D)
- Color Gamut : 72%(@CIE 1931)
- Color Temperature : 10,000K
- Power : 73W
- Response Time : 8ms(MPRT), 5ms(GTG)

圖一　LG 薄型 LCD 規格

圖二　LG 薄型 LCD 側視照片

會議同時也舉行產品展覽會(Exhibition)，其中大公司的攤位主要在展示技術，其它製造，材料與儀器等公司參展的目的除了打知名度，還希望能接觸到客戶好賣產品。今年的展覽會規模比往年擴大了近一倍，主要是與觸控螢幕相關的參展廠商攤位大增。但是各大公司所展示的技術則令人失望，乏善可陳。比較令人印象深刻的只有韓國 LG 一款厚度只有 2.6mm 的 42 吋 LED 背光 LCD（如圖一與圖二），其耗電量只有 73W(亮度 450 nit)。若此款 LCD 能夠量產而且價格又比 OLED 明顯便宜，則 OLED TV 前途堪慮。OLED TV 是 Sony 過去錯失 LCD 技術後，未來反敗為勝的希望。OLED TV 的主要優勢在輕薄，因此這幾年 Sony 壓寶在 OLED TV 上，是開發最積極的公司，希望 OLED TV 未來能取代 LCD TV。但 LG 這款 LCD 的重量與厚度已跟 OLED TV 差不多了，恐怕將壞了 Sony 的希望。

本人在 26 日早上 Session 29: Power Saving Device Designs 做論文口頭報告，題目是 Power-Savings Design of WLED Backlit LCDs by the Use of Unequal-Area RGB Color Filters。這個 Session 主題是節能省電設計，所報告的論文是改變傳統 LCD 像素的設計，達到 30%以上節能的效果。傳統 LCD 紅藍綠三色子像素的面積相同，為了達到白平衡條件，需要限制子像素的光通量而浪費電能。本論文提出紅藍綠三色子像素不等面積的設計，由於可以不需限制子像素的光通量便能達到白平衡條件，因此可以省電。由實例計算，這種設計可節省高達 34%的電能。Session Chair（主持人）Masaru Suzuki 博士雖是日本人但任職韓國光學與功能薄膜製造商 SKC Haas Display Films 研發主管，他對這篇論文很感興趣，問了不少問題，未來這個設計有實際應用的機會。

一般學術會議的口頭報告，報告人當場能回答問題的時間很有限。SID 有一特別的安排以彌補這缺陷。論文發表當天的議程結束後，大會提供大型場地，舉行一個小時的 Author Interview。每位報告人一

個攤位，使報告人與聽眾能直接面對面討論問題。另外，有些報告人在口頭報告中沒時間展示的軟硬體，便在其攤位上展示給觀眾看。由於同一個 Symposium Section 的報告人共用同一區的攤位，Author Interview 的場地也提供同一個 Symposium Section 的報告人之間有近距離的互動與認識機會。Author Interview 的效果很好，本人除回答關於報告內容的問題，也認識了新的業界與學界同儕。

二、與會心得

1. 由這幾年參與 SID 會議的觀察，韓日的平面顯示器產業界與學術界的表現消長很明顯。韓國越來越壯大，而日本的影響力則是越來越弱。台灣的學術界還很努力，但產業界則每況愈下。

2. 以往 Samsung 便很能善用國際上各國的研究資源，今年年初 Samsung 更透過 SID 廣發英雄帖，目的在透過 SID 這個平台，建立全世界研發人員的資料庫，並對外委託研究計畫。由這些件事可以看出身為產業霸主的 Samsung，不只是有韓國政府的支持而能致之。十年前，韓國顯示器產業遠不如台灣，更不必說與日本相比，現今回首不禁令人噓唏。在當代自由貿易與保護智慧財產的世界，注重研發才是王道。

3. 由於具有明顯節能的效益，韓國廠商 SKC 對於本人今年所發表論文很感興趣，未來可以有實際應用的機會。

三、建議事項

1. 鑑於上述與會心得，台灣產官學界應設法投入更多資源於顯示器技術開發，並加強彼此之間的合作。

2. 本人在會議報告論文中所提出的紅藍綠三色子像素不等面積的設計概念，值得國內相關業者參考。

四 、攜回資料名稱及內容

1. 會議論文光碟。

國科會補助計畫衍生研發成果推廣資料表

日期:2010/12/28

國科會補助計畫	計畫名稱: 廣色域攝影機設計之研究
	計畫主持人: 溫盛發
	計畫編號: 98-2221-E-216-002- 學門領域: 顯示技術

無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：溫盛發	**計畫編號：**98-2221-E-216-002-
計畫名稱：廣色域攝影機設計之研究	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	**量化**	**名稱或內容性質簡述**
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

□達成目標

■未達成目標（請說明，以 100 字為限）

　　□實驗失敗

　　□因故實驗中斷

　　■其他原因

說明：

原計畫目標之理論部分已完成，另一目標為自行組裝廣色域攝影機以實驗驗證，由於所申請經費被大幅刪減，遠不足以購買所需要的設備與耗材，因而放棄此實驗部分。

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

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