(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 August 2012 (16.08.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/107152 A1

(51) International Patent Classification:
*H04N 13/04* (2006.01)

(21) International Application Number:
PCT/EP2011/074325

(22) International Filing Date:
30 December 2011 (30.12.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11305139.5 10 February 2011 (10.02.2011) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17**:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

**Published**:

— *with international search report (Art. 21(3))*

(54) **Title**: COLOR CALIBRATION OF A 3D DISPLAY SYSTEM COMPRISING A 3D DISPLAY DEVICE AND 3D GLASSES

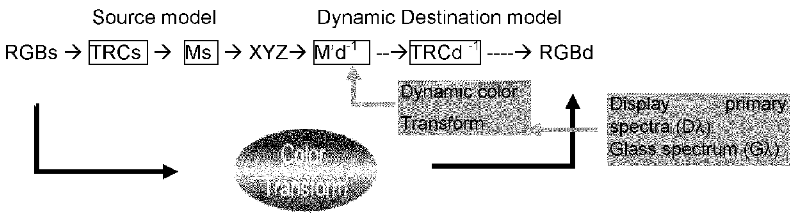


Fig.4

(57) **Abstract**: The method comprises the steps of: - Detecting new 3D glasses, - Computing a new color transform using spectral transfer function of this new detected 3D glasses, - Applying said new computed color transform to transform received source device dependent color image data into said destination device dependent color image data for the control of a display panel in order to display received 3D images represented by these color image data.

WO 2012/107152 A1

# COLOR CALIBRATION OF A 3D DISPLAY SYSTEM COMPRISING A 3D DISPLAY DEVICE AND 3D GLASSES

## Technical Field

The invention relates to the color calibration of a 3D display system comprising a 3D display device and 3D glasses having specific spectral transmission characteristics.

## Background Art

3D images of a 3D video content are generally transmitted to a terminal as source device dependent color image data representing these 3D images. The model of these source device dependent color image data is generally specific to a transmission standard.

3D images of this 3D video content are generally displayed on a display panel by controlling this display panel using destination device dependent color image data representing these 3D images. The model of these destination device dependent color image data is specific to the type of display panel that is used, and notably to the primary spectra of this display panel.

In order to display the 3D images of this 3D video content, the source device dependent color image data should then be transformed, i.e. corrected, into destination device dependent color image data, by using a specific color transform. Such a color transformation or correction corresponds to the color calibration of the display panel.

For such a color calibration or color management, color transformation or color correction processes are generally based on a workflow having the general frame shown in figure 2.

According to this general workflow, a source model performs a forward color transform, i.e. converts source device dependent color image data, e.g. received RGB values, into device independent color data, e.g. tristimulus XYZ values and a destination model performs an inverse color transform, i.e. converts device independent color data into destination device dependent color image data, i.e. calibrated RGB values.

Device dependent color image data of a 3D TV video content are generally prepared and transmitted to a 3D terminal according to usual standards. This standard defines a source model for the source device dependent color image data. In regular HD TV applications, source model can be described by parameters as defined in a standard REC-709. More specifically, see for instance ITU-R BT.709-4 "Parameter Values For The HDTV Standard For Production And International Programme Exchange", published in the SMPTE Journal, on September 1998 - 107:(9) pp. 836-854. According to this HD TV standard, source model is defined by a source chromaticity table with the following parameters:

| | Source chromaticity table | | | |
|---|---|---|---|---|
| | R | G | B | W |
| x | 0.64 | 0.3 | 0.15 | 0.3127 |
| y | 0.33 | 0.6 | 0.06 | 0.329 |
| z | 0.03 | 0.1 | 0.79 | 0.358 |

| | |
|---|---|
| Gamma = | 0.45 |

The display device is generally a 3D TV set. The destination model corresponds generally to a specific display panel, as to a specific LCD, PDP or projector. The destination model is defined by a destination chromaticity table with the following parameters:

| | Destination chromaticity table | | | |
|---|---|---|---|---|
| | R | G | B | W |
| x | xR | xG | xB | xW |
| y | yR | yG | yB | yW |
| z | zR | zG | zB | zW |

| | |
|---|---|
| Gamma = | 0.45 |

The destination chromaticity table defines a destination model for the destination device dependent color image data, i.e. for the calibrated RGB values.

Device independent color data, e.g. tristimulus XYZ or xyz values, are generally obtained with a spectrophotometer.

Using a source chromaticity table, a device independent 3x3 matrix color transform Ms can be calculated. Using a destination chromaticity table, another device independent 3x3 matrix color transform $Md^{-1}$ can be calculated. The calculation of these matrix Ms and $Md^{-1}$ are for instance performed with the SMPTE RP177 computation method. This method is notably disclosed in “Derivation of Basic Television Color Equations”, as published by SMPTE on January 1, 1993.

The workflow of figure 2 can be then refined according to the workflow of figure 3 and as follows. Based on a source gamma value, as gamma = 0.45, a source Tone Response Curve (TRCs) table can be calculated to get linear RGB values from the RGBs values received by the 3D terminal. This operation corresponds to a gammatization. Then, matrix color transform Ms is applied to the linear RGB values to get device independent color data, e.g. tristimulus XYZ values. Then, matrix color transform $Md^{-1}$ is applied to the tristimulus XYZ values to get other linear RGB values. Then, based on the destination gamma value of the display device, a destination Tone Response Curve (TRCd) table can be calculated, the inverse of which ($TRCd^{-1}$) is applied to the other linear RGB values to get final RGBd values to control the display panel in order to display the received 3D video content. This last operation corresponds to a degammatization.

The concatenation of the source gammatization (TRCs), the device independent 3x3 matrix color transform Ms, the device independent 3x3 matrix color transform $Md^{-1}$, and the source degammatization ($TRCd^{-1}$) forms the above mentioned color transform or color correction which transforms the source device dependent color image data into destination device dependent color image data.

The <u>specific problems related to the use of 3D glasses</u> to view a 3D video content displayed on a 3D display panel are as follows.

With the arrival of 3D TV, various 3D glasses technologies have been introduced at home. Most of the display CE manufacturers provide either 3D polarized or shutter glasses to view 3D TV.

3D shutter glasses generally comprise transmission means that able to communicate with a communication module of the 3D TV set at least to synchronize their shuttering means with the frames that are displayed on the display panel of the TV set. Such transmission means generally uses infra-red or wireless link. Such a link may also be used for purpose different from the synchronization, as to detect whether the 3D glasses are actually worn by a user, as disclosed in the document US2011-012896, where a “wireless communication module 198 transmits data to and receives data from the 3D glasses 195”.

Various issues have been reported about color rendering of 3D content on 3D display panels. For instance, Samsung’s 3D glasses have a greenish tint, while Sony’s have amber tint that blocks some blue. When displaying a stereoscopic content, Samsung and Panasonic 3D TV sets automatically compensate for the color filtering characteristics of 3D glasses. But if one were to use a non-tinted set of shutter 3D glasses on a Sony 3D TV set, the displayed image would appear too blue. On a Samsung 3D TV set, the displayed image would appear purple to the viewer wearing this set of shutter 3D glasses. Therefore, “universal” 3D glasses that can be used on different brands or models of 3D TV sets are difficult to realize. It also means that interoperability between equipments is not possible at the moment. It is not yet possible to bring 3D glasses to a friend's house who has another 3D TV set brand.

One solution to solve these issues has been proposed by Technicolor Princeton laboratory in USA to calibrate a 3D display system. This solution is disclosed in the document PCT/US10/002304 filed in USA on August 19, 2010.

In this solution, the color degradation by 3D glasses has been modeled by a gain A for each of the RGB components (Xout = A*Xin, with A <1). Then, the correction process is done in three steps:

- Evaluate a degradation factor. For this purpose, grey patches are displayed on a display screen and user is asked with a specific GUI (Graphic User Interface) to adjust a correction gain to recover balance between R, G and B component, i.e. to make R=G=B;
- Save user settings. Calculate correction gains.
- Apply corrections on individual RGB components using a 1D LUT.

This solution requires manual adjustment by the user, what is a main drawback for a Consumer Electronics (CE) equipment. In addition the measurement process is not accurate enough for following reasons:

- 3D glasses degradation model is too simple to get accurate color rendering;
- Grey patch number is limited for accurate gain computation.

Furthermore, it has to be pointed out that more complex correction such as Rout= f1(Rin,Gin,Bin) or Gout= f2(Rin,Gin,Bin) or Bout= f3(Rin,Gin,Bin) cannot be applied using a simple 1D LUT. Finally, the full calibration process of the display device has to be redone if new 3D glasses model is used.

## Summary of invention

In order to compensate for the specific color filtering characteristics of 3D glasses without the above drawback, the invention proposes to perform an automatic and accurate dynamic color correction on color image data representing 3D images to display on a 3D display panel, based on the spectral transfer function characterizing these 3D glasses. According to an embodiment of the invention, the spectral transfer function of these 3D glasses is transmitted to a 3D terminal, for instance to a display device or to a set top box connected to a display device. According to the invention, the 3D terminal then computes the color correction to be applied in real time on the color image data, e.g. RGB color components. These RGB color components represents the 3D images to display, as received by the 3D terminal. When a new 3D glasses model is detected by the display device, a new color correction is calculated taking into account a new spectral transfer function characterizing these new 3D glasses. Preferably, this new spectral transfer function is transmitted to the 3D terminal. This new color correction is then applied automatically in real time on these RGB color components in order to compensate for the color degradation specific to this new 3D glasses model. New destination device dependent color image data representing the 3D images to display are then obtained in order to control the display panel such as to display these 3D images.

More precisely, the subject of the invention is a method for displaying 3D images of a 3D video content by controlling a display panel using destination device dependent color image data, in order to view said 3D images through 3D glasses having specific spectral transfer function,
wherein source device dependent color image data representing said 3D images of said 3D video content are received by a 3D terminal and are

transformed by a color transform into said destination device dependent color image data for the control of said display panel,

said method comprising the steps of:

- Detecting new 3D glasses,
- At said terminal, computing a new color transform using spectral transfer function of said detected new 3D glasses,
- At said terminal, applying said new computed color transform to transform received source device dependent color image data into said destination device dependent color image data for the control of said display panel.

Preferably, according to a first variant, before the computing step, the method comprises a step of transmitting the spectral transfer function from said detected new 3D glasses to said 3D terminal.

Preferably, according to a second variant, the spectral transfer function of said detected new 3D glasses being stored in correspondence with a code specific to said detected new 3D glasses, the method comprises a step of transmitting a code specific to said detected new 3D glasses from said detected new 3D glasses to said 3D terminal and a step of extracting stored spectral transfer function corresponding to said transmitted code for the computing step.

Thanks to the spectral transfer function that models the color degradation of each 3D glasses model, an accurate color transform can be calculated for each 3D glasses model. According to the computational power of the 3D terminal, a simple 3x3 matrix or a more complex 3D LUT is calculated to represent this color transform : see the calculation of the M matrix below.

The main advantage of this invention is the automatic and dynamic color correction of the 3D glass color degradation. There is no user contribution contrary to the solution described in the above quoted document PCT/US10/002304. Furthermore the system is more accurate as it uses a spectral degradation model for glasses. In final, a two components calibrated equipment, combining a display panel and 3D glasses, is obtained and a better visual comfort is provided for the viewer.

Preferably, the specific spectral transfer function of the detected 3D glasses is their transmission spectrum $G(\lambda)$.

Preferably, the computing of a new color transform uses also display primary spectra characterizing said display panel.

Preferably, the computing of a new color transform is made spectrally, based on the glasses transmission spectrum $G(\lambda)$ and on the display primary spectra $D(\lambda)$. Preferably, this computing is performed according to the equations 1 and 2 as defined below.

The subject of the invention is also a 3D display system for displaying 3D images of a 3D video content comprising:

- a terminal for receiving source color image data representing 3D images of said 3D video content,
- a 3D display device comprising a receiver and a 3D display panel controlled by destination color image data and characterized by display primary spectra $D(\lambda)$ stored in a display memory of said 3D display device,
- 3D glasses characterized by glasses transmission spectrum $G(\lambda)$ stored in a glasses memory of said glasses and comprising transmission means able to communicate with the receiver of said 3D display device,

wherein the 3D terminal comprises :

- color transform means adapted to apply a color transform adapted to transform source color image data into destination color image data, and
- color transform computing means adapted to calculate said color transform using said glasses transmission spectrum and using display primary spectra stored in the display memory.

Preferably, according to a first variant, the terminal and the display device are the same apparatus.

Preferably, according to a second variant, the terminal is a set top box that is connected with the display device by a video-data-and-metadata link.

## Brief description of drawings

The invention will be more clearly understood on reading the description which follows, given by way of non-limiting example and with reference to the appended figures in which:

- Figure 1 illustrates the transmission spectrum of a set of 3D glasses;
- Figure 2, already quoted, illustrates the general workflow of the color

transformation or color correction for the color calibration of a display device according to the prior art;

- Figure 3, already quoted, illustrates a refined workflow of figure 2 including explicitly gammatization and degammatization operations;

- Figure 4 shows the workflow of figure 3 with the introduction of a dynamic color transform for the compensation of color degradation due to 3D new glasses, according to the invention;

- Figure 5 illustrates schematically the calculation of the tristimulus values XYZ using display primary spectrum $D(\lambda)$ characterizing the display panel of the 3D display system according to the invention, and using transmission spectral data characterizing the 3D glasses $G(\lambda)$ of this 3D display system;

- Figure 6 illustrates a first example of 3D display system according to the invention where the terminal and the 3D display device are the same apparatus;

- Figure 7 illustrates a second example of 3D display system according to the invention where the terminal is a set top box separated from the 3D display device.

It will be appreciated by those skilled in the art that the block diagrams presented herein represent conceptual views of illustrative circuitry embodying the invention. Similarly, it will be appreciated that any flow charts, flow diagrams, and the like represent various processes which may be substantially represented in computer readable media and so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

**Description of embodiments**

The 3D display system for displaying 3D images of a 3D video content comprises:

- a 3D terminal for receiving source color image data representing 3D images of a 3D video content,

- a 3D display device comprising a receiver and a 3D display panel controlled by destination color image data and characterized by display primary spectra $D(\lambda)$ stored in a display memory of the 3D display device,

- 3D glasses characterized by glasses transmission spectrum $G(\lambda)$, comprising a glasses memory and transmission means able to communicate with the receiver of the 3D display device.

The 3D terminal comprises also:

- color transform means adapted to apply a color transform adapted to transform source color image data into destination color image data, and
- color transform computing means adapted to calculate this color transform using glasses transmission spectrum transmitted to the terminal by the transmission means, and using display primary spectra $Dr(\lambda)$,$Dg(\lambda)$,$Db(\lambda)$ stored in the display memory.

The functions of the color transform means and of the color transform computing means may be provided through the use of dedicated hardware as well as hardware capable of executing software in association with appropriate software. Explicit use of the term “processor” should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor (“DSP”) hardware, read-only memory (“ROM”) for storing software, random access memory (“RAM”), and non-volatile storage.

<u>Modeling of the color degradation due to 3D Glasses</u>:

It is proposed to model the color degradation of 3D glasses by using the transmission spectrum of these glasses. Such a transmission spectrum is adequate to represent the spectral transfer function of these glasses. Most of the display device manufacturers provide “LCD shutter” glasses technology. Spectral transmission of such “LCD shutter” glasses can vary from one manufacturer to another. Most of the 3D glasses degrade more or less the blue part of the glasses transmission spectrum as shown in figure 1, which illustrates the spectral transmission curve of typical “LCD shutter” 3D glasses.

In order to allow the 3D TV system to perform a good color reproduction, the invention proposes to include the color degradation or color change due to the 3D glasses in an automatic color management system as described below.

In this embodiment of the invention, the 3D glasses of the 3D TV system comprise a glasses memory storing the spectral transmission data of these glasses, i.e. their transmission spectrum. As the shape of these spectral transmission curve or transmission spectrum representing the color degradation is generally quite smooth, their digital sampling can be done every 5 nm. Therefore, the curve or spectrum can be totally described with roughly 60 values, as (700nm – 400nm)/5nm = 60. These 60 values are stored in the memory of the 3D glasses or in the memory of the 3D terminal.

<u>3D Glass Detection means</u>:

Before the transmission or the extraction of the glasses transmission spectrum of new 3D glasses, the invention requires detecting a 3D glasses change. Two non limiting examples of detection are given below:

- Automatic detection: a 3D glass identifier code is beforehand known by the 3D display device and stored into the display memory of this 3D display device. At power-up of the 3D display system, the 3D glass identifier code is transmitted from the 3D glasses to the 3D display device. A display processor of the 3D display device then launches a comparison of this transmitted 3D glass identifier code with the 3D glass identifier code that is pre-stored in the display memory. If they are different, i.e. if no correspondence can be found by the processor between the transmitted code and the pre-stored code, then the processor asks the 3D glasses to transmit to the 3D display device its spectral transmission curve representing its color degradation, and a new color transform is computed and applied automatically as described below. Otherwise no change needs to be done for the color transform used to transform the source device dependent color image data into the destination device dependent color image data.
- Manual detection: in this other detection embodiment, at power-up of the 3D TV system, user can use a specific menu to access an online catalogue of 3D glasses. The user then selects on this menu the 3D glasses model, spectral transmission curve of these glasses is then extracted and stored automatically into the display memory and a new color transform is computed and applied automatically as described below.

<u>New color management workflow for the 3D TV system in the embodiment of the invention</u>:

In the context of 3D TV, the 3D glass color degradation model, as exemplified on figure 1 by glasses transmission spectrum, has to be introduced into the color management workflow of figure 3. If user decides to change 3D glasses model, a dynamic color transform for the compensation of the new color degradation due these 3D new glasses should be introduced in the inverse color transform operation $M'd^{-1}$, as shown on figure 4. As shown on figure 4, the calculation of this new inverse color transform operation $M'd^{-1}$ will depends on the display primary spectra ($D\lambda$) and on the 3D glasses transmission spectrum ($G\lambda$).

As soon as the 3D display device detects a new model of 3D glasses (see paragraph above concerning this detection), in order to obtain dynamically this new inverse color transform operation $M'd^{-1}$, a new destination chromaticity table is recalculated dynamically according to the following computation scheme.

1 – As illustrated schematically on figure 5, calculation of the tristimulus values XYZ using display primary spectral data $D(\lambda)$ characterizing the display panel, i.e red primary spectrum $Dr(\lambda)$, green primary spectrum $Dg(\lambda)$, and blue primary spectrum $Db(\lambda)$, and using transmission spectral data of the 3D glasses $G(\lambda)$. The spectral sensitivity curves $x(\lambda)$, $y(\lambda)$, $z(\lambda)$ of the 1931 CIE standard observer are also used for this first step of the computation scheme as defined by the following equations 1:

$$\left.\begin{aligned} X &= k\sum_{\lambda} G_{\lambda} D_{\lambda} \bar{x}_{\lambda} \Delta\lambda \\ Y &= k\sum_{\lambda} G_{\lambda} D_{\lambda} \bar{y}_{\lambda} \Delta\lambda \\ Z &= k\sum_{\lambda} G_{\lambda} D_{\lambda} \bar{z}_{\lambda} \Delta\lambda \\ k &= \frac{100}{\sum_{\lambda} G_{\lambda} \bar{y}_{\lambda} \Delta\lambda} \end{aligned}\right\} \quad \text{Equations 1}$$

2 – Calculation of the chromaticity values using following equations 2:

$$x = \frac{X}{X+Y+Z} \qquad y = \frac{Y}{X+Y+Z} \qquad z = \frac{Z}{X+Y+Z} \qquad \text{Equations 2}$$

3 – Population of a new destination chromaticity table:

A new destination chromaticity table is populated using previous equation 2.

| | Destination chromaticity table | | | |
|---|---|---|---|---|
| | R | G | B | W |
| x | xR | xG | xB | xW |
| y | yR | yG | yB | yW |
| z | zR | zG | zB | zW |

Using this new destination chromaticity table, a new device independent 3x3 matrix color inverse transform $M'd^{-1}$ is calculated with the above quoted SMPTE RP177 computation method. Then, the whole new color transform can be recalculated as explained above in reference to the workflow of figure 3. This new color transform is then applied to the RGB color values received by the 3D TV system.

As a conclusion of this embodiment, as soon as the display device detects a change of 3D glasses, a new color transform is calculated dynamically and applied to the RGB color values received by the 3D terminal instead of the previous one. Automatic and precise compensation of the color degradation due to the new 3D glasses can then be obtained. The main general advantage of the invention is the automatic and dynamic color correction of the 3D glasses color degradation. There is no user contribution. Furthermore the method is very accurate as it uses a spectral degradation model for glasses. In final, a two components (panel/glasses) calibrated equipment is obtained and a better visual comfort is provided for the viewer. Interoperability between 3D TV systems, and, more generally, between 3D display devices can then be obtained.

<u>Exemple 1</u>:

In a first example of a 3D display system embodying the invention, a set top box receives the source device dependent color image data and transmit them to the 3D display device which performs all treatments internally. The 3D display device is then considered as the 3D terminal receiving the source color component values RGBs. The Tone Response Curve (TRC) can be implemented into a 1D LUT while the Source model matrix Ms and the Destination model matrix $Md^{-1}$ are merged into a single 3x3 matrix M or into a more complex 3D LUT. The general color management architecture of figure 4 when adapted to this example of a 3D display system is depicted in figure 6.

The “1D-M-1D” structure shown in figure 6 can be implemented into either a FPGA or an ASIC inserted in the display device. The dynamic color transform algorithm that is applied to the color component values RGBs is run on a processor while the display primary spectral data are stored into either a ROM or a RAM memory of the display device. The receiver of the display device that is adapted to receive spectral transmission data from the 3D glasses should be compatible either for Infra red or wireless transmission with the 3D glasses.

When a new model of 3D glasses is detected by the display device, following sequential operations are performed:

1- Transmit glasses transmission spectrum from the 3D glasses to the receiver of the display device;

2- Compute a new destination chromaticity table according to the computation scheme above, using above equations 1 and 2 with the received glasses transmission spectrum;

3- Using the new destination chromaticity table, compute a new inverse destination model $M'd^{-1}$ (XYZd <-> RGBd) as described above;

4- Merge the new computed inverse destination model $M'd^{-1}$ and the source model Ms to get a new final color transform matrix M.

5- Apply the new final color transform matrix M on the device dependent color image data (RGB values) of the video signal received by the 3D display device through the set top box.

Of course, according to the scheme of figure 4, gammatization TRCs and degammatization $TRCd^{-1}$ operations are part of the new final color transform to be applied to the received device dependent source color image data representing the 3D images to display.

This example is also applicable to display device as nomad CE products such as tablets, PDA, …

Exemple 2:

In a second example of a 3D display system embodying the invention, most of the treatments are performed in the set top box connected the display device. The set top box is then considered as the 3D terminal receiving the source color component values RGBs. The set top box is connected to the display device through a video data link adapted to transmit color image data to the display device. This video data link is advantageously compliant with the HDMI standard. Such an example is advantageous because set-top boxes have generally higher computation power (CPU/ media processor) compared to a display device. This allows more precision of the color calibration.

As in the first example, the receiver of the display device is adapted to receive spectral transmission data from the 3D glasses, through an Infra red or wireless link. These glass spectral transmission data and the display primary spectral data should be transmitted from the display device to the set top box through a metadata uplink as shown in figure 7. This metadata link is advantageously compliant with the HDMI standard.

As in example 1, the Tone Response Curve (TRC) is implemented into a 1D LUT while the Source model matrix Ms and the Destination model matrix $Md^{-1}$ are merged into a single 3x3 matrix M or into a more complex 3D LUT. The color management general architecture of figure 4 when adapted to this example is now depicted in figure 7. The “1D-M-1D” structure shown on figure 7 is implemented into the CPU of the set top box. The display primary spectral data can be stored into either a ROM or a RAM memory of the display device.

When a new model of 3D glasses is detected by the display device, following sequential operations are performed by the set- top box (STB):

1- Using the infra red or wireless link, transmit glasses transmission spectrum from the 3D glasses to the receiver of the display device;

2- Using the metadata link, transmit metadata representing the received glasses transmission spectrum and the display primary spectra from the display device to the set top box (STB);

3- In the set top box, compute a new destination chromaticity table according to the computation scheme above, using equations 1 and equations 2 with the glasses transmission spectrum as received by the set top box through the metadata link ;

4- Using the new destination chromaticity table, compute a new corresponding inverse destination model $M'd^{-1}$ (XYZd <-> RGBd) using the method as described above;

5- Merge the new computed inverse destination model $M'd^{-1}$ and the source model Ms to get a new final color transform matrix M.

6- Apply the new final color transform matrix M on the device dependent color image data (RGB values) of the video signal received by the 3D display device through the set top box.

Of course, according to the scheme of figure 4, gammatization TRCs and degammatization $TRCd^{-1}$ operations are part of the new final color transform to be applied to the received device dependent source color image data representing the 3D images to display.

This second example is also applicable to embodiments where the set top box is replaced by a computer or a DVD player.

It is to be understood that the method according to the present invention may be implemented in various forms of hardware, software, firmware, special purpose processors, or combinations thereof. The software may be implemented as an application program tangibly embodied on a program storage unit. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPU"), a random access memory ("RAM"), and input/output ("I/O") interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit.

While the present invention is described with respect to particular examples and preferred embodiments, it is understood that the present invention is not limited to these examples and embodiments. The present invention as claimed therefore includes variations from the particular examples and preferred embodiments described herein, as will be apparent to one of skill in the art. While some of the specific embodiments may be described and claimed separately, it is understood that the various features of embodiments described and claimed herein may be used in combination.

## CLAIMS

1. Method for displaying 3D images of a 3D video content by controlling a display panel using destination device dependent color image data, in order to view said 3D images through 3D glasses having specific spectral transfer function,
wherein source device dependent color image data representing said 3D images of said 3D video content are received by a 3D terminal and are transformed by a color transform into said destination device dependent color image data for the control of said display panel,
said method comprising the steps of:
- Detecting new 3D glasses,
- At said terminal, computing a new color transform using spectral transfer function of said detected new 3D glasses,
- At said terminal, applying said new computed color transform to transform received source device dependent color image data into said destination device dependent color image data for the control of said display panel.

2. Method for displaying according to claim 1, comprising, before the computing step, a step of transmitting the spectral transfer function from said detected new 3D glasses to said 3D terminal.

3. Method for displaying according to claim 1 wherein spectral transfer function of said detected new 3D glasses being stored in correspondence with a code specific to said detected new 3D glasses, comprising a step of transmitting a code specific to said detected new 3D glasses from said detected new 3D glasses to said 3D terminal and a step of extracting stored spectral transfer function corresponding to said transmitted code for the computing step.

4. Method for displaying according to any one of the preceding claims wherein the specific spectral transfer function of said detected 3D glasses is their transmission spectrum $G(\lambda)$.

5. Method for displaying according to claim 4 wherein the computing of a new color transform uses also display primary spectra D(λ) characterizing said display panel.

6. Method for displaying according to claim 5 wherein said computing of a new color transform is made spectrally based on the glasses transmission spectrum G(λ) and on the display primary spectra D(λ).

7. 3D display system for displaying 3D images of a 3D video content comprising:
- a terminal for receiving source color image data representing 3D images of said 3D video content,
- a 3D display device comprising a receiver and a 3D display panel controlled by destination color image data and characterized by display primary spectra D(λ) stored in a display memory of said 3D display device,
- 3D glasses characterized by glasses transmission spectrum G(λ) stored in a glasses memory of said glasses and comprising transmission means able to communicate with the receiver of said 3D display device,
wherein the 3D terminal comprises:
- color transform means adapted to apply a color transform adapted to transform source color image data into destination color image data, and
- color transform computing means adapted to calculate said color transform using said glasses transmission spectrum G(λ) and using display primary spectra (Dr(λ),Dg(λ),Db(λ) ) stored in said display memory.

8. 3D display system according to claim 7 wherein said terminal and said display device are the same apparatus.

9. 3D display system according to claim 7 wherein said terminal is a set top box that is connected with said 3D display device by a video data and metadata link.

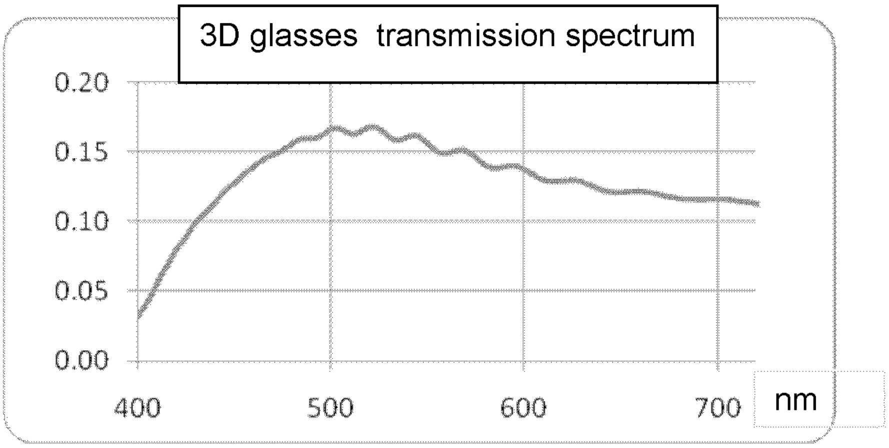


Fig.1

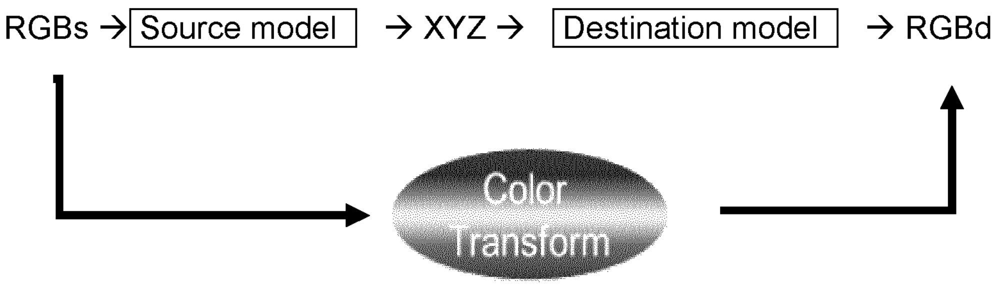


Fig.2

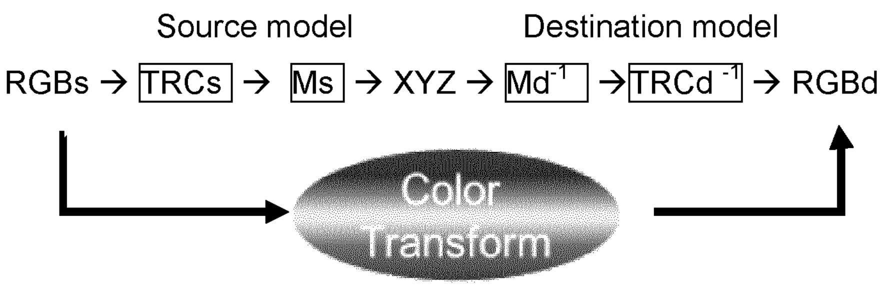


Fig.3

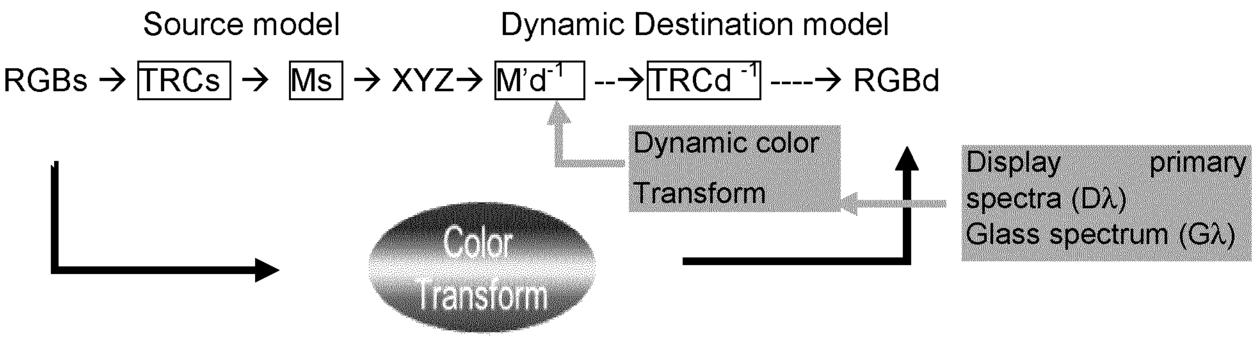


Fig.4

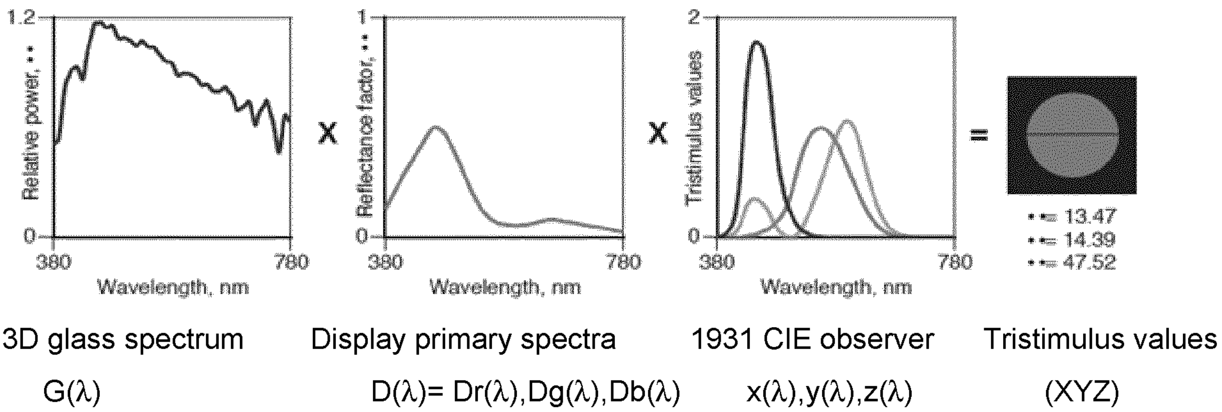


Fig.5

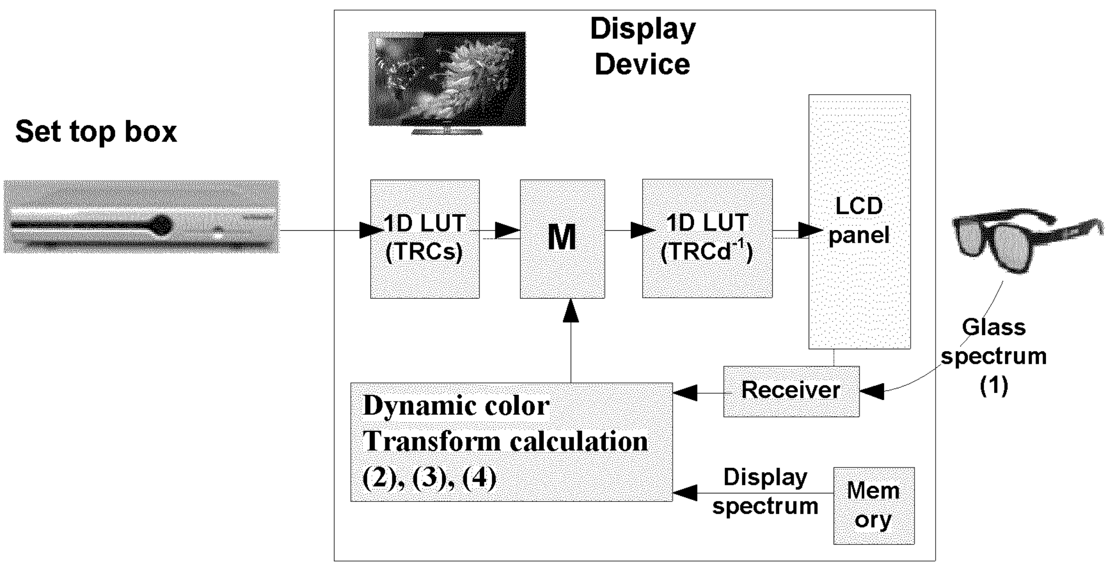


Fig.6

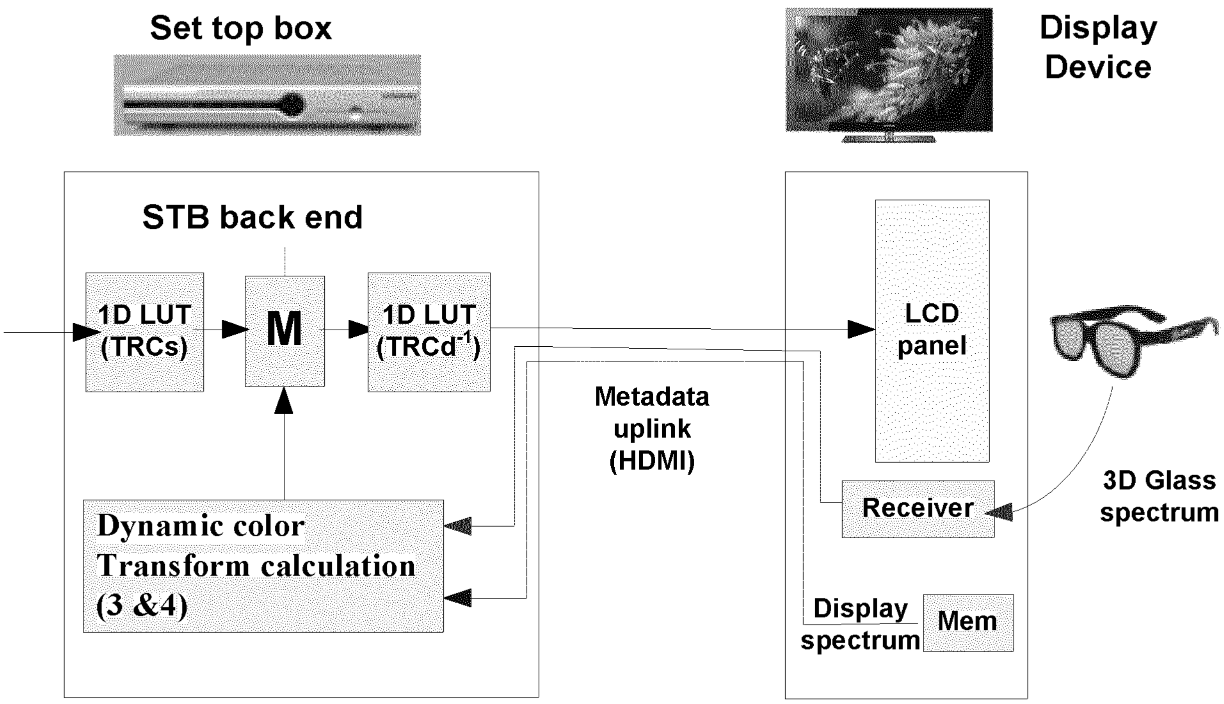
Set top box
Display
Device
STB back end
1D LUT
(TRCs)
M
1D LUT
(TRCd$^{-1}$)
LCD
panel
Metadata
uplink
(HDMI)
Dynamic color
Transform calculation
(3 &4)
Receiver
3D Glass
spectrum
Display
spectrum
Mem

Fig.7

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/074325

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N13/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 2008/316303 A1 (CHIU JOSEPH [US] ET AL) 25 December 2008 (2008-12-25) paragraph [0102] | 1-9 |
| A | KOOI F L ET AL: "Visual comfort of binocular and 3D displays", DISPLAYS DEVICES, DEMPA PUBLICATIONS, TOKYO, JP, vol. 25, no. 2-3, 1 August 2004 (2004-08-01), pages 99-108, XP004549562, ISSN: 0141-9382, DOI: 10.1016/J.DISPLA.2004.07.004 the whole document | 1 |
| A | US 2008/278807 A1 (RICHARDS MARTIN JOHN [US] ET AL) 13 November 2008 (2008-11-13) paragraph [0041] - paragraph [0045] | 1,7 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

9 March 2012

Date of mailing of the international search report

21/03/2012

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Information on patent family members

International application No
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| | | US 2010073769 A1 | 25-03-2010 |