

Description**SYSTEM AND METHOD FOR CORRECTING WHITE LUMINESCENCE IN VIDEO WALL DISPLAY SYSTEMS**

- [0001] The present invention relates to calibration of display devices, more specifically to a system and method for achieving general white luminescence balance in video wall display systems.
- [0002] Image display devices present images on screens thereof and combination of multi-display devices in order to form a large screen display environment called a video wall is one of the functions achievable through combination and simultaneous operation of a plurality of individual image display devices. The term video wall generally refers to the generation of a combined image from a single video input by means of a plurality of image display devices as a single video wall image. The video wall may typically be arranged in the form of 1x4, 2x2, 3x3, 4x4 or much larger screen formats.
- [0003] Video walls are basically preferred due to their capability to generate a very large screen whose tile layout can be customized by which a greater screen area and greater pixel density per unit cost can be achieved, which is advantageous due to manufacturing costs of single screens, hence allowing an unusual resolution when combined.
- [0004] Video walls are conventionally used in large public venues such as stadiums. Video walls can be driven from multi-monitor video cards, but complex arrangements require special video processors capable to manage large video walls. Software based video wall controllers however use PCs and networking equipment.
- [0005] A major problem that needs to be addressed in the field of video wall display systems is color matching. Even if all component screens utilize the same technology, due to material variations, assembly tolerances, component aging and environmental effects such as humidity and temperature; each screen can produce a different color balance, color temperature and white luminescence from the same input signal.
- [0006] When multiple screens are placed side by side, the human eye can easily discern this discrepancy. As it is impossible to determine which screens

will be used together and in which order, it is not possible to fix this difference between white luminescence of the screens beforehand. Hence, there is a need for a system and method that can perform white luminescence adjustment on the screens used in video wall display systems to provide improved, seamless visuals without relying on external devices or manual input.

[0007] Among others, one of the prior art disclosures in the technical field of the present invention may be referred to as WO 2009086468, which discloses a sensor for color calibration of one or more display devices using feedback obtained directly from said display devices. The sensor reads and quantifies the output of a display device and transmits the results to the image processor. The image processor compares the display characteristics and then modifies the 3D LUT (lookup table) of the display system according to the feedback signal to perform a "correction" that compensates for the differences between the display systems.

[0008] Another prior art disclosure in the technical field of the present invention may be referred to as US 7618146, which discloses a luminance correction circuit for a plurality of display devices. The luminance correction circuit comprises a timing circuit for generating display position information, a coefficient arrangement control unit for implementing a non-linear arrangement of gain coefficients for gradation control that is carried out in picture element units and a gradation conversion LUT unit for adjusting display positions based on the display position information from the timing circuit and then implementing a luminance level conversion of input signal levels of the picture signals.

[0009] The present invention provides a system and method for realizing uniform white luminescence distribution in a plurality of display devices utilized as a video wall in order to obtain uniform and seamless image quality.

[0010] The present invention therefore provides a system and method to achieve overall white luminescence balance in video wall display systems as provided by the characterizing features defined in Claim 1.

[0011] Primary object of the present invention is hence to provide a system and method for achieving overall white luminescence balance in video wall

display systems.

- [0012] Accompanying drawings are given solely for the purpose of exemplifying a system and method by which a video wall is operable, whose advantages over prior art were outlined above and will be explained in brief hereinafter.
- [0013] The drawings are not meant to delimit the scope of protection as identified in the claims nor should they be referred to alone in an effort to interpret the scope identified in said claims without recourse to the technical disclosure in the description of the present invention.
- [0014] Fig. 1 demonstrates general working steps in the form of a routing diagram structure according to the present invention.
- [0015] The present invention proposes a video wall system with a multitude of image display devices, each device comprising at least one input connector. The video wall system's operation is effectuated such that each image display device is individually set to identify its particular enlarged screen portion of the overall screen as delineated below.
- [0016] The video wall system of the invention is created by means of a plurality of image display devices, the latter together forming a combined very large screen in the form of a generally rectangular web. Each of the combined image display devices then generates and displays a certain dedicated portion of the video content so that the video content can be displayed on a combined large screen. Each of said image display devices comprises a control unit for identification and generation of the dedicated portion of the complete image or video content. Each image display device therefore processes the received image or video content to create a certain portion of the overall screen area together with a plurality of neighboring or adjacent image display devices.
- [0017] The video wall system may therefore operate according to a method of serial transmission of the image or video content to obtain an overall image in a much larger size than a single display device cannot display, by way of dividing the main image into a plurality of image portions for display on separate image display devices.
- [0018] A control station of the video wall system can typically be a computer system with video stream processing capabilities. The control station may

transfer the source images to a first image display device to be transmitted from said first image display device to one of the immediately neighboring display devices through the input and output connectors on the video transmission line. It is to be noted that two neighboring image display devices can be placed vertically, horizontally or otherwise with respect to one another so that a generally rectangular shape large screen is obtainable. Each image display device within the video wall system is configured to display a certain dedicated portion of the image or video content and accordingly divides the image or video content so as to generate a specially adapted portion thereof corresponding to the specific screen area of the overall combined screen size depending on the number of image display devices on the vertical and horizontal axes.

[0019] As is known, in video wall systems, even if all component screens utilize the same technology, due to material variations, assembly tolerances, component aging and environmental effects such as humidity and temperature; each screen can produce a different color balance, color temperature and white luminescence from the same input signal. Further, when multiple screens are placed side by side, the human eye discerns this discrepancy. Therefore, the present invention is devised under the recognition that white luminescence adjustment on the screens used in video wall display systems needs to be improved in order for ensuring seamless visuals without relying on external devices or manual input.

[0020] To this end, the invention proposes a method and system by which said control station individually communicates with each and every image display device in the video wall web to collect gamma, RGB and white luminescence values. In a preferred embodiment of the invention, said control station establishes a plurality of concurrent remote network connections with individual image display devices having respective MAC addresses so that a look-up table of current parametric values can be retrieved for each image display device.

[0021] Further, said control station simultaneously reconfigures current parametric values in said look-up table to eliminate any noticeable discrepancies along contact lines of neighboring screens whereby

uniformity of visual parameters in a plurality of display devices is ensured. As a result, the video wall performs in a uniform manner with regard to the image display parameters and a seamless image quality can be achieved conveniently and in a substantially practical manner without any additional input from the user. It is to be noted that configuration of a plurality of units making up the overall system would otherwise necessitate not only individual configuration of the units but also calculation of the optimal parameter values in view of the different values for each parameter in different image display devices. Therefore, the invention advantageously undertakes calculation of the optimal parametric values to be applied to each unit in the overall system in a substantially reduced amount of time.

[0022] It is also to be noted that by the optimal parametric values, a dynamically updated or adjustable set of values should be understood as the outer environment where the video wall system is installed may necessitate different sets of gamma, RGB and white luminescence values, which is advantageous in that the general visual performance of the video wall web units will be simultaneously and effectively optimized.

[0023] In a variation, the control station can be connected to the displays via wired or wireless connections. Typically, gamma, RGB and white luminescence values are read from the respective memories of the image display devices and for every PWM level, color gamut and color temperature values and white and RGB color coordinates are calculated. For every display device, gamma curves, color graphics and RGB W parameters are calculated and the mean and standard deviation of these values among the display devices are determined. According to these values, the gamma values of the displays are reconfigured so that each display has a similar corrected gamma value. Similarly, white luminescence levels are read from the display memory and reconfigured according to calculated mean and standard deviation values so that each display has a similar corrected white luminescence value.

[0024] In a nutshell, the present invention proposes a video wall system having a multitude of image display devices, each image display device receiving video transmission to generate and display a certain dedicated portion of a

video content by which the video content is displayable in the form of a combined screen, said video wall system further comprising a control station controlling the operation thereof in data communication with each image display device of the video wall system.

- [0025] In one embodiment of the present invention, said control station communicates with each image display device of the video wall system so as to retrieve visual setting parameters of each image display device.
- [0026] In a further embodiment of the present invention, said control station forms a look-up table of current parametric values retrieved in respect of each image display device.
- [0027] In a further embodiment of the present invention, said control station determines image display devices with predetermined levels of deviations from predetermined parametric values.
- [0028] In a further embodiment of the present invention, said control station transfers and simultaneously reconfigures parametric values of the image display devices with predetermined levels of deviations in view of the predetermined parametric values and additionally depending on environmental illuminance conditions.
- [0029] In a further embodiment of the present invention, said control station establishes remote network connections with individual image display devices having respective MAC addresses.
- [0030] In a further embodiment of the present invention, said visual setting parameters relate to gamma, RGB and white luminescence values.
- [0031] In a further embodiment of the present invention, said control station retrieves gamma, RGB and white luminescence values from the respective memories of each image display device and color gamut, color temperature values and white and RGB color coordinates are calculated.
- [0032] In a further embodiment of the present invention, said control station calculates gamma curves, color graphics and RGB W parameters for each image display device and the mean and standard deviation of said values among all display devices are determined.
- [0033] In a further embodiment of the present invention, said control station reconfigures the gamma values of the image displays with a

predetermined standard deviation so that each image display device has a similar corrected gamma value.

[0034] In a further embodiment of the present invention, said control station reconfigures white luminescence levels of the image displays with a predetermined standard deviation so that each image display device has a similar corrected white luminescence value.

[0035] In a further embodiment of the present invention, said gamma values or said white luminescence levels are corrected according to environmental illuminance conditions retrieved from an internal or remote network database in the form of time and location based environmental illuminance.

[0036] In a further embodiment of the present invention, said gamma values or said white luminescence levels are corrected according to environmental illuminance conditions measured by an illumination photometer in communication with said control station.

[0037] Therefore, the invention provides automatic correction of gamma and white luminescence of the image display devices having a predetermined level of deviation from predetermined parametric values in the form of gamma, RGB and white luminescence values in a video wall system. Additionally, gamma and white luminescence correction is carried out with respect to environmental illuminance conditions measured by an illumination photometer in communication with said control station or retrieved from a database as time and location based values. Applying gamma adjustments will have the effect of lightening or darkening certain tones while keeping the black point and the white point the same. Therefore, the gamma correction is applied depending on the environmental illuminance conditions, i.e. depending on the specific time of the day and amount of light being available.

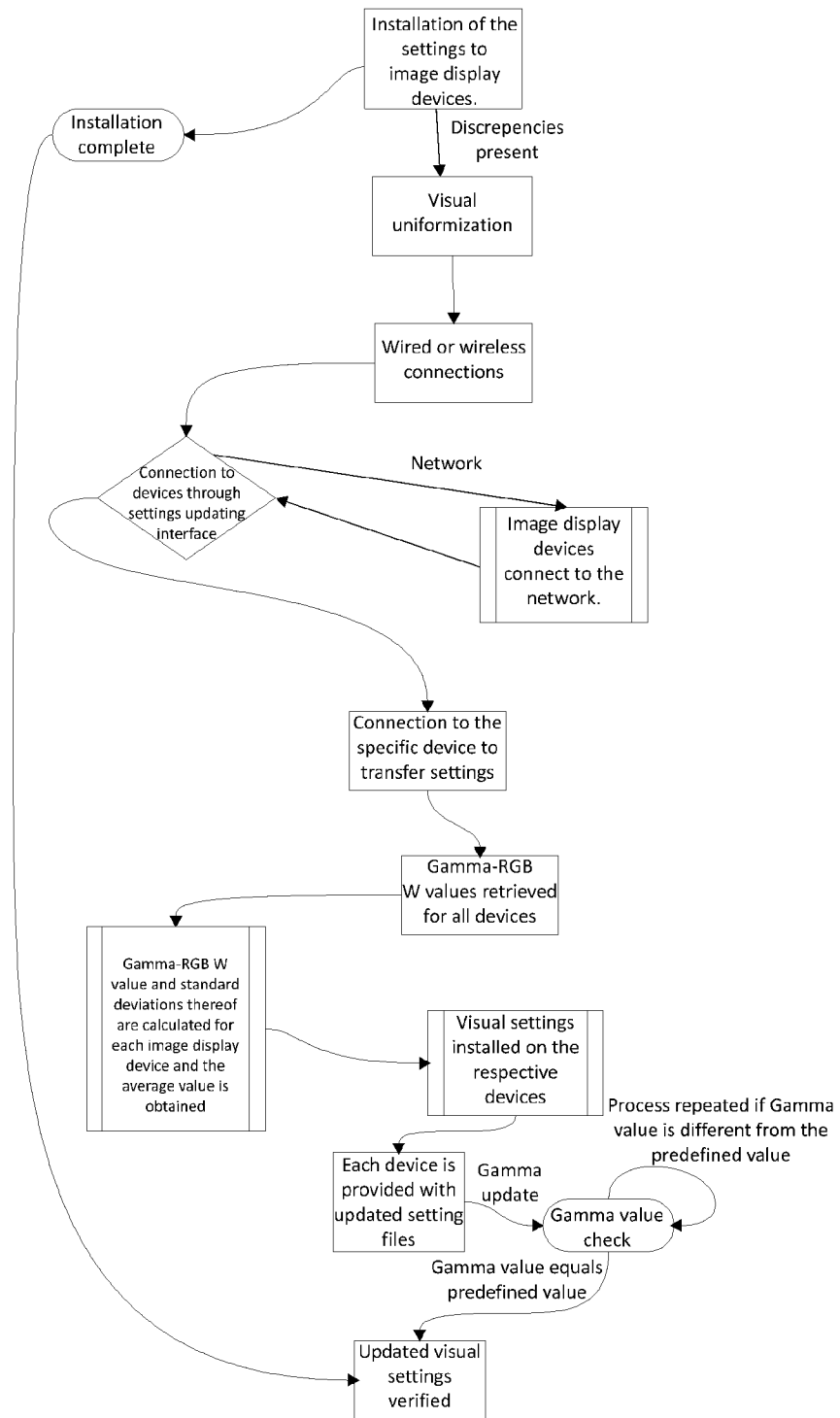
Claims

1. A video wall system having a multitude of image display devices, each image display device receiving video transmission to generate and display a certain dedicated portion of a video content by which the video content is displayable in the form of a combined screen, said video wall system further comprising a control station controlling the operation thereof in data communication with each image display device of the video wall system **characterized in that;** said control station communicates with each image display device of the video wall system so as to retrieve visual setting parameters of each image display device, said control station forms a look-up table of current parametric values retrieved in respect of each image display device, said control station determines image display devices with predetermined levels of deviations from predetermined parametric values and, said control station transfers and simultaneously reconfigures parametric values of the image display devices with predetermined levels of deviations in view of the predetermined parametric values and additionally depending on specific environmental illuminance conditions in the form of incident luminous flux in a time and location specific manner.
2. A video wall system as in Claim 1, **characterized in that** said control station establishes remote network connections with individual image display devices having respective MAC addresses.
3. A video wall system as in Claim 1 or 2, **characterized in that** said visual setting parameters relate to gamma, RGB and white luminescence values.
4. A video wall system as in Claim 3, **characterized in that** said control station retrieves gamma, RGB and white luminescence values from the respective memories of each image display device and color gamut, color temperature values and white and RGB color coordinates are calculated.
5. A video wall system as in Claim 4, **characterized in that** said control station calculates gamma curves, color graphics and RGB W parameters for each image display device and the mean and standard deviation of said values among all display devices are determined.
6. A video wall system as in Claim 5, **characterized in that** said control station reconfigures the gamma values of the image displays with a predetermined

standard deviation so that each image display device has a similar corrected gamma value.

7. A video wall system as in Claim 5 or 6, **characterized in that** said control station reconfigures white luminescence levels of the image displays with a predetermined standard deviation so that each image display device has a similar corrected white luminescence value.
8. A video wall system as in Claim 3 or 7, **characterized in that** said gamma values or said white luminescence levels are corrected according to environmental illuminance conditions retrieved from an internal or remote network database in the form of time and location based environmental illuminance.
9. A video wall system as in Claim 3, 7 or 8, **characterized in that** said gamma values or said white luminescence levels are corrected according to environmental illuminance conditions measured by an illumination photometer in communication with said control station.

Figure 1



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060185

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/14
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)
G09G G06F

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 practicable, search terms used)
EPO-Internal, 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 2014/198020 A1 (SYU SHENSIAN [CN] ET AL) 17 July 2014 (2014-07-17) paragraphs [0026] - [0042]; figures 2-7 -----	1-9
X	US 2011/242142 A1 (HUSSAIN SYED ATHAR [CA] ET AL) 6 October 2011 (2011-10-06) paragraphs [0020] - [0031]; figures 1-3 -----	1-9
X	EP 3 010 009 A1 (EIZO CORP [JP]) 20 April 2016 (2016-04-20) abstract paragraphs [0027] - [0070]; figures 1-5 -----	1-9
A	EP 1 701 331 A1 (RESEARCH IN MOTION LTD [CA]) 13 September 2006 (2006-09-13) paragraph [0046] ----- -/--	1,8

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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

"&" document member of the same patent family

Date of the actual completion of the international search 28 June 2016	Date of mailing of the international search report 08/07/2016
---	--

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Giancane, Iacopo
--	--

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060185

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/348468 A1 (CHEN CHENG [US] ET AL) 3 December 2015 (2015-12-03) paragraphs [0006], [0007] -----	1,8
A	WO 2016/033099 A1 (QUALCOMM INC [US]) 3 March 2016 (2016-03-03) paragraphs [0056] - [0059] -----	1,8
A	US 2016/019831 A1 (HALL WILLIAM Y [US]) 21 January 2016 (2016-01-21) paragraph [0079]; figure 12 -----	2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/EP2016/060185

Patent document cited in search report	Publication date	Publication date	Patent family member(s)	Publication date
US 2014198020	A1	17-07-2014	NONE	

US 2011242142	A1	06-10-2011	CN 102870152 A	09-01-2013
			EP 2553677 A1	06-02-2013
			JP 2013527489 A	27-06-2013
			KR 20130018824 A	25-02-2013
			US 2011242142 A1	06-10-2011
			WO 2011120142 A1	06-10-2011

EP 3010009	A1	20-04-2016	AU 2014279337 A1	04-02-2016
			CN 105308671 A	03-02-2016
			EP 3010009 A1	20-04-2016
			JP 5657058 B2	21-01-2015
			JP 2015001585 A	05-01-2015
			US 2016133202 A1	12-05-2016
			WO 2014199841 A1	18-12-2014

EP 1701331	A1	13-09-2006	CA 2537733 A1	07-09-2006
			EP 1701331 A1	13-09-2006

US 2015348468	A1	03-12-2015	US 2015348468 A1	03-12-2015
			WO 2015187353 A1	10-12-2015

WO 2016033099	A1	03-03-2016	US 2016063951 A1	03-03-2016
			WO 2016033099 A1	03-03-2016

US 2016019831	A1	21-01-2016	US 2016019831 A1	21-01-2016
			US 2016019834 A1	21-01-2016
