ASSIGNMENT

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned (hereinafter called the "Assignor"):

Stefan LANGE
Cedar Lodge Towpath, Shepperton
TW17 9LL Middlesex
Great Britain

hereby sell(s), assign(s) and transfer(s) to:

Rotolight Limited
c/o London Law, The White House, 57-63 Church Road, Wimbledon Village
SW19 5SB London
Great Britain

(hereinafter called the "Assignee"), its successors, assigns, nominees or other legal representatives, the undersigned's entire rights, title and interest in and to the invention titled:

LIGHTING SYSTEM AND CONTROL THEREOF

described and claimed in the following Patent Application:

US Patent Application No. 15/481,460,
filed on April 7, 2017,
and identified as Attorney Docket No. 69726

and in and to said Patent Application, and all original and reissued Patents granted therefore, and all divisions and continuations thereof, any corresponding PCT Patent Application and the National Phases thereof, including the right to apply and obtain Patents in all other countries, the right to claim priority under International Conventions, and the Letters Patent which may be granted thereon:

covenant that the undersigned have (has) the full right to convey the entire interest therein assigned;

authorize(s) and request(s) the Registrar of Patents, and any Official of any country whose duty it is to issue Patents on applications as aforesaid, to issue the said Letters Patent to the said Assignee;

and agree(s) to sign all lawful papers, make all rightful oaths, do all lawful acts requisite for such Patent Applications, and do everything possible to aid said Assignee to apply for, obtain and enforce Patent protection for said invention.

ASSIGNOR

Stefan LANGE

Date: 25th August '18

Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Roderick Allen GAMMONS (et al)

Application No./Patent No.: 15/481,460 Filed/Issue Date: April 7, 2017

Titled: LIGHTING SYSTEM AND CONTROL THEREOF

Rotolight Limited. (Name of Assignee) a Corporation (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
   - ☐ The extent (by percentage) of its ownership interest is ___%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
   - ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.
3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.
4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Inventors Roderick Allen GAMMONS, Andrew FRANCIS and Roderick Aaron GAMMONS To: Rotolight Limited
   The document was recorded in the United States Patent and Trademark Office at
   Reel 043748, Frame 0754, or for which a copy thereof is attached.
2. From: Inventor Stefan LANGE To: Rotolight Limited
   The document was recorded in the United States Patent and Trademark Office at
   Reel ___, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel ___, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel ___, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Martin D. Moynihan/	November 12, 2018
Signature	Date
Martin D. Moynihan	40338
Printed or typed Name	Title or Registration Number

Supplemental ADS

PTO/AIA/14 (OB-12)

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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	69726
	Application Number	15/481,460
Title of Invention	LIGHTING SYSTEM AND CONTROL THEREOF	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United states Patent and Trademark Office as outlined in 37 CFR 1.76.

This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Roderick Allen		GAMMONS	

Residence Information (Select One) ○ **US Residency** ◉ **Non US Residency** ○ **Active US Military Service**

City	Staines Upon Thames	State/Province	Surrey	Country	GB

Mailing Address of Inventor:

Address 1	135 Chertsey Lane		
Address 2			
City	Staines Upon Thames	**State/Province**	Surrey
Postal Code	TW18 3LR	**Country**	GB

Inventor 2

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrew		FRANCIS	

Residence Information (Select One) ○ **US Residency** ◉ **Non US Residency** ○ **Active US Military Service**

City	Witham	State/Province	Essex	Country	GB

Mailing Address of Inventor:

Address 1	4 Wickham Bishops		
Address 2			
City	Witham	**State/Province**	Essex
Postal Code	CM8 3NU	**Country**	GB

Inventor 3

Supplemental ADS

PTO/AIA/14 (08-12)

Approved for use through 01/31/2014. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	69726
	Application Number	15/481,460
Title of Invention	LIGHTING SYSTEM AND CONTROL THEREOF	

Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Roderick Aaron		GAMMONS	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Winkfield	State/Province	Windsor	Country	GB

Mailing Address of Inventor:

Address 1	Vetch Cottage, Lovel Road		
Address 2			
City	Winkfield	State/Province	Windsor
Postal Code	SL4 2EU	Country	GB

Inventor 4

Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Stefan		LANGE	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Shepperton	State/Province	Middlesex	Country	GB

Mailing Address of Inventor:

Address 1	Cedar Lodge, Towpath		
Address 2			
City	Shepperton	State/Province	Middlesex
Postal Code	TW17 9LL	Country	GB

Supplemental ADS

PTO/AIA/14 (08-12)

Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	69726
	Application Number	15/481,460
Title of Invention	LIGHTING SYSTEM AND CONTROL THEREOF	

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence Information of this application.

Customer Number	**67801**
Email Address	martin@ipatent.co.il

Application Information:

Title of the Invention	LIGHTING SYSTEM AND CONTROL THEREOF		
Attorney Docket Number	69726	**Small Entity Status Claimed** ☒	
Application Type	Non Provisional		
Subject Matter	Utility		
Suggested Class (If any)		**Sub Class (If any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	~~5~~ 6	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	⊙Customer Number	○US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	67801		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Supplemental ADS

PTO/AIA/14 (08-12)

Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	69726
	Application Number	15/481,460
Title of Invention	LIGHTING SYSTEM AND CONTROL THEREOF	

Prior Application Status	~~Pending~~ Expired		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Claims benefit of provisional	62/319,809	2016-04-08

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Application Number	Country	Filing Date (YYYY-MM-DD)	Priority Claimed
1606907.2	GB	2016-04-20	⊙ Yes ○ No

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h) (3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

⊙ Assignee	○ Legal representative under 35 U.S.C 117
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient propriety interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:	

Supplemental ADS

PTO/AIA/14 (OB-12)

Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	69726
	Application Number	15/481,460
Title of Invention	LIGHTING SYSTEM AND CONTROL THEREOF	

Name of the Deceased or Legally Incapacitated Inventor :	
If the Assignee is an Organization check here.	☒

Organization Name	Rotolight Limited		
Mailing Address Information:			
Address 1	c/o London Law, The White House, 57-63 Church Road, Wimbledon Village		
Address 2			
City	London	**State/Province**	
Country GB		Postal Code	SW19 5SB
Phone Number		Fax Number	
Email Address			

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications					
Signature	/**Martin D. Moynihan**/			Date (YYYY-MM-DD)	2018-11-12
First Name	Martin	Last Name	Moynihan	Registration Number	40338

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Electronic Patent Application Fee Transmittal	
Application Number:	15481460
Filing Date:	07-Apr-2017
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Filer:	Martin Dennis Moynihan
Attorney Docket Number:	69726
Filed as Small Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
CORRECTION OF INVENTORSHIP ON MERITS	2819	1	300	300
		Total in USD ($)		**300**

Electronic Acknowledgement Receipt	
EFS ID:	34272852
Application Number:	15481460
International Application Number:	
Confirmation Number:	5642
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Customer Number:	67801
Filer:	Martin Dennis Moynihan
Filer Authorized By:	
Attorney Docket Number:	69726
Receipt Date:	12-NOV-2018
Filing Date:	07-APR-2017
Time Stamp:	07:05:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$300
RAM confirmation Number	111318INTEFSW00008801501407
Deposit Account	501407
Authorized User	Martin Moynihan
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition for review by the Office of Petitions	69726PetitiontoAddInventorStefanLANGE.pdf	35807 2332d33b7bf65129fc4cb44f2acb09d389bb07ee	no	1
Warnings:					
Information:					
2	Oath or Declaration filed	69726ExecutedDeclarationStefanLANGE.pdf	593177 be1615a742659e85b9d9fd109f149f39008e37f2	no	3
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	69726ExecutedAssignmentStefanLANGESecondStatement.pdf	335848 2943921fc74a1d8735e9c07ac455b26c128851c6	no	3
Warnings:					
Information:					
4	Application Data Sheet	69726SupplementalApplicationDataSheet.pdf	78223 a4e3b0fb37a4144f94106fa5ae301b2f2a9da7ae	no	5
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
5	Fee Worksheet (SB06)	fee-info.pdf	30146 9ff1f7be28d470f1f83a8b4179238c48da7e9a34	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1073201		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/481,460	Filing Date 04/07/2017	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT		(Column 1)		(Column 2)	(Column 3)		
	09/07/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $50 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

AMENDMENT		(Column 1)		(Column 2)	(Column 3)		
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
JERMAINE MINOR

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 15481460 Document Date: 09/07/2018

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via eDAN using the Supplemental Content tab, or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: August 26, 2013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of.:		§		
		§		
	Roderick Allen GAMMONS et al.	§		
		§	Confirmation No.:	5642
Serial No.:	15/481,460	§		
		§		
Filed:	April 7, 2017	§	Group Art Unit:	2844
		§		
For:	LIGHTING SYSTEM AND CONTROL THEREOF	§		
		§		
		§	Attorney Docket:	**69726**
		§		
Examiner:	Thai N. PHAM	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE

Sir:

This is in response to the United States Patent and Trademark Office Action mailed March 9, 2018, which response is being made on or before September 9, 2018, and for which a three month extension of time fee is due and enclosed herewith.

Applicant submits this response for entry into the record, in which:

Amendments to the Specification begin on page 2.
Amendments to the Claims begin on page 4.
Amendments to the Drawings begin on page 8.
Remarks begin on page 9.

Please amend the above-identified application as follows:

In the Specification:

Please insert at Page 10, line 14, the following paragraph:

Figure 8 is a flow diagram of a method for controlling a lighting device

Please amend the Paragraph beginning at Page 10, line 20, as follows:

Figure 1 shows a schematic diagram of a 'flickerbox' lighting control system. The system comprises an analogue effect simulator, 300, a DMX distribution hub 302, an AC power generator 306, an AC power distribution module 302 and a plurality of incandescent lights 102. The analogue effect simulator 300 simulates a lighting effect such as fire, or electrical sparking based on various parameters ~~104~~. The analogue effect simulator 300 produces data 106 such as brightness parameters that vary over time for producing the desired lighting effect. The data 106 is used to modulate the light 102 such that the desired lighting effect is produced. The user has very limited ability to alter many of the parameters to adapt the lighting effect as desired.

Please amend the Paragraph beginning at Page 11, line 1, as follows:

Figure 2 schematically shows an example where a lighting effect simulator 100 and the light 102 are integrated in a single studio lamp device 120. In one example, the ~~lamp device~~ light 102 is an array of LEDs, preferably of differing colours. This arrangement does not require the DMX distribution hub 302, power elements 304, 306 as described above, and is more flexible in producing effects as will be described in more detail below. A microcontroller or other computing unit is integrated in the lamp device 120 for performing calculations. An input interface 105 including a control panel is provided at a back panel of the ~~light~~ lamp device 120. The control panel can include for example buttons, rotary knobs, sliders, and/or a display/input panel for user input of parameters for simulating an effect. The user input simulation parameters are optionally stored in memory 220. In a variant a simple digital interface is provided on the light itself for user input of simulation parameters to control the lighting effect. In another variant the ~~light~~ lamp device 120 is adapted for communication with a wireless user device and receives user-selectable simulation parameters to control the

lighting effect from the user device. The user device may for example be a tablet or smart phone with suitable hardware / software (e.g. an app) for receiving user input of simulation parameters and transmitting that data to the ~~light~~ lamp device 120. The system of Figure 2 is simpler to set up and less expensive than that of Figure 1 as there are fewer pieces of hardware. Furthermore the energy inefficiency of 'hot light' systems (i.e. a 1K hot light consumes 1000 watt/hour, vs 38 watt per hour of current generation LED system), Systems such as that described in Figure 1 using a flicker box and typically 'hot lights' also suffer from the significant disadvantage that a hot light is a fixed colour of light, either daylight 5600K or most commonly tungsten 3200K. When recreating an effect such a lightning this effect would appear at the blue end of the colour spectrum i.e. 7000K+ so utilising a 3200K light for this would require an operator to climb up a ladder to apply one or more CTB (Colour temperature blue) filter(s) to the light in order to achieve the desired colour temperature.

Please amend the Paragraph beginning at Page 17, line 9, as follows:

It should be appreciated that due to the nature of the light 102, the effects may be customised by a user. ~~,~~ As shown in Figure 8, a user may input simulation parameters 802 in order to customise a lighting effect, for example, the frequency/speed, peak/minimum brightness or colour / colour temperature may be dynamically changed, and/or made to vary over time in a customised manner. Such user-~~customised effects~~ input simulation parameters may be stored 804 in memory 220 and recalled 806 from the memory 220 at a later time. A time varying lighting value is calculated 808 based on the recalled simulation parameter and output 810 to the light 102. The effects may be triggered on cue (for example from a director) by sending a signal over a wired remote trigger or wireless device.

In the Claims:

1-74. (Cancelled).

75. (New) A method for controlling a lighting device to produce a range of different user customisable lighting effects, the method comprising:

receiving user input of at least one user input simulation parameter to customise a lighting effect;

storing in memory said at least one user input simulation parameter, said at least one user input simulation parameter depending on the lighting effect being simulated;

recalling from said memory said at least one stored user input simulation parameter;

calculating, using an effect simulator, a time varying lighting value based on said recalled simulation parameter; and

outputting to said lighting device said time varying lighting value thereby to simulate the lighting effect.

76. (New) The method according to Claim 75, wherein said user customisable simulation parameter is stored locally.

77. (New) The method according to Claim 75, wherein the simulation parameter comprises a colour or colour temperature.

78. (New) The method according to Claim 75, wherein the simulation parameter is related to at least one of: an effect frequency; an effect speed; a colour; a colour temperature; a trigger; a rate of increase of brightness; a rate of decrease of brightness; a rate of change of colour; a brightness; a local maximal (peak) brightness; a local minimal brightness; a brightness fluctuation period; and a colour fluctuation time period.

79. (New) The method according to Claim 75, wherein the lighting effect comprises a short time-period (e.g. stroboscopic) lighting effect with a user adjustable minimum pulse width.

80. (New) The method according to Claim 75, wherein the user customisable simulation parameter comprises a parameter indicative of a group consisting of: a camera recording frequency; a camera shutter speed; and a camera frame rate.

81. (New) The method according to Claim 75, wherein the lighting effect is designed to mimic at least one of: fire; lightning; police car light; television; a neon flickering sign; a candle; muzzle (gunshot); welding; spark/short circuit; a scan (e.g. fingerprint scanner); paparazzi flashes; fireworks; flashes (strobe); a propeller; a (nuclear) explosion; and a wormhole.

82. (New) The method according to Claim 75, wherein the lighting value comprises brightness and/or colour data.

83. (New) The method according to Claim 75, further comprising converting at least one of brightness and colour data into a lighting signal and outputting the lighting signal to the lighting device.

84. (New) The method according to Claim 75, wherein the controlling is for a lighting system for videography, broadcast, cinematography, studio filming and/or location filming.

85. (New) The method according to Claim 75, further comprising controlling at least one further lighting device.

86. (New) A controller adapted to control a lighting device to produce a range of different user customisable lighting effects, the controller comprising:

an input interface adapted to receive user input of at least one user input simulation parameter to customise a lighting effect;

a memory adapted to store said at least one user input simulation parameter, said at least one user input simulation parameter depending on the lighting effect being simulated; and

an effect simulator adapted to:

recall from said memory said at least one stored user input simulation parameter; and

calculate a time varying lighting value based on said recalled simulation parameter;

wherein the effect simulator is adapted to output said calculated time varying lighting value to the lighting device thereby to simulate a lighting effect.

87. (New) The controller according to Claim 86, wherein the controller is adapted to control at least one further lighting device.

88. (New) The controller according to Claim 86, wherein the controller comprises an input interface and wherein the input interface comprises at least one of: a wireless communication interface; a dial; a slider; a display and buttons.

89. (New) A lighting system comprising the controller according to Claim 86, and at least one lighting device.

90. (New) The lighting system according to Claim 89, wherein said controller and said lighting device are integrated in a combined unit.

91. (New) The lighting system according to Claim 89, wherein the lighting device is a lighting device for videography, broadcast, cinematography, studio filming and/or location filming.

92. (New) A lighting device comprising the controller according to Claim 86, wherein the lighting device comprises at least one light emitting diode.

93. (New) A lighting device according to Claim 92, wherein the lighting device is a lighting device for videography, broadcast, cinematography, studio filming and/or location filming.

94. (New) A computer program product comprising software code for controlling a lighting device to produce a range of different user customisable lighting effects, the computer program product adapted to perform, when executed, the steps of:

receiving user input of at least one user input simulation parameter to customise a lighting effect;

storing in memory said at least one user input simulation parameter, said at least one user input simulation parameter depending on the lighting effect being simulated;

recalling from said memory said at least one stored user input simulation parameter;

calculating, using an effect simulator, a time varying lighting value based on said recalled simulation parameter; and

outputting to said lighting device said time varying lighting value thereby to simulate a lighting effect.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of.:		§		
		§		
	Roderick Allen GAMMONS et al.	§		
		§	Confirmation No.:	5642
Serial No.:	15/481,460	§		
		§		
Filed:	April 7, 2017	§	Group Art Unit:	2844
		§		
For:	LIGHTING SYSTEM AND CONTROL THEREOF	§		
		§		
		§	Attorney Docket:	**69726**
		§		
Examiner:	Thai N. PHAM	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

LETTER TO CHIEF DRAFTSMAN

Sir:

Permission is requested to add new Figure 8.

Statement

The content of the new drawing includes no new matter.

Respectfully submitted,

/Martin D. Moynihan/

Martin D. Moynihan
Registration No. 40338
Telephone: (703) 859-9634

Date: September 7, 2018

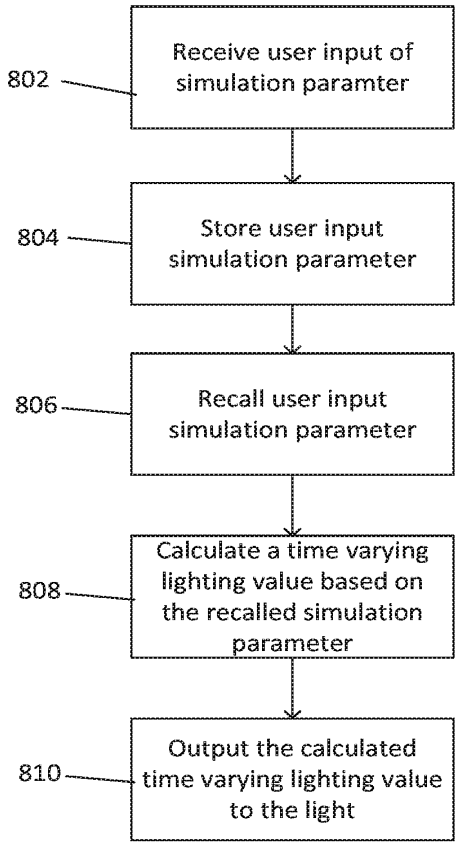

802
Receive user input of simulation paramter
804
Store user input simulation parameter
806
Recall user input simulation parameter
808
Calculate a time varying lighting value based on the recalled simulation parameter
810
Output the calculated time varying lighting value to the light

Figure 8

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of.:		§		
		§		
	Roderick Allen GAMMONS et al.	§		
		§	Confirmation No.:	5642
Serial No.:	15/481,460	§		
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		§	Attorney Docket:	**69726**
		§		
Examiner:	Thai N. PHAM	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

LETTER TO CHIEF DRAFTSMAN

Sir:

Permission is requested to correct Figures 2 and 4 as shown in red ink on the attached photocopies.

Since the foregoing are all relative minor changes and do not include new matter, the formal drawings, which are being submitted herewith in an accompanying letter, include the above-requested changes.

Respectfully submitted,

/Martin D. Moynihan/

Martin D. Moynihan
Registration No. 40338
Telephone: (703) 859-9634

Date: September 7, 2018

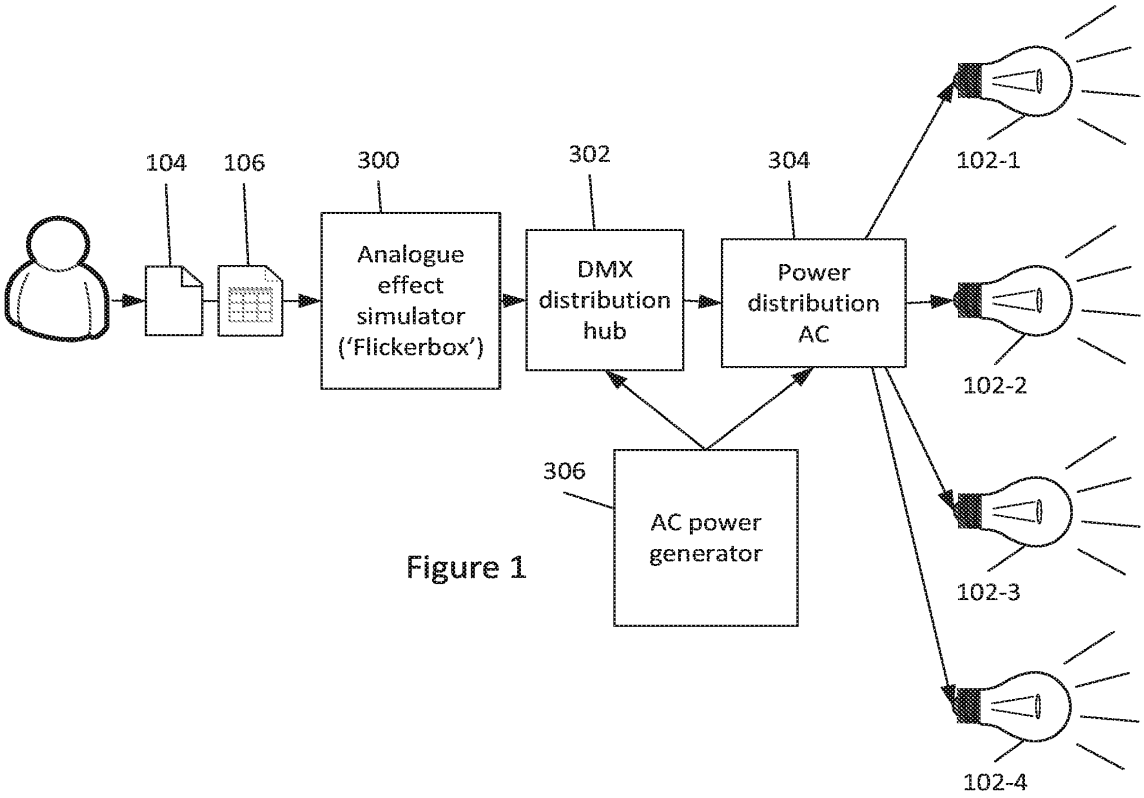


Figure 1

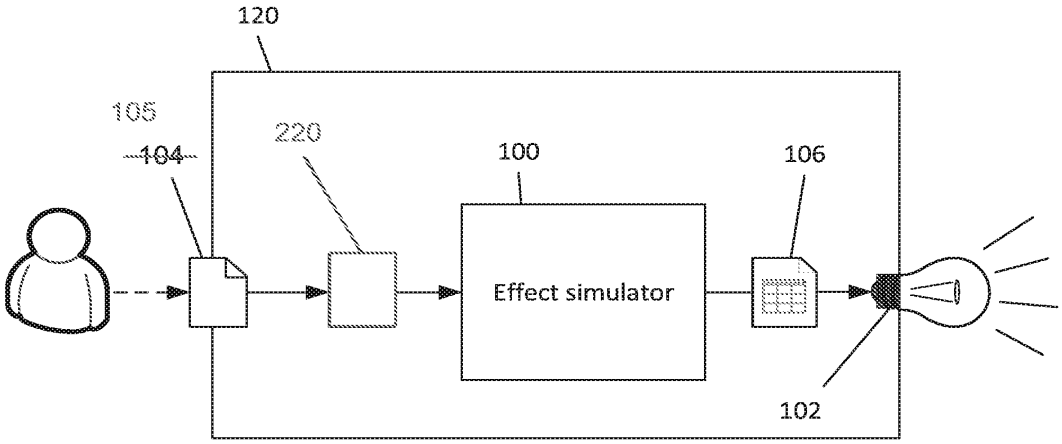


Figure 2

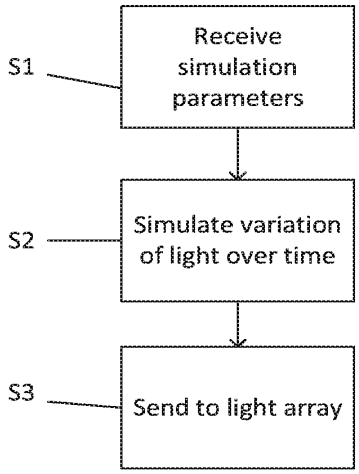


Figure 3

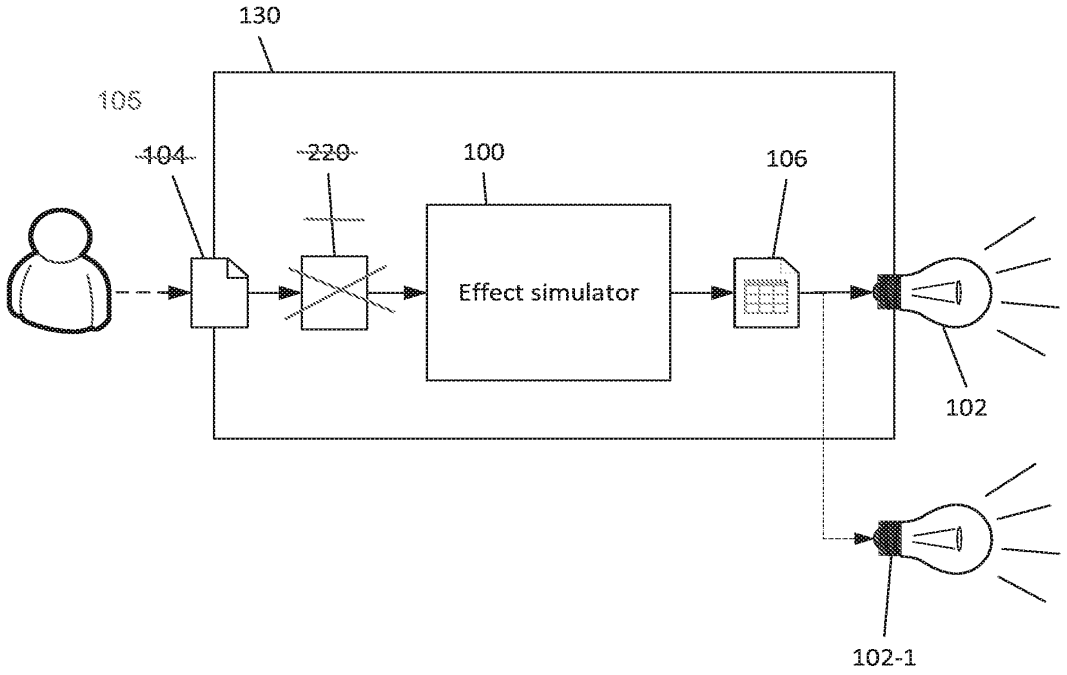


Figure 4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of.:		§		
		§		
	Roderick Allen GAMMONS et al.	§		
		§	Confirmation No.:	5642
Serial No.:	15/481,460	§		
		§		
Filed:	April 7, 2017	§	Group Art Unit:	2844
		§		
For:	LIGHTING SYSTEM AND CONTROL THEREOF	§		
		§		
		§	Attorney Docket:	**69726**
		§		
Examiner:	Thai N. PHAM	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

FORMAL DRAWINGS

Sir:

Applicant encloses herewith a new set of formal drawings, six (6) sheets, for the above-identified patent application.

Statement

The content of the replacement drawings includes no new matter.

Respectfully submitted,

/Martin D. Moynihan/

Martin D. Moynihan
Registration No. 40338
Telephone: (703) 859-9634

Date: September 7, 2018

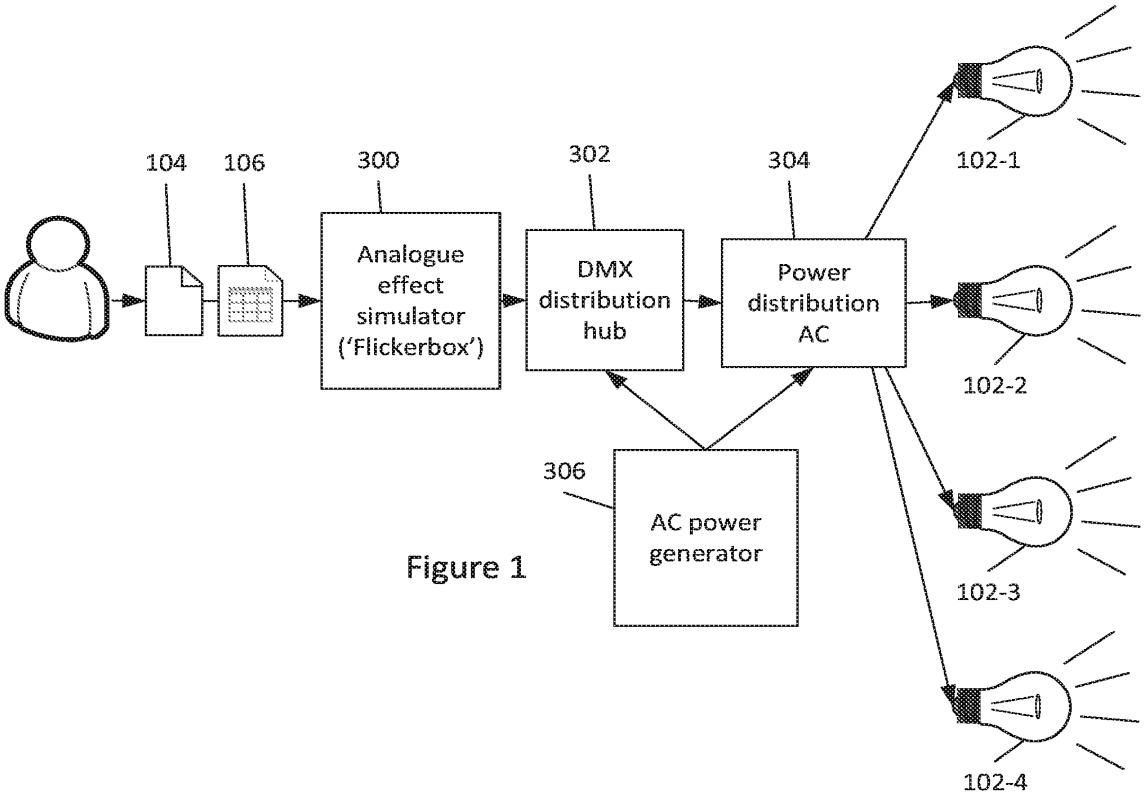


Figure 1

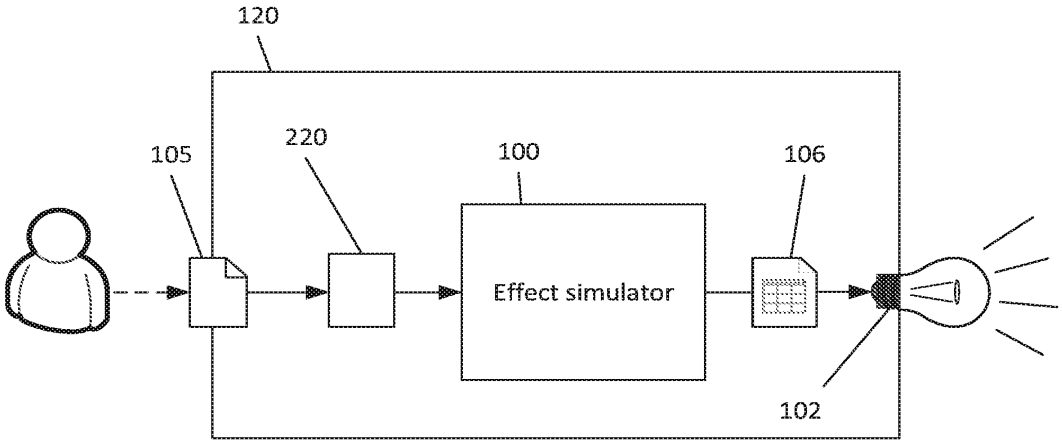


Figure 2

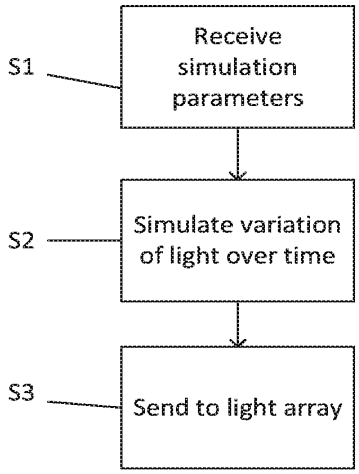


Figure 3

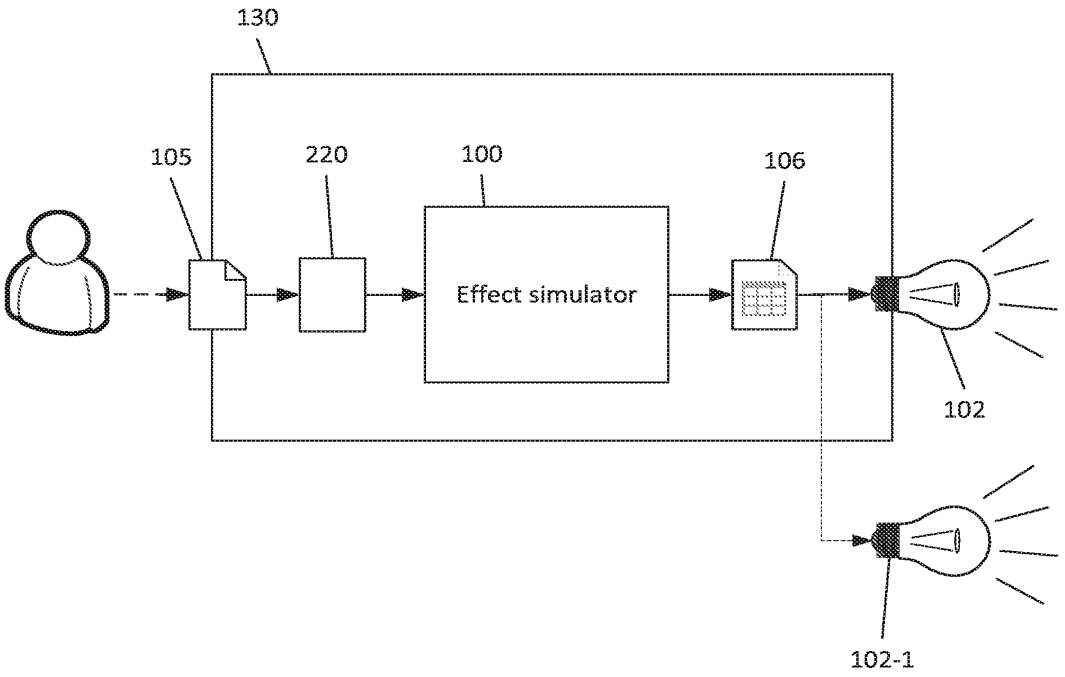


Figure 4

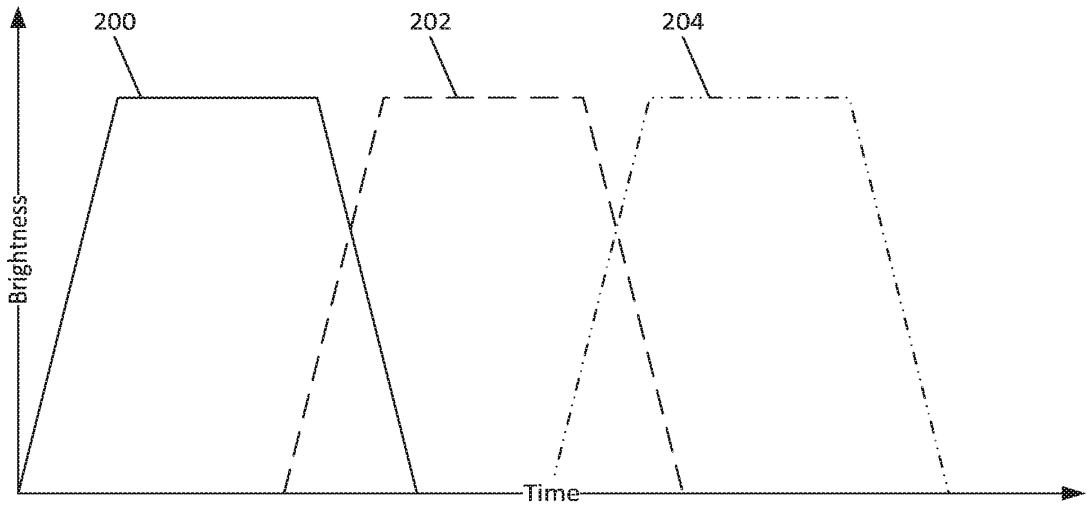


Figure 5

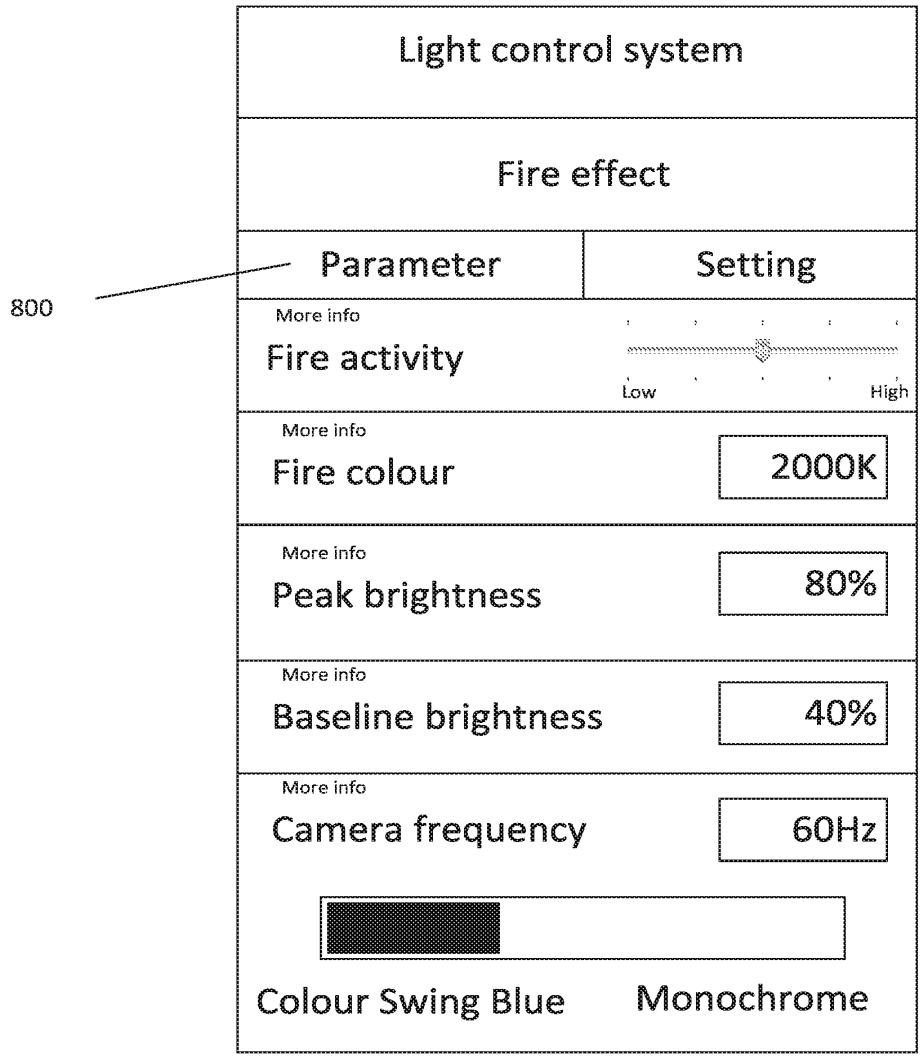

800
Light control system
Fire effect
Parameter
Setting
More info
Fire activity
Low
High
More info
Fire colour
2000K
More info
Peak brightness
80%
More info
Baseline brightness
40%
More info
Camera frequency
60Hz
Colour Swing Blue
Monochrome

Figure 6

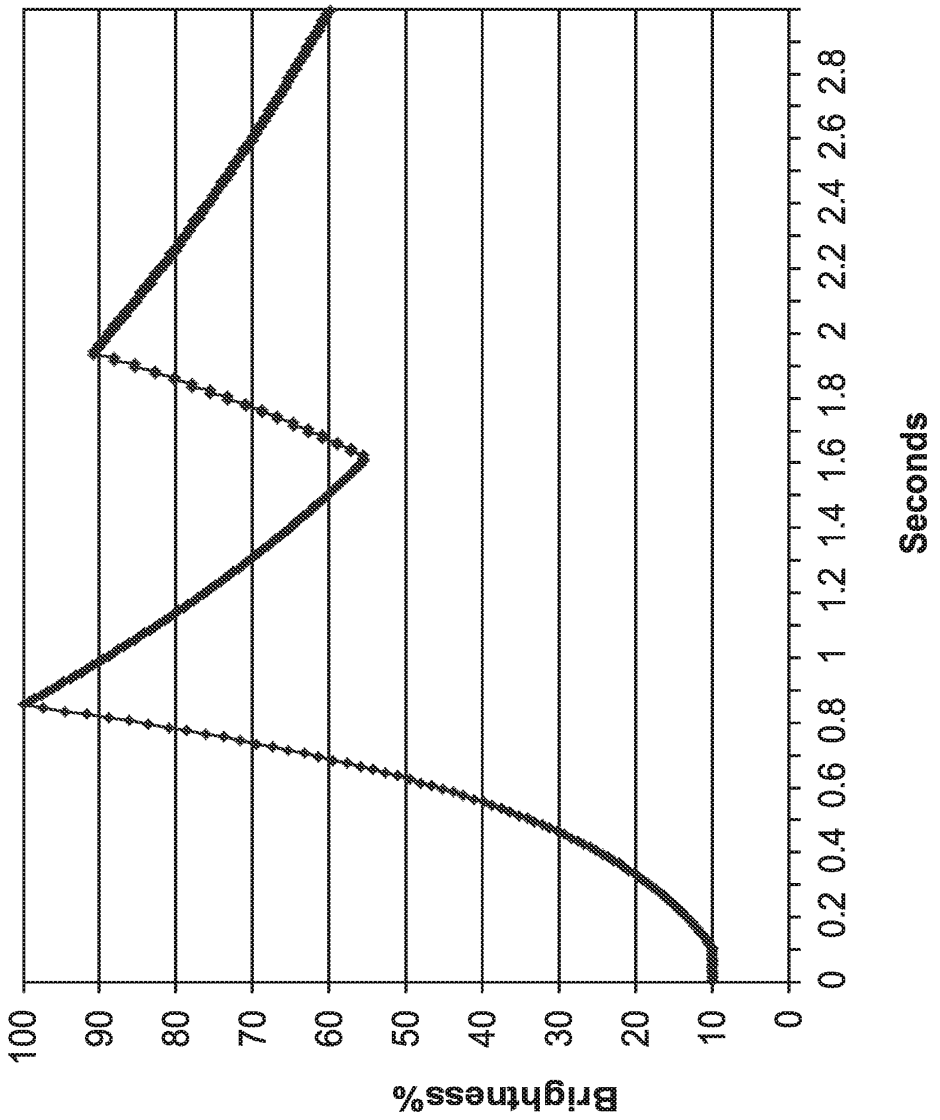

Brightness%
100
90
80
70
60
50
40
30
20
10
0
Seconds
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8

Figure 7

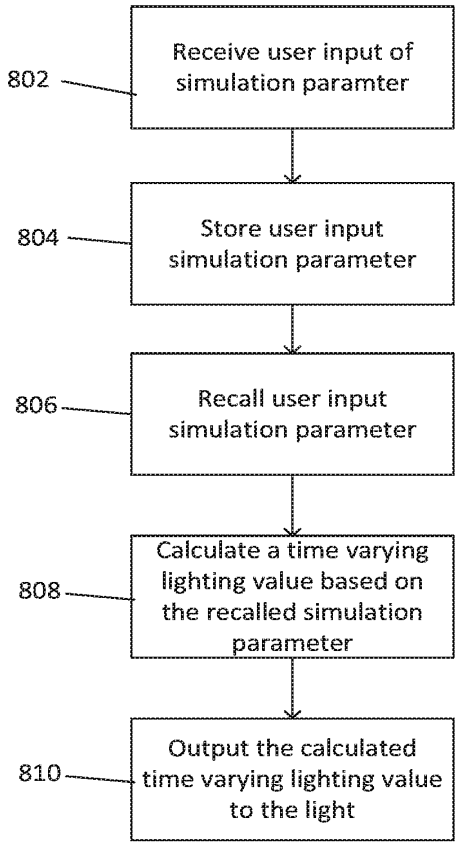

802
Receive user input of simulation paramter
804
Store user input simulation parameter
806
Recall user input simulation parameter
808
Calculate a time varying lighting value based on the recalled simulation parameter
810
Output the calculated time varying lighting value to the light

Figure 8

Electronic Patent Application Fee Transmittal	
Application Number:	15481460
Filing Date:	07-Apr-2017
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Filer:	Martin Dennis Moynihan
Attorney Docket Number:	69726
Filed as Small Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	2253	1	700	700
Miscellaneous:				
		Total in USD ($)		**700**

Electronic Acknowledgement Receipt	
EFS ID:	33652266
Application Number:	15481460
International Application Number:	
Confirmation Number:	5642
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Customer Number:	67801
Filer:	Martin Dennis Moynihan
Filer Authorized By:	
Attorney Docket Number:	69726
Receipt Date:	07-SEP-2018
Filing Date:	07-APR-2017
Time Stamp:	04:57:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$700
RAM confirmation Number	090718INTEFSW00007356501407
Deposit Account	501407
Authorized User	Martin Moynihan
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		69726ResponseOfficeAction9Mar2018.pdf	558104 01c838f3aa0cab6e5a3174c2cad8628b591e8268	yes	25

Multipart Description/PDF files in .zip description

Document Description	Start	End
Extension of Time	1	1
Amendment/Req. Reconsideration-After Non-Final Reject	2	2
Specification	3	4
Claims	5	8
Applicant Arguments/Remarks Made in an Amendment	9	9
Applicant Arguments/Remarks Made in an Amendment	10	13
Transmittal Letter	14	14
Drawings-only black and white line drawings	15	15
Transmittal Letter	16	16
Drawings-other than black and white line drawings	17	18
Transmittal Letter	19	19
Drawings-only black and white line drawings	20	25

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30418 9989c0a7d27860311156ddac368c24313ad2a8ea	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	588522

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of.:		§		
		§		
	Roderick Allen GAMMONS et al.	§		
		§	Confirmation No.:	5642
Serial No.:	15/481,460	§		
		§		
Filed:	April 7, 2017	§	Group Art Unit:	2844
		§		
For:	LIGHTING SYSTEM AND CONTROL THEREOF	§		
		§		
		§	Attorney Docket:	**69726**
		§		
Examiner:	Thai N. PHAM	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PETITION AND FEE FOR EXTENSION OF TIME UNDER 37 C.F.R. §1.136(a)

Sir:

(1) This is a petition for an extension of time to respond to the Office Action mailed **March 9, 2018**, for a period of **three (3) months**.

(2) Applicant is a:
X small entity ___ verified statement attached
___ verified statement filed

(3) Extensions (months)	Fees for small entity	Fee for other than small entity
☑ three months	**$ 700.00**	$ 1,400.00

(4) An amendment **X** is filed herewith
___ has been filed

(5) Please charge the extension fee and any other amount required to Deposit Account No. **50-1407**.

(6) The Commissioner is hereby authorized and requested to charge any additional fees which may be required in connection with this application or credit any overpayment to Deposit Account No. **50-1407**. This authorization and request is not limited to payment of all fees associated with this communication, including any Extension of Time fee, not covered by check or specific authorization, but is also intended to include all fees for the presentation of extra claims under 37 CFR §1.16 and all patent processing fees under 37 CFR §1.17 throughout the prosecution of the case. This blanket authorization does not include patent issue fees under 37 CFR §1.18.

Respectfully submitted,
/Martin D. Moynihan/
Martin D. Moynihan
Registration No. 40338
Telephone: (703) 859-9634

Date: September 7, 2018

Amendments to the Drawings:

Applicant attaches herewith a set of drawings with amendments to Figures 2 and 4 and added new Figure 8, as required by the Examiner. A complete set of formal drawings (6 sheets) are also attached herewith as required by the Examiner.

REMARKS

Reconsideration of the above-identified application in view of the amendments above and the remarks following is respectfully requested.

Claims 55-74 are in this Application. The drawings have been objected to. Claims 55-74 have been rejected under the double patenting rejection. Claims 55-74 have been cancelled herewith without prejudice.

Claims 75-94 are new, based on the specification, the drawings and the cancelled claims. No new matter is added.

Claim Amendments

Applicant canceled the pending claims and replaced them with replacement claims 21-40. The new claims find basis in the application as filed. In particular, the claims are based on the original claims, and page 17 lines 9-15 of the description as filed.

Specification Objections

Applicants amended the specification to make a number of clarifying amendments to the description.

Drawings Objections

Drawings have been rejected as the drawings must show every feature of the invention specified in the claims. Applicant amended Figures 2 and 4 and added a new Figure 8 to reflect the replacement claims. The amended drawings are attached.

With regard to new Claim 1, each step of the method is shown in new Figure 8. Basis for new Figure 8 can be found at page 17 lines 9-15 of the description as on file at the USPTO (this passage has itself been amended to refer to this new figure). The same applies to the steps referred to in Claim 20.

With regard to new Claim 12, each feature of this claim is shown in the figures as follows:

a. A “controller adapted to control a lighting device” was already shown in Figure 4 and labelled 130. Basis for this interpretation of the figures can be

found at page 14 line 2 which refers to "a lighting control unit 130" and page 14 line 12 which refers to "controllers 130".

b. An "input interface" is shown in amended Figures 2 and 4 and is labelled 105. Page 11 lines 7-8 of the description has been amended accordingly.

c. A "memory" is shown in amended Figures 2 and 4 and is labelled 220. Pages 11 and 17 of the description have been amended accordingly.

d. An "effect simulator" was already shown in Figures 2 and 4 and is labelled 100.

Double Patenting

Claims 55-74 are provisionally rejected on the ground of non-statutory double patenting as being unpatentable over claims 1-20 of co-pending application No. 15/820469. It is submitted that the new claims are distinct from the claims US Patent Application No. 15/820,469.

Conclusion

No Disclaimers or Disavowals

Although the present response may include amendments to the application or claims, or characterizations of claim scope or referenced art, Applicants do not concede that previously pending claims in this application are not patentable over the cited references. Rather, any amendments or characterizations are being made to expedite the issuance. Applicants reserve the right to pursue at a later date any previously pending or other broader or narrower claims that relate to subject matter supported by the instant application, including subject matter specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this application, or any parent, child or related prosecution history should not infer that Applicants have made any disclaimers or disavowals of any subject matter supported by the instant application.

In view of the above amendments and remarks it is respectfully submitted that the claims are now in condition for allowance. A prompt notice of allowance is respectfully and earnestly solicited.

Should the Examiner have any questions or comments as to the form, content, or entry of this paper, the Examiner is requested to contact the undersigned at the telephone number below prior to mailing the next Official Action. Similarly, if there are any further issues yet to be resolved to advance the prosecution of this application to issue, the Examiner is requested to telephone the undersigned counsel.

Any fees associated with this paper, for its entry into the record, may be charged to Deposit Account No. 50-1407.

During the pendency of this application, the Commissioner for Patents is hereby authorized to charge payment of any filing fees for presentation of extra claims under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17, or credit any overpayment, to Deposit Account No. 50-1407.

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Respectfully submitted,

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Date: September 7, 2018

Enclosures:

- Petition for Extension (Three Months)
- Letter to Chief Draftsman
- New Drawing Sheet
- Letter to Chief Draftsman
- Annotated Drawing Sheets
- Formal Drawing Transmittal Sheet
- Complete Set of Replacement Drawing Sheets

PTO/SB/08a (08-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(*use as many sheets as necessary*)

Complete if Known	
Application Number	15/481,460
Filing Date	April 07, 2017
First Named Inventor	GAMMONS Roderick Allen et al
Art Unit	2844
Examiner Name	PHAM Thai N.
Attorney Docket Number	69726

Sheet	1	of	2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind Code [2] (if known)	Publication Date DD-MMM-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	2004/0257007	23-Dec-2004	Lys et al.	
	2	2014/0139130	22-May-2014	Upton	
	3	2018/0094798	05-Apr-2018	Gammons et al.	
	4	2018/0112862	26-Apr-2018	Gammons et al.	
	5	2018/0135842	17-May-2018	Gammons et al.	
	6	7,777,427	17-Aug-2010	Stalker III	
	7	8,253,666	28-Aug-2012	Shteynberg et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Documents Country Code [3]- Number [4]- Kind Code [5] (*if known*)	Publication Date DD-MMM-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [6]
	8	CN 103090238	08-May-2013	Zheng et al.		
	9	CN 103313457	18-Sep-2013	Xing et al.		
	10	CN 103313458	18-Sep-2013	Xing et al.		
	11	CN 202841602	27-Mar-2013	Lv		
	12	EP 2120512	18-Nov-2009	Koninklijke Philips Electronics		
	13	EP 3002995	06-Apr-2016	Van de Sluis et al.		
	14	WO 2017/097741	15-Jun-2017	Van de Sluis et al.		

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[3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3).

[4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

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Group Art Unit	2844
Examiner Name	PHAM Thai N.
Attorney Docket Number	69726

Sheet	2	Of	2

OTHER PRIOR ART – NON PATENT LITERATURE DOCUMENTS

Examiner Initials	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	15	Official Action Dated 10 April 2018 From the US Patent and Trademark Office Re. Application No. 15/820,469. (19 pages)	
	16	Official Action Dated 22 March 2018 From the US Patent and Trademark Office Re. Application No. 15/849,793. (14 pages)	
	17	Official Action Dated 28 March 2018 From the US Patent and Trademark Office Re. Application No. 15/849,819. (17 pages)	
	18	Philips "Controlling LED Lighting: Transform Environments, Provide Confort and Security, Save Energy", Philips Color Kinetics, Product Catalog, P.1-36, 2011.	

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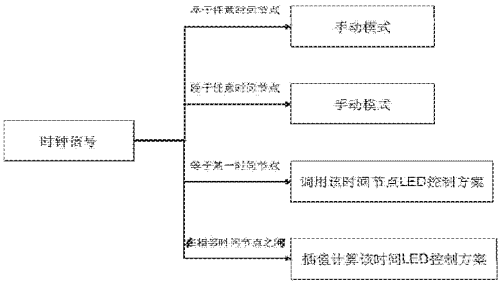
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(54)发明名称

色温随时间模拟自然光变化的LED光源照明的方法和装置

(57)摘要

本发明公开了一种色温随时间模拟自然光变化的LED光源照明的方法，首先在控制器中存储一系列不同时间节点和色温对应的LED光源的电流调整方案，控制器通过接受时钟的时间信号，并将时间信号和时间节点进行比较，然后提取相应的电流调整方案控制LED光源的电流，或者是手动选择色温，控制器根据该色温对应的电流调整方案，控制LED光源的电流，从而模拟自然光色温的变化，使LED照明模块的合成光具有较高的显色性。本发明还公开了一种色温随时间模拟自然光变化的LED光源照明的装置。



CN 103090238 A

1. 一种色温随时间模拟自然光变化的 LED 光源照明的方法，利用控制器调节 LED 光源的电流值以改变 LED 光源的发光特性，其特征在于，包括以下步骤：

1）预设一时间段，将该时间段内不同时间节点的色温以及所对应的实现该色温的 LED 电流值存储在控制器中；预设一色温范围，将该色温范围内不同色温以及所对应的实现该色温的 LED 电流值也存储在控制器中；

2）控制器将当前时间与步骤 1）中的时间段进行比较：

若当前时间对应步骤 1）中的某一时间节点，控制器向 LED 光源输出与该时间节点对应的 LED 电流值；

若当前时间处于步骤 1）中相邻两个时间节点之间，控制器通过插值算法得到调整后 LED 电流值，并向 LED 光源输出；

若当前时间不在步骤 1）的时间段内，则手动选择色温范围内的某一色温，控制器向 LED 光源输出与该色温对应的 LED 电流值。

2. 如权利要求 1 所述的色温随时间模拟自然光变化的 LED 光源照明的方法，其特征在于，所述 LED 光源由多个单色 LED 灯组成。

3. 如权利要求 2 所述的色温随时间模拟自然光变化的 LED 光源照明的方法，其特征在于，所述实现该色温的 LED 电流值的算法包括以下步骤：

1）设定目标色温为 CCTT，设 LED 光源合成光谱的色温为 CCTM，CCTz 和 CCT_M 应满足的边界条件为：

$$\begin{cases} |CCT_T - CCT_M| \le \Delta CCT \\ \Delta uv = \sqrt{(u_{T'} - u_m)^2 + (v_{T'} - v_m)^2} \le 0.005 \end{cases}$$

其中，ΔCCT 为 CCT_M 与 CCT_T 存在的偏差范围；

Δuv 为 LED 光源合成光谱的色坐标与黑体辐射曲线之间的距离；

$(u_{T'}, v_{T'})$ 和 (u_M, v_M) 分别为在 CIE1960-UCS 色品图中黑体辐射线上 CCT_M 处的色坐标与 LED 光源合成光谱的色坐标；

2）设多个单色 LED 灯的归一化的光谱分别为 $S_i(\lambda)$（i = 1, 2, 3...n），对应权重为 k_i（i = 1, 2, 3...n）；在 0~1 区间之间对权重 k_i（i = 1, 2, 3...n）随机赋值，使 LED 光源合成光谱满足上述的边界条件；

3）建立显色性 CRI 的评价函数 f = 100-CRI，采用下山单纯形法局部优化算法寻找显色性 CRI 获得极大值时对应的权重 k_i；

4）将权重 k_i 转化为亮度权重 Y_i，其中 Y_i 为 $k_i * S_i(\lambda)$ 对应的 CIE1931XYZ 颜色空间中的亮度，根据电流值 C_i 与亮度权重 Y_i 的对应关系，将亮度权重 Y_i 转化为电流值 C_i，即得实现该色温的 LED 电流值。

4. 如权利要求 3 所述的色温随时间模拟自然光变化的 LED 光源照明的方法，其特征在于，所述多个单色 LED 灯包括红光 LED 灯、绿光 LED 灯、品蓝光 LED 灯和暖白光 LED 灯，所述电流值包括各个单色 LED 灯的电流值。

5. 如权利要求 4 所述的色温随时间模拟自然光变化的 LED 光源照明的方法，其特征在于，所述的红光 LED 灯的波长为 600~630nm，绿光 LED 灯的波长为 500~540nm，品蓝光 LED 灯的波长为 450~470nm，暖白光 LED 灯的色温为 2500K~3000K。

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6. 如权利要求 1 所述的色温随时间模拟自然光变化的 LED 光源照明的方法，其特征在于，所述插值算法为：

设当前时间为 t，且在控制器存储的相邻时间节点 t_1 与 t_2 之间，设 t_1 对应的 n 种 LED 的电流值分别为 C_{i1}（i = 1, 2, 3. . . n），t2 对应的 n 种 LED 的电流值分别为 C_{i2}（i = 1, 2, 3. . . n），那么 t 对应的 n 种 LED 的电流值分别为 C_i（i = 1, 2, 3. . . n）如下：

$$\begin{cases} C_1 = \dfrac{t-t_1}{t_2-t_1} * C_{12} + \dfrac{t_2-t}{t_2-t_1} * C_{11} \\ C_2 = \dfrac{t-t_1}{t_2-t_1} * C_{22} + \dfrac{t_2-t}{t_2-t_1} * C_{21} \\ C_3 = \dfrac{t-t_1}{t_2-t_1} * C_{32} + \dfrac{t_2-t}{t_2-t_1} * C_{31} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ C_n = \dfrac{t-t_1}{t_2-t_1} * C_{n2} + \dfrac{t_2-t}{t_2-t_1} * C_{n1} \end{cases}$$ 。

7. 一种色温随时间模拟自然光变化的 LED 光源照明的装置，其特征在于，包括：LED 光源；

控制器，用于调整 LED 光源的电流值；

时钟，用于向控制器输送当前时间。

8. 如权利要求 7 所述的色温随时间模拟自然光变化的 LED 光源照明的装置，其特征在于，所述 LED 光源包括红光 LED 灯、绿光 LED 灯、品蓝光 LED 灯和暖白光 LED 灯。

9. 如权利要求 8 所述的色温随时间模拟自然光变化的 LED 光源照明的装置，其特征在于，所述的红光 LED 灯的波长为 600~630nm，绿光 LED 灯的波长为 500~540nm，品蓝光 LED 灯的波长为 450~470nm，暖白光 LED 灯的色温为 2500K~3000K。

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色温随时间模拟自然光变化的 LED 光源照明的方法和装置

技术领域

[0001] 本发明涉及 LED 照明领域，尤其涉及一种色温随时间模拟自然光变化的 LED 光源照明的方法和装置。

背景技术

[0002] 近年来，随着城市高层建筑增多，建筑内部自然采光不足的问题日益显现，通常需要人工照明进行补充，目前大多数人工照明采用的传统日光灯显色性较低且色温固定。

[0003] 显色性就是指不同光谱的光源照射在同一颜色的物体上时，所呈现不同颜色的特性。显色性光源对物体颜色呈现的程度，也就是颜色的逼真程度，显色性高的光源对颜色的再现较好，我们所看到的颜色也就较接近自然原色，显色性低的光源对颜色的再现较差，我们所看到的颜色偏差也较大。

[0004] 色温是表示光源光色的尺度，单位为 K（开尔文），色温指的是广播在不同的能量下，人眼所感受的颜色变化。色温是测量和标志波长的数值，光波长不同，呈现出光的颜色不同，尤其是自然光，随着时间、季节、地理位置的变化，其色温都会发生变化。

[0005] 公开号为 101561083 的中国发明专利公开了一种色温可变的 LED 发光装置及其实现方法，其原理是通过温度传感器采集外界环境的温度，控制器根据温度传感器所采集的数据来调整 LED 灯组的电压参数，以实现随着环境温度的变化而自动改变色温，使 LED 灯的光谱更接近自然光。

[0006] 上述专利的 LED 灯能随外界的温度而改变色温，但是温度不能完全准确体现色温的变化，造成色温变化的因素是多方面的，还有时间、季节和地理位置等。

[0007] 研究表明，维持正常的生理节律对人体健康十分重要，而光对人体的生理节律会产生明显影响。波长位于 450-470nm 的蓝光可以抑制褪黑素分泌，进而对生理节律产生重要影响。一天当中随着自然光色温的规律性的变化：即早晚色温较低，中午色温较高，蓝光部分的多少也随之变化，这一自然的变化过程维持了人体正常的生理节律。

发明内容

[0008] 为了实现色温随时间模拟自然光变化的人工照明，进而维持人体正常的生理节律，本发明提供了一种色温随时间模拟自然光变化的 LED 光源照明的方法和装置。

[0009] 一种色温随时间模拟自然光变化的 LED 光源照明的方法，利用控制器调节 LED 光源的电流值以改变 LED 光源的发光特性，包括以下步骤：

[0010] 1）预设一时间段，将该时间段内不同时间节点的色温以及所对应的实现该色温的 LED 电流值存储在控制器中；预设一色温范围，将该色温范围内不同色温以及所对应的实现该色温的 LED 电流值也存储在控制器中。

[0011] 2）控制器将当前时间与步骤 1）中的时间段进行比较：

[0012] 若当前时间对应步骤 1)中的某一时间节点，控制器向 LED 光源输出与该时间节点对应的 LED 电流值；

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[0013] 若当前时间处于步骤 1)中相邻两个时间节点之间，控制器通过插值算法得到调整后 LED 电流值，并向 LED 光源输出；

[0014] 若当前时间不在步骤 1）的时间段内，则手动选择色温范围内的某一色温，控制器向 LED 光源输出与该色温对应的 LED 电流值。

[0015] 所述 LED 光源由多个单色 LED 灯组成。

[0016] 所述实现该色温的 LED 电流值的算法包括以下步骤：

[0017] 1）设定目标色温为 CCT_T，设 LED 光源合成光谱的色温为 CCT_M，CCT_T 和 CCT_M 应满足的边界条件为：

[0018] $$\begin{cases} |CCT_T - CCT_M| \le \Delta CCT \\ \Delta uv = \sqrt{(u_{T'} - u_m)^2 + (v_{T'} - v_m)^2} \le 0.005 \end{cases}$$

[0019] 其中，Δ CCT 为 CCT_M 与 CCT_T 存在的偏差范围；

[0020] Δ uv 为 LED 光源合成光谱的色坐标与黑体辐射曲线之间的距离；

[0021] $(u_{T'}, v_{T'})$ 和 (u_M, v_M) 分别为在 CIE1960-UCS 色品图中黑体辐射线上 CCT_M 处的色坐标与 LED 光源合成光谱的色坐标；

[0022] 2）设多个单色 LED 灯的归一化的光谱分别为 $S_i(\lambda)(i = 1, 2, 3...n)$，对应权重为 $k_i(i = 1, 2, 3...n)$；在 0~1 区间之间对权重 $k_i(i = 1, 2, 3...n)$ 随机赋值，使 LED 光源合成光谱满足上述的边界条件；

[0023] 3）建立显色性 CRI 的评价函数 f = 100-CRI，采用下山单纯形法局部优化算法寻找显色性 CRI 获得极大值时对应的权重 k_i；

[0024] 4）将权重 k_i 转化为亮度权重 Y_i，其中 Y_i 为 $k_i * S_i(\lambda)$ 对应的 CIE1931XYZ 颜色空间中的亮度，根据电流值 C_i 与亮度权重 Y_i 的对应关系，将亮度权重 Y_i 转化为电流值 C_i，即得实现该色温的 LED 电流值。

[0025] 本发明 LED 电流值的方案均根据上述的算法得到，使电流值调整后的 LED 光源发出的合成光具有较高的显色性。

[0026] 所述多个单色 LED 灯包括红光 LED 灯、绿光 LED 灯、品蓝光 LED 灯和暖白光 LED 灯，所述电流值包括各个单色 LED 灯的电流值；且所述的红光 LED 灯的波长为 600~630nm，绿光 LED 灯的波长为 500~540nm，品蓝光 LED 灯的波长为 450~470nm，暖白光 LED 灯的色温为 2500K~3000K。LED 光源发出的光谱为上述四种单色 LED 灯的合成光谱，该合成光谱能模拟自然光。

[0027] 所述的时间段为北京时间上午 8 时至下午 17 时，该时间段内每隔半个小时设有一个时间节点。本发明的目的为实现色温随时间模拟自然光变化，因此时间段设置为北京时间上午 8 时至下午 17 时，弥补上述时间段内建筑内部自然光采光不足的缺陷。

[0028] 当前时间处于两个相邻时间节点之间，可通过插值算法得到单色 LED 灯的电流值，所述插值算法为：

[0029] 设当前时间为 t，且在控制器存储的相邻时间节点 t_1 与 t_2 之间，设 t_1 对应的 n 种 LED 的电流值分别为 $C_{i1}(i = 1, 2, 3...n)$，t_2 对应的 n 种 LED 的电流值分别为 $C_{i2}(i = 1, 2, 3...n)$，那么 t 对应的 n 种 LED 的电流值分别为 $C_i(i = 1, 2, 3...n)$ 如下：

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[0030]
$$\begin{cases} C_1 = \dfrac{t-t_1}{t_2-t_1} * C_{12} + \dfrac{t_2-t}{t_2-t_1} * C_{11} \\ C_2 = \dfrac{t-t_1}{t_2-t_1} * C_{22} + \dfrac{t_2-t}{t_2-t_1} * C_{21} \\ C_3 = \dfrac{t-t_1}{t_2-t_1} * C_{32} + \dfrac{t_2-t}{t_2-t_1} * C_{31} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ C_n = \dfrac{t-t_1}{t_2-t_1} * C_{n2} + \dfrac{t_2-t}{t_2-t_1} * C_{n1} \end{cases}$$ 。

[0031] 本发明还提供了一种色温随时间模拟自然光变化的 LED 光源照明的装置，包括：LED 光源；

[0032] 控制器，用于调整 LED 光源的电流值；

[0033] 时钟，用于向控制器输送当前时间。

[0034] 本发明的 LED 照明装置具有两种控制模式，一是通过时间来自动控制 LED 光源的电流值，二是通过手动调节 LED 光源合成光的色温来控制 LED 光源的电流值。

[0035] 所述 LED 光源包括红光 LED 灯、绿光 LED 灯、品蓝光 LED 灯和暖白光 LED 灯，且所述的红光 LED 灯的波长为 600~630nm，绿光 LED 灯的波长为 500~540nm，品蓝光 LED 灯的波长为 450~470nm，暖白光 LED 灯的色温为 2500K~3000K。上述四种单色 LED 灯发出的合成光能很好的模拟自然光，且发出的合成光具有较高的显色性。

[0036] 本发明的有益效果是实现了与自然光色温变化相一致的人工照明，有利于维持人体正常的生理节律，并且在不同色温下都获得了较高的显色性。

附图说明

[0037] 图 1 为本发明的色温随时间模拟自然光变化的 LED 光源照明的装置的结构简图；

[0038] 图 2 为本发明选取的四种单色 LED 灯的参数；

[0039] 图 3 为本发明的四种单色 LED 灯的归一化光谱；

[0040] 图 4 为本发明的色温随时间模拟自然光变化的 LED 光源照明的工作流程；

[0041] 图 5 为本发明的色温对应的 LED 电流值的算法；

[0042] 图 6 为本发明的色温对应的 LED 电流值的算法的边界条件；

[0043] 图 7 为本发明高显色 LED 控制方案的相对亮度与电流值的对应关系；

[0044] 图 8 为本发明的不同时间节点的 LED 电流值控制方案；

[0045] 图 9 为本发明中不同色温的 LED 电流值控制方案。

[0046] 图中 1 为时钟，2 为控制器，3 为 LED 光源。

具体实施方式

[0047] 下面结合附图对本发明色温随时间模拟自然光变化的 LED 光源照明的方法及装置作进一步详细描述。

[0048] 如图 1 所示，一种色温随时间模拟自然光变化的 LED 光源照明的装置，包括时钟 1、控制器 2 和 LED 光源 3，LED 光源 3 包括红光 LED 灯、绿光 LED 灯、品蓝光 LED 灯和暖白光

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LED 灯。

[0049] 本实施例选择 Lumileds LUXEON Rebel 系列 LED，四种单色 LED 灯的参数如图 2 所示，四种单色 LED 灯的归一化光谱如图 3 所示，其中，暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的归一化的光谱分别为 $S_1(\lambda)$、$S_2(\lambda)$、$S_3(\lambda)$ 和 $S_4(\lambda)$。

[0050] 控制器 2 内存储有北京时间四种单色 LED 灯电流值的方案，包括晴天上午 8 点到下午 17 点中以半个小时为一时间节点的电流值方案(如图 4 所示)，每个时间节点均对应有色温；以及色温为 2500K~6000K 内 8 组色温节点对应的 LED 电流值方案(如图 5 所示)。通过上述方案对四种单色 LED 灯的电流进行调整，调整后 LED 光源 3 发出的合成光具有较高的显色性，如图 6 所示，实现该色温的 LED 电流值的算法如下：

[0051] 1、设目标色温为 CCT_T，由目标色温确定边界条件，在实际应用时允许 LED 光源合成光谱色温 CCT_M 与 CCT_T 存在一定偏差，且允许 LED 光源合成光谱的色坐标与黑体辐射曲线存在一定距离(如图 7 所示)，边界条件为：

[0052] $$\begin{cases} |CCT_T - CCT_M| \le \Delta CCT \\ \Delta uv = \sqrt{(u_{T'} - u_m)^2 + (v_{T'} - v_m)^2} \le 0.005 \end{cases}$$

[0053] 其中，ΔCCT 为 CCT_M 与 CCT_T 存在的偏差范围，Δuv 为 LED 光源合成光谱的色坐标与黑体辐射曲线之间的距离，其中 $(u_{T'}, v_{T'})$ 和 (u_M, v_M) 分别为在 CIE1960-UCS 色品图中黑体辐射线上 CCT_M 处的色坐标与 LED 光源合成光谱的色坐标，本发明中 $\Delta CCT = 50K$；

[0054] 2、建立关于显色性(CRI)的评价函数 $f = 100-CRI$，因为以下采用的下山单纯形法局部优化算法只会寻找评价函数的极小值，故为使 CRI 获得极大值，需 f 取得极小值；

[0055] 3、设暖白、品蓝、绿、红 4 种 LED 灯的归一化的光谱分别为 $S_1(\lambda)$、$S_2(\lambda)$、$S_3(\lambda)$、$S_4(\lambda)$，对应权重为 k_1、k_2、k_3、k_4；如图 3 所示，k_i 在 0、1 区间之间，四种单色 LED 灯的光谱归一化的目的在于统一权重 k_i 的区间为 0、1 之间；随机赋值直至满足边界条件为止，并设此 $k_i(i = 1,2,3,4)$ 为初始值；

[0056] 4、在边界条件以内，采用下山单纯形法局部优化算法寻找显色性(CRI)获得极大值时对应的权重 k_i；

[0057] 5、将权重 k_i 转化为亮度权重 Y_i，其中 Y_i 为 $k_i*S_i(\lambda)$ 对应的 CIE1931XYZ 颜色空间中的亮度，通过实验测得控制电流 C_i 与亮度权重 Y_i 的对应关系，如图 8 所示，再将亮度权重 Y_i 转化为控制电流 C_i，即得实现该色温的 LED 电流值。

[0058] 如图 9 所示，本发明的色温随时间模拟自然光变化的 LED 光源照明的装置的工作步骤如下：

[0059] 1、设定时间段为北京时间上午 8 时至下午 17 时，该时间段内每隔半个小时设有一个时间节点，并将每个时间节点对应的 LED 电流值存储在控制器中；预设色温范围为 2500K~6000K，将色温节点间隔 500K，将色温节点对应的 LED 电流值也存储在控制器中；

[0060] 2、时钟将当前时间 t 传递至控制器，控制器将当前时间 t 与上述设定的时间段进行比较，判断当前时间与时间段的关系；

[0061] 若当前时间 t 不在时间段内，控制器处于手动模式，发出相应的声音信号提醒人们，可通过手动选择 2500K~6000K 之间间隔 500K 的某一色温，控制器根据该色温节点对应的 LED 电流值控制 LED 灯；

[0062] 例如：若实时的时间数据 t=18:00，根据图 5 中色温对应的调整方案，可人为选择

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LED 光源发出合成光的色温，假如人工选择色温为 3500K，控制器将暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的电流分别调整为 222.94mA、1.71mA、58.09mA、17.26mA。

[0063] 若当前时间 t 正好对应某一时间节点，控制器调取改时间节点的 LED 电流值。

[0064] 例如：当前时间 t=8:30，则由图 4 可知：暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的电流分别为 271.01mA、0mA、20.805mA、8.188mA；

[0065] 若当前时间 t 处于相邻两个时间节点之间，控制器通过插值算法得到调整后的电流值，并对应调整各单色 LED 灯的电流值，插值算法如下：

[0066] 设时钟传递的当前时间为 t，且 t 处于相邻时间节点 t_1 与 t_2 之间，t_1 对应的暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的电流值为 C_{w1}、C_{b1}、C_{g1}、C_{r1}，t_2 对应的暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的电流值为 C_{w2}、C_{b2}、C_{g2}、C_{r2}，则 t 对应的暖白光 LED 灯、品蓝光 LED 灯、绿光 LED 灯和红光 LED 灯的电流值 C_w、C_b、C_g、C_r 为：

[0067]
$$\begin{cases} C_w = \dfrac{t-t_1}{t_2-t_1} * C_{w2} + \dfrac{t_2-t}{t_2-t_1} * C_{w1} \\ C_b = \dfrac{t-t_1}{t_2-t_1} * C_{b2} + \dfrac{t_2-t}{t_2-t_1} * C_{b1} \\ C_g = \dfrac{t-t_1}{t_2-t_1} * C_{g2} + \dfrac{t_2-t}{t_2-t_1} * C_{g1} \\ C_r = \dfrac{t-t_1}{t_2-t_1} * C_{r2} + \dfrac{t_2-t}{t_2-t_1} * C_{r1} \end{cases}$$

[0068] 例如：当前时间 t=12:10 时刻，由图 4 可知：

[0069] t_1=12:00，C_{r1}=9.13mA，C_{g1}=84.91mA，C_{b1}=6.20mA，C_{w1}=199.76mA；

[0070] t_2=12:30，C_{r2}=10.92mA，C_{g2}=92.04mA，C_{b2}=6.93mA，C_{w2}=190.11mA；

[0071] 根据上面的插值算法，可得到得：

[0072] C_r=10.32mA，C_g=89.66mA，C_b=6.69mA，C_w=193.33mA。

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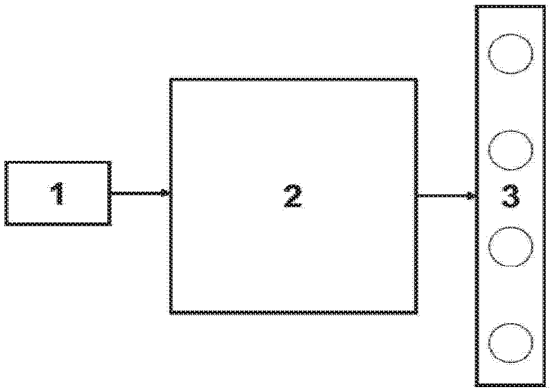


图 1

颜色	代码	主波长 (nm)
品蓝色	LXM2-PR02-0100	450
绿色	LXM2-PM01-0090	525
红色	LXM2-PD01-0040	625
暖白色	LXML-PW30	3000K（色温）

图 2

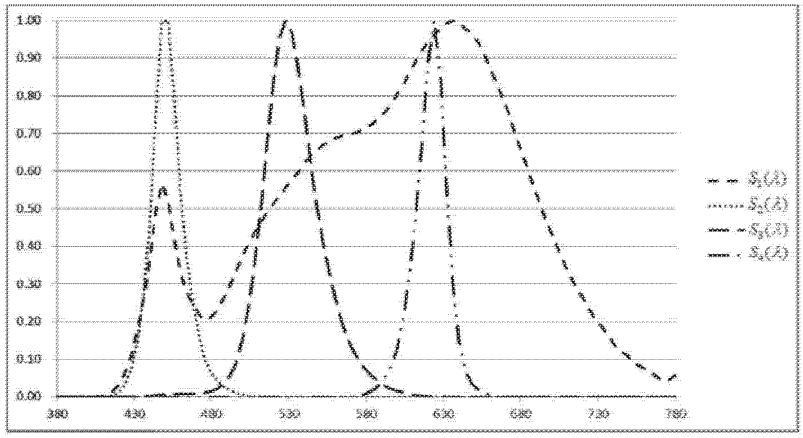


图 3

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时间	色温(CCT)(K)	暖白1ED(mA)	晶蓝LED(mA)	绿色LED(mA)	红色LED(mA)	显色性（CRI）
8:00	2500	262.39	0	14.145	23.469	93
8:30	2900	271.01	0	20.805	8.188	93
9:00	3350	231.4	0.7248	41.303	26.569	95
9:30	3600	245.36	2.6097	44.94	7.0924	92
10:00	3950	237.36	3.2564	53.963	5.423	95
10:30	4200	200.33	4.0388	78.79	16.842	93
11:00	4500	225.04	4.8781	64.089	5.9892	90
11:30	4900	158.83	5.7617	108.64	26.76	96
12:00	5200	199.76	6.1977	84.911	9.1306	93
12:30	5500	190.11	6.9322	92.039	10.917	93
13:00	5150	206.22	5.6586	83.335	4.7877	92
13:30	4850	228.14	5.4495	66.41	0	90
14:00	4500	230.07	4.2995	64.638	0.99155	89
14:30	4250	230.58	3.6549	61.222	4.5428	91
15:00	3900	243.71	2.9395	49.694	3.659	93
15:30	3550	253.6	2.5309	38.16	5.7065	95
16:00	3150	239.79	1.3159	40.594	18.302	90
16:30	2900	249.56	0.23753	33.682	16.522	92
17:00	2550	255.42	0	19.397	25.09	91

图 4

色温(CCT)	暖白1ED(mA)	晶蓝LED(mA)	绿色LED(mA)	红色LED(mA)	显色性（CRI）
2500	259.94	0.00	13.90	26.16	93.00
3000	253.97	0.00	31.83	14.21	92.00
3500	222.94	1.71	58.09	17.26	90.00
4000	222.87	3.07	64.05	10.01	92.00
4500	222.31	5.23	65.46	7.00	93.00
5000	217.80	5.49	74.28	2.43	91.00
5500	210.14	7.20	78.12	4.54	90.00
6000	203.43	7.74	85.92	2.91	89.00

图 5

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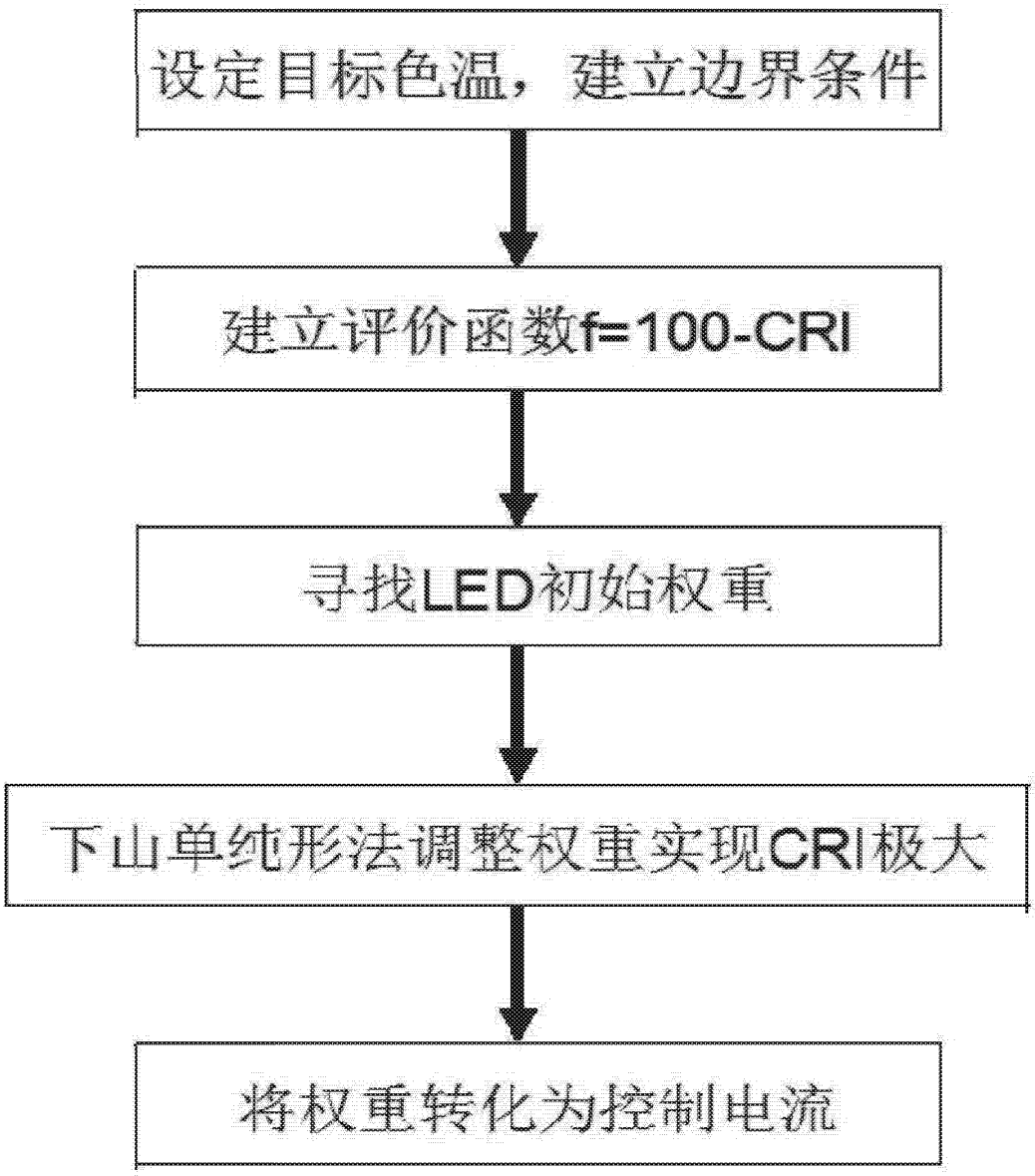


图 6

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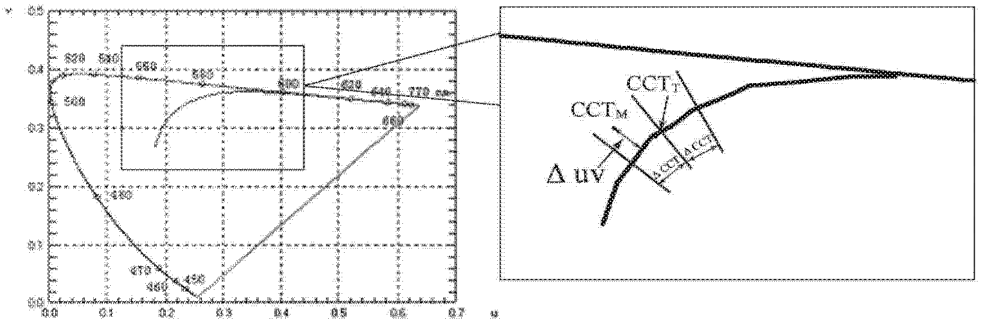


图 7

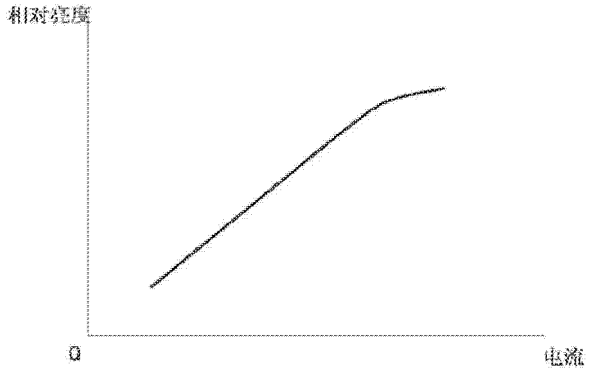


图 8

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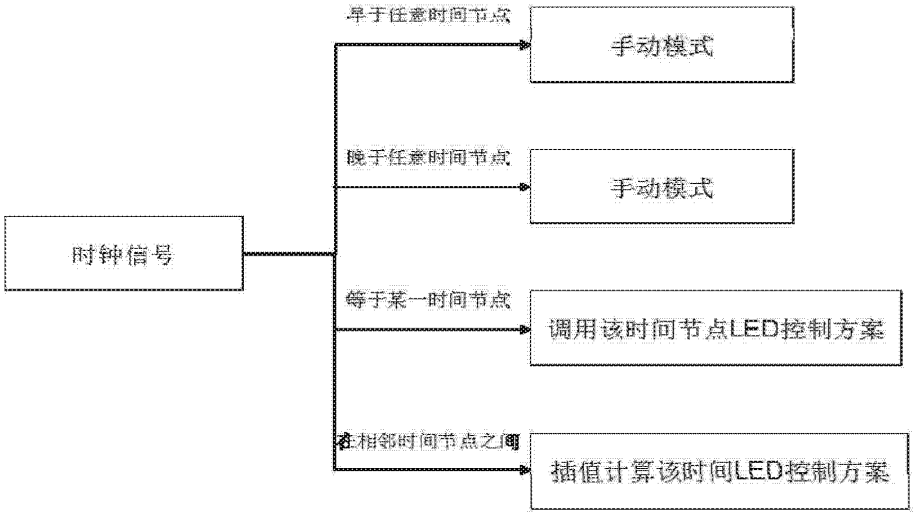


图 9

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Record 4/4 CN103313458A Method for realizing landscape lighting through system integration | through the system integrated method for landscape lighting

Publication Number: CN103313458A

Title: Method for realizing landscape lighting through system integration | through the system integrated method for landscape lighting ***(Translation from Clarivate Analytics)***

Title - DWPI: Landscape illumination method for integrated testing device, involves selecting landscape illumination system, where landscape illumination system is provided with power distribution box, switch power supply unit, controller and LED lamp

Abstract:

Disclosed is a landscape lighting system integration technology. A landscape lighting system is composed of a mains supply, a power distribution box, a switching power supply, a controller, LED lamps and other lamps. An integration method for the system includes the following two steps: (1) choosing the landscape lighting system; and (2) organically integrating the landscape lighting system with specific task equipment and specific task software to form an integrated landscape lighting system. With the integrated landscape lighting system, instabilities in a landscape lighting system specially designed for an individual case can be addressed, and a landscape lighting system designed for a specific task is enabled to be lower in cost, higher in development efficiency and more stable and more reliable in operation.

A landscape lighting system integrated technology, the landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps, the integration method of the system is divided into two steps: (1) selecting the existing landscape illumination system, (2) the landscape lighting system and specific task device and specific task software landscape illumination system are organically integrated, are integrated. The integrated landscape lighting system can solve the unstable factors of specially designed for individual landscape lighting system, that is task-specific design of landscape lighting system cost is lower, the development efficiency is high, and the operation is more stable and reliable.

(Translation from Clarivate Analytics)

Abstract - DWPI:

Abstract - DWPI Novelty:

The method involves selecting a landscape illumination system, where the landscape illumination system is provided with a power distribution box, a switch power supply unit, a controller and an LED lamp.

Abstract - DWPI Use:

Landscape illumination method for an integrated testing device.

Abstract - DWPI Advantage:

The method enables reducing operation cost and providing high working efficiency and stable and reliable operation.

Abstract - DWPI Drawing Description: The drawing shows a block diagram illustrating a landscape illumination method.'(Drawing includes non-English language text)'

Claims:

1. A through system integrated method for realizing illumination of landscape, the landscape lighting system comprising a city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps, through system integration for landscape lighting method comprising the following steps: (1) according to the requirement of engineering implementation effect site and landscape building or landscape landscape lighting, selecting light source and lamp, selecting an existing control system, through field test to obtain the basis of landscape lighting system, (2) to a dynamic change in landscape lighting illumination effect according to the computer simulation and field test. to meet dynamically changing requirements, (3) the landscape lighting system of the base and part or all is landscape lighting need of power distribution box, a switch power supply, a controller, an LED lamp and other lamps in integration, through system integration landscape lighting.

2. The through system integration according to claim 1 method for realizing landscape lighting, the dynamically changing lighting effect, which is through the LED lamp for simulating dynamic effect, realizing dynamic change by controlling display effect of chip control LED lamp illumination effect.

(Translation from Clarivate Analytics)

Description:

through the system integrated method for landscape lighting

Technology field

[0001] The technical field relates to landscape lighting integrated technology, through system integration method for landscape lighting, i.e., the existing landscape lighting system and specific

task-specific landscape lighting system for system integration method.

Background technology

[0002] In recent years, with the continuous development of urbanization process to multicolor, variable is characteristic of, it has strong decorative effect, the dynamic change of the urban landscape lighting obtained rapid development in our country. but the landscape lighting system combines the latest technology of optical, art, electronics, computer, communication and many subjects such as production, large technical difficulty, and due to the particularity of the sight point so that the large part of landscape lighting system is a specially designed proprietary system.

[0003] the important technology in a landscape lighting system relates to the technical field of landscape lighting and lamp control device and finish the task of the device and software system integration can not be avoided, the former can complete basic illumination function, the latter transmits a specific task and the existing lamp system organically integrated. the traditional method is that it develops landscape illuminating lamp, the sample lot of product testing and analysis, and development of control software or control method to control it, then through commissioning, meet the design requirement of the landscape lighting system. This method needs a lot of money and manpower resource investment, and due to the more links, by circulation of multiple long time to finish the predetermined target task.

[0004] The technical problem to be solved by the invention

[0005] The purpose of the invention is to provide a new solving method through system integration to realize landscape lighting system method of the invention based on the existing landscape lighting system and specific task-specific landscape illumination system, providing for the traditional method, the method overcomes the defect that the traditional method of high investment, long period and low applicability, can fast meet various new landscape lighting systems use requirement.

[0006] content:

[0007] The technical solution of the invention is as follows:

[0008] A through system integrated method for realizing illumination of landscape, the landscape lighting system comprising a city power, a distribution box, a switch power supply, a controller, an

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LED lamp and other lamps, through system integration for landscape lighting method comprising the following steps:

[0009] (I) The effect to be implemented to project site and landscape building or landscape landscape lighting, selecting light source and lamp, selecting an existing control system, through field test to obtain the basis of landscape lighting system;

[2] (0010) to a dynamic change in landscape lighting illumination effect according to the computer simulation and field debugging, meets dynamic change requirement;

[3] (0011) the landscape lighting system of part or all of the foundation and organically integrates in landscape lighting need of power distribution box, a switch power supply, a controller, an LED lamp and other lamps, through system integration landscape lighting.

[0012] dynamically varying lighting effect is through the LED lamp for simulating dynamic effect, realizing dynamic change by controlling display effect of chip control LED lamp illumination effect.

[0013] According to the landscape effect and select the proper color temperature, light distribution curve and other technical parameters, if necessary, software programming the LED change effect, lighting effect such as dynamic change confirmation, to achieve final landscape lighting system.

[0014] Specific implement method of the invention is to provide a through system integrated method for realizing illumination of landscape, the landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps. the method comprises the steps of:

[0015] 1. according to the engineering field of building or scenery of the landscape lighting and landscape effect is required to be realized, the technical index is decomposed, according to these technical index to select an appropriate lamp system;

[0016] 2. for the lamp system evaluation, further improvement can not satisfy the performance;

[0017] 3. the system for dynamically varying lighting effect is required for software programming and field debugging, the computer simulation and to meet the dynamic change requirement;

[0018] 4. the light pollution to the color temperature, illumination intensity, field test, the power

density required to satisfy the design requirement;

[0019] 5. The final requirement of landscape lighting system, selecting the final lamp brand, distribution scheme, a construction technology and power distribution scheme, the landscape lighting system are organically integrated.

[0020] wherein said lamp system evaluation comprises light source, colour temperature, illumination and power density, evaluation of light pollution, control protocol, control mode, dust-proof and water-proof grade, appearance size, construction technology.

[0021] evaluation of the light source apparatus, light source comprises an LED light source, a high-pressure gas lamp, fluorescent lamp, electric appliance comprises inductance ballast and compensation capacitor, electronic ballast, a switch power supply, an LED light source controller according to the requirement to select the proper light source and electrical appliance.

[0022] evaluation of the colour temperature, the warm color temperature value less than 3000k, the colour temperature value is 3000k to 5000k, cooling the colour temperature value is greater than 5000k, according to the design requirement to select the corresponding colour temperature value.

[0023] the illumination and power density evaluation, to satisfy the energy saving requirement. The city night lighting design specification (JGJ/T 163-2008) 6.6.2, selected corresponding power density value, such as a large city district, as white wall paint when building decoration material when power density is not greater than 6.7 Watts per square meter, the corresponding illumination intensity is not greater than 1501x.

[0024] the light pollution evaluation, according to city night lighting design specification (JGJ/T 163-2008) light pollution limits the requirement, selecting the proper lamp.

[0025] the control protocol in evaluation control protocol is X-1O, Internet, Lonworks, EIB-ZigBee, 1-Bus, T-Bus, *HBS, DAL1, DMX-512, CAN, ART-net, C-Bus, Dynet any one of selecting an appropriate control protocol according to the requirement.

[0026] evaluating the control mode, the control mode is a seesaw switch control, circuit breaker control, timing switch, acousto-optic control switch, a manual remote control, scene control, detecting control, constant illumination control in the any one kind of.

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[0027] evaluation of the dustproof and waterproof level, in open fields, a lamp protection level is not less than IP54; the ceiling, a lamp protection level is not less than IP43, when the serious environment pollution, the lamp protection level is not less than IP65.

[0028] the shape size evaluation, according to the installing condition in scene, the size can not interfere, which seriously affects the appearance of building.

[0029] The construction technique evaluation according to the scene condition evaluates whether a proper installation space, the installation position, whether the building and scenic spot appearance.

[0030] dynamically varying lighting effect is realized through the LED lamp needs to be dynamic effect software programming, the dynamic effect output forming corresponding instruction through address conversion, is transmitted to the control chip of the LED lamp so as to control the display effect of the LED lamp so as to realize dynamic change through the control chip of the lighting effect.

[0031] The landscape lighting system integrated technology is a system engineering, derived from many years of lighting engineering practice, the technology selection a lot of technology and experience data under a light source, color temperature, illumination and power density, comprehensive system light pollution, control protocol, control mode, dust-proof and water-proof level, shape size, items such as construction process of the optimization. Description

[0032] Picture 1 is the system of landscape illumination system frame.

Preferred Embodiment

:

[0033] Picture 1 is the system diagram, the system of landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps.

[0034] An embodiment of the present invention is sight lighting engineering of a museum, comprising the following detailed explanation of this system integration technology for realizing the method of:

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[0035] 1. according to the engineering field of building or scenery of the landscape lighting and landscape effect is required to be realized, the technical index is decomposed, according to these technical index to select an appropriate lamp system embodiment of the museum, the glass curtain wall designed to form waterfall effect, of the pillar museum front projector for projecting lighting, building side and roof decorative member needs illumination, colour temperature is warm tone and required to have the lamp remote switch. The previous engineering practice, selecting lamp system uses previous engineering project in the 8 watt of the LED line lamp, column bottom is 1000 watt narrow projecting upwards, colour temperature light high-pressure sodium is selected 2200k, the building entrance side is 150 watt high pressure sodium light projector, color temperature 2200k, building roof decorative member selected 70 watt high pressure sodium lamp light projector, color temperature 2200k.

[0036] 2. for the lamp system evaluation, further improvement can not satisfy the performance of remote controller fixing position according to experience the selected lamp system without problem, there is no need to change, only the glass curtain wall internal design line lamp, but the selected lamp system cannot realize remote switch lamp function, selecting the street lamp remote switch, the controller supports a mobile phone short message switching function. the system for dynamically varying lighting effect is required for software programming and field debugging, the computer simulation and to meet the dynamic change requirement; the glass curtain wall designed to form waterfall effect, making software programming again. the glare requirements, color temperature, illumination intensity, field test, the power density required to meet the design requirements, via the field test, it can satisfy the design requirement.

[0037] 3. The final requirement of landscape lighting system, selecting the final lamp brand, distribution scheme, a construction technology and power distribution scheme, the landscape lighting system are organically integrated. line lamp brand choose domestic factories and each lighting side uniformly. designing auxiliary fixing rod for fixing line lamp between the fixing claw of the glass curtain wall, a distribution from the building power supply.

[0038] maximum possible eliminates the redesign process in various factors affect the quality of through integrated landscape illumination system such that shorter work period and high efficiency, but also reduces the cost.

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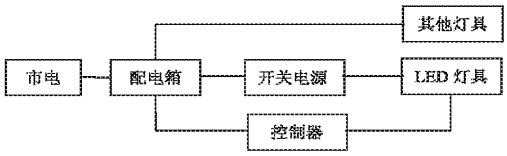
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(54)发明名称

通过系统集成实现景观照明的方法

(57)摘要

一种景观照明系统集成技术，该景观照明系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成，系统的集成方法分两步：(1) 选择现有的景观照明系统；(2) 将上述景观照明系统和特定任务设备和特定任务软件进行有机集成，形成一体化的景观照明系统。通过集成的景观照明系统能够解决为个案特别设计的景观照明系统出现的不稳定因素，使得为特定任务设计的景观照明系统成本更低，开发效率更高，运行更加稳定可靠。



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1. 一种通过系统集成实现景观照明的方法，所述景观照明系统包括市电、配电箱、开关电源、控制器、LED 灯具和其他灯具，通过系统集成实现景观照明的方法步骤如下：

根据要实施景观照明的建筑物或景点的工程现场，结合景观的效果要求，将景观照明的技术指标进行分解，根据这些技术指标来选择灯具系统；

进行灯具系统评估，所述灯具系统评估包括光源电器、色温、照度及功率密度、光污染、控制协议、控制方式、防尘防水等级、外形尺寸、施工工艺的评估，对于性能不能满足要求的做出相应的调整；

对有动态变化照明效果要求的景观照明进行电脑模拟和现场联调，以满足动态变化要求；

对有光污染要求、色温、照度、功率密度要求的灯具进行现场试灯，以满足设计要求；

根据景观照明系统的最终要求，选取最终灯具品牌、布灯方案、施工工艺及配电方案，完成景观照明系统的有机集成。

2. 根据权利要求 1 所述的通过系统集成实现景观照明的方法，所诉动态变化照明效果，是通过 LED 灯实现，进行动态效果模拟，通过控制芯片控制 LED 灯的显示效果实现动态变化的照明效果。

3. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述光源电器的评估，其中的光源包括：LED 光源，高压气体灯，荧光灯；其中的电器包括：电感镇流器，补偿电容，电子镇流器，开关电源，LED 光源的控制器，根据需求选择合适的光源和电器。

4. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述色温评估，暖色色温值 <3000k，中间色色温值 3000k — 5000k，清凉色色温值 >5000k，根据设计要求选择对应的色温值。

5. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述控制协议评估，控制协议是 X-10、CEBus、Lonworks、EIB、I-Bus、T-Bus、HBS、DALI、DMX-512、ACN、ART-net、C-Bus、Dynet 中的任意一种，根据需求选择合适的控制协议。

6. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述控制方式评估，控制方式是跷板开关控制、断路器控制、定时开关、声光控开关、手动遥控控制、场景控制、动静探测控制、恒照度控制中的任意一种。

7. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述外形尺寸评估，根据现场安装条件，外形尺寸不能发生干涉、严重影响建筑物外观的情形。

8. 根据权利要求 2 所述的通过系统集成实现景观照明的方法，所述施工工艺评估，是根据现场情况评估是否具有适当的安装空间、安装位置，是否影响建筑和景点外观。

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通过系统集成实现景观照明的方法

技术领域

[0001] 本技术领域涉及景观照明集成技术，通过系统集成实现景观照明的方法，即，将现有景观照明系统和特定任务专用景观照明系统进行系统集成的方法。

背景技术

[0002] 近年来，随着城市化进程的不断深入，以“多彩、多变”为特征的、具有强烈装饰效果、动态变化的城市景观照明在我国得到迅速发展。但由于景观照明系统融合了光学、美术、微电子、计算机、通讯及生产制造等多学科的最新技术，技术难度大，同时由于其景观点的特殊性使得很大一部分景观照明系统是专门设计的专有系统。

[0003] 在景观照明系统涉及的技术领域中，景观照明灯具及其灯具控制设备和为完成该任务的设备及软件的系统集成是不可回避的重要技术，前者能够完成基本的照明功能，后者将特定任务和现有灯具系统进行有机整合。传统的做法是：研制景观照明灯具样品，进行大量的产品测试和分析，同时开发控制软件或控制方法对其进行控制，再通过试运行，完成满足设计要求的景观照明系统。这种做法需要大量的资金以及人力物力投入，且因为涉及环节较多，需经过多次长时间的循环才能完成既定的目标任务。

[0004] 本发明所要解决的技术问题

[0005] 本发明的目的是提出一种通过系统集成来实现景观照明系统的方法，本发明基于现有景观照明系统和特定任务专用景观照明系统，针对传统做法给出的新的解决方法，该方法克服了传统方法的高投入、长周期、低适用性的缺点，能够快速满足各种新型景观照明系统得使用要求。

[0006] 内容：

[0007] 本发明所采用的技术方案是：

[0008] 一种通过系统集成实现景观照明的方法，所述景观照明系统包括市电、配电箱、开关电源、控制器、LED 灯具和其他灯具，通过系统集成实现景观照明的方法步骤如下：

[0009] (1) 根据要实施景观照明的建筑物或景点的工程现场和景观的效果要求，选择光源及灯具，选择现有的控制系统，通过现场试验，得到基础的景观照明系统；

[0010] (2) 对有动态变化照明效果要求的景观照明进行电脑模拟和现场联调，以满足动态变化要求；

[0011] (3) 将上述基础的景观照明系统和为景观照明需要的配电箱、开关电源、控制器、LED 灯具和其他灯具中的部分或全部进行有机集成，通过系统集成实现景观照明。

[0012] 动态变化照明效果，是通过 LED 灯进行动态效果模拟，通过控制芯片控制 LED 灯的显示效果实现动态变化的照明效果。

[0013] 根据景观效果的要求，选择合适的色温、配光曲线等技术参数，必要时对 LED 变化效果进行软件编程，对动态变化等照明效果确认，完成最终的景观照明系统。

[0014] 本发明的具体实施方法是提出一种通过系统集成实现景观照明的方法，该景观照明系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成。所述的方法包括步

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骤：

[0015] 1. 根据要实施景观照明的建筑物或景点的工程现场特点和要实现的景观效果要求，将技术指标进行分解，根据这些技术指标来选择适当的灯具系统；

[0016] 2. 进行灯具系统评估，对于性能不能满足的进一步改造；

[0017] 3. 对有动态变化照明效果要求的系统重新进行软件编程，并进行电脑模拟和现场联调，以满足动态变化要求；

[0018] 4. 对有光污染要求、色温、照度、功率密度要求的灯具进行现场试灯，以满足设计要求；

[0019] 5. 根据景观照明系统的最终要求，选取最终灯具品牌、布灯方案、施工工艺及配电方案，完成景观照明系统的有机集成。

[0020] 其中所述灯具系统评估包括进行光源电器、色温、照度及功率密度、光污染、控制协议、控制方式、防尘防水等级、外形尺寸、施工工艺的评估。

[0021] 所述光源电器的评估中，光源包括：LED 光源，高压气体灯，荧光灯；电器包括：电感镇流器，补偿电容，电子镇流器，开关电源，LED 光源的控制器，根据需求选择合适的光源和电器。

[0022] 所述色温的评估中，暖色色温值＜ 3000k，中间色色温值 3000k-5000k，清凉色色温值＞ 5000k，根据设计要求选择对应的色温值。

[0023] 所述照度及功率密度评估中，为满足节能要求，根据城市夜景照明设计规范（JGJ/T 1632008）表 6.6.2 的规定，选定对应功率密度值，比如：在大型城市商业区，当建筑物饰面材料为白色外墙涂料时功率密度不宜大于 6.7 瓦 / 平方米，对应照度不宜大于 150lx。

[0024] 所述光污染评估中，根据城市夜景照明设计规范（JGJ/T 163-2008）中对“光污染的限制”要求，选择合适的灯具。

[0025] 所述控制协议评估中，控制协议是 X-10、CEBus、Lonworks、EIB、I Bus、T Bus、HBS、DALI、DMX-512、ACN、ART-net、C-Bus、Dynet 中的任意一种，根据需求选择合适的控制协议。

[0026] 所述控制方式评估中，控制方式是跷板开关控制、断路器控制、定时开关、声光控开关、手动遥控控制、场景控制、动静探测控制、恒照度控制中的任意一种。

[0027] 所述防尘防水等级的评估，在露天场地，灯具防护等级不低于 IP54；在有顶棚场地，灯具防护等级不低于 IP43，当环境污染严重时，灯具防护等级不低于 IP65。

[0028] 所述外形尺寸评估，根据现场安装条件，外形尺寸不能发生干涉、严重影响建筑物外观的情形。

[0029] 所述施工工艺评估，是根据现场情况评估是否具有适当的安装空间、安装位置，是否影响建筑和景点外观。

[0030] 所诉动态变化照明效果，是通过 LED 灯实现的，需要进行动态效果软件编程，将该动态效果通过地址转换输出成相应的指令，传输到 LED 灯的控制芯片，从而通过控制芯片控制 LED 灯的显示效果从而实现动态变化的照明效果。

[0031] 本景观照明系统集成技术是一项系统工程，来源于多年的照明工程实践，是在大量的技术和经验数据下的技术选择，是光源电器、色温、照度及功率密度、光污染、控制协议、控制方式、防尘防水等级、外形尺寸、施工工艺等诸多项目的全面综合系统优化。

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附图说明：

[0032] 图 1 是景观照明系统的系统构成框图。

具体实施方式：

[0033] 图 1 是景观照明系统的系统构成框图，该系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成。

[0034] 本发明的实施例是一个博物馆的景观照明工程，下面详细说明本系统集成技术的实现方法的具体步骤：

[0035] 1. 根据要实施景观照明的建筑物或景点的工程现场特点和要实现的景观效果要求，将技术指标进行分解，根据这些技术指标来选择适当的灯具系统；本实施例博物馆设计要求正面的玻璃幕墙形成瀑布效果，博物馆前的柱子用投光灯突出照明，建筑物侧面和屋顶装饰构件需要照亮，色温要求为暖色调，同时要求具有遥控开关灯。根据以前的工程实践，选用以前工程项目中选用的灯具系统：8 瓦的 LED 线条灯；柱子底部采用 1000 瓦窄光高压纳灯向上投光，色温选 2200k；建筑物入口侧面选择 150 瓦的高压纳灯宽光投光灯，色温 2200k；建筑物屋顶装饰构件选择 70 瓦的高压纳灯中光投光灯，色温 2200k。

[0036] 2. 进行灯具系统评估，对于性能不能满足的进一步改造；根据经验，所选灯具系统没有问题，不需要进行改造，只需要在玻璃幕墙内部设计线条灯的固定位置，但所选灯具系统原来不能实现遥控开关灯功能，选用现有路灯遥控开关的远程控制器，该控制器支持手机短信开关功能。对有动态变化照明效果要求的系统重新进行软件编程，并进行电脑模拟和现场联调，以满足动态变化要求；设计要求正面的玻璃幕墙形成瀑布效果，重新尽心软件编程。对有眩光要求、色温、照度、功率密度要求的灯具进行现场试灯，以满足设计要求；经过现场试灯，能够满足设计要求。

[0037] 3. 根据景观照明系统的最终要求，选取最终灯具品牌、布灯方案、施工工艺及配电方案，完成景 观照明系统的有机集成。灯具品牌选择国内某厂家的线条灯，各照明侧面均匀布灯。在玻璃幕墙的固定爪之间设计辅助固定杆来固定线条灯，配电箱从建筑物电源取电。

[0038] 通过集成的景观照明系统尽最大可能地消除了重新设计过程中各种因素对质量的影响，使得工期更短，效率更高，同时也降低了成本。

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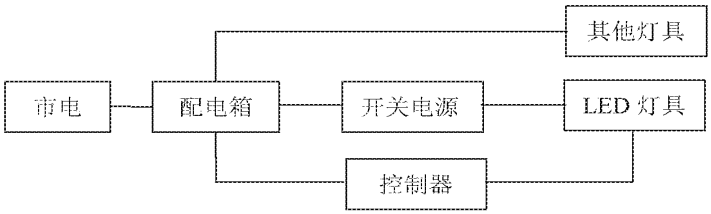


图 1

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Record 2/4 CN103313457A Method for realizing landscape lighting through system integration | through the system integrated method for landscape lighting

Publication Number: CN103313457A

Title: Method for realizing landscape lighting through system integration | through the system integrated method for landscape lighting ***(Translation from Clarivate Analytics)***

Title - DWPI: Method for controlling integrated testing device of landscape lighting system, involves adjusting illuminating effect of landscape lighting system according to color temperature of light

Abstract:

Disclosed is a landscape lighting system integration technology. A landscape lighting system is composed of a mains supply, a power distribution box, a switching power supply, a controller, LED lamps and other lamps. An integration method for the system includes the following two steps: (1) choosing the landscape lighting system; and (2) organically integrating the landscape lighting system with specific task equipment and specific task software to form an integrated landscape lighting system. With the integrated landscape lighting system, instabilities in a landscape lighting system specially designed for an individual case can be addressed, and a landscape lighting system designed for a specific task is enabled to be lower in cost, higher in development efficiency and more stable and more reliable in operation.

A landscape lighting system integrated technology, the landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps, the integration method of the system is divided into two steps: (1) selecting the existing landscape illumination system, (2) the landscape lighting system and specific task device and specific task software landscape illumination system are organically integrated, are integrated. The integrated landscape lighting system can solve the unstable factors of specially designed for individual landscape lighting system, that is task-specific design of landscape lighting system cost is lower, the development efficiency is high, and the operation is more stable and reliable.

(Translation from Clarivate Analytics)

Abstract - DWPI:

Abstract - DWPI Novelty:

The method involves providing a commercial power supply, a power distribution box, a switch power supply, a controller, an LED lamp and other lamps and lanterns in a landscape lighting system. The software task is selected to form an integral landscape lighting system, according to

the technical index of the landscape light. The illuminating effect of the landscape lighting system is adjusted according to the color temperature of light. The power density of the lamp is to meet according to the requirement of landscape lighting system.

Abstract - DWPI Detailed Description:

An INDEPENDENT CLAIM is included for an integrated testing device of landscape lighting system.

Abstract - DWPI Use:

Method for controlling integrated testing device of landscape lighting system.

Abstract - DWPI Advantage:

The construction period and construction process of the landscape lighting system can be reduced. The efficiency, stability and stability of the landscape lighting system can be improved.

Abstract - DWPI Drawing Description: The drawing shows a block diagram of the landscape lighting system. (Drawing includes non-English language text)

Claims:

1. A through system integrated method for realizing illumination of landscape, the landscape lighting system comprising a city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps, the system is integrated to realize landscape lighting method comprising the following steps: according to the engineering field of building or landscape landscape lighting, combined effect to landscape, the technical index of the landscape lighting decomposition, according to the technical index to select the lamp system, the lamp system to evaluate. the lamp system evaluated comprises a light source, a colour temperature, illumination and power density, light pollution, control protocol, control mode, dust-proof and water-proof level, size, appearance evaluation construction process. the performance cannot satisfy the claim made by the corresponding adjusting, to a dynamic change in landscape lighting illumination effect according to the computer simulation and field debugging, meets dynamic change requirement, the light pollution to the color temperature, luminance, power density requirement for field test, to satisfy the design requirement according to the final requirement of landscape lighting system, selecting the final lamp brand, distribution scheme, a construction technology and power distribution scheme, the landscape lighting system are organically integrated.

2. The through system integrated for landscape lighting according to claim 1 method for dynamically varying lighting effect is realized through the LED lamp for simulating dynamic effect, realizing dynamic change by controlling display effect of chip control LED lamp illumination effect.
3. The through system integrated for landscape lighting according to claim 2 method for evaluation of the light source apparatus, wherein the light source comprises an LED light source, a high-pressure gas lamp, fluorescent lamp, and wherein the appliance comprises: a controller of inductive ballast and compensation capacitor, electronic ballast, a switch power supply, an LED light source, selecting the proper light source and electrical appliance.
4. The through system integration according to claim 2 method for landscape lighting, the color temperature estimation, warm color temperature value 3000k, the middle colour temperature value is 3000k-5000k, and colour temperature value is greater than 5000k, according to the design requirement to select the corresponding colour temperature value.
5. The through system integration according to claim 2 method for landscape lighting, the control protocol evaluation control protocol is X-10, Internet, Lonworks, EIB, -Bus, T-Bus, *HBS, DAL1, DMX-512, CAN, ART-net, C-Bus, Dynet any one of selecting an appropriate control protocol according to the requirement.
6. The integrated method for realizing landscape lighting the through system according to claim 2, said controlling way evaluation, control mode is a control rocker switch, breaker control, timing switch, acousto-optic control switch, a manual remote control, scene control, activity detection control, a constant luminance control in the any one kind of.
7. The through system integration according to claim 2 method for realizing landscape lighting, the size evaluation, according to the installing condition in scene, size is not capable of generating interference, seriously influence the appearance of building.
8. The through system integration according to claim 2 method for realizing landscape lighting, the construction technology evaluation according to the scene condition evaluates whether a proper installation space, the installation position, whether the building and scenic spot appearance.

(Translation from Clarivate Analytics)

Description:

through the system integrated method for landscape lighting

Technology field

[0001] The technical field relates to landscape lighting integrated technology, through system integration method for landscape lighting, i.e., the existing landscape lighting system and specific task-specific landscape lighting system for system integration method.

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Background technology

[0002] In recent years, with the continuous development of urbanization process to multicolor, variable is characteristic of, it has strong decorative effect, the dynamic change of the urban landscape lighting obtained rapid development in our country. but the landscape lighting system combines the latest technology of optical, art, electronics, computer, communication and many subjects such as production, large technical difficulty, and due to the particularity of the sight point so that the large part of landscape lighting system is a specially designed proprietary system.

[0003] the important technology in a landscape lighting system relates to the technical field of landscape lighting and lamp control device and finish the task of the device and software system integration can not be avoided, the former can complete basic illumination function, the latter transmits a specific task and the existing lamp system organically integrated. the traditional method is that it develops landscape illuminating lamp, the sample lot of product testing and analysis, and development of control software or control method to control it, then through commissioning, meet the design requirement of the landscape lighting system. This method needs a lot of money and manpower resource investment, and due to the more links, by circulation of multiple long time to finish the predetermined target task.

[0004] The technical problem to be solved by the invention

[0005] The purpose of the invention is to provide a new solving method through system integration to realize landscape lighting system method of the invention based on the existing landscape lighting system and specific task-specific landscape illumination system, providing for the traditional method, the method overcomes the defect that the traditional method of high investment, long period and low applicability, can fast meet various new landscape lighting systems use requirement.

[0006] content:

[0007] The technical solution of the invention is as follows:

[0008] A through system integrated method for realizing illumination of landscape, the landscape lighting system comprising a city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps, through system integration for landscape lighting method comprising

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the following steps:

[0009] (I) The effect to be implemented to project site and landscape building or landscape landscape lighting, selecting light source and lamp, selecting an existing control system, through field test to obtain the basis of landscape lighting system;

[2] (0010) to a dynamic change in landscape lighting illumination effect according to the computer simulation and field debugging, meets dynamic change requirement;

[3] (0011) the landscape lighting system of part or all of the foundation and organically integrates in landscape lighting need of power distribution box, a switch power supply, a controller, an LED lamp and other lamps, through system integration landscape lighting.

[0012] dynamically varying lighting effect is through the LED lamp for simulating dynamic effect, realizing dynamic change by controlling display effect of chip control LED lamp illumination effect.

[0013] According to the landscape effect and select the proper color temperature, light distribution curve and other technical parameters, if necessary, software programming the LED change effect, lighting effect such as dynamic change confirmation, to achieve final landscape lighting system.

[0014] Specific implement method of the invention is to provide a through system integrated method for realizing illumination of landscape, the landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps. the method comprises the steps of:

[0015] 1. according to the engineering field of building or scenery of the landscape lighting and landscape effect is required to be realized, the technical index is decomposed, according to these technical index to select an appropriate lamp system;

[0016] 2. for the lamp system evaluation, further improvement can not satisfy the performance;

[0017] 3. the system for dynamically varying lighting effect is required for software programming and field debugging, the computer simulation and to meet the dynamic change requirement;

[0018] 4. the light pollution to the color temperature, illumination intensity, field test, the power density required to satisfy the design requirement;

[0019] 5. The final requirement of landscape lighting system, selecting the final lamp brand, distribution scheme, a construction technology and power distribution scheme, the landscape lighting system are organically integrated.

[0020] wherein said lamp system evaluation comprises light source, colour temperature, illumination and power density, evaluation of light pollution, control protocol, control mode, dust-proof and water-proof grade, appearance size, construction technology.

[0021] evaluation of the light source apparatus, light source comprises an LED light source, a high-pressure gas lamp, fluorescent lamp, electric appliance comprises inductance ballast and compensation capacitor, electronic ballast, a switch power supply, an LED light source controller according to the requirement to select the proper light source and electrical appliance.

[0022] evaluation of the colour temperature, the warm color temperature value less than 3000k, the colour temperature value is 3000k to 5000k, cooling the colour temperature value is greater than 5000k, according to the design requirement to select the corresponding colour temperature value.

[0023] the illumination and power density evaluation, to satisfy the energy saving requirement. The city night lighting design specification (JGJ/T 1632008) 6.6.2, selected corresponding power density value, such as a large city district, as white wall paint when building decoration material when power density is not greater than 6.7 Watts per square meter, the corresponding illumination intensity is not greater than 1501x.

[0024] the light pollution evaluation, according to city night lighting design specification (JGJ/T 163-2008) light pollution limits the requirement, selecting the proper lamp.

[0025] the control protocol in evaluation control protocol is X 10, Internet, Lonworks, EIB, I Bus, T Bus> HBS> DAL1, DMX-512, CAN, ART-net, C-Bus, Dynet any one of selecting an appropriate control protocol according to the requirement.

[0026] evaluating the control mode, the control mode is a seesaw switch control, circuit breaker control, timing switch, acousto-optic control switch, a manual remote control, scene control, detecting control, constant illumination control in the any one kind of.

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[0027] evaluation of the dustproof and waterproof level, in open fields, a lamp protection level is not less than IP54; the ceiling, a lamp protection level is not less than IP43, when the serious environment pollution, the lamp protection level is not less than IP65.

[0028] the shape size evaluation, according to the installing condition in scene, the size can not interfere, which seriously affects the appearance of building.

[0029] The construction technique evaluation according to the scene condition evaluates whether a proper installation space, the installation position, whether the building and scenic spot appearance.

[0030] dynamically varying lighting effect is realized through the LED lamp needs to be dynamic effect software programming, the dynamic effect output forming corresponding instruction through address conversion, is transmitted to the control chip of the LED lamp so as to control the display effect of the LED lamp so as to realize dynamic change through the control chip of the lighting effect.

[0031] The landscape lighting system integrated technology is a system engineering, derived from many years of lighting engineering practice, the technology selection a lot of technology and experience data under a light source, color temperature, illumination and power density, comprehensive system light pollution, control protocol, control mode, dust-proof and water-proof level, shape size, items such as construction process of the optimization. Description

[0032] Picture 1 is the system of landscape illumination system frame.

Preferred Embodiment

:

[0033] Picture 1 is the system diagram, the system of landscape lighting system of city power, a distribution box, a switch power supply, a controller, an LED lamp and other lamps.

[0034] An embodiment of the present invention is sight lighting engineering of a museum, comprising the following detailed explanation of this system integration technology for realizing the method of:

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[0035] 1. according to the engineering field of building or scenery of the landscape lighting and landscape effect is required to be realized, the technical index is decomposed, according to these technical index to select an appropriate lamp system embodiment of the museum, the glass curtain wall designed to form waterfall effect, of the pillar museum front projector for projecting lighting, building side and roof decorative member needs illumination, colour temperature is warm tone and required to have the lamp remote switch. The previous engineering practice, selecting lamp system uses previous engineering project in the 8 watt of the LED line lamp, column bottom is 1000 watt narrow projecting upwards, colour temperature light high-pressure sodium is selected 2200k, the building entrance side is 150 watt high pressure sodium light projector, color temperature 2200k, building roof decorative member selected 70 watt high pressure sodium lamp light projector, color temperature 2200k.

[0036] 2. for the lamp system evaluation, further improvement can not satisfy the performance of remote controller fixing position according to experience the selected lamp system without problem, there is no need to change, only the glass curtain wall internal design line lamp, but the selected lamp system cannot realize remote switch lamp function, selecting the street lamp remote switch, the controller supports a mobile phone short message switching function. the system for dynamically varying lighting effect is required for software programming and field debugging, the computer simulation and to meet the dynamic change requirement; the glass curtain wall designed to form waterfall effect, making software programming again. the glare requirements, color temperature, illumination intensity, field test, the power density required to meet the design requirements, via the field test, it can satisfy the design requirement.

[0037] 3. The final requirement of landscape lighting system, selecting the final lamp brand, distribution scheme, a construction technology and power distribution scheme, the landscape lighting system are organically integrated. line lamp brand choose domestic factories and each lighting side uniformly. designing auxiliary fixing rod for fixing line lamp between the fixing claw of the glass curtain wall, a distribution from the building power supply.

[0038] maximum possible eliminates the redesign process in various factors affect the quality of through integrated landscape illumination system such that shorter work period and high efficiency, but also reduces the cost.

(Translation from Clarivate Analytics)

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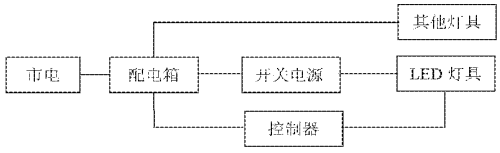
权利要求书1页 说明书3页 附图1页

(54)发明名称

通过系统集成实现景观照明的方法

(57)摘要

一种景观照明系统集成技术，该景观照明系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成，系统的集成方法分两步：(1) 选择现有的景观照明系统；(2) 将上述景观照明系统和特定任务设备和特定任务软件进行有机集成，形成一体化的景观照明系统。通过集成的景观照明系统能够解决为个案特别设计的景观照明系统出现的不稳定因素，使得为特定任务设计的景观照明系统成本更低，开发效率更高，运行更加稳定可靠。



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1. 一种通过系统集成实现景观照明的方法，所述景观照明系统包括市电、配电箱、开关电源、控制器、LED 灯具和其他灯具，通过系统集成实现景观照明的方法步骤如下：

（1）根据要实施景观照明的建筑物或景点的工程现场和景观的效果要求，选择光源及灯具，选择现有的控制系统，通过现场试验，得到基础的景观照明系统；

（2）对有动态变化照明效果要求的景观照明进行电脑模拟和现场联调，以满足动态变化要求；

（3）将上述基础的景观照明系统和为景观照明需要的配电箱、开关电源、控制器、LED 灯具和其他灯具中的部分或全部进行有机集成，通过系统集成实现景观照明。

2. 根据权利要求 1 所述的通过系统集成实现景观照明的方法，所述动态变化照明效果，是通过 LED 灯进行动态效果模拟，通过控制芯片控制 LED 灯的显示效果实现动态变化的照明效果。

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通过系统集成实现景观照明的方法

技术领域

[0001] 本技术领域涉及景观照明集成技术，通过系统集成实现景观照明的方法，即，将现有景观照明系统和特定任务专用景观照明系统进行系统集成的方法。

背景技术

[0002] 近年来，随着城市化进程的不断深入，以“多彩、多变”为特征的、具有强烈装饰效果、动态变化的城市景观照明在我国得到迅速发展。但由于景观照明系统融合了光学、美术、微电子、计算机、通讯及生产制造等多学科的最新技术，技术难度大，同时由于其景观点的特殊性使得很大一部分景观照明系统是专门设计的专有系统。

[0003] 在景观照明系统涉及的技术领域中，景观照明灯具及其灯具控制设备和为完成该任务的设备及软件的系统集成是不可回避的重要技术，前者能够完成基本的照明功能，后者将特定任务和现有灯具系统进行有机整合。传统的做法是：研制景观照明灯具样品，进行大量的产品测试和分析，同时开发控制软件或控制方法对其进行控制，再通过试运行，完成满足设计要求的景观照明系统。这种做法需要大量的资金以及人力物力投入，且因为涉及环节较多，需经过多次长时间的循环才能完成既定的目标任务。

[0004] 本发明所要解决的技术问题

[0005] 本发明的目的是提出一种通过系统集成来实现景观照明系统的方法，本发明基于现有景观照明系统和特定任务专用景观照明系统，针对传统做法给出的新的解决方法，该方法克服了传统方法的高投入、长周期、低适用性的缺点，能够快速满足各种新型景观照明系统得使用要求。

[0006] 内容：

[0007] 本发明所采用的技术方案是：

[0008] 一种通过系统集成实现景观照明的方法，所述景观照明系统包括市电、配电箱、开关电源、控制器、LED 灯具和其他灯具，通过系统集成实现景观照明的方法步骤如下：

[0009] (1) 根据要实施景观照明的建筑物或景点的工程现场和景观的效果要求，选择光源及灯具，选择现有的控制系统，通过现场试验，得到基础的景观照明系统；

[0010] (2) 对有动态变化照明效果要求的景观照明进行电脑模拟和现场联调，以满足动态变化要求；

[0011] (3) 将上述基础的景观照明系统和为景观照明需要的配电箱、开关电源、控制器、LED 灯具和其他灯具中的部分或全部进行有机集成，通过系统集成实现景观照明。

[0012] 动态变化照明效果，是通过 LED 灯进行动态效果模拟，通过控制芯片控制 LED 灯的显示效果实现动态变化的照明效果。

[0013] 根据景观效果的要求，选择合适的色温、配光曲线等技术参数，必要时对 LED 变化效果进行软件编程，对动态变化等照明效果确认，完成最终的景观照明系统。

[0014] 本发明的具体实施方法是提出一种通过系统集成实现景观照明的方法，该景观照明系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成。所述的方法包括步

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骤：

[0015] 1. 根据要实施景观照明的建筑物或景点的工程现场特点和要实现的景观效果要求，将技术指标进行分解，根据这些技术指标来选择适当的灯具系统；

[0016] 2. 进行灯具系统评估，对于性能不能满足的进一步改造；

[0017] 3. 对有动态变化照明效果要求的系统重新进行软件编程，并进行电脑模拟和现场联调，以满足动态变化要求；

[0018] 4. 对有光污染要求、色温、照度、功率密度要求的灯具进行现场试灯，以满足设计要求；

[0019] 5. 根据景观照明系统的最终要求，选取最终灯具品牌、布灯方案、施工工艺及配电方案，完成景观照明系统的有机集成。

[0020] 其中所述灯具系统评估包括进行光源电器、色温、照度及功率密度、光污染、控制协议、控制方式、防尘防水等级、外形尺寸、施工工艺的评估。

[0021] 所述光源电器的评估中，光源包括：LED 光源，高压气体灯，荧光灯；电器包括：电感镇流器，补偿电容，电子镇流器，开关电源，LED 光源的控制器，根据需求选择合适的光源和电器。

[0022] 所述色温的评估中，暖色色温值＜ 3000k，中间色色温值 3000k-5000k，清凉色色温值＞ 5000k，根据设计要求选择对应的色温值。

[0023] 所述照度及功率密度评估中，为满足节能要求，根据城市夜景照明设计规范（JGJ/T 163-2008）表 6.6.2 的规定，选定对应功率密度值，比如：在大型城市商业区，当建筑物饰面材料为白色外墙涂料时功率密度不宜大于 6.7 瓦 / 平方米，对应照度不宜大于 150lx。

[0024] 所述光污染评估中，根据城市夜景照明设计规范（JGJ/T 163-2008）中对“光污染的限制”要求，选择合适的灯具。

[0025] 所述控制协议评估中，控制协议是 X-10、CEBus、Lonworks、EIB、I-Bus、T-Bus、HBS、DALI、DMX-512、ACN、ART-net、C-Bus、Dynet 中的任意一种，根据需求选择合适的控制协议。

[0026] 所述控制方式评估中，控制方式是跷板开关控制、断路器控制、定时开关、声光控开关、手动遥控控制、场景控制、动静探测控制、恒照度控制中的任意一种。

[0027] 所述防尘防水等级的评估，在露天场地，灯具防护等级不低于 IP54；在有顶棚场地，灯具防护等级不低于 IP43，当环境污染严重时，灯具防护等级不低于 IP65。

[0028] 所述外形尺寸评估，根据现场安装条件，外形尺寸不能发生干涉、严重影响建筑物外观的情形。

[0029] 所述施工工艺评估，是根据现场情况评估是否具有适当的安装空间、安装位置，是否影响建筑和景点外观。

[0030] 所诉动态变化照明效果，是通过 LED 灯实现的，需要进行动态效果软件编程，将该动态效果通过地址转换输出成相应的指令，传输到 LED 灯的控制芯片，从而通过控制芯片控制 LED 灯的显示效果从而实现动态变化的照明效果。

[0031] 本景观照明系统集成技术是一项系统工程，来源于多年的照明工程实践，是在大量的技术和经验数据下的技术选择，是光源电器、色温、照度及功率密度、光污染、控制协议、控制方式、防尘防水等级、外形尺寸、施工工艺等诸多项目的全面综合系统优化。

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附图说明：

[0032] 图 1 是景观照明系统的系统构成框图。

具体实施方式：

[0033] 图 1 是景观照明系统的系统构成框图，该系统由市电、配电箱、开关电源、控制器、LED 灯具和其他灯具组成。

[0034] 本发明的实施例是一个博物馆的景观照明工程，下面详细说明本系统集成技术的实现方法的具体步骤：

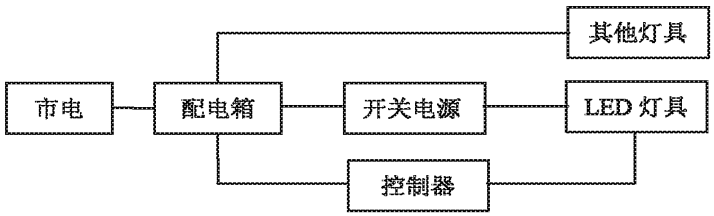
[0035] 1. 根据要实施景观照明的建筑物或景点的工程现场特点和要实现的景观效果要求，将技术指标进行分解，根据这些技术指标来选择适当的灯具系统；本实施例博物馆设计要求正面的玻璃幕墙形成瀑布效果，博物馆前的柱子用投光灯突出照明，建筑物侧面和屋顶装饰构件需要照亮，色温要求为暖色调，同时要求具有遥控开关灯。根据以前的工程实践，选用以前工程项目中选用的灯具系统：8 瓦的 LED 线条灯；柱子底部采用 1000 瓦窄光高压纳灯向上投光，色温选 2200k；建筑物入口侧面选择 150 瓦的高压纳灯宽光投光灯，色温 2200k；建筑物屋顶装饰构件选择 70 瓦的高压纳灯中光投光灯，色温 2200k。

[0036] 2. 进行灯具系统评估，对于性能不能满足的进一步改造；根据经验，所选灯具系统没有问题，不需要进行改造，只需要在玻璃幕墙内部设计线条灯的固定位置，但所选灯具系统原来不能实现遥控开关灯功能，选用现有路灯遥控开关的远程控制器，该控制器支持手机短信开关功能。对有动态变化照明效果要求的系统重新进行软件编程，并进行电脑模拟和现场联调，以满足动态变化要求；设计要求正面的玻璃幕墙形成瀑布效果，重新尽心软件编程。对有眩光要求、色温、照度、功率密度要求的灯具进行现场试灯，以满足设计要求；经过现场试灯，能够满足设计要求。

[0037] 3. 根据景观照明系统的最终要求，选取最终灯具品牌、布灯方案、施工工艺及配电方案，完成景 观照明系统的有机集成。灯具品牌选择国内某厂家的线条灯，各照明侧面均匀布灯。在玻璃幕墙的固定爪之间设计辅助固定杆来固定线条灯，配电箱从建筑物电源取电。

[0038] 通过集成的景观照明系统尽最大可能地消除了重新设计过程中各种因素对质量的影响，使得工期更短，效率更高，同时也降低了成本。

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附图 1

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Record 1/4 CN103090238A Light emitting diode (LED) light source illumination method and device with color temperature simulating natural light change along with time | LED light source lighting method and device for colour temperature simulating natural light changes over time;

Publication Number: CN103090238A

Title: Light emitting diode (LED) light source illumination method and device with color temperature simulating natural light change along with time | LED light source lighting method and device for colour temperature simulating natural light changes over time; ***(Translation from Clarivate Analytics)***

Title - DWPI: Natural LED light source color temperature changing time simulating method, involves manually selecting time period of color temperature to simulate natural light color temperature changing time of LED light source

Abstract:

The invention discloses a light emitting diode (LED) light source illumination method and device with color temperature simulating natural light change along with time. Firstly a series of different time nodes and a current adjustment scheme of an LED light source relative to color temperature are stored in a controller, the controller is used for comparing time signals with the time nodes by accepting the time signals of time and then extracting relative current adjustment scheme to control the LED light source current, or choosing the color temperature manually; the controller controls the LED light source current and then simulates natural light color temperature change according to the current adjustment scheme relative to the color temperature, and therefore composite light of an LED illumination module has high color rendering. The invention further discloses an LED light source illumination device with the color temperature simulating natural light change along with time.

The invention claims a colour temperature simulating natural light changes with time of LED light source illuminating method, firstly storing a series of different time nodes and current regulation scheme of LED light source colour temperature corresponding to the controller; the controller through receiving the clock of the time signal and the time signal and the time node, then extracting the corresponding current regulation plan control LED light source current, or manually selecting the color temperature controller according to the colour temperature corresponding to the current adjustment scheme. current for controlling the LED light source, so as to simulate change of natural light colour temperature, the LED illumination module synthetic light with higher color rendering. The invention further claims a colour temperature simulating natural light changes with time of LED light source illumination device.

(Translation from Clarivate Analytics)

Abstract - DWPI:

Abstract - DWPI Novelty:

The method involves adjusting a current value of an LED light source via a controller to change light emitting characteristics of the LED light source. Preset time period of color temperature and the current value of the LED light source are stored in the controller. The time period of the color temperature is manually selected to simulate natural light color temperature changing time of the LED light source according to a LED light source current adjustment scheme. The LED light source is provided with multiple single-color LED lamps.

Abstract - DWPI Detailed Description:

An INDEPENDENT CLAIM is also included for a natural LED light source color temperature changing time simulating device.

Abstract - DWPI Use:

Natural LED light source color temperature changing time simulating method.

Abstract - DWPI Advantage:

The method enables realizing LED light source natural light color temperature changing time simulating process in an effective manner and improving LED illuminating module synthesis light color rendering efficiency.

Abstract - DWPI Drawing Description: The drawing shows a block diagram illustrating a natural LED light source color temperature changing time simulating method.'(Drawing includes non-English language text)'

Claims:

1. A colour temperature simulating natural light changes with time of LED light source illuminating method, uses the controller adjusting LED light source current value to change the LED light source light-emitting characteristic, wherein it comprises the following steps: O presetting a time period, the time period in the colour temperature of different time corresponding to the node and realizing the colour temperature of the LED current value stored in the controller, a preset color temperature range, the color temperature range in corresponding to different colour temperature

and realize the colour temperature of the LED current value is also stored in the controller; a certain time node 2) controller compares the current time with the step I) in the time space for comparison: if the current time corresponding to the step I), the controller node corresponding to the time to output by the LED light source of the LED current value; in the time space of adjacent between two time nodes if the current time is in the step I), the controller adjusting LED current value is obtained through interpolation algorithm, and output to the LED light source, if the current time is not in the step I), then manually selecting a colour temperature in colour temperature range, the controller corresponding to LED light source output with the color temperature value of the LED current.

2. The colour temperature according to claim 1 simulating natural light changes with time of LED light source illuminating method, wherein said LED light source is composed of multiple single-colour LED lamp.

3. The colour temperature according to claim 2 simulating natural light changes with time of LED light source illumination, wherein the method realizing the color temperature of the LED current value algorithm comprises the following steps: setting target colour temperature is CCTT O, synthetic spectrum set LED light source color temperature is CCTM, CCTz and CCTm should satisfy the boundary conditions are:wherein CAP-ACCT is the presence of CCTm and CCTt deviation range, the distance between the colour coordinate and the blackbody radiation curve of Auv synthetic spectrum for the LED light source, (uT. , v) and (u, vM) is a synthetic spectrum with the LED light source colour coordinate in the black body radiation is CCTm is the CIE1960-UCS chromaticity diagram of the color coordinate, 2) is set a plurality of spectral normalization of monochromatic LED lamps are Si ([lambda]) (i = 1, 2, 3. .. n), the corresponding weight is ni (i= 1, 2, 3. .. n), the (interval between the weight i*n; (i = 1, 2, 3. .. n) random assignment, synthetic spectrum satisfy the boundary condition of the LED light source, 3) establishing evaluation function f of the CRI colour rendering = 100-CRI, adopting the simplex method corresponding to the downward weight Iii local optimization algorithm to find the CRI colour rendering obtained maximum value, 4) the weight Ici is converted into brightness weights Yi, wherein Yi is the brightness IijSi (lambda) corresponding to the CIE1931XYZ color space. The corresponding relation between the current value Ci and luminance weighting, weighting the luminance Yi into current value Ci, obtaining the colour temperature of the LED current value.

4. The colour temperature according to claim 3 simulating natural light changes with time of LED light source illuminating method, wherein said multiple monochromatic LED lamp comprises a red light LED lamp, a green LED lamp, the blue-light LED lamp and warm white light LED lamp, the current value comprises a current value of each single-colour LED lamp.

5. The colour temperature according to claim 4 simulating natural light changes with time of LED light source illuminating method, wherein the wavelength of the red light LED lamp is 60 (T630nm

wavelength of green light LED lamp is 50 (T540nm wavelength of the blue-light LED lamp is 45 T470nm, the colour temperature of the warm white light LED lamp is 2500K to 3000K.

6. The colour temperature according to claim 1 simulating natural light changes with time of LED light source illuminating method, wherein the interpolation algorithm is as follows: set the current time is t, and the controller stores the adjacent time node h to between t2, the set current value of h corresponding to n LED are Cil (i = 1, 2, 3. .. n), current value of t2 corresponding to a n LED are respectively Ci2 (i = 1, 2, 3. .. n), then the current value of t corresponding to n LED respectively is Ci (i= 1, 2, 3. .. n) as follows:

7. A colour temperature simulating natural light changes with time of LED light source illumination device, wherein it comprises an LED light source, a controller for adjusting the LED light source current value, a clock for conveying the current time to the controller.

8. device of LED light source illumination of simulating natural light changes over time the color temperature according to claim 7, wherein the LED light source comprises a red light LED lamp, a green LED lamp, the blue-light LED lamp and warm white light LED lamp.

9. device of LED light source illumination of simulating natural light changes over time the color temperature according to claim 8, wherein the wavelength of the red light LED lamp is 60 (T630nm wavelength of green light LED lamp is 50 (T540nm wavelength of the blue-light LED lamp is 45 T470nm, the colour temperature of the warm white light LED lamp is 2500K to 3000K.

(Translation from Clarivate Analytics)

Description:

LED light source lighting method and device for colour temperature simulating natural light changes over time;

Technology field

[0001] The invention relates to the LED illumination field, specifically to a colour temperature simulating natural light changes with time of LED light source illuminating method and device.

Background technology

[0002] In recent years, with increased city high-rise building, building interior natural lighting problem of insufficient increasingly appears, it is often necessary to artificial lighting, the present most artificial illumination traditional fluorescent lamp is low and the colour temperature is fixed.

[0003] rendering means different spectrum of light source shine on the object of the same color,

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the present characteristic of different color. degree, namely the vivid in color rendering light source of the object colour and high colour rendering light source reproduction of the colour is good, we see the colour closer to natural colors, light source of low color rendering reproduction of the colour is poor, we see the color deviation is larger.

[0004] the color temperature is represented by light source light colour scale, the unit is K (Kelvin), color temperature refers to the broadcast in different energy, human eyes feel the color change. is the measured numerical value and mark wavelength color temperature, light different in wavelength, exhibit a different colour of light, especially natural light, along with the change of time, season, geographic location, its color temperature will be changed.

[0005] China invention patent public number is 101561083 claims a LED light-emitting device with changeable colour temperature and implementation method thereof, wherein the principle is collecting external environment through temperature sensor of temperature, controller according to temperature data collected by the sensor to adjust the voltage parameter of the LED lamp group to realize with the change of environment temperature and automatically changing color temperature, so that the spectrum of the LED lamp is more close to natural light.

[0006] The patent of LED lamp temperature of the outside and changing color temperature, but temperature can not completely accurately reflects the change of colour temperature, the colour temperature change factor in many aspects, further with time, season and geographical location.

(0007) research shows that maintain the normal physiological rhythm is very important for human health and light physiological rhythm of human body will generate obvious effect. blue light wavelength is 450-470nm can suppress melatonin secretion so as to produce important influence on physiological rhythm. one day with the regularity of change of the color temperature of the natural light is low colour temperature, high noon colour temperature, blue-light part is also changed, the changing process of the natural maintain normal human physiological rhythm.

Invention contents

[0008] artificial illumination simulating natural light changes with time in order to realize colour temperature so as to maintain the human body normal physiological rhythm, the present invention provides a color temperature simulating natural light changes with time of LED light source illuminating method and device.

[0009] A color temperature simulating natural light changes with time of LED light source illuminating method, uses the controller adjusting LED light source current value to change the luminous characteristics of LED light source, comprising the following steps:

[0010] I) presetting a time period, the time period in the colour temperature of different time corresponding to the node and realizing the colour temperature of the LED current value stored in the controller, a preset color temperature range, the color temperature range in corresponding to different colour temperature and realize the colour temperature of the LED current value is also stored in the controller.

[0011] 2) controller compares the current time with the step I) in the time space by comparing:

[0012] if the current time corresponding to the step I) in the certain time node, output node corresponding to the time of the LED current value to LED light source controller;

[0013] if the current time is in the step I) adjacent between two time nodes, the controller adjusting LED current value is obtained through interpolation algorithm, and output to the LED light source;

[0014] If the current time is not in step I) of the time space in, then manually select a color temperature in the colour temperature range, the controller corresponding to LED light source output with the color temperature value of the LED current.

[0015] said LED light source is composed of multiple single-colour LED lamp.

(0016) realizing the colour temperature of the LED current value algorithm comprises the following steps:

[0017] I) setting target colour temperature is CCTt, synthetic spectrum set LED light source color temperature is CCTM, CCTt and CCTm should satisfy the boundary conditions are:

[0018]Formula(refer to the tiff*

[0019] wherein CAP-ACCT is CCTm with CCTt the presence of deviation range;

the distance between the colour coordinate and the blackbody radiation curve of (0020] lambda Uv synthetic spectrum for the LED light source;

[0021] (uT, v) and (u, vM) is a synthetic spectrum with the LED light source colour coordinate in the black body radiation is CCTm is the CIE1960-UCS chromaticity diagram color coordinate;

[0022] 2) a plurality of spectrum of the normalized single-colour LED lamps are Si (lambda) (i = 1, 2, 3. .. n), the corresponding weight is ki (i = l, 2, 3. .. n), the (interval between the weights ki (i = 1, 2, 3. .. n) random assignment, synthetic spectrum satisfy the boundary condition of the LED light source;

[0023] 3) establishing evaluation function f of the CRI colour rendering = 100-CRI, using simplex method corresponding to the downward weight lii local optimization algorithm to find the CRI colour rendering obtained maximum value;

[0024] 4) the weight lii into brightness weight Yi, wherein Yi is the brightness MSix (lambda) corresponding to the CIE1931XYZ color space, according to the corresponding relation of the current value Ci and luminance weight Yi, Yi luminance weight into current value Ci, obtaining the colour temperature of the LED current value.

[0025] solution of the invention LED current value are obtained according to the above algorithm, synthesizing light emitted after adjusting the LED light source the current value has a higher color rendering.

[0026] said multiple monochromatic LED lamp comprises a red light LED lamp, a green LED lamp, the blue-light LED lamp and warm white light LED lamp, the current value comprises a current value of each single-colour LED lamp; and the wavelength of the LED light of the red light is 60 (T630nm wavelength of green light LED lamp is 50 (T540nm, product blue-light LED lamp with wavelength of 45 nm (T470nm, warm white light LED lamp is 2500 M 3000 K color temperature. the LED light source is emitted spectrum is the spectrum for synthesizing single-colour LED lamp, the synthetic spectrum can simulate natural light.

[0027] the time is Beijing time is 8 am to 17 pm, in this time every half an hour a time node is set. The purpose of the invention is to realize colour temperature simulating natural light changes with time, so the time period is set as the Beijing time 8 am to 17 pm, makes up the defect of insufficient natural light lighting of the building interior in the time period.

[0028] current time is in between two adjacent time node can be through interpolation algorithm to

obtain the single-colour LED lamp current value, the interpolation algorithm is as follows:

[0029] set the current time is t, and the controller stores the adjacent time node A and between t2, the set current value of h corresponding to n LED are CilQ = (1, 2, 3. .. n), current value of t2 corresponding to a n LED are respectively Ci2 (i = 1, 2, 3. .. n), then the current value of t corresponding to n LED respectively is CiQ = (1, 2, 3. .. n) as follows:

[0031] The invention also provides a colour temperature simulating natural light changes with time of LED light source illumination device, comprising an LED light source;

[0032] a controller for adjusting the LED light source current value;

[0033] clock, for conveying the current time to the controller.

[0034] LED lighting device of this invention has two kinds of control modes, one is to automatically control the LED light source through time of current value, the second is through color temperature manual adjustment synthetic light of the LED light source to control the LED light source current value.

[0035] The LED light source comprises red light LED lamp, a green LED lamp, the blue-light LED lamp and warm white light LED lamps, and the red light LED lamp whose wavelength is 60 (T630nm wavelength of green light LED lamp is 50 (T540nm wavelength of the blue-light LED lamp is 45 (T470nm, D lamp colour temperature warm white light LE is 2500 gamma 3000 . the four-colour synthetic light emitted by the LED lamp imitating natural light, and synthetic light emitted with high color rendering.

[0036] The beneficial effect of the invention is to realize the artificial illumination consistent with the natural light colour temperature change, which is helpful for keeping human body normal physiological rhythm, and to obtain high color rendering at different color temperatures.

Description according to claim claimimages

[0037] Picture 1 is the structure sketch of the device of LED light source illumination colour temperature of the invention simulating natural light changes over time;

[0038] Picture 2 is the parameter of the four-colour LED lamp selected by this invention;

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[0039] Picture 3 is the invention of the four normalized spectrum monochromatic LED lamp;

[0040] Picture 4 is the colour temperature of the invention simulating natural light changes with time of LED light source illumination of the work flow;

[0041] Picture 5 is the algorithm of the LED current value corresponding to the colour temperature of the invention;

[0042] Picture 6 is the boundary condition of the algorithm of the LED current value corresponding to the colour temperature of the invention;

[0043] Picture 7 is the corresponding relationship of the relative brightness of the invention has high colour rendering LED control scheme and the current value;

[0044] Picture 8 is the LED current value control scheme of different time nodes of the present invention;

[0045] Picture 9 is the LED current value control scheme with different color temperature in the invention.

[0046] In the picture I is clock, 2 is a controller, 3 is a LED light source.

Preferred Embodiment

[0047] Following combine the accompanying drawings to make simulating natural light changes with time of the invention colour temperature of the LED light source lighting method and device to make further detailed description.

[0048] device of LED light source illumination simulating natural light changes with time as shown in FIG. 1, a colour temperature, comprising a clock 1, controller 2 and LED light source 3. LED light source 3 comprises a red light LED lamp, a green LED lamp, the blue-light LED lamp and warm white light LED lamp.

[0049] This embodiment select Lumileds LUXEON Rebel series LEDs, four monochromatic LED lamp parameter as shown in FIG. 2, four normalized spectrum monochromatic LED lamp 3 shown

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in FIG. wherein the warm white light LED lamp, the blue-light LED lamp, a green LED lamp and red light LED lamp of the normalized spectrum is S1 (lambda), S2 (lambda), S3 (lambda) and S4 (lambda).

[0050] controller 2 is stored with Beijing time four single-colour LED lamp current value of solution, comprising a sunny morning 8 point is a time value solution of the current node (as shown in FIG. 4) for half an hour in the afternoon 17 points, each time node corresponding to color temperature and color temperature is 2500 Gln-Glu 6000 8 group colour temperature corresponding to the node of the LED current value scheme (as shown in FIG. 5). the four-colour LED lamp through the solution of current to adjust, after adjusting LED light source 3 emits the synthesized light with higher color rendering, as shown in FIG. 6, the algorithm realizing the colour temperature of LED current value as follows:

[0051] 1, a target color temperature is CCTt, the target colour temperature confirming boundary condition, in practical application allows the LED light source synthetic spectrum colour temperature CCTm and CCTt there is a certain deviation, and the colour coordinate and the blackbody radiation curve and there is a certain distance (as shown in FIG. 7) allows the LED light source synthetic spectrum, boundary conditions are as follows:

[0052]Formula(E)(refer to the tiff*

[0053] wherein CAP-ACCT is CCTm with CCTt the presence of deviation range, the distance between the colour coordinate and the blackbody radiation curve of Auv synthetic spectrum for the LED light source, wherein,) and (u, vM) lambda CCT = 50 K is a synthetic spectrum with the LED light source colour coordinate in the black body radiation is CCTm is the CIE1960-UCS chromaticity diagram of colour coordinates in the present invention;

[0054] 2, establishing the evaluation function f with respect to color rendering (CRI) 100-CRI, because the following is the downhill simplex method local optimization algorithm will find the minimum evaluation function, so to obtain maximum, the CRI to obtain minimum;

[0055] 3, a warm white, blue, green, and red 4 LED lamp of the normalized spectrum are respectively S1 (lambda), S2 (lambda), S3 (lambda), S4 (A.), the corresponding weight is k1, k2, k3, k4, as shown in FIG. 3, ki-Ras between the 0, 1 interval, for the purpose of spectral normalization of monochromatic LED lamp uniform interval of weight h is between O, I, random assignment until satisfy the boundary condition. and set the k, i = 1, 2, 3, 4) as an initial value;

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[0056] 4, within the boundary condition, using the downhill simplex method local optimization algorithm to find color rendering (CRI) weight h corresponding to the obtained maximum value

[0057] 5, the weight i*n; is converted to brightness weights Yi, wherein Yi is the brightness MSix (lambda) corresponding to the CIE1931XYZ color space, through experiment measured control current Ci Yi corresponding relation with the luminance weight, as shown in FIG. 8, then the luminance weight Yi into control current Ci to obtain the colour temperature of the LED current value.

device [0058] as shown in FIG. 9, the colour temperature of the invention simulating natural light changes with time of LED light source illumination of the working steps are as follows:

[0059] 1, setting time is Beijing time is 8 am to 17 pm, in this time every half an hour a time node is set, and the LED current value corresponding to each time node stored in the controller; the preset colour temperature range of 2500 Gln-Glu 6000 K, the color temperature node interval 500K, nodes corresponding to the colour temperature LED current value is also stored in the controller;

[0060] 2, clock the current time t to the controller, the controller sends the current time t and the time space of the set by comparing and judging the relationship between the current time and the time period;

[0061] if the current time t is in the time period, the controller is in the manual mode, sends the corresponding sound signal to remind people, between through manual selection 2500 M 6000 K 500K of a certain color temperature, controller according to the colour temperature corresponding to the node of the LED current value controlling the LED lamp;

[0062] e.g.: if the time data t = 18: 00, according to FIG. 5 in corresponding colour temperature adjustment scheme, can manually select LED light source emits synthetic light color temperature, if manual selection color temperature is 3500K, the warm light LED lamp controller, the blue-light LED lamp, a green LED lamp and red light LED lamp current are respectively adjusted to 222.94mA, 1.71mA, 58.09mA, 17.26mA.

[0063] If certain time node corresponding to the current time t, the controller calls the time changing node value of the LED current.

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[0064] example: current time t=8: 30, it can be known from FIG. 4, the warm white light LED lamp, the blue-light LED lamp, a green LED lamp and red light LED lamp current are respectively 271.0lmA, Tropicalis, 20.805mA, 8.188mA;

[0065] if the current time t is adjacent between two time nodes, controller through interpolation algorithm to obtain the adjusted current value and correspondingly adjusts current value of each colour LED lamp, interpolation algorithm is as follows:

[0066] set clock transmission of current time is t, and t is time interval between two adjacent node A and between t2, corresponding to warm white light LED lamp, the blue-light LED lamp; the green light LED lamp and red light LED lamp current value is CwlX1 CglXrt, corresponding to t2 warm white light LED lamp, the blue-light LED lamp, a green LED lamp and red light LED lamp current value is Cw2, Cb2, Cg2, (2, t corresponding to warm white light LED lamp. the blue-light LED lamp, a green LED lamp and red light LED lamp current value, Cb, Cg, Cr is:

[0067] TABLES(refer to the tiff*

[0068] example: current time t=12: time 10, it can be known from FIG. 4:

[0069] 1 to 00: =12, Crl=9.13mA, Cgl=84.91mA, Cbl=6.20mA, Cwl=199.76mA;

[0070] t2 = 12 30, Cr2 = l0.92mA, Cg2 = 92.04mA, Cb2 = 6.93mA, Cw2 = 190.1lmA;

[0071] The interpolation algorithm, can be obtained:

[0072] Cr=l0.32mA, Cg=89.66mA, Cb=6.69mA, Cw=193.33mA.

(Translation from Clarivate Analytics)

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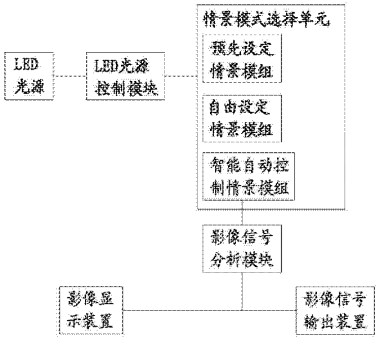
权利要求书 1 页 说明书 2 页 附图 2 页

(54)实用新型名称

可调适的LED气氛照明系统

(57)摘要

可调适的LED气氛照明系统，包括LED光源，还包括可调节LED光源亮度、色温、颜色、闪烁频率的LED光源控制模块和情景模式选择单元，情景模式选择单元、LED光源控制模块和LED光源依次电连接；所述情景模式选择单元包括并联的预先设定情景模组和自由设定情景模组。本实用新型既具备多种不同的固定照明效果，又具备可智能自动实时调适光气氛的变化照明效果，能够满足阅读、休憩、观影及游戏等各种不同场所的照明需求，不但可以达到护眼及缓解视觉疲劳的功效，而且可以使得用户的视觉环境与影像画面的情境相适配，使其享受身临其境的视觉效果。



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1. 可调适的LED气氛照明系统，包括LED光源，其特征是：还包括可调节LED光源亮度、色温、颜色、闪烁频率的LED光源控制模块和情景模式选择单元，情景模式选择单元、LED光源控制模块和LED光源依次电连接；所述情景模式选择单元包括并联的预先设定情景模组和自由设定情景模组。

2. 根据权利要求1所述的可调适的LED气氛照明系统，其特征是：还包括可综合解析影像信号的影像信号分析模块，所述情景模式选择单元还包括与预先设定情景模组、自由设定情景模组并联的智能自动控制情景模组；可与给影像显示装置传输影像信号的影像信号输出装置电连接的影像信号分析模块，与情景模式选择单元中智能自动控制情景模组电连接。

3. 根据权利要求2所述的可调适的LED气氛照明系统，其特征是：所述LED光源、LED光源控制模块、情景模式选择单元和影像信号分析模块，可为一体式组件，或为分体式组件。

4. 根据权利要求2所述的可调适的LED气氛照明系统，其特征是：所述LED光源与LED光源控制模块之间、LED光源控制模块与情景模式选择单元之间、情景模式选择单元与影像信号分析模块之间，可为有线电连接，或为无线电连接。

5. 根据权利要求1所述的可调适的LED气氛照明系统，其特征是：所述LED光源是指以LED作为照明光源的灯具，包括台灯、立灯、灯箱、筒灯。

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可调适的 LED 气氛照明系统

技术领域

[0001] 本实用新型涉及一种照明系统，具体地说是一种可调适的 LED 气氛照明系统。

背景技术

[0002] 目前，市场上的 LED 照明系统主要强调 LED 光源的光线亮度、色温等光学特性参数以及 LED 光电转换效率，一般所产生的照明效果都是单一不可调适的，无法根据不同的照明需求提供多种不同的固定照明效果，更无法提供可智能自动实时调适光气氛的变化照明效果。

[0003] 最新有一种使用于 5D 影院的场景气氛照明系统，为实现智能自动变化光气氛的照明效果，需搭配复杂的控制系统以及预先针对个别画面进行场景气氛照明变化的编辑，需求大量的人力及技术支持，很难适用于一般消费市场。

发明内容

[0004] 本实用新型的目的是提供一种可调适的 LED 气氛照明系统，使其既具备多种不同的固定照明效果，又具备可智能自动实时调适光气氛的变化照明效果。

[0005] 为达到上述目的，本实用新型所采取的技术方案是：可调适的 LED 气氛照明系统，包括 LED 光源，还包括可调节 LED 光源亮度、色温、颜色、闪烁频率的 LED 光源控制模块和情景模式选择单元，情景模式选择单元、LED 光源控制模块和 LED 光源依次电连接；所述情景模式选择单元包括并联的预先设定情景模组和自由设定情景模组。

[0006] 进一步，所述可调适的 LED 气氛照明系统，还包括可综合解析影像信号的影像信号分析模块，所述情景模式选择单元还包括与预先设定情景模组、自由设定情景模组并联的智能自动控制情景模组；可与给影像显示装置传输影像信号的影像信号输出装置电连接的影像信号分析模块，与情景模式选择单元中智能自动控制情景模组电连接。

[0007] 所述 LED 光源、LED 光源控制模块、情景模式选择单元和影像信号分析模块，可为一体式组件，或为分体式组件。

[0008] 所述 LED 光源与 LED 光源控制模块之间、LED 光源控制模块与情景模式选择单元之间、情景模式选择单元与影像信号分析模块之间，可为有线电连接，或为无线电连接。

[0009] 所述 LED 光源是指以 LED 作为照明光源的灯具，包括但不限于台灯、立灯、灯箱、筒灯。

[0010] 本实用新型的工作原理是：可通过情景模式选择单元选择预先设定情景模组，再通过 LED 光源控制模块调适 LED 光源，使其呈现预设的照明效果，以满足不同场景的照明需求；亦可通过情景模式选择单元选择自由设定情景模组，再通过 LED 光源控制模块实现自行调适 LED 光源，使其呈现自定义的照明效果，以满足不同使用者的个人照明需求；还可通过情景模式选择单元选择智能自动控制情景模组，再通过影像信号分析模块综合解析来自影像信号输出装置的影像信号后，利用 LED 光源控制模块实时自动调适 LED 光源，使其能够配合影像画面实时变化照明效果，以达到创造光气氛的效果。

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[0011] 本实用新型既具备多种不同的固定照明效果，又具备可智能自动实时调适光气氛的变化照明效果，能够满足阅读、休憩、观影及游戏等各种不同场所的照明需求，不但可以达到护眼及缓解视觉疲劳的功效，而且可以使得用户的视觉环境与影像画面的情境相适配，使其享受身临其境的视觉效果。

附图说明

[0012] 图 1 是本实用新型第一实施例的结构示意图；

[0013] 图 2 是本实用新型第二实施例的结构示意图。

具体实施方式

[0014] 下面结合附图对本实用新型作进一步的详细说明：

[0015] 实施例 1：参看图 1，本实用新型可调适的 LED 气氛照明系统，包括 LED 光源、LED 光源控制模块和情景模式选择单元，情景模式选择单元、LED 光源控制模块和 LED 光源依次电连接；所述情景模式选择单元包括并联的预先设定情景模组和自由设定情景模组。

[0016] 实施例 2：参看图 2，本实用新型可调适的 LED 气氛照明系统，包括 LED 光源、LED 光源控制模块、情景模式选择单元和影像信号分析模块，情景模式选择单元、LED 光源控制模块和 LED 光源依次电连接；所述情景模式选择单元包括并联的预先设定情景模组、自由设定情景模组和智能自动控制情景模组；可与给影像显示装置传输影像信号的影像信号输出装置电连接的影像信号分析模块，与情景模式选择单元中智能自动控制情景模组电连接。

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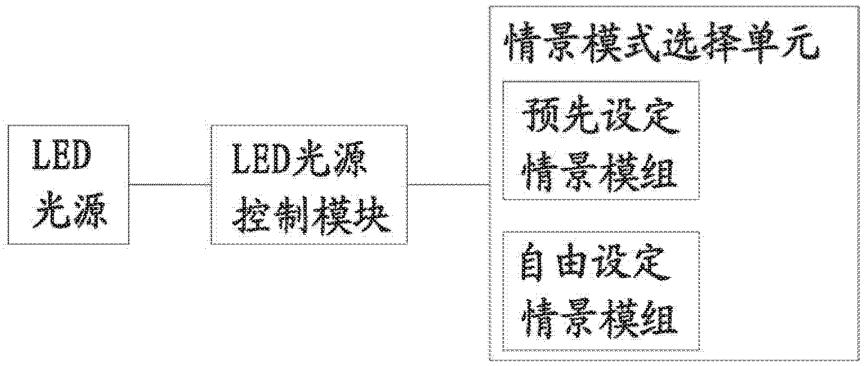


图 1

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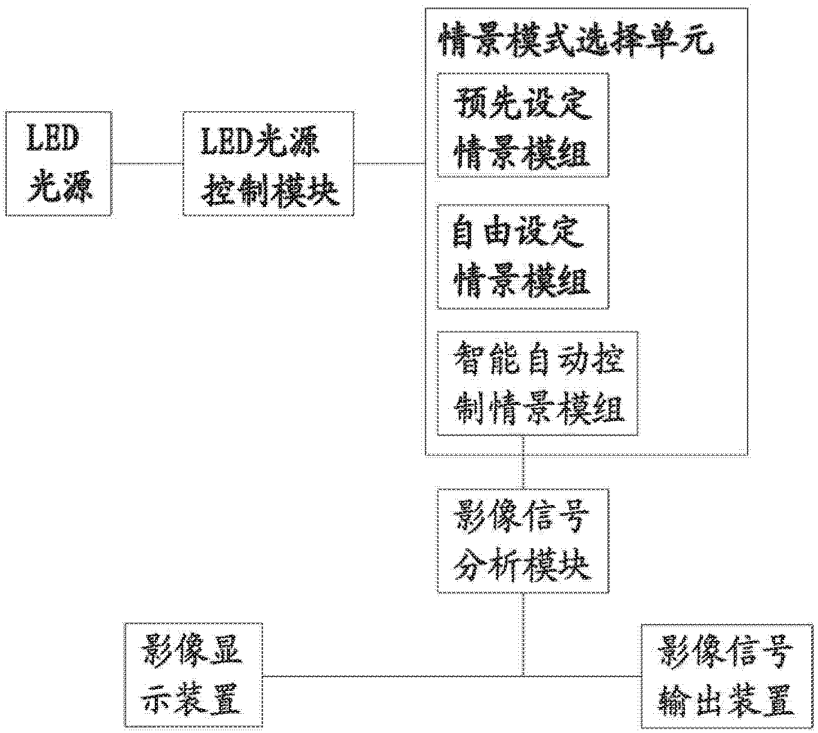


图 2

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Record 3/4 CN202841602U Adjustable LED atmosphere illumination system | An adaptable LED atmosphere lighting system

Publication Number: CN202841602U

Title: Adjustable LED atmosphere illumination system | An adaptable LED atmosphere lighting system ***(Translation from Clarivate Analytics)***

Title - DWPI: Adjustable LED atmospheric lighting system has LED light source and LED light source control module that are electrically connected with scene mode selecting unit comprising preset scene module

Abstract:

The utility model relates to an adjustable LED atmosphere illumination system comprising an LED light source, an LED light source control module and a situation mode selection unit. The LED light source control module is used for adjusting the brightness, the color temperature, the color and the flicker frequency of the LED light source. The situation mode selection unit, the LED light source control module and the LED light source are successively and electrically connected. The situation mode selection unit includes a preset situation module group and a freely-set situation module group, wherein the two groups are connected in parallel. According to the utility model, the adjustable LED atmosphere illumination system enables various fixed illuminating effects as well as the changed illuminating effect of intelligent, automatic and real-time light atmosphere adjustment to be realized, thereby meeting illuminating requirements at different occasions like reading, resting, film watching and game playing and the like. Therefore, the efficacies of eye protection and visual fatigue relieving can be realized and the visual environment of the user can be matched with a scene in an image picture, so that the user can enjoy the visual immersive effect.

An adaptable LED atmosphere lighting system, comprising an LED light source, further comprising an adjustable LED light source brightness, LED light source control module and contextual model of color temperature, color, flashing frequency selecting unit, a contextual model selection unit, LED light source control module and the LED light source are electrically connected, the contextual model selection unit that comprises, in parallel, a predetermined scene module and freely set the scene module. The utility model not only has a plurality of different fixing lighting effect, and it has intelligent automatic real-time adapted light atmosphere of varying lighting effect, it can satisfy the illuminating requirement of reading, resting, viewing and game and so on all kinds of different places, which not only can reach the eye and visual fatigue relieving function, but also can be matched so that the context of the visual environment and the image picture of the user, so

as to enjoy the immersive visual effect.

(Translation from Clarivate Analytics)

Abstract - DWPI:

Abstract - DWPI Novelty:

Capable of adapting the system of atmosphere lighting of LED, comprising an LED light source, further comprising a LED light source brightness, colour temperature, colour, twinkling frequency of the LED light source control module and a scene mode selecting unit, scene mode selection unit, an LED light source control module and an LED light source electrically connected with the scene mode selecting unit comprises a preset scene module and the scene module. This utility model not only visual effect comprises a plurality of different fixed illumination effect, but also has a capable of being electrically heated intelligently automatically real-time adjusting lighting atmosphere to change the illumination effect, can meet reading, resting, and game watching different places such as the illumination requirement, it not only can reach the eye-protecting function and relieving visual fatigue, and it can make the scenes of visual environment and the image picture of the user, to enjoy the experience.

Claims:

1. An adaptable LED atmosphere lighting system, comprising an LED light source, wherein it further comprises an adjustable LED light source brightness, LED light source control module and contextual model of color temperature, color, flashing frequency selecting unit, a contextual model selection unit, LED light source control module and the LED light source are electrically connected, said scene mode selecting unit comprises, in parallel, a preset scene module and freely set the scene module.

2. The LED atmosphere lighting system of adjustable according to claim 1, wherein it further comprises a comprehensive analysis of image signal of the image signal analyzing module, the contextual model selection unit further comprises a preset scene module. free setting intelligent automatic control scene module scene modules in parallel, electrically connect the image signal analyzing module and transmitting image signal to the image display device of the image signal output device, and contextual model selection unit intelligent automatic control scene module electrical connection.

3. The said adaptable LED atmosphere lighting system according to claim 2, wherein the LED light source, the LED light source control module, scene mode selecting unit and the image signal analyzing module, can be integrated components, or separated component.

4. The said adaptable LED atmosphere lighting system according to claim 2, wherein the LED light source between the LED light source control module, an LED light source control module and contextual model selection unit between the contextual model selection unit and the image signal

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analyzing module is can be cable connection, or a wireless connection.

5. The LED atmosphere lighting system of adjustable according to claim 1, wherein said LED light source is that using LED as the illumination light source of the lamp, comprises a lamp stand, a lamp box, the lamp tube.

(Translation from Clarivate Analytics)

Description:

An adaptable LED atmosphere lighting system

Technology field

[0001] This utility model relates to an illuminating system, specifically an adaptable LED atmosphere lighting system.

Background technology

[0002] Currently, LED lighting system on the market mainly emphasize the LED light source of the light brightness, color temperature and the like optical characteristics parameter and LED photoelectric conversion efficiency, generally are singly generated lighting effect can not be adapted, cannot provide a plurality of different fixing lighting effect according to different illumination requirements, and cannot provide intelligent automatic real-time adapted light atmosphere of varying lighting effect.

[0003] A scene atmosphere lighting system used in theatre, to achieve the lighting effect of the intelligent automatic change light atmosphere, with complex control system and for individual picture for editing the scene atmosphere lighting change, needs a lot of manpower and technical support, it is difficult for general consumer market.

Invention contents

[0004] This utility model aims at providing a LED atmosphere lighting system capable of adapting to make it not only has a plurality of different fixing lighting effect, and it has intelligent automatic real-time adapted light atmosphere of varying lighting effect.

[0005] In order to reach said purpose, this utility model adopts the technical solution is as follows: the adjustable LED atmosphere lighting system, comprising an LED light source, further

comprising an adjustable LED light source brightness, color temperature, color, LED light source control module and the scene mode of a flicker frequency selecting unit, a contextual model selection unit, LED light source control module and the LED light source are electrically connected, the contextual model selection unit that comprises, in parallel, a predetermined scene module and freely set the scene module.

[0006] Further, the LED atmosphere lighting system of the adjustable, further comprising a comprehensive analysis of the image signal of the image signal analyzing module, the contextual model selection unit further comprises a preset scene module. free setting intelligent automatic control scene module scene modules in parallel, electrically connect the image signal analyzing module and transmitting image signal to the image display device of the image signal output device, and contextual model selection unit intelligent automatic control scene module electrical connection.

[0007] the LED light source, the LED light source control module, scene mode selecting unit and the image signal analyzing module, can be integrated components, or separated component.

, contextual model selection unit between the image signal analyzing module, can be a cable connection, or a wireless connection (0008) of the LED light source between the LED light source control module, an LED light source control module and contextual model selection unit between

[0009] The LED light source refers to lamp using LED as lighting source, including but not limited to desk lamp, surface-decorative lamp box, the lamp tube.

[0010] This utility model of the working principle is: through scene mode selecting unit selects the preset scene module, and adapting the LED light source through LED light source control module, to make it present preset lighting effect. to satisfy the illumination requirements of different scene, also can through scene mode selecting unit selects the free setting scene module, and realizing self-adaptation LED light source through LED light source control module, to make it present custom lighting effect to satisfy the individual illumination demand of different users; it also can through scene mode selecting unit selects the intelligent automatic control scene module, then through image signal analyzing module comprehensively analyzes the image signal output device of image signal, and uses LED light source control module real time self-adapting LED light source, so that it can be matched image real-time varying lighting effect, so as to reach the effect of creating light atmosphere.

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[0011] This utility model not only has a plurality of different fixing lighting effect, and it has intelligent automatic real-time adapted light atmosphere of varying lighting effect, and can meet the reading, resting, cando and game lighting requirements of different places, which not only can reach the eye and visual fatigue relieving function, but also can be matched so that the context of the visual environment and the image picture of the user, so as to enjoy the immersive visual effect.

Description according to claim claimimages

[0012] picture 1 is the utility model structure schematic diagram of the first embodiment;

[0013] picture 2 is the utility model structure schematic diagram of the second embodiment.

Preferred Embodiment

[0014] Following combine the accompanying drawings of this utility model to make further detailed explanation:

[0015] Embodiment 1: refer to picture 1, this utility model adjustable LED atmosphere lighting system, comprising an LED light source, an LED light source control module and contextual model selection unit, scene mode selection unit, an LED light source control module and the LED light source are electrically connected, the contextual model selection unit that comprises, in parallel, a predetermined scene module and freely set the scene module.

[0016] Embodiment 2: refer to picture 2, this utility model adjustable LED atmosphere lighting system, comprising an LED light source, an LED light source control module, scene mode selection unit and the image signal analyzing module, a contextual model selection unit, LED light source control module and the LED light source are electrically connected, the contextual model selection unit comprises a preset scene module in parallel, freely setting the context module and the intelligent automatic control scene module, can electrically connect the image signal analyzing module and transmitting image signal to the image display device of the image signal output device. and contextual model selection unit intelligent automatic control scene module is electrically connected.

(Translation from Clarivate Analytics)

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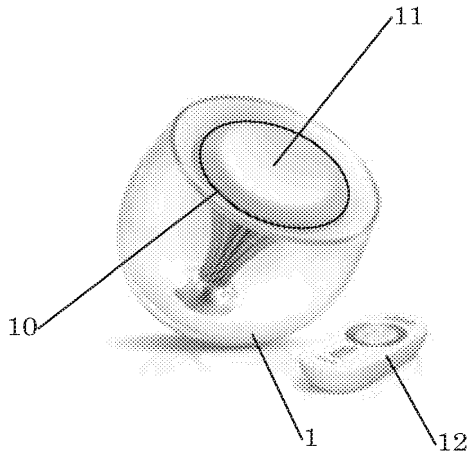
(72) Inventor: **The designation of the inventor has not yet been filed**

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(54) Stochastic dynamic atmosphere

(57) The invention concerns a lighting device for creating dynamic atmospheres, said lighting device comprising: at least one light source; the light source being adapted to operate in a plurality of color states, the light source emitting differing colors for each color state; a controller for controlling the color state of the light source; the controller further comprising a random generator to provide a transition between a previous and a subsequent state the controller is adapted to provide the transition based on probabilistic output provided by the random generator implementing a stochastic model, the probabilistic output dependent on at least the previous color state. In addition, a method is provided for generating the stochastic model; and a method for creating dynamic atmospheres based on probabilistic output provided by the stochastic model.

Figure 1



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Description

FIELD OF INVENTION

[0001] The invention relates to a lighting device with changing colors.

DESCRIPTION OF THE PRIOR ART

[0002] People have been listening to music for a long time for distraction and relaxation. More recently, alternative entertainment may be found in watching television or even more recently, watching movies on video or dvd. It is also known for quite some time that creating additional atmospheric effects, accompanying the audio or video entertainment source greatly enhances the user experience.

[0003] One way to create an additional atmosphere is to provide additional graphics, functionality present in most media players. Graphical effects are shown while listening to a song. These effects are generated on basis of the rhythm or the frequency (often represented by the Fast Fourier Transform (FFT) signal) of the song that is playing.

[0004] A more profound way to create an atmosphere is by generating light effects.
An exemplary application hereof is a light organ. In a light organ, a number of colored lights are flashing on the rhythm or on the frequency of the music. These light effects are also directly derived from the song that is playing.

[0005] However, these light effects are unable to reflect natural atmospheres and light transitions as found in nature. Both methods have the disadvantage that similar input will provide similar effects. Therefore the effects will be predictable and repetitive. Another disadvantage is that creating the effects depends on playing the entertainment source. In the above methods, sometimes noise - e.g. from a (pseudo)random generator - is added to the effects to make the effects look less repetitive and predictable. However, this is only a makeshift measure for camouflaging the drawbacks of the methods. It does not really make the effects unpredictable and natural. Another example of creating a natural atmosphere with light effects is by providing an extra illumination signal with the entertainment source. This is e.g. described in the prior art document US6166496. Although this approach avoids scripting and therefore repetition and predictability may be avoided, other disadvantages are present. The first drawback is that a significant amount data needs to be stored and transported to the lighting device. Another disadvantage, as in the previous examples is that the additional effects can only be created in combination with the entertainment source. It is not possible recreate an atmosphere without playing the entertainment source.

SUMMARY OF THE INVENTION

[0006] In one aspect, the invention aims to provide a natural and unpredictable atmosphere. In another aspect, the invention regards a device for autonomously creating dynamic atmospheres. According to an aspect of the invention, a lighting device for creating dynamic atmospheres, said lighting device comprising: at least one light source; the light source being adapted to operate in a plurality of color states, the light source emitting differing colors for each color state; a controller for controlling the color state of the light source; the controller further comprising a random generator to provide a transition between a previous and a subsequent state wherein the controller is adapted to provide the transition based on probabilistic output provided by the random generator implementing a stochastic model, the probabilistic output dependent on at least the previous color state.

[0007] According to another aspect, a method for creating dynamic atmospheres is provided, the method comprising: operating a multimedial source in a plurality of states, each state associated with a perceptual differing atmosphere; and providing a transition between a previous and subsequent state, based on probabilistic output provided by a stochastic model, the probabilistic output dependent on at least the previous state.

[0008] According to another aspect, a method is provided for generating a stochastic model, comprising: receiving multimedial input, clustering the multimedial input according to a predefined aspect; computing a statistic on subsequent transitions between the clusters; and generating probability parameters associated with the computed statistic so as to implement the stochastic model.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention will be further elucidated in the figures:

Fig. 1 shows a first embodiment according to the invention;
Fig. 2 shows a detail of the embodiment in Fig. 1.
Fig. 3 shows a schematic example of a stochastic model implementing transitions between subsequent states; and
Fig. 4 shows schematic diagram of a method for generating a stochastic model according to the invention and of a

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method for creating dynamic based on the stochastic model; and
Fig. 5 shows subsequent steps according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0010] Turning to Figure 1, a schematic drawing is shown of a lighting device 1 for creating dynamic atmospheres, implementing an illuminator 11 housed on a mounting plate 10. The illuminator 11 comprises a controller 20 that controls the coloring of the device 1 according to an aspect of the invention. The controller 20 is provided, as can be seen in Figure 2 on a mounting plate 10 (printed circuit board) housing essential circuitry for controlling the light sources 21, in particular, as in this example, a plurality of sources of any RGB composition, such as: one or two red high brightness LED sources, a green and a blue source. Alternatively, other light sources, such as an incandescent light source may also be used, or any other multiprimary light source, or color temperature adjustable light source. More in particular, the light source (in this example comprising an RGB triplet) is adapted to operate in a plurality of color states, wherein a color state is defined by the (composite) light source emitting a specific color. Thus, a color state may be defined by a specific CIE XYZ coordinate, or coordinated in any derived color space, e.g. an RGB combination. This defines the perceived coloring of the light, in addition to a controlled intensity of the respective RGB sources 21. Otherwise, the light source may vary the radiated wavelength, to generate a specific color in the visible light spectrum.

[0011] To control the color state, controller 20 is provided, which can inter alia be programmed to drive the light sources to emit a specific coloring. In particular, the light source 1 can thus operate in different subsequent color states, that is, first, the light source 1 emits a first specific color, and, after a certain time, the light source 1 changes color under control of the controller 20.

[0012] The controller 20 may be preset by control parameters that may be preprogrammed, but, in a preferred embodiment, may also be uploaded, for example, as an added feature on a remote device 12, conventionally used for varying the color. In particular, the color states may be predefined and uploaded via a terminal or wireless data controller 22. In addition, other control parameters may be preprogrammed or uploadable. For example, the transition dynamics may be variable or presettable. Thus, a user can define the dynamic behavior between subsequent states, so that the state transitions can proceed in a pace and a manner that is desired or that fits a certain ambiance. The transition dynamics presetting circuitry may are also be part of the controller 20 as here depicted. In addition, the probabilistic parameters as further described hereinbelow may also be preprogrammed or uploadable via the data controller 22.

[0013] For defining spatial configurations based on a probabilistic model, to be explained further herein below, the data controller may also be used as a data link is adapted to communicate with other light sources comprised in the device.

[0014] Accordingly, where several lighting devices of the type illustrated in Figure 1 are used, the lighting device 1 could also comprise detectors for detecting physical location with respect to neighboring lighting devices and the model and the processor/stochastic modeling means is arranged to co-operate with the model and the processor/stochastic modeling means of the neighboring lighting devices to provide the random/stochastic atmosphere.

[0015] Thus, by a negotiating mechanism, the devices 1 may communicate their respective states to each other or to a central control system, which may decide how the spatial and/or temporal dynamics of subsequent color states will evolve.

[0016] Herein, a temporal color transition will be defined as a change in color states of a color device that evolves over time. A spatial color transition will be defined as a change in color states between two spatially annexed devices, for example, in particular, in a system comprising a geometric arrangement (for instance: a matrix array or random clustered arrangement) of a plurality lighting devices, each having a specific color state. In may be appreciated, that the stochastic relations between timely and spatially annexed states may be controlled independently of each other, and one or both of them may be controlled by the probabilistic output provided by the random generator implementing the stochastic model. In particular, a 'previous state' may be understood in a spatial sense, in that a previous and a subsequent state may be formed by two annexed lighting devices.

[0017] In addition, the data link may be attached to communicate with other multimedial sources, such as audio, and or video sources. Thus, in addition to the color transitions, other perceptual ambiance transitions, such as audio sounds or imaging effects may be controlled by the inventive principle.

[0018] Figure 3 shows in more detail a schematic example of a stochastic model defining transitions between subsequent states (1)-(5), as implemented in the controller 20. To this end, the processor comprises a random generator (not shown). The output of this generator defines which transition between a previous and a subsequent state will take place. That is, based on the probabilistic outcome of the generator, and starting from a present state (which will become the previous state) the controller decides and controls which subsequent state (1)-(5) is realized, based on this present state. Figure 3 implements a Markov type chain model that is a probabilistic/stochastic (instead of deterministic) process for describing transitions of a system from one state to another. However, the stochastic model is not limited to (purely) Markov type processes but could also be implementing other probabilistic models like probabilistic automata and Bayesian networks.

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[0019] In this preferred example, given the present state, future states are independent on the past states. However, this dependency can also be added in a more generalized form. At each instant the system may change its state from the current state to another state, or remain in the same state, according to a certain probability distribution. The probabilities associated with various state-changes are termed transition probabilities.

[0020] A finite state machine may be used as a representation of a Markov chain. If the machine is in state x at time n, then the probability that it moves to state y at time n + 1. However, this is not limited to temporal transitions, but could also apply to spatial transitions. Also, a combined temporal and spatial transition model can be applied, where, for instance a plurality of light sources can be used in a predefined spatial configuration, each of which apply a color state that may have a spatial probabilistic correlation. A way to describe such relations are Markov Random Fields known in the art. Thus, a probabilistic correlation may exist that neighboring light sources are in predefined mutual states; wherein the terms previous and 'subsequent' are used in a generalized spatial context which may be defined by a nearest neighbor principle. In addition, a probabilistic correlation may exist that each light state will evolve, in a temporal manner from a previous to a subsequent state.

[0021] In Figure 3, the nodes (30) represent the possible states of the system. Arrows (31) between nodes i and j represent the probability that the system changes from state i to j in a single time step.

[0022] In the exemplary state machine it can be seen that a system in state 1 at a time n, has a probability of 95% that the system continues to stay in state 1 at time n + 1 and a probability of 5% that the system moves to state 2 at time n + 1. Furthermore, the diagram shows that a system in state 3 at time n has a probability of 85% to continuing this state at n + 1, a probability of 12% of moving to state 4 at time n + 1 and a probability of 3 % to state 1 at time n + 1.

[0023] The probability parameters of a Markov chain model may also be represented in a transition probability matrix:

	1	2	...	n
1	p_{11}	p_{12}		P_{1n}
2	p_{21}	p_{22}		p_{2n}
...				
N	p_{n1}	p_{n2}		p_{nn}

[0024] Figure 4 shows a schematic diagram of a method for generating a stochastic model according to the invention and of a method for creating dynamic based on the stochastic model. In this diagram, the parameters of the probability model, as implemented in controller 20 need to be determined, e.g. from a video source or an image 40 (as shown in Figure 4) displaying natural (temporal and/or spatial) color transitions. Second, the model has to be loaded in the controller 20 of lighting device 1, where it has to be executed.

[0025] The modeling and rendering of arrangement of colors from image 40 is schematically indicated in subsequent model generating step 41. A rendering device 21 includes at least one light source that renders a sequence of colors based on the generated model.

[0026] The model generating step 41 will be described further in detail with reference to Figure 5. First, it can be seen from Figure 4, that the image is clustered in certain areas, each area defining a mean color weight. In another example, dynamic lighting effects, associated with temporal color transitions may be derived from video content of for example natural scenes, such as water, fire or scenery. Accordingly, a stochastic (Markov) model is generated from a temporal color distribution of a video source sequence; or from a spatial color distribution of an image. As a distance measure, delta E (CIE Lab), known in the art may be used. In addition, the smallest clusters of the color distribution are removed, and a centroid of each cluster can be used as node in the Markov chain.

[0027] Accordingly, the step 501 in Figure 5 wherein multimedial input is clustered according to a predefined aspect, such as color, chromaticity, lightness in one example, concerns:

1. Extracting representative color features (fi) from each frame $0 \leq i \leq m$ of the source video.
The extracted color features from every frame represent the overall color composition of the frame or the illumination color in the frame. As example features the mean color of the frame, the median and the trimean color can be used, as well as the lighting color estimate using for example the grayworld, the whitepatch or the PCA (principal component analysis) algorithm.
2. Reduce the number of colors by clustering the extracted colors (fi) into color classes (cj), $0 \leq j \leq n$ and substituting every color (fi) with its class representative (fi*). The variance in every class (Vj) is also learned.
Any general non-supervised clustering algorithm can be used to find the clusters of colors. In our example implementation, k-means clustering and blurring mean shift are used.
3. Taking the classes (cj) as states of the Markov Chain. The transition probabilities (pa,b) $0 \leq a,b \leq n$ of the Markov

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Chain are estimated in a step 502 using the observed transitions in the clustered source colors (fi*).

[0028] Another clustering aspect can be according to a time integral aspect, such as average color or sound level over a predetermined time.

[0029] Alternatively, the source material can be a static image. In this case, the transition probabilities are estimated from the neighborhood probabilities of states (color classes) and the speed of rendering is manually controlled.

[0030] Alternatively, the model can be manually crafted. A light design artist may manually 'VJ like' create the color states and the transition probabilities. For the latter there are several possibilities. A designer could only determine the probabilities between predetermined color states. Another possibility is to let the user determine both the colors (distribution) in the range and the probabilities for each state transition. This could be done with software on a computer and the resulting model may be transferred to the lighting device, for example, through downloading from a website.

[0031] The Markov model generated this way is then incorporated into a (standalone) lighting device which can autonomously render the random/stochastic atmospheres.

[0032] For the learning process of these models, the input is not limited to video and pictures, but may include audio, all kinds of sensors (pressure, temperature or physiological) or a combination of the above.

[0033] Rendering of color states according to the derived model:

[0034] Given the number of colors N and update frequency f:

The model uses:

N^2 numbers for the state transition probabilities
3N numbers for the RGB values for the colors
In terms of processing power:
f (pseudo) random numbers generated per second
f log(N) table look-ups per second
[f operations of a low pass filter per second]

Hence, for realistic N ($5 \leq N \leq 20$) and f ($25 \leq f \leq 50$), implementations are possible on very small processing platforms. Step 503, wherein probabilistic output is derived from a model implementing a stochastic process, will be further explained based on an example. Suppose a model with 4 states and four state transitions. For example, the probabilities to stay in state 1,or go to states 2, 3 and 4 when in state 1 may be 0.7, 0.05. 0.1 and 0.15 respectively.

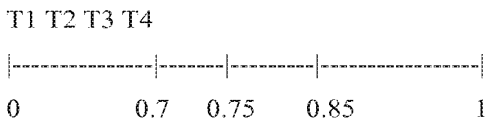
The probability of going to another state while in state 1:

Transition from S1 to

S1	70%
S2	5%
S3	10%
S4	15%

One possibility to map the random numbers on the transition is a linear search.

This means that the random numbers between 0 - 0.7 will result in staying in the same state, random numbers between 0.7 - 0.75 will result in transition 2, 0.75 - 0.85 to transition 3 and 0.85 - 1 to transition 4.



Of course the order of the transitions may be changed.

Accordingly, in step 504, the outcome of the model is used to generate a state transition to change the color state of the device.

The rendering of a model is a simple operation that only requires one random draw from a uniform [0, 1] distribution and a linear search per time interval at which the model is rendered (usually for models learned from video material 25 Hz). An alternative mapping method is binary search.

For a single light source, the rendering process was done by a random generator that picks the state transitions. For an

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Markov Random Field (MRF), a technique like Gibb's sampling can be used to generate a sequence of colors for all light devices.

The embodiments in this invention disclosure include lighting devices. The invention though is not limited to only light as output, but covers sound (soundscapes), smell, vibration and tactile output as additional modalities as well. It also covers a combination of these output modalities. More in particular, it may be understood that the invention also covers embodiments, without express indication to the contrary, of combined features as described hereabove.

Claims

1. A lighting device for creating dynamic atmospheres, said lighting device comprising:

   - at least one light source; the light source being adapted to operate in a plurality of color states, the light source emitting differing colors for each color state;
   - a controller for controlling the color state of the light source; the controller further comprising a random generator to provide a transition between a previous and a subsequent color state; wherein
   - the controller is adapted to provide the transition based on probabilistic output provided by the random generator implementing a stochastic model, the probabilistic output dependent on at least the previous color state.

2. A lighting device according to claim 1, wherein the transition regards a temporal and/or spatial color transition between previous and subsequent color states.

3. A lighting device according to claim 1, further comprising a transition dynamics presetting circuit, for defining the transition dynamics between subsequent states.

4. A lighting device according to claim 1 further comprising a terminal for exchanging stochastic model parameters; transition dynamic parameters and/or color state parameters.

5. A lighting device according to claim 1, further comprising multimedial output devices associated with the color state.

6. A system comprising a geometric arrangement of a plurality of coupled lighting devices according to claim 1.

7. A lighting device according to claim 1, further comprising:

   - multimedial output devices driven by multimedial sources,
   - a clustering circuit for clustering the multimedial output according to a predefined aspect;
   - a computational circuit for computing a statistic on subsequent transitions between the clusters;
   - a processing circuit for generating probability parameters associated with the computed statistic; and
   - an output circuit for outputting the probability parameters to the random generator so as to implement the stochastic model.

8. A device for generating a stochastic model for a device according to claim 1, comprising:

   - an input for receiving multimedial input,
   - a clustering circuit for clustering the multimedial input according to a predefined aspect;
   - a computational circuit for computing a statistic on subsequent transitions between the clusters;
   - a processing circuit for generating probability parameters associated with the computed statistic; and
   - an output circuit for outputting the probability parameters so as to implement the stochastic model.

9. A method for creating dynamic atmospheres, the method comprising:

   - operating a multimedial source in a plurality of states, each state associated with a perceptually differing atmosphere; and
   - providing a transition between a previous and subsequent state, based on probabilistic output provided by a stochastic model, the probabilistic output dependent on at least the previous state.

10. The method according to claim 9, wherein the multimedial source is a light source, and wherein the state is a color state.

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11. A method for generating a stochastic model, comprising:

- receiving multimedial input,
- clustering the multimedial input according to a predefined aspect;
- computing a statistic on subsequent transitions between the clusters; and
- generating probability parameters associated with the computed statistic so as to implement the stochastic model.

12. The method according to claim 11, wherein the parameters of the stochastic model are extracted from a temporal color distribution of a video source sequence.

13. The method according to claim 11, wherein the parameters of the stochastic model are extracted from a spatial color distribution of an image.

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Figure 1

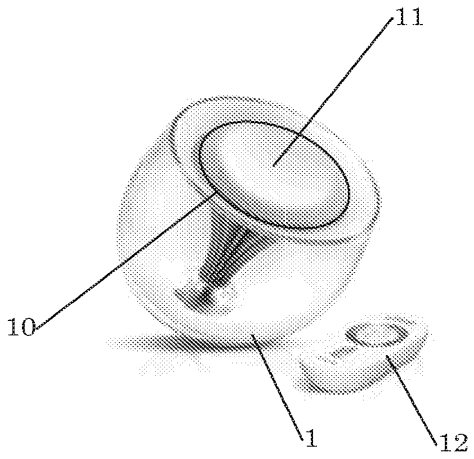


Figure 2

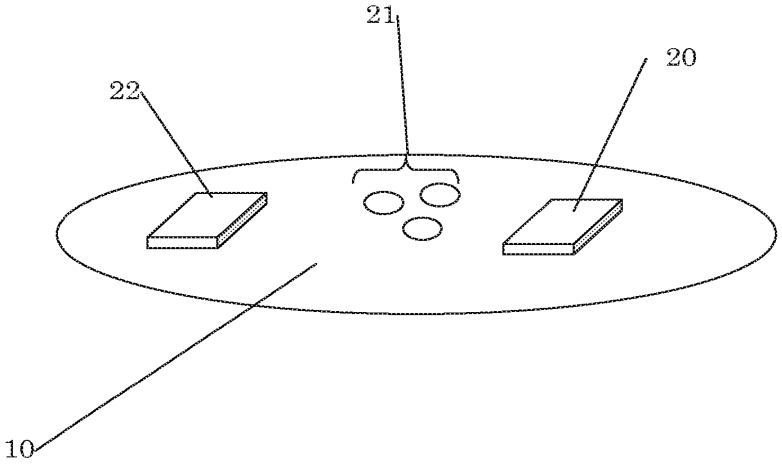


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Figure 3

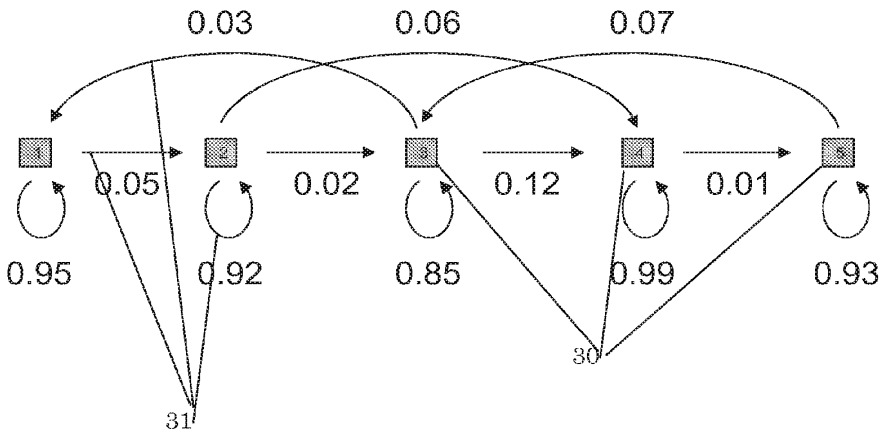


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Figure 4

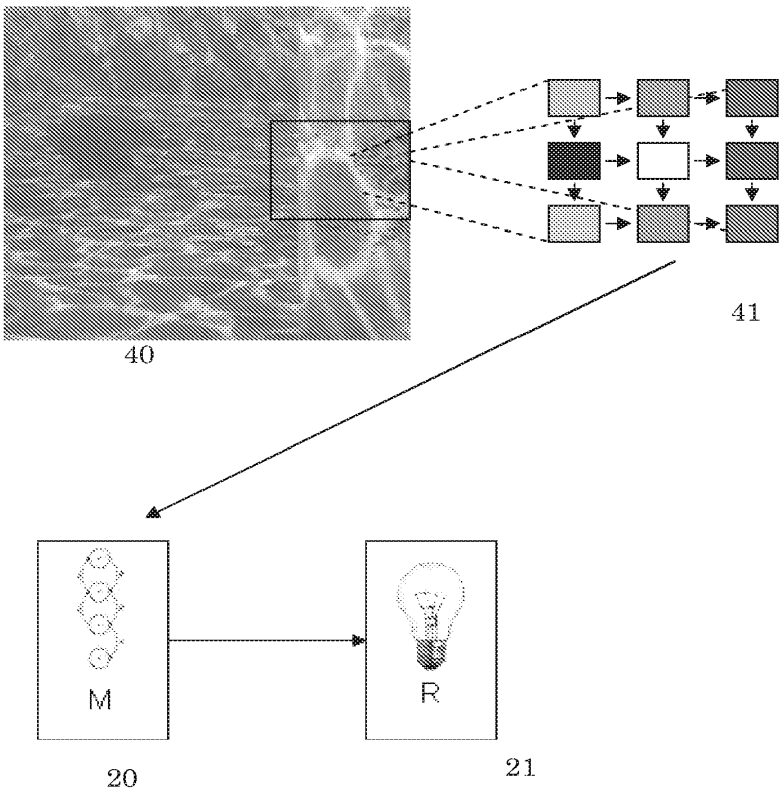


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Figure 5

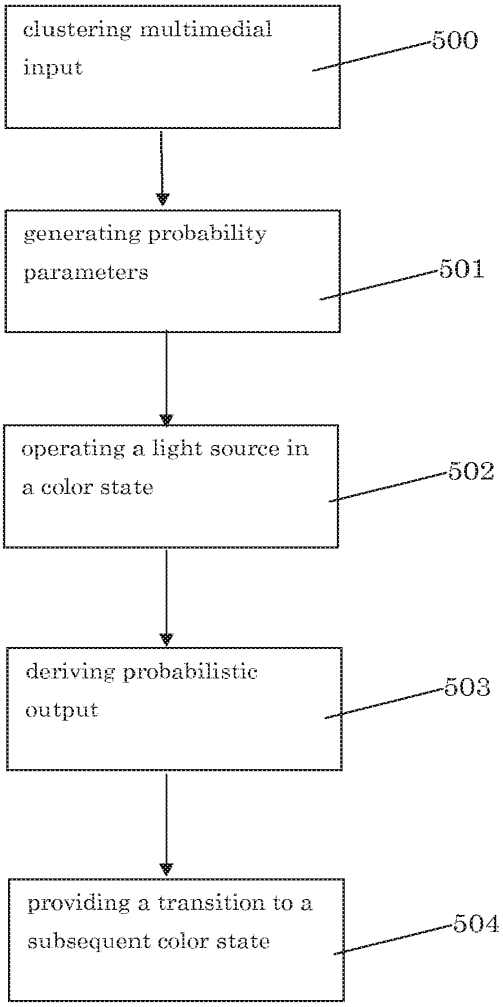


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EUROPEAN SEARCH REPORT

Application Number
EP 08 15 6094

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Y	US 6 611 297 B1 (AKASHI YUKIO [JP] ET AL) 26 August 2003 (2003-08-26) * column 3, lines 55-62 * * column 14, lines 6-9 * * column 30, lines 8-59 *	1-7,9-13	INV. H05B37/02
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X	US 2006/233437 A1 (DIEHL HANS-PETER [DE]) 19 October 2006 (2006-10-19) * page 3, paragraph 37 * * page 3, paragraph 39 *	8	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 September 2008	Benedetti, Gabriele

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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(54) LIGHTING DEVICE

(57) There is provided a wearable or portable lighting device for playing out, together with a plurality of other wearable or portable lighting devices, a predetermined time-varying lighting pattern over a space occupied by said device and the other devices; said device comprising: at least one light source; memory for storing a representation of the time-varying lighting pattern; and at least one controller configured to determine a current location of said device, to receive a timing signal for determining a current stage of the time-varying lighting pattern in synchronization with the other devices, and based on said determination and said timing signal, with reference to the representation in memory, to select a portion of the time-varying lighting pattern corresponding to the current location and stage and to cause the at least one light source to play-out said portion.

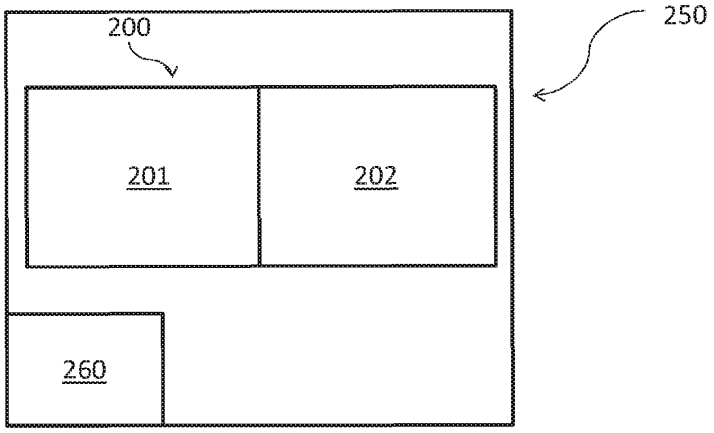


Figure 2

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to a lighting device, a centralized control unit and a lighting system comprising the same.

BACKGROUND OF THE INVENTION

[0002] A plurality of wearable and/or handheld lighting devices located within a space can each be controlled to collectively render a synchronized lighting effect that creates an immersive light experience as part of concerts and other events with large crowds. In one example involving a concert, a plurality of user-held lighting devices within an arena are each configured to emit a light corresponding to a respective part of a preconfigured light show. The light emitted by each of the plurality of devices is configured such that, at a distance from the user-held devices, an overall image/lighting effect is formed. This is shown in Figure 1.

[0003] Figure 1 shows an arena comprising a plurality of lighting devices 100 in the form of handheld user lighting devices. The arena is divided into a plurality of light regions 101a-101d, with one or more of the lighting devices 100 falling within each of the regions. In other words, each region comprises at least one lighting device 100. The lighting devices 100 may be arranged to output a particular sequence of colored light in dependence on which region they are located in. For example, assume that the arena is divided into quadrants. The handheld lighting devices in the upper left quadrant 101a are initially configured to emit a blue light, before cycling through red, green and yellow lights. The handheld lighting devices in the upper right quadrant 101b are initially configured to emit a red light before cycling through green, yellow and blue lights. The handheld lighting devices in the lower left quadrant 101c are initially configured to emit a green light before cycling through yellow, blue and red lights. Finally, the handheld lighting devices in the lower right quadrant are initially configured to emit a yellow light before cycling through blue, red and green lights. In this manner, a particular large-scale lighting effect can be achieved. A camera directed towards these handheld lighting devices may then record the lighting effect before outputting the recorded lighting effect to a display that the users of the handheld lighting devices can view in real-time. The lighting effect may be synchronized to an audio track being played at the concert.

[0004] There are numerous ways of coordinating the lighting show provided by the handheld lighting devices. One way of doing this is for a centralized control unit to periodically send respective lighting control information for a particular time period to each of the plurality of lighting devices based on a determined location of the lighting devices.

SUMMARY OF THE INVENTION

[0005] When such lighting effects are based on time-varying pattern, such as a video file, a robust and reliable way to control thousands of such lighting devices is required. Streaming the data to every wearable or portable lighting device in real time is technologically challenging, expensive and reduces the battery time of the wearable or portable lighting devices.

[0006] To address this, the present application proposes a system for controlling multiple wearable or portable lighting devices.

[0007] According to one aspect, there is provided a wearable or portable lighting device for playing out, together with a plurality of other wearable or portable lighting devices, a predetermined time-varying lighting pattern over a space occupied by said device and the other devices; said device comprising: at least one light source; memory for storing a representation of the time-varying lighting pattern; and at least one controller configured to determine a current location of said device, to receive a timing signal for determining a current stage of the time-varying lighting pattern in synchronization with the other devices, and based on said determination and said timing signal, with reference to the representation in memory, to select a portion of the time-varying lighting pattern corresponding to the current location and stage and to cause the at least one light source to play-out said portion.

[0008] Advantageously, the predetermined time-varying lighting pattern has elements (or portions) that are accessed via both a current location of the lighting device and a current time. Thus, as either of these quantities change, the portion of the predetermined time-varying lighting pattern currently being played-out by the lighting device also changes. This allows for multiple lighting devices to be synchronized so as to, together, play out a predetermined time-varying pattern over a space without the need for users to stay in a predetermined location (e.g. their seats). To avoid sending substantial amounts of data during an event, the predetermined time-varying lighting pattern mentioned above can comprise the entire time-varying lighting pattern to be played out during that event. It is thus understood that a lighting device only plays out a portion of the stored predetermined time-varying lighting pattern during a single event.

[0009] In another embodiment, there is provided a centralized control unit comprising a controller configured to: send a predetermined time-varying lighting pattern for forming a lighting pattern over a space to a plurality of lighting devices; and send to each of the lighting devices a timing signal, wherein for each lighting device the timing signal can be used in combination with a current location of said device to identify a portion of the predetermined time-varying lighting pattern for playing-out said portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other aspects will now be described

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in more detail, with reference to the appended figures showing embodiments.

Fig. 1 illustrates an example lighting system;
Fig. 2 illustrates an example lighting system; and
Fig. 3 illustrates a schematic of an example lighting device.

[0011] All the figures are schematic, not necessarily to scale, and generally only show parts for elucidating various embodiments or aspects of the invention, wherein other parts may be omitted or merely suggested.

DETAILED DESCRIPTION

[0012] Figure 2 shows a lighting system 200 comprising a plurality of light regions 201, 202. Although only two regions are shown (and described below) for the sake of illustration, it will be understood that more than two of such regions may be comprised within the lighting system 200. The lighting system 200 may be dedicated to provide illumination for a specific space comprising the plurality of light regions 201, 202, such as (in the present example) an arena of a concert hall 250 during a concert. One light region 201 may be constituted by one or a group of lighting devices (such as is described below) for illuminating a specific region of the concert hall 250. The other light region 202 may be constituted by one or a group of lighting devices (such as is described below) for illuminating a different specific region of the concert hall 250. The light regions 201, 202 do not necessarily have to be immediately adjacent to each other, though that is one possibility.

[0013] The lighting system 100 may further comprise a centralized control unit 260 for controlling the light regions 201, 202, although this not essential to some embodiments described herein. The centralized control unit 260 may receive instructions for controlling the light regions 201, 202 either from a remote source or a local source. As an example of a remote source, the centralized control unit 260 may receive an instruction regarding how the arena should be lit during a subsequent time period from a control unit located outside of the arena (e.g. from a remote computer terminal or server). In this case, the centralized control unit 260 would comprise an interface suitable for receiving communications according to at least one communication protocol. Therefore, the centralized control unit 260 would comprise an interface allowing external control of the lighting system 200, such as an API (application programming interface). For example, the lighting system 200 may be externally controlled according to an IP (internet protocol) based standardized lighting control and management protocol and/or a Web Service based lighting control and management protocol, which may be defined on top of a CoAP (constrained application protocol) or a HTTP (hypertext transfer protocol) application protocol. As an example of a local source, the centralized control unit 260 may receive an instruction regarding how the arena should be lit during a subsequent time period from an input provided by a local operator. In this latter case, the centralized control unit 260 would comprise a user interface for receiving the input from the local operator e.g. the centralized control unit 260 may take the form of a computer terminal or lighting desk. In both of these cases, the instruction may indicate a particular predetermined time-varying lighting pattern to be played out, and/or timings associated with that predetermined time-varying lighting pattern.

[0014] As mentioned above, the lighting system is configured to provide an immersive lighting experience to users located within the specific space. To do this, there is provided a plurality of wearable or portable lighting devices suitable for playing out a predetermined time-varying lighting pattern over a space occupied by the plurality of the lighting devices. Embodiments of such lighting devices are now described.

[0015] Each of the lighting devices comprises: at least one light source; memory for storing a representation of the time-varying lighting pattern; and at least one controller configured to determine a first current location of that lighting device, to receive a timing signal for determining a current stage of the time-varying lighting pattern in synchronization with the other lighting devices, and based on said determination and said timing signal, with reference to the representation in memory, to select a portion of the time-varying lighting pattern corresponding to the current location and stage and to cause the at least one light source to play-out said portion.

[0016] Thus, assuming that the predetermined time-varying lighting pattern is stored in memory as a video, each lighting device receives an input on its location and a play-out time and determines a pixel in the video file based on both this location information and play-out time. This pixel represents the lighting to be emitted by that lighting device at that time at the location of the lighting device and so the lighting device controls its light output at that time so as to be representative of this pixel.

[0017] A schematic of such a lighting device 300 is shown in Figure 3. The lighting device 300 of Figure 3 comprises data storage 301, a receiver 302 for (in suitable embodiments) receiving a location input, a processor 303 and at least one light source 304. In this instance, the processor 303 implements the functionality of the above (and below) described controller. The data storage is configured to store the entire video content of the predetermined time-varying lighting pattern to be played over the course of an event (although it is understood that a lighting device will not play out the entire light show stored in the memory). The processor 303 is configured to derive partial content (such as a pixel/segment of a light show) from the entire stored predetermined time-varying light sequence based on a determination of a current location and on a timing signal received by the controller suitable for determining a current stage of the time-varying lighting pattern. The processor 303 is further configured to cause a lighting control signal to be passed

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to the at least one light source 304 based on this partial content. The lighting control signal controls the light emitted by the at least one light source 304.

[0018] The at least one light source may be a single light source in isolation, such as a light emitting diode. The at least one light source of the lighting device may be a pixel of a display, such as a liquid crystal (LCD) display, comprising multiple pixels. The at least one light source of the lighting device may be a set number of pixels of a display of the lighting device. The set number may be equal to or less than the total number of pixels on the display. This is useful where the display of the lighting device is to be configured to function as either one or multiple pixels in an overall image to be formed by a collection of similarly configured lighting devices. Thus, when the display of the lighting device is configured to act as two pixels in the overall image, half of the pixels of the display may form one of the overall-image pixels whilst the other half of the pixels of the display may form the other overall-image pixel. It is understood that there does not have to be an equal number of pixels of the display for both of the overall-image pixel. The overall-image produced by the similarly configured lighting devices is discernible from a distance at which the light emitted from all of the similarly configured lighting devices can be viewed. It is understood that the term "image" is merely illustrative and intended to convey a predetermined configuration of lighting elements across the specific space.

[0019] The lighting device 300 may comprise multiple types of memory. For example, there may be a read-only portion and a flash portion. The memory may be embedded in the lighting device and/or may reside on a removable drive. By "removable", it is meant that the drive is configured for repeated easy insertion and removal from the lighting device.

[0020] The controller may be a processor, or a bank of processors, configured to execute instructions loaded into the temporary memory (such as random-access memory).

[0021] Now, various features and/or embodiments associated with the lighting device and the functionality executed thereby is described.

[0022] The lighting device 300 is preferably a lighting device 300 that is wearable by a user in the space or may otherwise be held by or attached to a user in the space. For example, the lighting device 300 may be any of: a mobile phone of the user, a wristband, a t-shirt and/or a wand.

[0023] The controller of the lighting device 300 is configured to select a first portion of the predetermined time-varying lighting pattern in dependence on both the first current location and the timing signal. Thus the ways in which a current location can be determined will be explored first, before looking at different timing signals.

[0024] The controller of the lighting device 300is configured to determine a current location of the lighting device 300. This may be determined in any of a variety of ways.

[0025] For example, the controller may determine the location following receipt at the lighting device 300 of a location indication from a centralized control unit 260 (as described above and/or below). In other words, the centralized control unit 260 is able to determine the location of the lighting device 300 and to inform the controller of the lighting device 300 of its locality via a suitable wireless channel. The camera and/or the projector embodiments described below may be used by the centralized control unit 260 to determine the location of the lighting device 300. The centralized control unit 260 may be local. By local, it is meant within the vicinity of the lighting device 300. For example, a controller in the vicinity of the concert hall. The local centralized control unit may have previously provided the video data to the lighting device 300.

[0026] Described below are some of the examples of how the centralized control unit 260 and/or the controller of the lighting device 300 may obtain location information (although the following is described in terms of the controller of the lighting device 300 determining the location, the centralized control unit 260 may receive this information instead and forward it on to the controller of the lighting device 300).

[0027] The controller of a lighting device 300 may determine the location of its lighting device 300 based on the receipt of location information from a location services provider, such as from a global positioning system and/or via a cellular services provider.

[0028] The controller may determine the location following receipt at the lighting device 300 of location information from similar adjacent lighting devices 300.

[0029] The lighting device 300 may determine its location using location information received via receiver 302 from a camera directed towards the lighting device 300. In this case, the camera is orientated such that the lighting device 300 is viewable within the lens-view of the camera. The information received from the camera may be used to determine the location of the lighting device 300. For example, the camera may observe a lighting device 300 cycling through a particular light sequence and that information may be used to locate the lighting device 300 in the view of the camera. The camera information may be relayed via another lighting device 300 in the vicinity. In an example, the lighting devices may be turned on one-by-one and/or lighting devices in different segments of the crowds may be turned on simultaneously. The corresponding view captured by the camera may be used to determine the location of at least one of the active lighting devices.

[0030] Alternatively or additionally, the lighting device 300 may determine its location using location information received via receiver 302 from a projector directed towards the lighting device 300. The projector (such as an infra-red projector), may be configured to project lighting coordinates to individual lighting devices. The projector may project a first light signal or flash to facilitate localization. This first light signal or flash may also be used as

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the above-mentioned timing signal (e.g. as a trigger and/or an indication of the time at which the selected portion of the time-varying pattern should be played out). However, it is understood that a second light signal or flash may be used as the above-mentioned timing signal. This latter system has an advantage of allowing the lighting device more time to select the portion for play-out whereas the other system has an advantage of minimizing the number of transmissions to be made. The projector may convey such information as is mentioned above using coded, modulated light. Another manner of determining the location of a lighting device is to using an electrical signal (such as a radio frequency signal) comprising the absolute or relative location of the lighting device. A relative or absolute location measurement may also be made by the lighting device itself.

[0031] Alternatively or additionally, the lighting device 300 may determine its location using location information received from at least one of a variety of location service providers. For example, from satellite based GPS-like system. The lighting device 300 may also obtain location information from neighboring lighting devices 300. This includes both relative and absolute location information.

[0032] Now the role of, and different types of timing signal are discussed.

[0033] The timing signal is received by the controller of the lighting device 300 and used by that controller to determine a time at which the first portion should be played out.

[0034] The timing signal may be a trigger signal received from the centralized control unit.

[0035] Alternatively or in addition, the timing signal may be received in advance from an external source (such as the above-mentioned centralized control unit 260). In this case, the controller on the lighting device 300 assesses the timing signal relative to an internal determination of an absolute or relative time made by the lighting device 300 itself i.e. each lighting device 300 may comprise a respective local clock operable to keep time in synchronization with the other lighting devices 300, wherein the timing signal specifies a timing of the time-varying pattern in advance. For example, the timing signal may comprise an advance schedule for the lighting pattern, or the timing inherent in the video. Said selection by a particular lighting device 300 may then be performed by reference to its local clock.

[0036] Now, the predetermined time-varying lighting pattern is discussed.

[0037] The predetermined time-varying lighting pattern is preferably the lighting pattern to be played out during an entire show e.g. a concert. In other words, the predetermined time-varying lighting pattern comprises lighting information for the entire specific space for the duration of the event. This means that each lighting device 300 does not have to receive multiple data updates throughout the event/show that comprise video and/or image data. Thus this system can reduce the transmission overhead that takes place during the show.

[0038] The time-varying lighting pattern is preferably entirely stored in the read only memory in the lighting device 300. During execution, the portion of the time-varying lighting pattern is loaded into temporary memory (such as RAM) for execution by the controller.

[0039] The predetermined time-varying lighting pattern may be stored as video data. In this case, the timing signal could help determine a frame synchronization with the video. Further, the first current location may be used to locate an area in the determined frame e.g. a pixel, as described above. The predetermined time-varying pattern and/or the mapping between time, location and video pixels may be stored such that a range of times and/or locations corresponds to the same pixel. Further, it is preferable for the spatial resolution of the video to be selected in dependence on the number of the plurality of the lighting devices to be used in the system. For example, a lower number of lighting devices may require a video having a higher spatial resolution than the spatial resolution used for a higher number of lighting devices 300. The video to be used in the system may be sent wirelessly to all lighting devices 300 before the start of the event, e.g. sent out wirelessly by the centralized control unit 260. Alternatively, the video to be used in the system may be stored on flash cards that can be inserted into respective lighting devices.

[0040] The portion of the time-varying pattern may be further selected in dependence on at least one of: the age of a user of the lighting device 300; and/or a status of the user while the portion is being played-out. For example, when near a bar at the venue, the lighting pattern emitted by the lighting device 300 may change to indicate whether the user is of or over the minimum purchase age for alcohol.

[0041] Preferably, when a change in location is detected by a device, the portion of the time-varying lighting pattern output by that lighting device 300 is updated using the same procedure. Thus the controller may be further configured to: determine a second current location of the lighting device 300 during a subsequent stage of time-varying lighting pattern and to cause the at least one light source to play-out a further portion of the time-varying potion of the time-varying lighting pattern corresponding to the second current location. In other words, the controller is configured to update the portion of video data being played out via a display if the lighting device 300 moves into a region associated with a different portion of the image mentioned above. In other words, the lighting device 300 will play out the video data associated with that different portion of the image. In this manner, even if the lighting device 300 moves around with a user, the overall-image will remain clear and unmixed. The second current location may thus be associated with a different portion of the time-varying lighting pattern than the first current location. In other words, the further portion may be different to the portion of claim 1.

[0042] Now, further operations of the controller of the lighting device 300 in embodiments are discussed.

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[0043] The controller is further configured to cause the at least one light source to initiate play-out of said first portion of the predetermined time-varying lighting pattern. As described above, there are a plurality of lighting devices 300 configured to operate as described in close proximity to each other e.g. within an arena or concert hall. Together, the light emitted by each of the plurality of lighting devices 300 cooperates to form an image that is visible from a distance at which all of the plurality of lighting devices 300 can be viewed simultaneously. The portion of the predetermined time-varying lighting pattern output by the lighting 300 device corresponds to a fraction (e.g. a pixel) of this image. Thus, said play-out can be said to cause a fraction of an image to be output from the lighting device 300. It is understood that, by "image", it is merely meant a particular preconfigured orientation of lights (or a particular instant of the time-varying lighting pattern). As time and/or the location of a lighting device 300 changes, the selected frame and/or pixel of the predetermined time-varying lighting pattern being played out also changes.

[0044] The controller of the lighting device 300 may be further configured to only cause the at least one light source to play-out the further portion on condition that the second current location is different than the first current location by more than a predetermined amount. This means that the at least one light source will not needlessly oscillate between different portions where a user is close to a boundary region. Also, this process allows a lighting device 300 to not use as much battery power compared to the case where location information is always used to determine a frame/pixel synchronization, as repeated reloading different portions of the time-varying lighting pattern is avoided. The predetermined amount may be dependent on the size of the space in which the lighting devices 300 are and/or on the resolution of an image to be made by the time-varying lighting pattern at a given instant.

[0045] The controller may be configured to control a lighting parameter (e.g. the intensity, the number of pixels/the fractional number of light sources of the device to be used for playing out the selected portion, etc.) of the portion played out by the at least one light source in dependence on the number of similarly configured lighting devices 300 in the immediate locality of the lighting device 300. For example, if there are lots of similarly configured lighting devices 300 in the immediate locality of the lighting device 300, the intensity of the portion played out may be lower than in the event of there being fewer similarly configured lighting devices 300 in the immediate locality of the lighting device 300. The lighting parameter can be selected or configured so that the image mentioned above appears to be of relatively uniform intensity across the space in which the plurality of devices is located. The number of similarly configured lighting devices 300 in the immediate locality may be determined by determining the number of lighting devices 300 within a predetermined number of meters of the lighting device 300. For example, the number of lighting devices 300 within a radius of 1m of the lighting device 300 under consideration may be determined. The lighting parameter may then be selected based on the number of similarly configured lighting devices 300 determined to be in the immediate locality and the total number of the plurality of lighting devices 300.

[0046] The lighting device 300 may be flexible and further comprise a sensor configured to determine the shape and/or orientation of the lighting device 300. The controller 303 of the lighting device 300 may be further configured to use the determined shape and/or orientation of the lighting device 300 to modify the first portion played out in order to customize the played out portion for the current shape and/or orientation of the lighting device 300. In this manner, the overall-image formed by the plurality of lighting devices 300 may have less distortion than when the configuration and/or shape of the lighting device 300 is not taken into account.

[0047] It is further understood that the lighting device 300 may receive additional signals that may be used in the selection of a portion of the time-varying lighting pattern corresponding to the first current location and stage. For example, the lighting device 300 may receive a signal to select the portion as an initial step in the process outlined above. In response to this received signal, the lighting device 300 may then determine the current location and the current stage for selecting the portion as described above. Alternatively or in addition, the lighting device 300 may receive a signal that indicates a particular time-varying lighting pattern (e.g. that indicates one video file out of multiple stored video files) stored in the memory of the lighting device 300 from which the portion is to be selected.

[0048] Some more detail is now discussed regarding the centralized control unit 260 in accordance with some embodiments of the present disclosure. The centralized control unit 260 may operate in the lighting system 200 described above. The centralized control unit 260 is configured to send the predetermined time-varying lighting pattern for forming a lighting pattern over a space to a plurality of lighting devices 300; and send to each of the lighting devices 300 the timing signal, wherein for each lighting device the timing signal can be used in combination with a current location of said lighting device to identify a portion of the predetermined time-varying lighting pattern for playing-out said portion.

[0049] This centralized control unit 260 may be used in conjunction with the above-mentioned plurality of lighting devices 300. The centralized control unit is preferably located locally to the space in which the plurality of lighting devices 300 is operating.

[0050] The centralized control unit 260 may be configured to determine a location for each of the plurality of lighting devices 300 and to send to each lighting device 300 an indication of the respective location of that lighting device 300 for any lighting device 300 whose location has changed. Preferably, to reduce the amount of over-

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head during a concert, the location is only transmitted if it has changed from the previous location by more than a predetermined amount.

[0051] The centralized control unit 260 may be further configured to provide at least one of the plurality of lighting devices with a timing indication for use in selecting said portion of said video data.

[0052] Note however that the centralized control unit 260 is not necessarily required in all possible embodiments. For example, the time-varying pattern may be pre-loaded onto each of the lighting devices (e.g. by means of a memory stick or even at the time of manufacture), and/or the timing signal could be shared wirelessly between the lighting devices in a distributed fashion.

[0053] A particular embodiment of a lighting system 200 is now described.

[0054] In the system, there are a plurality of such wearable/attachable lighting devices, each of which is associated with a respective user. Each wearable lighting device has an entire video stored locally (e.g. on a flash card) that is accessible to that lighting device.

[0055] During the experience, the plurality of lighting devices 300 are in the same locality as each other such that their users form a crowd. Just before the start of the experience, the lighting devices receive input on their location in the crowd from the centralized control unit. The lighting devices may also receive location information from the centralized control unit during the experience to update the location. Each wearable lighting device 300 is also configured to receive timing signals from a centralized control unit 260 during play-out of the video that corresponds to a time in the video file.

[0056] Based on the determined location, the wearable lighting device plays-out only a part of the video during the subsequent segment, for example, one or a set (not all) of spatially adjacent pixels in the video. The part of the video may comprise one or more pixels. In other, words, the output may have both a left-handed and a right-handed component that are the same or different. It may be desirable to include sensing means to determine the orientation or shape of the output of the lighting device. For example, it would be useful for the lighting device to determine the orientation of its light output relative to the lens of a camera recording the space in which the lighting device is located. Further, when the lighting device is flexible, it would be useful for both the shape and orientation of the lighting device to be determined.

[0057] A camera, such as the one mentioned above, captures the light pattern effect resulting from each lighting device playing their selected part of the video. This resulting light pattern is then displayed to the crowd via a display screen directed towards the crowd.

[0058] In addition to the location and timing information, the selection of the part of the video to be played out in a subsequent time period may be performed in dependence on the function of the lighting device. For example, the lighting device may be used to indicate a user's age (e.g. above or below 18 years old) at the bar, or a color indicative of the person's role at the event while at the reception desk.

[0059] Each of the plurality of lighting devices may determine when to start playing out the selected part of the video following the receipt of a trigger signal. Alternatively, each of the plurality of lighting devices may determine when to start playing out the selected part of the video following receipt of an absolute or relative time stamp until the start of the play-out time.

[0060] Where the centralized control unit operates in an area having a camera having a field of view that encompasses the plurality of lighting devices, the centralized control unit comprises a processor for determining location information for each of the plurality of lighting devices from information received from the camera relating to the field of view recorded by the camera.

[0061] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

[0062] A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunications systems. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A wearable or portable lighting device (300) for playing out, together with a plurality of other wearable or portable lighting devices, a predetermined time-varying lighting pattern over a space occupied by said device (300) and the other devices; said device (300) comprising:

    - at least one light source (304);
    - memory (301) for storing a representation of the time-varying lighting pattern; and
    - at least one controller (303) configured to determine a first current location of said device (300), to receive a timing signal for determining a current stage of the time-varying lighting pattern in synchronization with the other devices, and based on said determination and said timing signal, with reference to the representation in memory (301), to select a portion of the time-varying lighting pattern corresponding to the first

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current location and stage and to cause the at least one light source (304) to play-out said portion.

2. A device (300) as claimed in claim 1, wherein the timing signal is a trigger signal from a centralized control unit remote from the device (300).

3. A device (300) as claimed in claim 1, further comprising a local clock operable to keep time in synchronization with the other devices, wherein the timing signal specifies a timing of the time-varying pattern in advance, and said selection is performed by reference to the local clock.

4. A device (300) as claimed in any preceding claim, further comprising a receiver configured to receive information from a camera directed towards the device (300), wherein said information is used to determine the location of the device (300).

5. A device (300) as claimed in any of claims 1 to 3, further comprising a receiver configured to receive information from a projector directed towards the device (300), wherein said information is used to determine the location of the device (300).

6. A device (300) as claimed in any preceding claim, wherein the controller (303) is configured to control a lighting parameter of the portion played out by the at least one light source (304) in dependence on the number of other devices in a locality of the device (300).

7. A device (300) as claimed in any preceding claim, wherein said portion is further selected in dependence on at least one of: the age of a user of the device (300); and/or a status of the user while the portion is being played out.

8. A device (300) as claimed in any preceding claim, wherein the controller (303) is further configured to determine a second current location of the device at a subsequent stage of the time-varying lighting pattern, and to cause the at least one light source (304) to play-out of a further portion of the time-varying lighting pattern corresponding to the second current location and stage.

9. A device (300) as claimed in claim 8, wherein the controller (303) is configured to cause the at least one light source (304) to play-out the further portion on condition that the second current location is different than said first current location by more than a predetermined amount.

10. A device (300) as claimed in any preceding claim, wherein the device (300) comprises a sensor configured to determine the shape and/or orientation of the at least one light source (304) in the device (300).

11. A centralized control unit (260) comprising a controller configured to;

- send a predetermined time-varying lighting pattern for forming a time-varying lighting pattern over a space to a plurality of devices (300) within the space; and
- send to each of the devices (300) a timing signal for determining a current stage of the time-varying lighting pattern, wherein for each device (300) the timing signal can be used in combination with a current location of said device (300) to identify and select a portion of the predetermined time-varying lighting pattern for playing-out.

12. A centralized control unit (260) as claimed in claim 11, wherein the controller is further configured to determine a location for each of the plurality of devices (300) and to transmit to each device (300) an indication of the respective location of that device (300) for any device (300) for use as the current location.

13. A centralized control unit (260) as claimed in any of claims 11 and 12, wherein the timing indication is one of: a trigger signal; an absolute time; and a relative time.

14. A centralized control unit (260) as claimed in any of claims 11 to 13, wherein the centralized control unit receives information from a camera having a field of view that encompasses said plurality of devices (300) and wherein the centralized control unit comprises a processor for determining location information for each of the plurality of devices (300) from this received information.

15. A lighting system comprising;

- a plurality of devices (300) as claimed in claim 1; and
- a centralized control unit (260) as claimed in claim 11,

wherein the centralized control unit is configured to transmit information to each of the plurality of devices (300) for determining the current location in each device (300).

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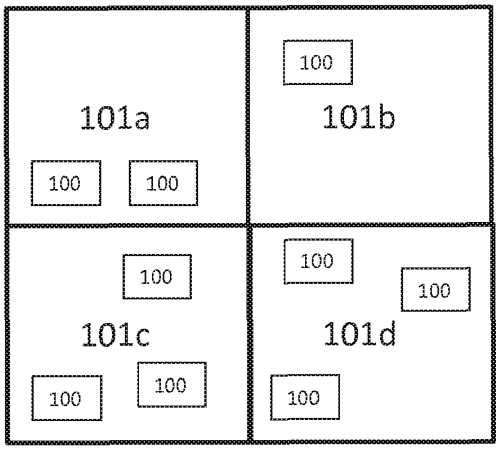


Figure 1

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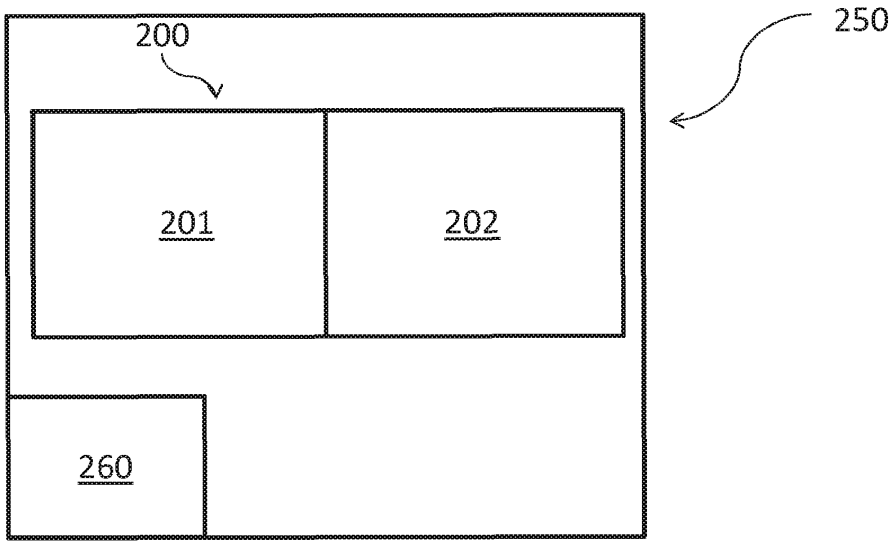


Figure 2

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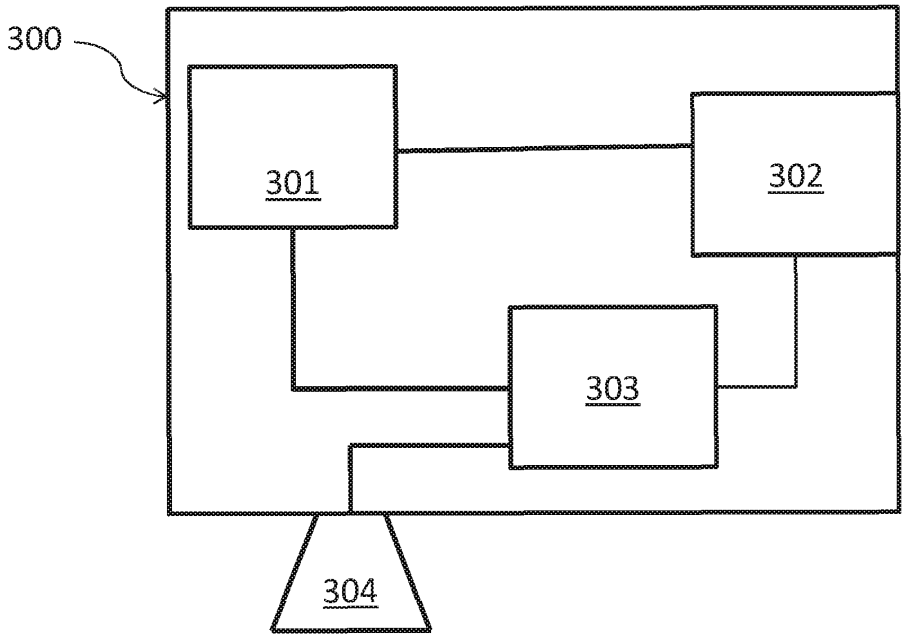


Figure 3

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Europäisches Patentamt
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Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 18 7578

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	WO 2013/021209 A1 (RB CONCEPTS LTD [GB]; REGLER JASON CHARLES [GB]; WANT DAVID [GB]; DEAR) 14 February 2013 (2013-02-14) * the whole document *	1-3,6, 11,13,15 4,5,7, 10,14 8,9,12	INV. H05B37/02
X Y	GB 2 440 784 A (BAILEY PETER JAMES [GB]) 13 February 2008 (2008-02-13) * the whole document *	1-3,6-9, 11-13,15 4,5,10, 14	
Y	EP 1 870 802 A1 (BARCO NV [BE]) 26 December 2007 (2007-12-26) * column 9, paragraph 45 *	4,5,14	
Y	WO 2006/126122 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; DUINE PETER A [NL]; CORNELISSEN H) 30 November 2006 (2006-11-30) * page 8, line 11 - page 9, line 13; figure 3 *	4,5,7, 10,14	TECHNICAL FIELDS SEARCHED (IPC) H05B G09F G06F H04R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 February 2016	Brosa, Anna-Maria

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 18 7578

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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11-02-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Declarations under Rule 4.17:

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

[Continued on next page]

(54) Title: DYNAMIC LIGHT EFFECT BASED ON AN IMAGE

(57) Abstract: A method is provided for controlling one or more lighting devices to generate a dynamic light effect based on an image. A first area in the image is selected based on first selection criteria (e.g. object recognition). Within this first area, a sequence of sub-areas (260, 262, 264) are selected based on second selection criteria (e.g. zooming in to a recognized object). Color values are extracted from each sub-area and the one or more lighting devices are controlled based on the extracted color values.

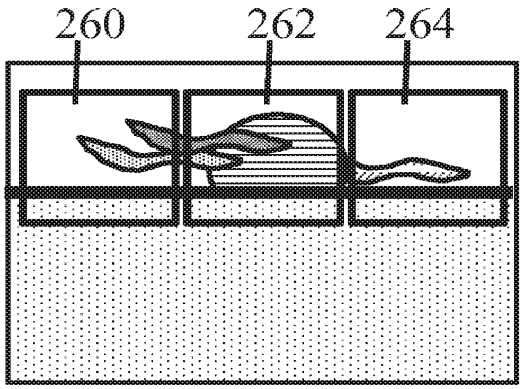


Fig. 2c

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Published:

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

Dynamic light effect based on an image

FIELD OF THE INVENTION

The invention generally relates to a method of controlling a lighting device, and more specifically to a method for generating a dynamic light effect. The invention further relates to a computer program product for performing the method.

BACKGROUND OF THE INVENTION

Modern lighting devices offer advanced control features, such as color control and dim level control. Output of a lighting device can be controlled through a user interface, for example, an application on a smart phone. Current user interfaces allow individual control of lighting devices, such as picking individual colors based on which the light output of a lighting device is controlled. The light output can be static or dynamic (i.e. changing over time). Especially when a dynamic light effect is required, it is tedious for a user to select a large number of colors to provide input for such an effect. There is a need for a simplified and intuitive control option for generating a dynamic light effect.

SUMMARY OF THE INVENTION

The inventors have realized that controlling a lighting device based on an image provides intuitive control to a user. Methods known in the state of the art, requiring a user to pick a sequence of colors in an image (e.g. using a color picker) are burdensome for the user when applied to generating a dynamic light effect. An automated method in which fully random colors in an image are picked can provide undesirable light effects. The method proposed by the inventors offers intuitive control based on an image (e.g. a single, static image), yet also simplified control.

In a first aspect, a method of controlling a lighting device to generate a dynamic light effect is provided. The method comprises: receiving an image; selecting a first area in the received image based on first selection criteria; selecting a sequence of sub-areas in the first area based on second selection criteria; extracting a set of color values, each color value extracted from a sub-area in the sequence of sub-areas; and controlling the lighting device based on the extracted set of color values to render a dynamic light effect. The image

can be displayed to a user via a user interface, for example: if the user has to select an image, the same interface in which a user selects the image can display the image; the image can be shown through a wall panel, smart phone or other device when the image is selected automatically or selected by the user.

To create a dynamic light effect, the lighting device is controlled to emit light of a first color from the set of colors and subsequently of a second color from the set of colors, and so on. The dynamic light effect can loop (i.e. emit a first color, a second color, .., a Nth color; and start again from the first color) or bounce (i.e. emit a first color, a second color, …, a Nth color and traverse back via N-1, N-2, …, to the first color), such that a single dynamic light effect is rendered multiple times. The dynamic light effect can comprise transitions, such as a transition from a first color to a second color, each comprised in the set of colors, through a third color, not necessarily comprised in the set of colors.

The sub-areas in the sequence of sub-areas can be overlapping, for example to support smooth transitions in a dynamic light effect, or non-overlapping. As part of extracting color values from a sub-area, the color values extracted from one or more other sub-areas in the sequence of sub-areas can be taken into account. For example, color values can be extracted that are similar in hue and/or brightness to the ones already part of the set of color values.

The extracted colors can be rendered in a particular order, such as in the same order as the sub-areas in the sequence of sub-areas from which the colors have been extracted. The sequence of the sub-areas then determines the order of the colors in the set of colors. The set of colors is thus, in this example, an ordered set of colors and the dynamic light effect is generated based on the ordered set of colors, such that at least a part of the dynamic light effect comprises rendering colors, by a lighting device, in a sequence following the sequence of the sub-areas from which the colors have been extracted. The color(s) extracted from a first sub-area would then be rendered first, those from a second sub-area would then be rendered second and those from a third sub-area would then be rendered last, or vice-versa.

In an embodiment of the method according to the first aspect, selecting the first area in the received image based on the first selection criteria comprises: detecting a focal point in the received image; and selecting as the first area an area in the received image comprising the detected focal point. This is beneficial as it allows automatic selection of the first area to support further ease of use for a user. As an example, the selection can be

performed without user intervention, or the user can be presented multiple first areas, each based on a focal point or other criteria, to select from.

In another embodiment of the method according to the first aspect, selecting the first area in the received image based on the first selection criteria comprises: determining a color homogeneity of each of a plurality of areas in the received image; and selecting one of the plurality of areas as the first area based on the determined color homogeneity of the one of the plurality of areas. This allows, for example, to detect an area in the received image made up of a color set that is more homogenous than the color set that the remainder of the image outside the area is made up out of; and selecting this area as the first area. This is advantageous as it allows a color, and indirectly possibly also an object, that is visually dominant in the image to be selected. A dynamic light effect based on this principle of selection of the first area can be highly recognizable by a user as being related to the image.

In yet another embodiment of the method according to the invention, selecting the first area in the received image based on the first selection criteria comprises: detecting an object in the received image; and selecting as the first area an area comprising the detected object. The detected object can be one of a set of natural phenomena, the set of natural phenomena comprising: a fire, a cloud, a body of water, a waterfall, and a heavenly body. Detecting a salient feature and computer vision methods supporting such are known to the person skilled in the art. Applying object selection to perform the selection of the first area is beneficial as it enables further automated creation of the dynamic light effect requiring even less user intervention, while resulting in a generated light effect that matches a user's expectations based on the received image.

In an especially advantageous embodiment of the method according to the first aspect, receiving the image comprises a user selecting the image from a set of images. For example, the user can select an image from an image library of images (s)he has taken, the user can take an image with a camera integrated into a smart phone executing the method, the user can download an image from a remote service, etc.

In yet further embodiments of the method according to the invention, selecting the sequence of sub-areas in the first area based on the second selection criteria comprises: determining a path in the first area in the received image; and selecting the sequence of sub-areas in the first area along the determined path. The determined path can run parallel to an axis of the received image. Determining the path in the first area of the received image can comprise: detecting one or more objects in the first area of the received image, such that the path crosses at least one of the one or more detected objects. As another example, the path in

the first area of the received image can be selected by a user. For example, a user can draw a line om the received image as displayed in a user interface, such as through a touch screen of a smart phone.

In an especially beneficial embodiment of the method according to the first aspect, the sub-areas in the sequence of sub-areas in the first area are of different sizes. As an example, the sub-areas in the sequence of sub-areas can be of an increasingly smaller size. This creates a zoom effect, whereby, for example, when a first area is selected based on object recognition, the object is zoomed in on. Other options comprise zooming out of an object, panning across an image to an object and then zooming in or out, etc.

In an embodiment of the method according to the first aspect, extracting a color value from a sub-area in the sequence of sub-areas comprises: extracting a dominant color value. This increases the likelihood of a user recognizing the dynamic light effect as being related to the image the user has seen on which the effect is based. The dominant colors are highly recognizable in both the image and the light effect.

In a further embodiment of the method according to the first aspect, the method further comprises: determining a particular order of the extracted color values based on at least one of: hue, saturation and brightness of the extracted color values, such that the one or more lighting devices are controlled based on the determined order of extracted color values. This allows the dynamic light effect to be rendered such that colors of the same hue are rendered in sequence (or out of sequence). An examplary use of such is a dynamic effect wherein the light level dims up as the various colors are rendered.

In a second aspect, a computer program product is provided for performing the method according to the first aspect and any of its embodiments. Such a computer program product can reside on a smart phone, tablet, wall panel or other device as an application. As a further example, the computer program product can be made downloadable through an application store accessible to the smart device. The computer program product can run on a single device, such as a single smart phone, or across multiple devices. For example, user input can be acquired through a user interface on a smart device, whereas image processing steps are performed on a server. As yet another example, control commands to control the one or more lighting devices to generate the dynamic light effect can be sent from the smart device or from a controller, such as a bridge device, arranged for controlling the one or more lighting devices.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 shows schematically and exemplarily a method of controlling one or more lighting devices to generate a dynamic light effect based on an image,

Figs. 2a, 2b, 2c and 2d show schematically and exemplarily respectively an image, selection of a first area in the image, selection of a sequence of sub-areas in the first area of the image, and extraction of color values from the sequence of sub-areas,

Figs. 3a and 3b show schematically and exemplarily determination of a path in a first area in an image and selection of a sequence of sub-areas in the first area along the determined path, and

Fig. 4 shows schematically and exemplarily a selection of a sequence of sub-areas in a first area of an image to zoom in on an object in the image.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 shows an embodiment of a method 100 of controlling one or more lighting devices to generate a dynamic light effect. The method 100 comprising: receiving 110 an image; selecting a first area 120 in the received image based on first selection criteria; selecting a sequence of sub-areas 130 in the first area based on second selection criteria; extracting at least one color value 140 from each sub-area in the sequence of sub-areas; and controlling 150 the one or more lighting devices based on the extracted color values.

The number of sub-areas in the sequence of sub-areas, the size of the sub-areas and the number of colors extracted from each sub-area can depend on the desired length and variation of the light scene. These can, for example, be user selectable, predetermined or dependent on the received image or selection of the first area. An intelligent system can be capable of generating a dynamic light scene based on a few inputs. For example, two colors are provided and intermediate colors are determined. In another implementation of the method, the colors rendered are those comprised in the color set only and a system executing the method does not need to be arranged to create, for example, transitions between colors. If a system executing the method has more intelligence (e.g. processing power) to generate variations based on a limited number of sub-areas, as an example only, two or three sub-areas could suffice. A larger number, such as over ten sub-areas, would help to realize some more natural variation in the scene or can be used with a system having less intelligence.

Sub-areas can be overlapping or non-overlapping. Again, the amount of overlap can be user selectable, predetermined or dependent on the received image or selection of the first area. Selecting overlapping sub-areas can help to create smooth transitions. For example, if a user wants to have calm dynamics, subsequent sub-areas in the sequence of sub-areas can largely overlap (e.g. for a shifting window, only move a few percent along one sub-area axis such that sub-areas almost fully overlap) whereas if more vivid dynamics are desired, subsequent sub-areas can have a small overlap (e.g. 50% overlap or less).

The sequence of sub-areas can be selected based on a path. Such a path can be provided by a user, for example, by providing (touch) input via a user interface to indicate the path in the first area of the image. As an example, path input can be received from a user first; such that the first area is selected based on the sub-areas selected along the path. Further examples of determining a path are: using object detection such that a path can be determined that crosses and/or avoids certain objects or features in the image; or zooming into or out of an object in the image. As a simple example, a path can be determined by detecting a (substantially) linear element in the image, or by taking an axis of the image as a basis for determining a path. Linear elements in an image, such as a horizon, can be recognized using image analysis or an assumption can be made that a horizon is a horizontal line in an image between two areas of different (sets of) colors. The latter allows the path to simply run parallel along an image axis.

Fig. 2a shows a static image 200 of a sky 205 and body of water 210 with, along the horizon 215, a setting sun 220. The sky 205 comprises clouds 225, 230, 240. In Fig. 2b a selection of a first area 250 in the image is shown. Fig. 2c shows the selection of a sequence of sub-areas 260, 262, 264 in the first area. Fig. 2d shows three sets of colors 270, 280, 290 extracted from the sub-areas 260, 262, 264 respectively. The first set of colors 270 comprises the color 272 of cloud 225, the color 274 of the body of water 210, and the color 276 of cloud 230. The second set of colors 280 comprises the color 282 of the sun 220, the color 284 of the body of water 210, and the color 286 of cloud 230. The third set of colors 290 comprises the color 292 of the sky 205, the color 294 of cloud 240, and the color 296 of the body of water 210. As an example, a lighting system (not shown) comprising three lighting devices can be controlled to generate a dynamic lighting effect based on the three sets of colors 270, 280, 290. A first lighting device in the system can first emit light of color 272, then of color 282 and finally of color 292; similarly a second lighting devices emits a sequence of colors 274, 284, 294; and a third lighting device emits a sequence of colors 276,

286, 296. Other options for the dynamic light effect are for all three lighting devices to render the same colors synchronously (e.g. to create a more intense effect) or non-synchronously (e.g. to simulate clouds moving). The colors may be rendered in a particular order, for example colors from the same sub-area are rendered in a random sequence, yet a lighting device first renders the colors extracted from the first sub-area 260, and only then from the next sub-areas 262, 264 in sequence.

Fig. 3a shows an image 200 in which a first area 250 has been selected. A path 300 has been determined in the first area 250. The path can be determined based on an axis of the image (e.g. to horizontally cross the image), on object recognition (e.g. to encircle a recognized object), on a user providing the path as input, or on other criteria. In Fig. 3b, a sequence of sub-areas 310 has been plotted along the path 300. The set of colors can then be extracted from these sub-areas, and the dynamic light effect can be rendered.

Fig. 4 shows an image 400 comprising an object 410 (e.g. a log fire, the object set against a beach background). Using image processing the object (i.e. the log fire, continuing the example) can be recognized as an area of interest and/or a salient feature in the image. For example, image processing can determine that the object 410 is a focal point in the image (e.g. the object 410 being in-focus and the remainder of the image, the beach background, being out-of-focus). As a further example, image processing can identify the object 410 and based on this determine that it should form the basis in the image 400 for generating a dynamic light effect. A first area 420 in the image 400 is selected, the first area 420 comprising the object 410. A sequence of sub-areas 430, 440 within the first area 420 is selected. In this example, sub-areas 430, 440 in the sequence are of increasingly smaller dimensions. Further, in this example, sub-area 440 is fully comprised in sub-area 430 and sub-area 430 is fully comprised in first area 420. This creates a zoom-effect, wherein the colors extracted to create the dynamic light effect are increasingly determined by the colors present in the object 410. The zoom effect can be based on the aforementioned image processing, such that a recognized object is zoomed in on for example. Another option is for a user to zoom into (an object in) the image, for example by performing a zoom gesture (e.g. pinch) on a touch screen.

The method can be executed by a computer program product, such as an application for a smart phone or an embedded software component on a controller for a lighting system. Selection of the first area, the sequence of sub-areas and performing the extraction of the color values can, for example, comprise a fully automatic process, or it can be made dependent on user input or user confirmation. The extracted color values can,

continuing the example, be presented to a user in a user interface, for example, alongside the image from which they are extracted.

The order in which colors are rendered by a lighting device or presented in a user interface can be determined such that there is minimal perceptual difference between subsequent colors. This produces a visually pleasant palette or gradient. If the perceptual difference between individual colors is defined as a cost, then an algorithm for sorting the palette is searching for a palette order such that total cost is minimum over the complete set of colors. For a linear gradient presented through a user interface or for rendering colors in sequence by a lighting device, the cost function can be defined as: Difference[1-2] + Difference [2-3] +…+ Difference [N-1 – N]. Wherein each number (1, 2, ..., N) is a color from the set of colors. When presenting a gradient in a user interface not in a linear fashion but radially, the cost function is: Difference [1-2] + Difference [2-3] +…+ Difference [N-1 – N] + Difference [N – 1]. For linear visualization, the difference between first and the last color in the palette is not relevant, while it has to be taken into account for radial palettes. As such, the most distant colors will most likely occur at the ends of the linear palette.

The perceptual difference between individual colors, as used in these cost functions, can be calculated with standard 'dE' functions (i.e. International Commission on Illumination's delta Empfindung metric) of various color spaces. The best results can be obtained with perceptually linear color spaces like CIELAB, CIELUV or CIECAM02. Optional further steps can be executed for linear ordering of the colors. For example, more dominant and more frequently occurring colors can be shown first (e.g. on the left in a horizontal gradient in a user interface).

The (ordered) colors can be turned into a gradient using standard gradient functions. For example, a function provided by the operating system of a smart phone on which the method is executed. If no gradient function is supported, as a further example, linear interpolation can be used.

When there are multiple lighting devices, colors can be assigned to individual lighting devices or each lighting device can render the same color(s). When lighting devices render different colors, the following is an example to illustrate how colors can be assigned to lighting devices. A first color for the first lighting device is picked (e.g. randomly or based on the ordered colors). The picked color can then be excluded from the color set and for the next lighting device a new color can be picked from the color set. This process can be repeated until all lighting devices (or light sources in a luminaire) have a color assigned. Alternatively, instead of randomly picking colors for the additional light sources, the adjacent colors of the

color palette can be picked. This could have the advantage of creating a smooth color gradient in a space or on a luminaire with multiple light sources. Examples of other rules that can be applied to assign a color to a lighting device are: choosing a complementary color, choosing an opposite color, etc. Assigning colors to lighting devices can be applied to a group of lighting devices instead of a single lighting device or luminaire, e.g. multiple lighting devices in close proximity can be grouped together. As a further example, the calculated weight of dominant colors can be mapped to lighting devices according to the prominence of the light effect generated by each lighting device. For instance, for each lighting device an effect contribution factor may be determined based on the lighting device's position, type, number of lighting nodes, typical lumen output, etc. Colors that are more dominant in the palette, in the set of colors or in the (first area or sub-area) in the image can be assigned to lighting devices that have a large contribution factor.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

1. A method of controlling a lighting device to generate a dynamic light effect, the method comprising:
- receiving an image,
- selecting a first area in the received image based on first selection criteria,
- selecting a sequence of sub-areas in the first area based on second selection criteria,
- extracting a set of color values, each color value extracted from a sub-area in the sequence of sub-areas; and
- controlling the lighting device based on the extracted set of color values to render a dynamic light effect,
wherein selecting the first area in the received image based on the first selection criteria comprises:
- detecting a focal point in the received image; and
- selecting as the first area an area in the received image comprising the detected focal point.

2. The method according to claim 1, wherein selecting the first area in the received image based on the first selection criteria comprises:
- determining a color homogeneity of each of a plurality of areas in the received image; and
- selecting one of the plurality of areas as the first area based on the determined color homogeneity of the one of the plurality of areas.

3. The method according to claim 1, wherein selecting the first area in the received image based on the first selection criteria comprises:
- detecting an object in the received image; and
- selecting as the first area an area comprising the detected object.

4. The method according to claim 3, wherein the detected object is one of a set of natural phenomena, the set of natural phenomena comprising: a fire, a cloud, a body of water, a waterfall, and a heavenly body.

5. The method according to any one of the preceding claims, wherein receiving the image comprises a user selecting the image from a set of images.

6. The method according to any one of the preceding claims, wherein selecting the sequence of sub-areas in the first area based on the second selection criteria comprises:

- determining a path in the first area in the received image; and
- selecting the sequence of sub-areas in the first area along the determined path.

7. The method according to claim 6, wherein the determined path runs parallel to an axis of the received image.

8. The method according to claim 6, wherein determining the path in the first area of the received image comprises:

- detecting one or more objects in the first area of the received image, and

wherein the path crosses at least one of the one or more detected objects.

9. The method according to claim 6, wherein the path in the first area of the received image is selected by a user.

10. The method according to any one of the preceding claims, wherein the sub-areas in the sequence of sub-areas in the first area are of different sizes.

11. The method according to claim 10, wherein the sub-areas in the sequence of sub-areas are of an increasingly smaller size.

12. The method according to any one of the preceding claims, wherein extracting a color value from a sub-area in the sequence of sub-areas comprises:

- extracting a dominant color value of the sub-area.

13. The method according to any one of the preceding claims, the method further comprising:

- determining a particular order of the extracted color values based on at least one of: hue, saturation and brightness of the extracted color values, such that the one or more lighting devices are controlled based on the determined order of extracted color values.

14. A computer program product arranged for performing the method according to any one of the preceding claims when run on a computer device.

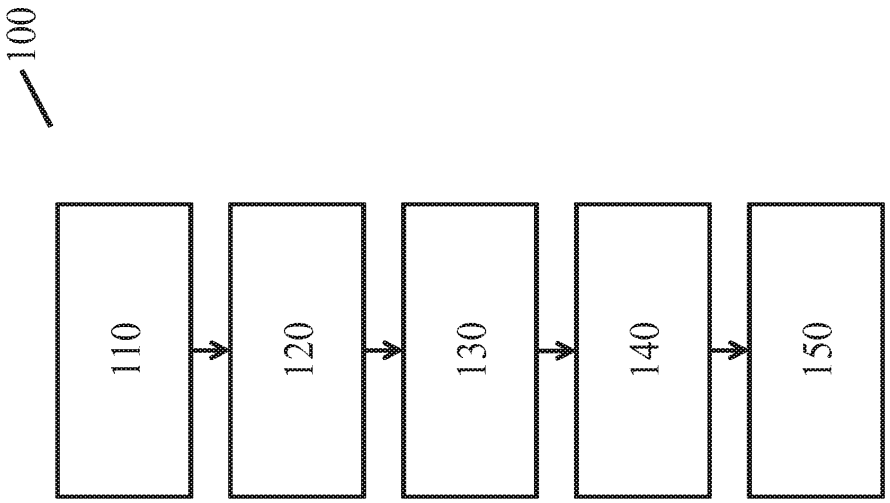


Fig. 1

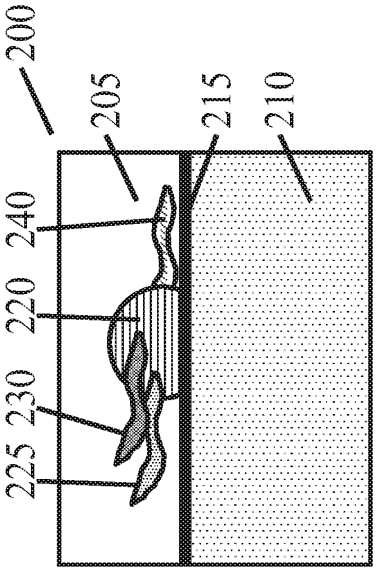


Fig. 2a

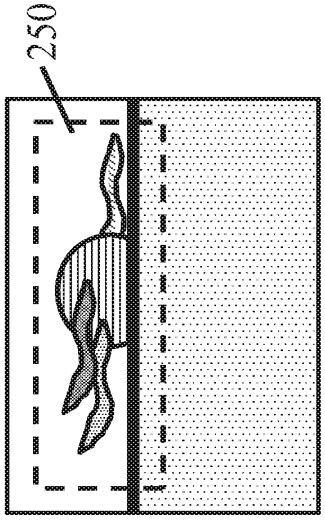


Fig. 2b

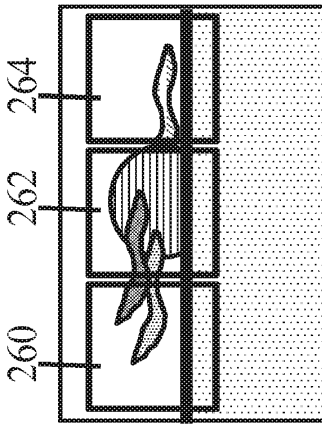


Fig. 2c

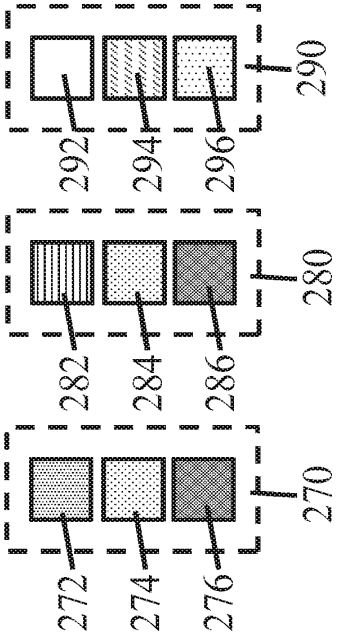


Fig. 2d

Fig. 3a

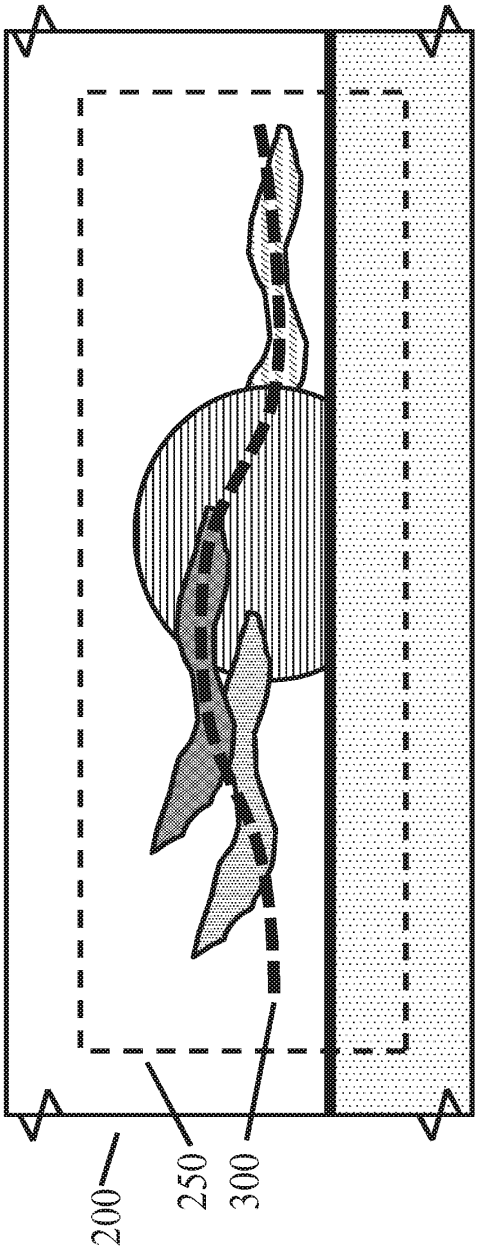
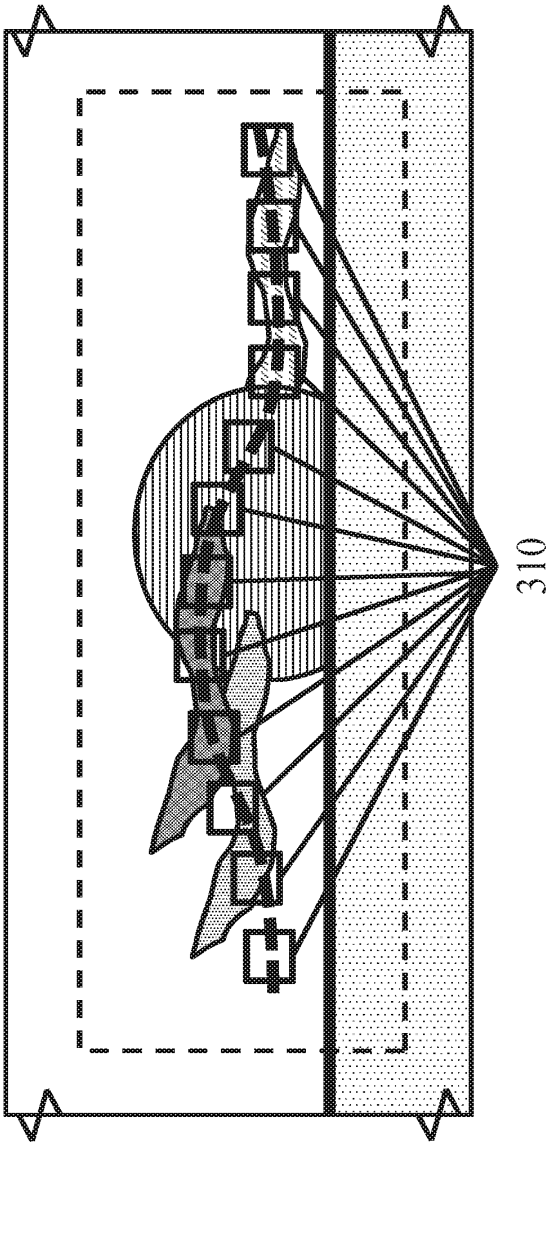


Fig. 3b



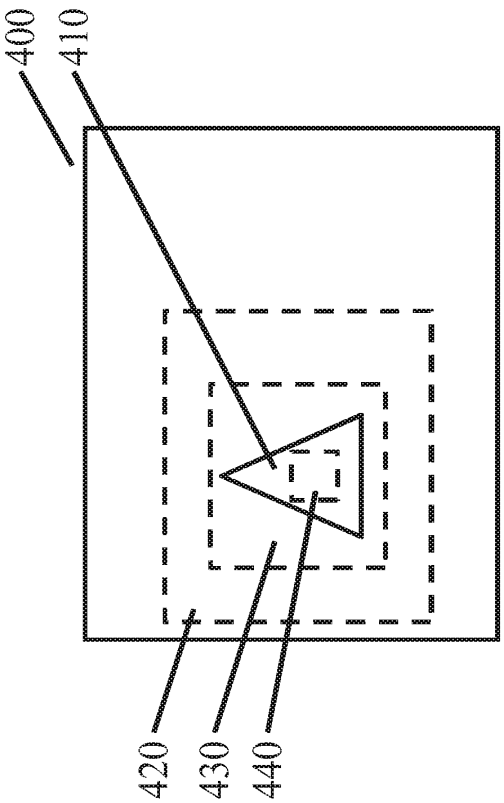


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/079847

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B37/02 H05B33/08
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)
H05B

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	EP 2 120 512 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]) 18 November 2009 (2009-11-18)	1,3-5, 7-14
Y	the whole document	2,6
X	WO 2011/124933 A1 (NATUREN KFT [HU]; BERKES BALAZS [HU]; FERENCZ ANDRAS [HU]) 13 October 2011 (2011-10-13)	1,14
Y	the whole document page 10, line 20 - line 26	2,6

☐ 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	Date of mailing of the international search report
21 February 2017	28/02/2017

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

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/079847

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2120512 A1	18-11-2009	CN 102027806 A	20-04-2011
		EP 2120512 A1	18-11-2009
		EP 2274959 A1	19-01-2011
		JP 5592878 B2	17-09-2014
		JP 2011521412 A	21-07-2011
		KR 20110013471 A	09-02-2011
		RU 2010150817 A	20-06-2012
		TW 201001115 A	01-01-2010
		US 2011057582 A1	10-03-2011
		WO 2009138935 A1	19-11-2009
WO 2011124933 A1	13-10-2011	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

Electronic Patent Application Fee Transmittal	
Application Number:	15481460
Filing Date:	07-Apr-2017
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Filer:	Martin Dennis Moynihan/Benjamin Frohlinger
Attorney Docket Number:	69726
Filed as Small Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	120	120
		Total in USD ($)		**120**

Electronic Acknowledgement Receipt	
EFS ID:	33312042
Application Number:	15481460
International Application Number:	
Confirmation Number:	5642
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Customer Number:	67801
Filer:	Martin Dennis Moynihan/Benjamin Frohlinger
Filer Authorized By:	Martin Dennis Moynihan
Attorney Docket Number:	69726
Receipt Date:	30-JUL-2018
Filing Date:	07-APR-2017
Time Stamp:	08:17:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$120
RAM confirmation Number	073018INTEFSW00007849501407
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	_USPTOltr.pdf	24120 89fbba10b54332a91f8dc5bf7a5e587acdc28794	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	_form1449.pdf	45160 9a138bcfed2c979420212e20b33b09069cdca32d	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	8-298091.pdf	1654556 3ab7f78fd7265f22836d923ba471c0a1456a4291	no	21
Warnings:					
Information:					
4	Foreign Reference	9-298092.pdf	875610 2ecd72f9e30695bb59c600f7de303b5f1013a44c	no	15
Warnings:					
Information:					
5	Foreign Reference	10-298093.pdf	781271 9becafa5cb2e7cca5e84809465f8381f00ecab68	no	18
Warnings:					
Information:					
6	Foreign Reference	11-298097.pdf	647881 cc57c2d0fda8fa0996f46315f496e85e3030a9e0	no	12
Warnings:					

Information:					
7	Foreign Reference	12-298094.pdf	448652 b27fd079819c708b99fa992d69fd54f735a5a67b	no	14
Warnings:					
Information:					
8	Foreign Reference	13-298095.pdf	314892 f878b34666c6b867d51598967a2af2c2044b01a2	no	13
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Information:					
9	Foreign Reference	14-298101.pdf	2031944 7822a75e3c6383193da7e376afab8ed6df3c421e	no	20
Warnings:					
Information:					
10	Non Patent Literature	15-290434.pdf	2396344 8d835babd95a7e6346f3c615c79361270ea6f97c	no	19
Warnings:					
Information:					
11	Non Patent Literature	16-289117.pdf	1995319 2a7599ff18a906fa31fbddb09fd57c113f16d783	no	14
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12	Non Patent Literature	17-289561.pdf	2255802 97c0bff0567268a753b2f850561be9e3158a3b5a	no	17
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13	Non Patent Literature	18-298096.pdf	14905749 70cd16f8b95babc669cf30c431b9bb661aa15edb	no	36
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Information:					

14	Fee Worksheet (SB06)	fee-info.pdf	30415 1ae6c8d2690e0bc5fd2320bab64dfc5509228301	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	28407715	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	§		
	§		
GAMMONS Roderick Allen et al	§		
	§	Confirmation No.:	5642
Serial No.: 15/481,460	§		
	§		
Filed: April 07, 2017	§	Group Art Unit:	2844
	§		
For: LIGHTING SYSTEM AND CONTROL THEREOF [CineSFX]	§		
	§	Attorney Docket:	69726
Examiner: PHAM Thai N.	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a PTO Form 1449 which lists citations which may be material to the patentability and examination of the above identified application. Also enclosed are copies of the references cited, other than U.S. Patents and U.S. patent applications. These are submitted in compliance with the duty of disclosure defined in 37 CFR 1.56, 37 CFR 1.97 and 37 CFR 1.98. The Examiner is requested to make these citations of official record in this application.

The undersigned states:

A. NO CERTIFICATION OR FEE DUE

☐ This Information disclosure Statement is being filed within three months of filing a national application or entry of a national phase of an international application; or before the mailing date of a first Office action on the merits of the above-identified application. Accordingly, no fee or Certification is believed due. However, if a fee is due, authorization to deduct such fee from the Deposit Account 501407 of the undersigned is hereby provided.

B. CERTIFICATION

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or

That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement.

C. FEE

☒ Please charge the fee of $120 (Small Entity Status) set forth in 37 CFR 1.17(p) to Deposit Account 501407. Appropriate fee attached.

This Information Disclosure Statement under 37 CFR 1.56 is not to be construed as a representation that a search has been made, that additional matter which is material to the examination of this application does not exist, or that any one or more of the citations listed constitutes prior art as defined by 35 U.S.C. 102.

It is respectfully requested that the Examiner consider the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims, and sign the enclosed form PTO-1449 to evidence that the cited information has been fully considered by the Patent and Trademark Office during the examination of this application. Notwithstanding any statements by the Applicant, the Examiner is urged to form his/her own conclusion regarding the relevance of the cited information.

FOR PATENT TERM ADJUSTMENT CALCULATION PURPOSES ONLY:

Unless indicated otherwise, to the best of our knowledge and procedures, each item of information contained in the information disclosure statement was first known no more than thirty days prior to the filing of the information disclosure statement, either by the inventor named in the application, Attorney or agent who prepares or prosecutes the application, and every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, the applicant, an assignee, or anyone to whom there is an obligation to assign the application.

Respectfully submitted,

/ Martin D. Moynihan /

Martin D. Moynihan
Registration No. 40338
Telephone: (703)859-9634

Date: 27 July 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/481,460	04/07/2017	Roderick Allen GAMMONS	69726	5642

67801 7590 03/09/2018

MARTIN D. MOYNIHAN d/b/a PRTSI, INC.
P.O. BOX 16446
ARLINGTON, VA 22215

EXAMINER
PHAM, THAI N

ART UNIT	PAPER NUMBER
2844	

NOTIFICATION DATE	DELIVERY MODE
03/09/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@ipatent.co.il

Office Action Summary	Application No. 15/481,460	Applicant(s) GAMMONS ET AL.	
	Examiner THAI PHAM	Art Unit 2844	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08/17/2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *55-74* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *55-74* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *04/07/2017* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *11/28/2017*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Receipt of preliminary amendment filed on 10/10/2013 is acknowledged. Claims 1-54 have canceled. Claims 55-74 are newly added. Thus claims 55-74 are pending in the instant application.

Priority

Receipt is acknowledged of certified copies of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Information Disclosure Statement

The information disclosure statements (IDSs) submitted on 11/28/2017 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements have been considered by the examiner.

Drawings

The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the limitation recites “a controller for controlling at least one lighting device,” “a calculating device” “a wired or wireless interface,” and “a random number source” must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate

prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

The drawings are objected to under 37 CFR 1.83(a) because they fail to show “**a controller for controlling at least one lighting device,” “a calculating device” “a wired or wireless interface,” and “a random number source”** as described in the specification. Any structural detail that is essential for a proper understanding of the disclosed invention should be shown in the drawing. MPEP § 608.02(d). Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and

where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the claims at issue are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the reference application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO internet Web site contains terminal disclaimer forms which may be used. Please visit http://www.uspto.gov/forms/. The filing date of the application will determine what form should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 55-74 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending application No. 15820469. Although the claims at issue are not identical, they are not patentably distinct from each other because the claim limitations of the copending application no. 15820469 clearly anticipated the claim limitations of the pending application. They are containing the same essential limitations. They are both containing same structure includes controller couple to a bicycle wheel configured to do the same function.

Regarding claims 55. 67 and 74, the limitations of the applicant's claims are obvious variations of the mapped claims above. While the pending claim uses different

vernacular than the copending claims, one of ordinary skilled in the art would recognize that the claims are directed to substantially the same invention. The principle difference is that the pending claims are broader in scope than the copending claims. It is generally understood that anticipation is the epitome of obviousness. Alternatively, the elimination of an element and its function is generally held to be within the skill of the art.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to THAI PHAM whose telephone number is (571)270-5518. The examiner can normally be reached on 5/4/9 M-F 9:00 AM - 6:30PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas Owens can be reached on (571)272-1662. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/THAI PHAM/
Primary Examiner, Art Unit 2844
03/05/2018

Notice of References Cited	Application/Control No. 15/481,460	Applicant(s)/Patent Under Reexamination GAMMONS ET AL.	
	Examiner THAI PHAM	Art Unit 2844	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	US-				
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15481460	GAMMONS ET AL.
	Examiner	Art Unit
	THAI PHAM	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	03/05/2018								
	1	-								
	2	-								
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	4	-								
	5	-								
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15481460	GAMMONS ET AL.
	Examiner	Art Unit
	THAI PHAM	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	03/05/2018								
	37	-								
	38	-								
	39	-								
	40	-								
	41	-								
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	68	✓								
	69	✓								
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	71	✓								
	72	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15481460	GAMMONS ET AL.
	Examiner	Art Unit
	THAI PHAM	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	03/05/2018								
	73	✓								
	74	✓								

Exhibit 1002
Aputure v. Rotolight - IPR2024-01422
Page 604 of 1082

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BIB DATA SHEET

CONFIRMATION NO. 5642

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/481,460	04/07/2017 RULE	315	2844	69726

APPLICANTS
Rotolight Limited, London, UNITED KINGDOM;

INVENTORS
Roderick Allen GAMMONS, Staines Upon Thames, UNITED KINGDOM;
Andrew FRANCIS, Witham, UNITED KINGDOM;
Roderick Aaron GAMMONS, Winkfield, UNITED KINGDOM;

**** CONTINUING DATA **************************
This appln claims benefit of 62/319,809 04/08/2016

**** FOREIGN APPLICATIONS **************************
UNITED KINGDOM 1606907.2 04/20/2016

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
12/20/2017

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☑ Yes ☐ No	☑ Yes ☐ No	/THAI N PHAM/ Examiner's Signature	☐ Initials	UNITED KINGDOM	5	20	3

ADDRESS
MARTIN D. MOYNIHAN d/b/a PRTSI, INC.
P.O. BOX 16446
ARLINGTON, VA 22215
UNITED STATES

TITLE
LIGHTING SYSTEM AND CONTROL THEREOF

FILING FEE RECEIVED		
800	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15481460	GAMMONS ET AL.
	Examiner	Art Unit
	THAI PHAM	2844

CPC- SEARCHED		
Symbol	Date	Examiner
H05B37/02 OR H05B37/0272 OR H05B37/029 OR H05B37/0281 OR H05B33/08 OR H05B33/0842 OR F21V23/00 OR F21V23/003	3/5/2018	TP

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
CPC search, Text search, Inventor name search, Assignment data search, backward and forward search	3/5/2018	TP
Looked at IDS	3/5/2018	TP
Looked at PCT and ISA search report	3/5/2018	TP

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"15481460"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 11:32
S2	4	(("GAMMONS") near3 ("Roderick") near3 ("Allen")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/20 11:33
S3	378	(("FRANCIS") near3 ("Andrew")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/20 11:34
S4	3	(("GAMMONS") near3 ("Roderick") near3 ("Aaron")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/20 11:34
S5	3	S2 and S3 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 11:34
S6	1	(("ROTOLIGHT") near3 ("LIMITED")).AANM.	USPAT	OR	ON	2018/02/20 11:35
S8	22	("20070159347" | "20080129226" | "5307295" | "5921659" | "5924784" | "7038399" | "7353071").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 11:44
S9	3	("3787752").PN. OR ("7365649").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/20 11:46
S10	26	"2424525"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 11:48
S11	48723	(H05B37/02 OR H05B37/0272 OR H05B37/029 OR H05B37/0281 OR H05B33/08 OR H05B33/0842 OR F21V23/00 OR F21V23/003).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 12:23
S12	4	"20080129226"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 12:24
S13	1	"15820469"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/20 15:21
S14	5	"2005052751"	EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/01 18:49

S15	9	light$4 with control$4 with simulat$4 with (calculat$4 or comput$4) with random	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/02 17:39
S16	574	light$4 with control$4 with (calculat$4 or comput$4) with random	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/02 17:41
S17	48822	(H05B37/02 OR H05B37/0272 OR H05B37/029 OR H05B37/0281 OR H05B33/08 OR H05B33/0842 OR F21V23/00 OR F21V23/003).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/02 17:41
S18	37	S17 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/02 17:41
S19	181	light$4 same control$4 same simulat$4 same (calculat$4 or comput$4) same random same (wire$1less or wifi or zigbee) same user	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/02 17:50

3/5/2018 2:20:27 PM
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/481,460	04/07/2017	2875	800	69726	20	3

CONFIRMATION NO. 5642

REPLACEMENT FILING RECEIPT

67801
MARTIN D. MOYNIHAN d/b/a PRTSI, INC.
P.O. BOX 16446
ARLINGTON, VA 22215

OC000000098230998

Date Mailed: 12/21/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Roderick Allen GAMMONS, Staines Upon Thames, UNITED KINGDOM;
Andrew FRANCIS, Witham, UNITED KINGDOM;
Roderick Aaron GAMMONS, Winkfield, UNITED KINGDOM;

Applicant(s)

Rotolight Limited, London, UNITED KINGDOM;

Power of Attorney: The patent practitioners associated with Customer Number 67801

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/319,809 04/08/2016

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
UNITED KINGDOM 1606907.2 04/20/2016 Access Code Provided

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Permission to Access Search Results: No

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Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to**

Retrieve Electronic Priority Application(s) (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 12/20/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/481,460**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No
** **SMALL ENTITY** **
Title

LIGHTING SYSTEM AND CONTROL THEREOF

Preliminary Class

362

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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Application number: 1606907.2

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South Wales
NP10 8QQ

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Signed A HAYES

Dated 25 April 2016

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Patents Form 1
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Request for grant of a patent

Concept House
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Application number GB 1606907.2

1.	Your reference	**P46809GB**
2.	Full name, address and postcode of the applicant or of each applicant Patents ADP number *(if you know it)*	**Rotolight Limited** **c/o London Law, The White House** **57-63 Church Road** **Wimbledon Village SW19 5SB** **United Kingdom**
3.	Title of the invention	**Lighting system and control thereof**
4.	Name of your agent *(if you have one)* "Address for service" to which all correspondence should be sent. This may be in the European Economic area or Channel Islands (see warning note below) *(including the postcode)* Patents ADP number *(if you know it)*	**Mathys & Squire LLP** **Mathys & Squire LLP** **The Shard** **32 London Bridge Street** **London SE1 9SG** **United Kingdom**
5.	Priority declaration: Are you claiming priority from one or more earlier-filed patent applications? If so, please give details of the application(s)	

Country	Application number	Date of filing	PDAS Access Code
United States of America	**62/319,809**	**08 Apr 2016**	

6.	Divisionals etc: Is this application a divisional application, or being made following resolution of an entitlement dispute about an earlier application. If so, please give the application number and filing date of the earlier application	Number of earlier UK application	Date of filing *(day / month / year)*
7.	Inventorship: (Inventors must be individuals not companies) Are all the applicants named above also inventors?	**No**	
8.	Are you paying the application fee with this form?	**Yes**	

Patents Form 1

9. Accompanying documents: please enter the number of pages of each item accompanying this form.

Continuation sheets of this form

Description:	**13**
Claim*(s)*:	**5**
Abstract:	**1**
Drawing*(s)*:	**5**

If you are not filing a description, please give details of the previous application you are going to rely upon

Country	Application number	Date of filing	PDAS Access Code

10. If you are also filing any of the following, state how many against each item.

Priority documents:	**0**
Statement of inventorship and right to grant of a patent (Patents Form 7):	**1**
Request for search (Patents Form 9A):	**1**
Request for a substantive examination (Patents Form 10):	**1**
Any other documents (please specify):	**PDAS Registration Form** **Covering Letter**

11. I/We request the grant of a patent on the basis of this application.

Signature: **Subject: Dani Kramer 20244; Issuer: European Patent Office, European Patent Office CA G2** Date: **20 Apr 2016**

12. Name, e-mail address, telephone, fax and/or mobile number, if any, of a contact point for the applicant

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Lighting system and control thereof

Field of invention

This invention relates to a lighting system, and the control of a lighting system, and the simulation of lighting special effects, and in particular to a lighting system for videography, broadcasting and cinematography.

Background

In the film, broadcast and TV industry a lighting controller called a 'flicker box' which is independent of a lighting device, is used to produce flickering light effects to mimic flickering light for example from a fire place, candle, electrical spark or lightning for on set television/broadcast production use.

The flicker effect provided by these devices is typically created using the analogue circuitry modulators contained within the 'flicker box', controlled manually by dials and levers. Use of a flicker box is typically a complex, costly and time consuming process that requires the setup, connection and control of multiple pieces of hardware typically including external Digital Multiplex (DMX) and power distribution devices, as well as typically requiring a physical wired connection to the 'hot' light source desired to be controlled.

Typically such 'flicker boxes' require specialist knowledge and understanding to operate and remain inaccessible or 'out of reach' to lower budget television productions.

Furthermore, many 'flicker boxes' are incompatible with LED light sources, and such systems require the use of 'hot' incandescent light sources which are energy inefficient and also pose health and safety risks to those working on set, typically therefore requiring qualified lighting gaffers and operators.

An improved solution is desired.

According to one aspect of the invention, there is provided a method for controlling a lighting device to produce user customisable lighting effect, the method comprising: calculating a time varying lighting value based on at least one simulation parameter; and outputting said time varying lighting value thereby to simulate a lighting effect.

According to another aspect of the invention there is provided a controller for controlling a lighting device to produce a lighting effect, the controller comprising: a calculating device adapted to calculate a time varying lighting value based on at least one simulation

parameter; and an output adapted to control a lighting device according to the determined variation of lighting over time.

In a further aspect of the present invention there is provided a light with the built-in capability to generate a range of customizable cinematic special lighting effects, by modulating the speed, duration, power/brightness, and/or colour temperature of the light output.

Preferably, the parameters of the effects including but not limited to speed, duration, power/brightness and colour temperature can be controlled locally via a simple user interface on the light itself.

Preferably, the start/stop "triggering" of the effects can be controlled locally via a simple user interface on the light itself, remotely via WiFi, Bluetooth, Zigbee or wireless DMX from a smart phone or tablet, or from a wired 3.5mm minijack remote trigger, or a wired DMX trigger.

Preferably, the parameters of the effects can be controlled remotely via WiFi, Bluetooth, Zigbee or wireless DMX from a smart phone or tablet.

Preferably, the parameters of the effects can be controlled Via a serial communications interface (eg. RS232, USB or DMX) from a PC running custom lighting control software.

Preferably, the light source containing in built special effects is in the form of an LED lighting fixture. Alternatively it is in the form of or 'hot' light incandescent fixture.

Preferably, multiple lights may be connected together via wired DMX, or via WiFi, Bluetooth, Zigbee or wireless DMX to produce a synchronised large area special effect.

Preferably, when multiple lights are connected together to produce a synchronized large area special effect, the inter-relationship of those connected lights is customizable so as to allow all of the connected devices to fire at the same time if desired, or, to enable a staggered effect to take place over an extended time duration and with customizable power intensity, in order to create the effect that a static object is moving as the lights "chase" around a scene.

Preferably, the system includes rolling shutter compensation enabling the minimum light pulse width to be adjusted to suit the shutter speed or frame rate of the user's camera in

order to prevent 'strobing' due to the light effect being out of phase/sync with the frame rate of the camera, ensuring that each frame captured by the camera is fully illuminated.

Preferably, a light source can be designated as a 'master', and have connected 'slave' light sources which fire in synchronization with the 'master', or in a customizable sequence, with regard duration, power and/or colour temperature.

Preferably, the 'slave' light sources are connected to the 'master' light source via wired DMX, wireless DMX, wifi, Bluetooth, or RS232 sync cable.

Preferably, the light contained in built special effects, can be powered both from mains power, and/or via its own internal battery power source, providing greater flexibility and portability for location shooting.

Preferably, the light source is capable of producing customisable effects including, but not limited to : Fire, Lightning, Police light, TV simulation, Neon Flickering sign, Muzzle (gunshot), Welding, Spark/Short Circuit, Scan (e.g. fingerprint scanner), Papparrazi flashes, Propeller, (Nuclear) Explosion and Wormhole.

The invention extends to any novel aspects or features described and/or illustrated herein.

Further features of the invention are characterised by the other independent and dependent claims

Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

Furthermore, features implemented in hardware may be implemented in software, and vice versa. Any reference to software and hardware features herein should be construed accordingly.

Any apparatus feature as described herein may also be provided as a method feature, and vice versa. As used herein, means plus function features may be expressed alternatively in terms of their corresponding structure, such as a suitably programmed processor and associated memory.

It should also be appreciated that particular combinations of the various features described and defined in any aspects of the invention can be implemented and/or supplied and/or used independently.

The invention also provides a computer program and a computer program product comprising software code adapted, when executed on a data processing apparatus, to perform any of the methods described herein, including any or all of their component steps.

The invention also provides a computer program and a computer program product comprising software code which, when executed on a data processing apparatus, comprises any of the apparatus features described herein.

The invention also provides a computer program and a computer program product having an operating system which supports a computer program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein.

The invention also provides a computer readable medium having stored thereon the computer program as aforesaid.

The invention also provides a signal carrying the computer program as aforesaid, and a method of transmitting such a signal.

The invention extends to methods and/or apparatus substantially as herein described with reference to the accompanying drawings.

The invention will now be described by way of example, with references to the accompanying drawings in which:

Figure 1 is a schematic diagram of a 'flickerbox' lighting system;
Figure 2 is a schematic diagram of a further lighting system;
Figure 3 is a flow diagram of a method for adjusting a lighting device;
Figure 4 is a schematic diagram of a further lighting system;
Figure 5 shows a time/brightness plot for a system of linked lights;
Figure 6 is a graphic user interface for user input of simulation parameters; and

Figure 7 is a graph of light brightness over time.

Detailed description

In the present description the term 'camera' may be understood to mean a camera (such as a digital camera, or 'film' camera) operable to record moving images. The lighting system may therefore be for a lighting system for videography, broadcasting, cinematography, studio filming and/or location filming.

Figure 1 shows a schematic diagram of a 'flickerbox' lighting control system. The system comprises an analogue effect simulator, 300, a DMX distribution hub 302, an AC power generator 306, an AC power distribution module 302 and a plurality of incandescent lights 102. The analogue effect simulator 300 simulates a lighting effect such as fire, or electrical sparking based on various parameters 104. The analogue effect simulator 300 produces data 106 such as brightness parameters that vary over time for producing the desired lighting effect. The data 106 is used to modulate the light 102 such that the desired lighting effect is produced. The user has very limited ability to alter many of the parameters to adapt the lighting effect as desired

Figure 2 schematically shows an example where a lighting effect simulator 100 and the light 102 are integrated in a single studio lamp device 120. In one example, the lamp device is an array of LEDs, preferably of differing colours. This arrangement does not require the DMX distribution hub 302, power elements 304, 306 as described above, and is more flexible in producing effects as will be described in more detail below. A microcontroller or other computing unit is integrated in the lamp 120 for performing calculations. A control panel is provided at a back panel of the light 120. The control panel can include for example buttons, rotary knobs, sliders, and/or a display/input panel for user input of parameters for simulating an effect. In a variant a simple digital interface is provided on the light itself for user input of simulation parameters to control the lighting effect. In another variant the light 120 is adapted for communication with a wireless user device and receives user-selectable simulation parameters to control the lighting effect from the user device. The user device may for example be a tablet or smart phone with suitable hardware / software (e.g. an app) for receiving user input of simulation parameters and transmitting that data to the light 120.The system of Figure 2 is simpler to set up and less expensive than that of Figure 1 as there are fewer pieces of hardware. Furthermore the energy inefficiency of 'hot light' systems (i.e. a 1K hot light consumes 1000 watt/hour, vs 38 watt per hour of current generation LED system), Systems such as that described in Figure 1 using a flicker box and typically 'hot lights' also suffer from the significant disadvantage that a hot light is a fixed colour of light, either daylight 5600K or most commonly tungsten 3200K. When recreating an effect such a lightning this effect

would appear at the blue end of the colour spectrum i.e. 7000K+ so utilising a 3200K light for this would require an operator to climb up a ladder to apply one or more CTB (Colour temperature blue) filter(s) to the light in order to achieve the desired colour temperature.

Having the ability to control the special FX from the light source, which in itself is a bi-colour LED Fixture also entirely eliminates that aspect of the process, the user can simply adjust the colour temperature from the back of the unit, with a visible numeric display of that number eliminating significant time from the process.

This is also a significant limiting factor in the creation of effects such as fire which typically burn blue on hotter peaks. It would be possible using an LED light source containing in built special effects to reproduce both the warm “orange” light output near the tungsten end of the scale, whilst also adding a “colour swing blue” on the peaks from the same light source, something that would not be possible using a legacy system.

Examples of user defined parameters that the light containing in built special effects can customize in simulating a lighting effect are now described in more detail:

- **Brightness**: The peak luminance of the effect from 1% to 100% of the lamp’s available luminance output.

- **Colour**: For multicolour effects this sets the range of colours used over the spectrum of red, green and blue. For single colour effects it sets the colour temperature of the light.

- **Trigger**: To start the effect running. For example, a manual trigger may be selected for manually triggering the start of a lightning burst, TV screen, or other effect.

- **Frequency**: typically from 0.5Hz to 50Hz. This sets an average period between light peaks – e.g. a roaring fire may have a higher frequency than a single candle flame.

- **Depth**: typically from 0% to 90%. This sets a base level of illumination of the effect. For example a fire may have a base level of 50% illumination superimposed on a level varying from 50% to 100% to simulate flickering flames.

- **Rolling Shutter Compensation**: Film and TV cameras typically operate at frequencies between 24Hz and 60Hz. In order to provide consistent illumination during each camera frame, short time-period (e.g. stroboscopic) lighting effects should have a minimum pulse width which lasts at least one camera frame period. This parameter can be adjusted to suit the camera and frame rate.

- '**Colour Swing Blue'** simulates the effect of flame going up the chimney, 'peaks' within the fire effect can be switched to transition between yellow and blue, to match the colour of a flame, creating a more dynamic and 3D fire effect. The brighter the 'spark' the more blue the light output is. The colour of the output is therefore dependent on the brightness of the output (or vice versa).

Further examples of lighting effects are for example to mimic television screen flicker, cinema illumination, illumination in a vehicle passing through a tunnel, or any situation where the lighting varies over time in a characteristic manner. A simulation can be defined that represents the characteristics of the lighting effect, and suitable random parameters can be used to introduce a realistic variance in the lighting effect.

In a variant the simulator operates with pre-defined parameters and random numbers, without further user input of parameters. This can still provide a realistic lighting effect, albeit with less adaptation to the user's preferences.

Figure 3 illustrates a simple example of a method for simulating a lighting effect. In a first step S1 simulation parameters are received, such as random parameters and/or user-selectable parameters. Where a random parameter is algorithmically generated it is only pseudo-random, but for the purposes of the simulation a pseudo-random parameter is sufficiently random for realistic simulation and is hence considered to be equivalent to a truly random parameter. In a second step S2 a simulation is performed based on a simulation model and the received parameters. The nature of the simulation model can vary greatly, depending on the lighting effect that is desired and the sophistication of the desired simulation. The simulation calculates how the lighting changes over time in order to produce the desired lighting effect. Following simulation in a third step S3 the lighting information determined by the simulation is output, for example to a lighting device, in order to produce the desired lighting effect.

Figure 4 schematically shows an example showing a master light source 102 built into a lighting control unit 130 and a 'slave' light source 102-1 separate from the lighting control unit. The lighting effect simulator 100 creates data 106 characterising a lighting effect and controls the master light 102 as described above. The data 106 is transmitted to the slave light 102-1 via (for example) a serial communication interface (e.g. RS232, USB or DMX) or by wireless transmission (e.g. Wi-Fi®, Bluetooth® Zigbee®, or via a mobile communication network utilising protocols such as GSM (Groupe Special Mobile) 3GPP (3rd Generation Partnership), or 4G LTE (Long term evolution)). The additional 'slave' light source 102-1 thereby allows the production of a lighting effect with more than one light device but without duplication of controllers 130. Such additional light sources can for example increase the area of illumination or increase the power of the lighting effect.

The use of multiple lights 102 affords additional options for producing advanced effects. Figure 5 shows a time/brightness plot of a 'chase' effect. In this example, three lights produce outputs 200, 202 and 204 separated in time. In such a way, an effect of a light source (such as a passing car) can be replicated. The relative timing of the light sources can be adjusted depending on the relative location of the sources, and the speed of the effect to be replicated. It should be noted that the 'fade up' and 'fade down' portions of each light output 200, 202, 204 overlap with one-another to more accurately replicate the effect of a moving object, as opposed to a element jumping from one location to another.

Related effects utilising similar timing controls are be 'paparazzi' of multiple flashes coming from different locations, or a 'propeller' simulating a light source being obscured by a rotating propeller. The use of a single controller 130 may be used to control all of the lights 102 so as to ensure an appropriate delay (or absence of delay).

Figure 6 shows an example of a graphic user interface 800 for user input of simulation parameters. In the illustrated example the lighting effect to be simulated is a fire effect. The user can select a fire activity (with a slider positioned from 'low' to 'high') to set a frequency parameter as described above; a fire colour; a peak brightness; a baseline brightness to set a depth parameter as described above; and a camera frequency. A wide range of further parameters can be provided for user input, for example if the fire activity, brightness and/or colour is to change over time (to mimic a fire dying down and reducing to embers or to mimic addition of fuel to a fire). The user may also be provided with an option of superimposing different types of lighting effects, for example to mimic candlelight during a lightning storm.

In one example, the rolling shutter compensation controls a minimum light pulse to match the shutter speed or frame rate of the user's camera (camera frequency) to ensure even illumination across the frame and eliminate possible strobing. Therefore, the duration of the light pulse is longer than one period of the camera's recording frequency, or in other words, the lighting value varies at a lower frequency than the frequency of the camera.

The lighting effect simulator 100 typically provides data 106 in the form of brightness and/or colour values that vary over time. In order to cause the light 102 to produce the desired effect a lighting data converter may convert the data 106 from the lighting effect simulator 100 into a suitable signal for a particular light 102. For example for a light emitting diode (LED) array lighting the data conversion occurs at an LED lamp control logic that produces and supplies a separate pulse-width-modulation output for each LED colour to an LED drive circuit. A lighting data converter may be provided separately from the lighting effect simulator 100 and the light 102 or it may be integrated with one or the other or both.

The light 102 in one example comprises an array of different types of LEDs, preferably red, green, blue and white LEDs, or a bi colour fixture comprising warm typically 2800K LEDs and 'cool' 7000K LEDs which blend together to create a range of colour from 3200-6300K. The array may be a panel, flood light, spot light, a cluster or any other arrangement of LEDs. This provides the ability for the lighting to produce light of any visible colour by varying the relative intensities of the different LEDs. The lighting may alternatively be a filament (incandescent), halogen or other type of lighting.

The simulation may be performed on the fly, with lighting data values output from the simulator 100 to the light 102 in near-real time, or the simulation may be performed in advance and the lighting data values output for storage and later use to enable quick reproduction on set or location.

The lighting control system can reduce the number of devices required to provide lighting effects, especially where the lighting effect simulator is integrated in a light. This can significantly reduce equipment costs and time required to set up equipment. The system is also more portable allowing power from its on internal power source or battery instead of requiring an external power generator or mains powered solution. The lighting control system can be used for studio and location filming lighting systems, and more generally for videography, broadcast and/or cinematography.

A non-exhaustive list of example effects that may be produced by the system are as follows:

- Strobe - The strobe range in one example is from 1hz up to 4hz. The last used strobe parameters are stored in non-volatile memory (which applies to any effect described herein). A user may rotate a knob on the device to adjust the 'duty cycle' (flash duration) to eliminate issues with rolling shutter cameras.
- Lightning – this effect simulates lightning in a random manner, but a user may control the speed at which the lighting bursts re-occur. This effect is most realistic if the brightness is set to 100% and colour temperature is set at 6000K. A user may rotate a knob on the device to adjust the 'duty cycle' (flash duration) to eliminate issues with rolling shutter cameras. The duration of the lightning flashes in one example is 20ms. The lightning strikes in one example come in bursts of between 2 and 8 random length pulses.
- Throb - Throb is a regular smoothly pulsing light
- Weld - this effect replicates a welding arc.
- Colour cycle – This is a regular smoothly pulsing light which fades between the tungsten and blue LEDs

- Fire – this effect replicates a fire with 'dancing flames' as is described in more detail below.
- Police – This effect is an emulation of an emergency services light, and may be most realistic in blue light.
- Television – This effect is an emulation of someone watching TV.

It should be appreciated that due to the nature of the light 102, the effects may be customised by a user, for example, the frequency/speed, peak/minimum brightness or colour / colour temperature may be dynamically changed, and/or made to vary over time in a customised manner. Such user-customised effects may be stored and recalled at a later time. The effects may be triggered on cue (for example from a director) by sending a signal over a wired remote trigger or wireless device.

It should also be appreciated that multiple effects may be emulated simultaneously, for example, fire and lightning may be present simultaneously using a single lighting unit.

An example of a simulation for producing a fire effect is now described in more detail.

Fire is simulated as a series of 'sparks'. Each spark has the following random parameters:

- ***Interval***: New sparks are generated at an interval which varies randomly between a defined maximum and minimum interval.
- ***Peak***: The peak luminance of each spark varies randomly between a defined minimum and maximum.
- ***Ramp-up time***: The luminance of each spark ramps up to the peak at a randomly generated rate.
- ***Fade-down time***: The fade from the peak is linked to the ramp-up time but is much slower – simulating the gradual decline in luminance of a burning ember.

If the interval is short with respect to the ramp-up and fade-down time, then sparks can overlap in time – in which case the brightest spark determines the lamp luminance.

The lighting effect simulator typically cycles round a loop calculating new lamp brightness and colour values. Alternatively the calculation can be triggered by an interrupt generated by a timer. The calculation is typically performed every 250μs.

The duration of each spark can be controlled by choosing whether or not to perform a new brightness calculation based on the value of a counter which is decremented every time an interrupt occurs. When the counter reaches zero it is either reset to its previous start value or, for a new spark, a new count start value is randomly generated. In this way each spark has a different speed, duration and peak – simulating the look of a real flame.

Generating the light output with the simulation provides a greater level of user adjustment and control than that produced by simply sampling the intensity of a real flame and replaying it at different speeds.

An example sequence of instructions for the simulation is as follows:

At the end of a spark up and down period:

- Reset duration for next spark to between 2.5s to 5s
- Generate new brightness targets for the next spark between 12.5% and 100% of current maximum brightness setting.
- Offset the random brightness targets by the requested brightness floor value
- Set the new peak brightness target for the new spark
- Ensure the new targets are greater than the existing faded brightness value to prevent downward jumps
- Set the fade direction to UP

Start new animation frame:

- Calculate brightness fade step sizes:
    - Fade up fast, progressively larger fade step sizes
    - Change fade direction at peak
    - Fade down slow, progressively smaller fade step sizes
- Set the frame rate for the new spark to a random value
    - prevent the curtailment of a long fade by a new short pulse: if the faded brightness is still > 25% of max then don't allow new FramePeriod to be less than old.

Figure 7 shows an example of the brightness varying over time produced according to a simulation as described above. Two peaks can be seen, one reaching 100% intensity and the other reaching 91% intensity. The first peak fades up from 10% to 100% in 0.85 seconds, and back down to 56% in 0.75 seconds. The second peak fades up from 56% to 91% in 0.33 seconds, and back down to 60% in 1.07 seconds. The fade up starts

shallower and becomes steeper as it progresses. The fade down starts steep and becomes shallower as it progresses. A toggle switch is also shown which toggles between 'Colour Swing Blue' and 'Monochrome'. Colour Swing Blue represents modifying the colour of peaks in brightness so as to replicate the increased temperature of sparks in a fire, Monochrome may be used when (for example) filming in black and white, or when altering colour of the effect may have deleterious effects on other elements of the scene (for example, rendering text difficult to read).

An example of a simulation for producing a lightning effect is now described in more detail. Lightning is simulated as a sequence of 'bursts' or groups of flashes. The number of flashes in each burst, the delay between bursts, the delay between each flash within the burst, and the amplitude of each flash are all set randomly within certain boundaries. The minimum 'on' time period of each flash can be set by the user to ensure full illumination of the camera frame. The lamp can also be set into a mode where a burst of flashes is triggered by the push of a button. In this way the effect can be triggered on demand by the user.

An example sequence of instructions for the simulation of lightning, with a series of bursts of flashes, is as follows:

At the end of a burst of flashes recalculate the parameters for the next burst:

- Reset the number of flashes in a burst to a random number between 2 and 10
- Reset the period to next burst to a random number between 2.5 and 5s.

Calculate parameters for each flash in a burst of flashes:

- Randomly modulate brightness of each flash slightly
- Reset the time to next flash to a random number between 8ms and 220ms
- Reset the 'on' flash duration to a random number between 8ms and 120ms
    - ensure a minimum off-period is maintained between flashes
- For the final flash set the duration to a random number between 10ms and 113ms

The lighting system, lighting effect simulator, lighting controller, lighting device, computing device, and/or computer program product may have one or more of the following features:

- built-in capability to generate a range of cinematic special effects by modulating the colour and brightness of the light output.

- the parameters of the effects can be controlled via a simple user interface on the lamp itself.
- the parameters of the effects can be controlled remotely via WiFi or DMX from a smart phone or tablet.
- networked with other lights to produce a synchronised large area special effect.
- minimum light pulse width can be adjusted to suit the shutter speed or frame rate of the user's camera to ensure even illumination across the frame.

Various other modifications will be apparent to those skilled in the art. It will be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention. For example, it should be appreciated that the effect simulator 100 or the computing device 130 may be separate from any light 102, and connectable to lights 102, by either a wired or wireless connection.

The lighting effect simulator 100 may be provided by way of a suitably adapted computing device 120 or 130 such as a PC, tablet or smart phone, with suitable software for user input of simulation parameters. The computing device 120 or 130 may be a suitably adapted light controller device with suitable controls for user input of simulation parameters

Reference numerals appearing in the claims are by way of illustration only and shall have no limiting effect on the scope of the claims.

Claims

1. A method for controlling a lighting device to produce user customisable lighting effects, the method comprising:
   calculating a time varying lighting value based on at least one simulation parameter; and
   outputting said time varying lighting value thereby to simulate a lighting effect.

2. A method according to Claim 1 further comprising receiving said at least one simulation parameter for characterising a lighting effect.

3. A method according to Claim 1 or 2 wherein said at least one simulation parameter for characterising a lighting effect is random.

4. A method according to Claim 3 wherein said at least one simulation parameter for characterising a lighting effect is random within predefined boundaries.

5. A method according to Claim 3 or 4, wherein the random simulation parameter is determined in dependence on one or more user-selectable simulation parameters.

6. A method according to Claim 5, wherein the random simulation parameter is in a range determined in dependence on one or more user-selectable simulation parameters.

7. A method according to any of the preceding claims, wherein the simulation parameter is a colour or colour temperature.

8. A method according to Claim 7 wherein the colour or colour temperature varies in dependence on a brightness lighting value.

9. A method according to any of the preceding claims, wherein the simulation parameter is related to one or more of: a rate of increase of brightness; a rate of decrease of brightness; a rate of change of colour;; a brightness; a local maximal brightness; a local minimal brightness; a brightness fluctuation period; and a colour fluctuation period.

10. A method according to any of Claims 2 to 9 further comprising receiving a user input of one or more user-selectable simulation parameters and adapting the simulation in dependence on the one or more user-selectable simulation parameters.

11. A method according to any preceding claim, wherein the simulation parameter comprises at least one of: a maximum brightness; a minimum brightness; a colour; a fluctuation period; and a trigger.

12. A method according to any preceding claim, wherein the simulation parameter comprises a camera recording frequency.

13. A method according to Claim 12 wherein the time varying lighting value is calculated so as to vary at a slower rate than said camera recording frequency.

14. A method according to any of the preceding claims, wherein the simulation iterates through repeated cycles of receiving at least one random simulation parameter and simulating the lighting effect.

15. A method according to any of the preceding claims, wherein the lighting effect is designed to mimic at least one or more of: fire flickering; police light; television; lightning flashing; electrical sparking; and fireworks.

16. A method according to any of the preceding claims, wherein the lighting value comprises brightness and/or colour data.

17. A method according to Claim 16, further comprising converting brightness and/or colour data into lighting signals and outputting the lighting signal data.

18. A method according to any of the preceding claims, further comprising controlling one or more light in dependence on the output.

19. A method according to Claim 18, wherein the controlling comprises changing the brightness and/or colour of the light.

20. A method according to any of the preceding claims, further comprising receiving a definition of a trigger event, said trigger event initiating said output of the time varying lighting value thereby to simulate a lighting effect.

21. A method according to Claim 20 further comprising detecting an occurrence of the trigger event and outputting said time varying lighting value thereby to simulate a lighting effect.

22. A method according to any of the preceding claims, further comprising storing the calculated lighting value.

23. A method according to any of the preceding claims, wherein the controlling is for a

lighting system for videography, broadcast, cinematography, studio filming and/or location filming.

24. A method according to any preceding claim comprising controlling a plurality of lights in dependence on the output.

25. A method according to claim 24 wherein the said plurality of lights output different lighting values so as to simulate a lighting effect.

26. A method according to claim 25 wherein the output of said plurality of lights is offset in time.

27. A method according to claim 26 wherein the output of said plurality of lights overlap with one-another so as to simulate a moving light source.

28. A method according to any of claims 24 to 27 wherein one light is a master light and the others of said plurality of lights are slaves.

29. A computing device adapted to perform a method according to any one of the preceding claims.

30. A controller for a lighting device comprising a computing device according to Claim 29.

31. A controller for controlling a lighting device to produce a lighting effect, the controller comprising:
    a calculating device adapted to calculate a time varying lighting value based on at least one simulation parameter; and
    an output adapted to control a lighting device according to the determined variation of lighting over time.

32. A controller according to Claim 30 or 31 further comprising a random number source adapted to provide a random number for producing a random simulation parameter for characterising a lighting effect.

33. A controller according to any of Claims 30 to 32, wherein the controller is adapted to control a plurality of lighting devices in dependence on the time varying lighting value.

34. A controller according to any one of Claims 30 to 33, wherein the controller comprises a wireless communication interface adapted for wireless communication with one or more lighting devices.

35. A controller according to any one of Claims 30 to 34, wherein the controller comprises an input interface adapted to receive a user input.

36. A controller according to Claim 35, wherein the input interface comprises at least one of: a wireless communication interface; a dial; a slider; a display and buttons; and a touch screen.

37. A controller according to any one of Claims 30 to 36, further comprising a converter adapted to convert brightness and/or colour data from the simulator into lighting signals for output by the output.

38. A controller according to any one of Claims 30 to 37, adapted to perform a method according to any one of Claims 1 to 28.

39. A lighting system comprising a controller according to any one of Claims 30 to 38 and at least one lighting device.

40. A lighting system according to Claim 39 wherein said controller and said lighting device are integrated in a combined unit.

41. A lighting system according to Claim 40 further comprising a further lighting device separate from said controller.

42. A lighting system according to any of Claims 39 to 41 wherein the lighting device is a lighting device for videography, broadcast, cinematography, studio filming and/or location filming.

43. A lighting device comprising a controller according to any one of Claims 30 to 38.

44. A lighting device according to Claim 43 wherein the lighting device is a lighting device for videography, broadcast, cinematography, studio filming and/or location filming.

45. A computer program product for controlling a lighting device to produce a lighting effect, the computer program product adapted to perform, when executed, the steps of:

    calculating a time varying lighting value based on at least one simulation parameter; and

    outputting said time varying lighting value thereby to simulate a lighting effect.

46. A computer program product according to Claim 45, adapted to perform, when executed, the steps of a method according to any one of Claims 2 to 28.

47. A method substantially as herein described and/or as illustrated with reference to the accompanying figures.

48. A computing device substantially as herein described and/or as illustrated with reference to the accompanying figures.

49. A controller for a lighting device substantially as herein described and/or as illustrated with reference to the accompanying figures.

50. A lighting system substantially as herein described and/or as illustrated with reference to the accompanying figures.

51. A lighting device substantially as herein described and/or as illustrated with reference to the accompanying figures.

52. A computer program product substantially as herein described and/or as illustrated with reference to the accompanying figures.

Abstract

The present invention relates to a method for controlling a lighting device to produce user customisable lighting effects, the method comprising: calculating a time varying lighting value based on at least one simulation parameter; and outputting said time varying lighting value thereby to simulate a lighting effect. The invention also relates to a controller for controlling a lighting device to produce a lighting effect, the controller comprising: a calculating device adapted to calculate a time varying lighting value based on at least one simulation parameter; and an output adapted to control a lighting device according to the determined variation of lighting over time. In a further aspect of the present invention there is provided a light with the built-in capability to generate a range of customizable cinematic special lighting effects, by modulating the speed, duration, power/brightness, and/or colour temperature of the light output.

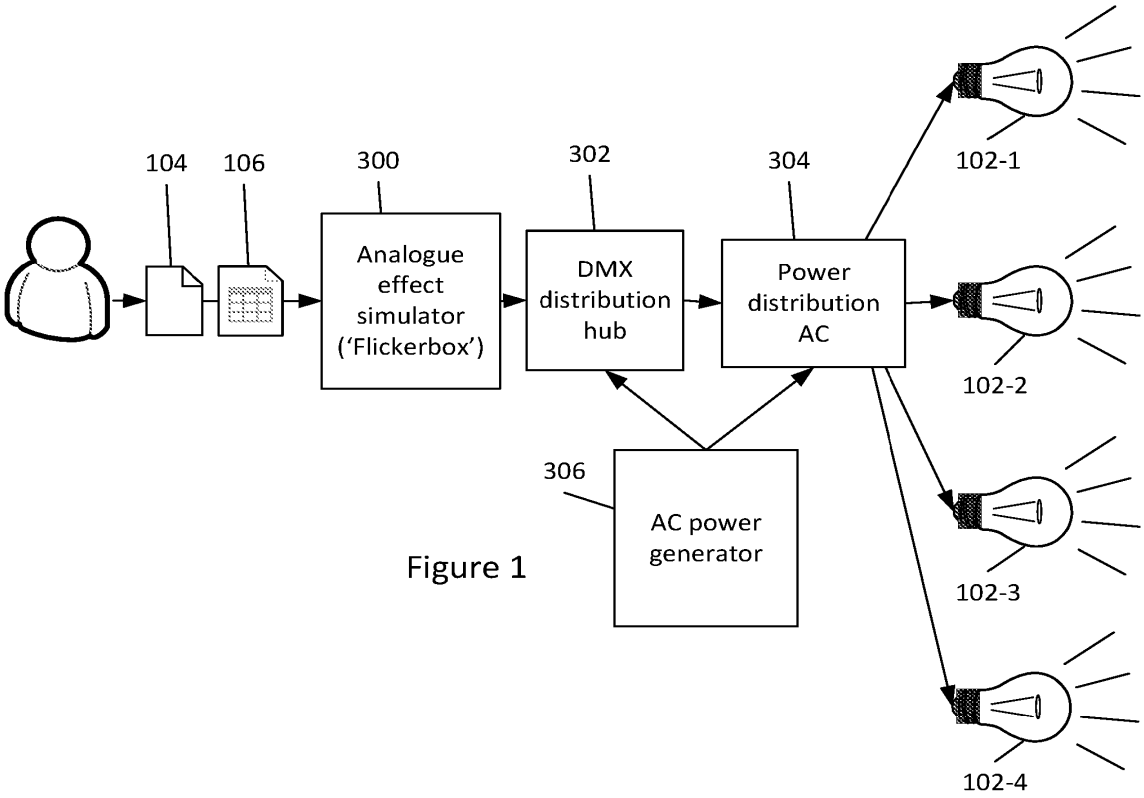


Figure 1

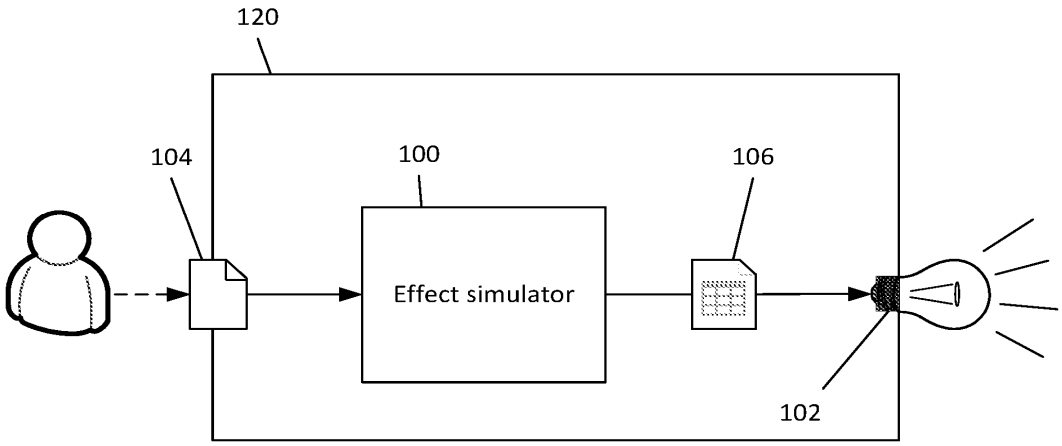


Figure 2

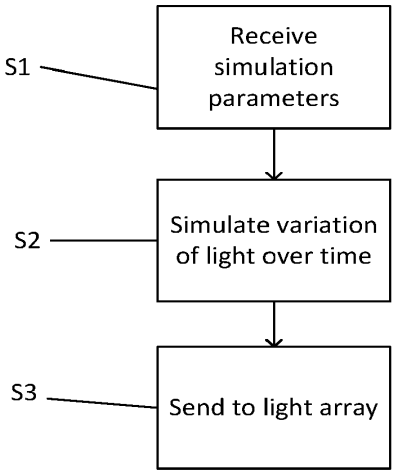


Figure 3

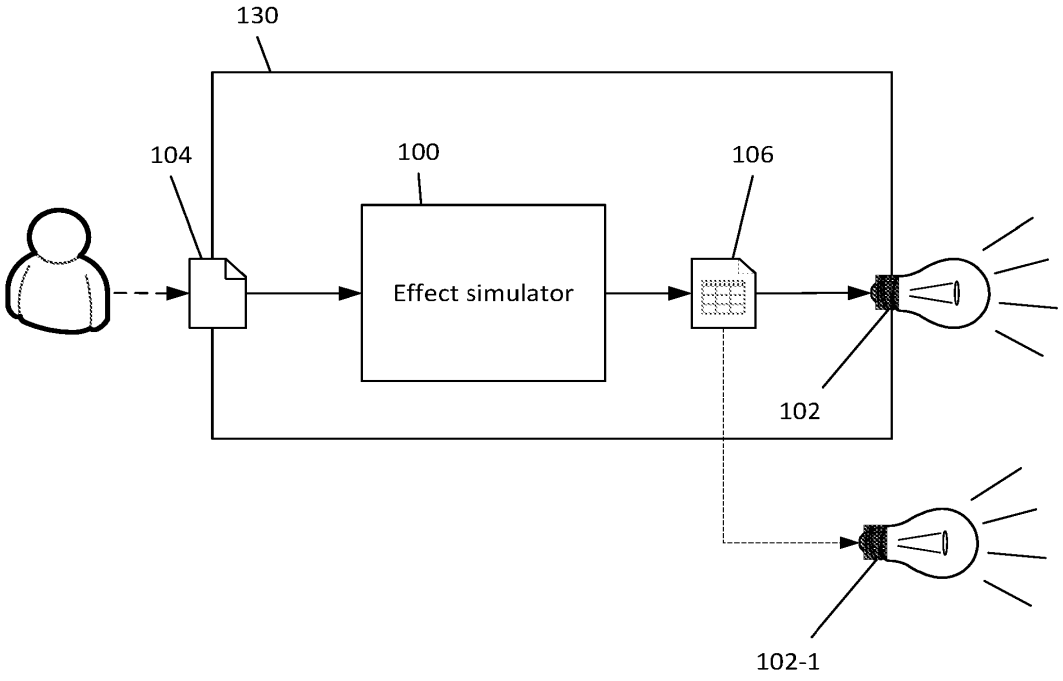


Figure 4

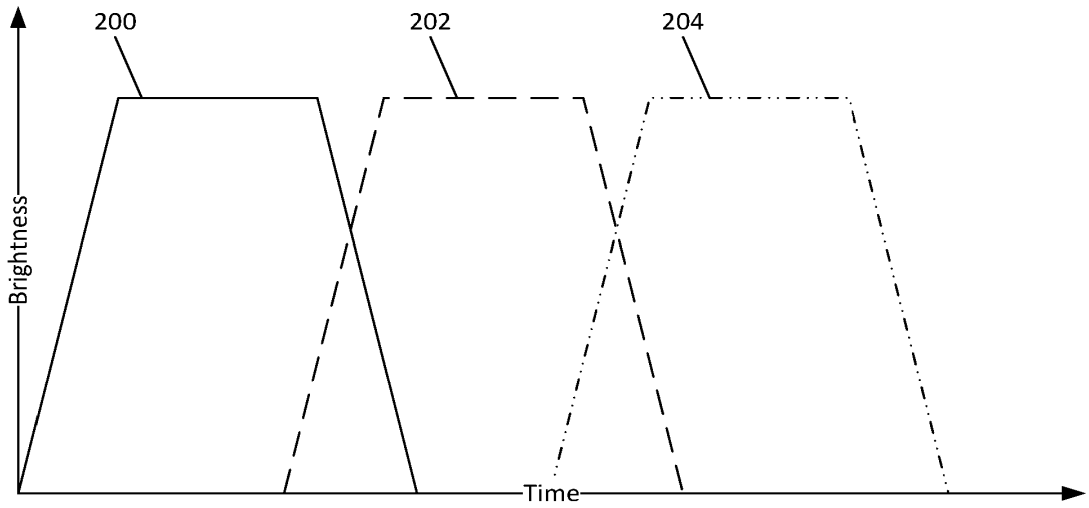


Figure 5

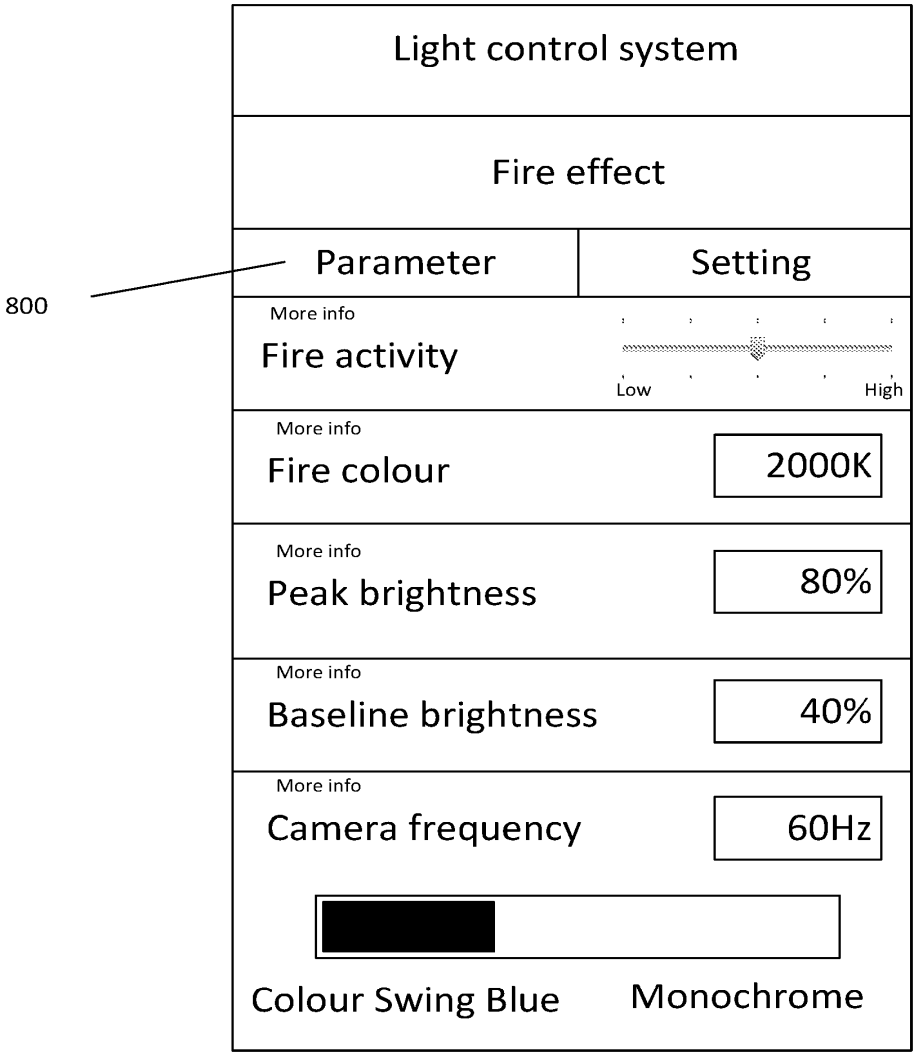

800
Light control system
Fire effect
Parameter
Setting
More info
Fire activity
Low
High
More info
Fire colour
2000K
More info
Peak brightness
80%
More info
Baseline brightness
40%
More info
Camera frequency
60Hz
Colour Swing Blue
Monochrome

Figure 6

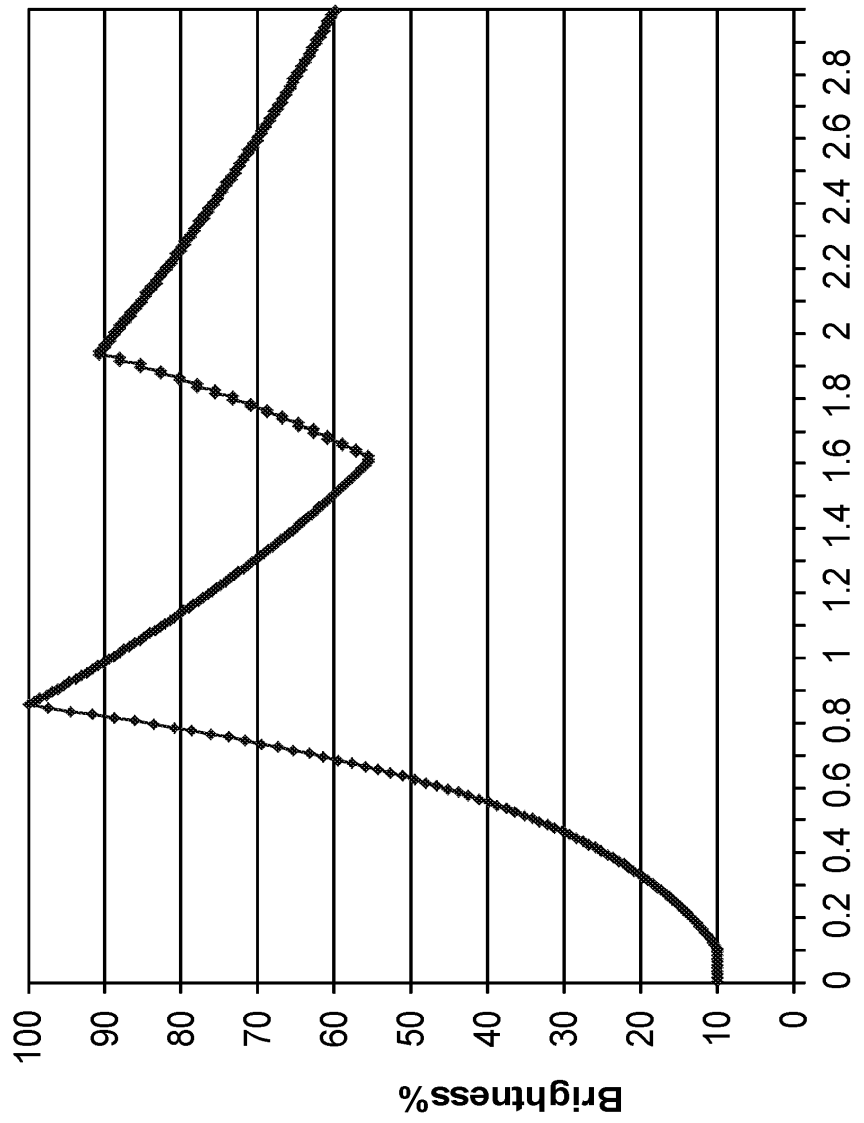

Brightness%
100
90
80
70
60
50
40
30
20
10
0
Seconds
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8

Figure 7

Doc Code: PD.REQ.RETR
Document Description: Request for USPTO to retrieve priority docs

PTO/SB/38 (10-14)
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Send completed form to: Commissioner for Patents
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COMPLETE IF KNOWN	
Application Number	15/481,460
Filing Date	April 7, 2017
First Named Inventor	Roderick Allen GAMMONS
Art Unit	2844
Examiner Name	CARIASO ALAN B
Attorney Docket Number	69726

Pursuant to 37 CFR 1.55(h), the undersigned hereby requests that the USPTO retrieve an electronic copy of each of the following foreign applications for which priority has been claimed under 35 U.S.C. 119(a)-(d) from a foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement. This Request must be submitted:

- within the later of sixteen months from the filing date of the prior foreign application or four months from the actual filing date of an application under 35 U.S.C. 111(a),
- within four months from the later of the date of commencement (37 CFR 1.491(a)) or the date of the initial submission under 35 U.S.C. 371 of an application entering the national stage under 35 U.S.C. 371, or
- with a petition under 37 CFR 1.55(e).

☐ **OPTION A**

Please retrieve the priority application identified in Column C, a certified copy of which is contained in the EP or JP application identified in Columns A and B:

	A	B		C	
	Code for Participating Office (EP or JP only)	Application containing the non-participating priority application		Non-participating priority application to be retrieved	
		App. No.	Filing Date	Country Code	App. No.
1					

☑ **OPTION B**

This Request may be used for the infrequent circumstance when a claim for priority to an application filed in a participating foreign intellectual property office was made prior to that foreign intellectual property office becoming a participating foreign intellectual property office.

Please retrieve the priority application identified in Columns A and B:

	A	B		
	Code for Participating Office (e.g., EP, JP, KR, CN) or WIPO DAS Depositing Office (e.g., AU, DK, ES, FI, GB, IB, SE)	Application to be retrieved		
		App. No.	Filing Date	Access Code (for WIPO DAS Depositing Office)
1	GB	1606907.2	2016-04-20	CF91
2				

The USPTO will not attempt to retrieve the identified priority application(s) unless an identical claim for foreign priority to the application identified above is made pursuant to 37 CFR 1.55(d) or a petition is granted under 37 CFR 1.55(e). Applicants are advised to consult Private PAIR (accessed through www.uspto.gov) to assure that the retrieval has been successful. The applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period set forth in 37 CFR 1.55(g)(1).

I hereby declare that I have the authority to grant access to the above-identified foreign application(s).

/Martin D. Moynihan/	December 20, 2017
Signature	Date
Martin D. Moynihan	718.930.5399
Printed or Typed Name	Telephone Number
	40338
Title	Registration Number, if applicable

This collection of information is required by 37 CFR 1.55(d). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt

EFS ID:	31281706
Application Number:	15481460
International Application Number:	
Confirmation Number:	5642
Title of Invention:	LIGHTING SYSTEM AND CONTROL THEREOF
First Named Inventor/Applicant Name:	Roderick Allen GAMMONS
Customer Number:	67801
Filer:	Martin Dennis Moynihan
Filer Authorized By:	
Attorney Docket Number:	69726
Receipt Date:	20-DEC-2017
Filing Date:	07-APR-2017
Time Stamp:	01:15:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for USPTO to retrieve priority docs	69726Formsb0038.pdf	148679 7a77b6c52a9d6511428b9d4bf11d30c27744bfa3	no	1
Warnings:					

Information:	
Total Files Size (in bytes):	148679

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/481,460	04/07/2017	Roderick Allen GAMMONS	69726

CONFIRMATION NO. 5642

67801
MARTIN D. MOYNIHAN d/b/a PRTSI, INC.
P.O. BOX 16446
ARLINGTON, VA 22215

PUBLICATION NOTICE

OC000000095780051

Title:LIGHTING SYSTEM AND CONTROL THEREOF

Publication No.US-2017-0343197-A1
Publication Date:11/30/2017

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(*use as many sheets as necessary*)

	Complete if Known
Application Number	15/481,460
Filing Date	April 07, 2017
First Named Inventor	GAMMONS Roderick Allen et al
Art Unit	2844
Examiner Name	
Attorney Docket Number	69726

Sheet 1 of 2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind Code [2] (if known)	Publication Date DD-MMM-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	2007/0159347	12-Jul-2007	Weitzel	
	2	2008/0129226	05-Jun-2008	DeWitt et al.	
	3	5,307,295	26-Apr-1994	Taylor et al.	
	4	5,921,659	13-Jul-1999	Hunt et al.	
	5	5,924,784	20-Jul-1999	Chliwnyj et al.	
	6	7,038,399	02-May-2006	Lys et al.	
	7	7,353,071	01-Apr-2008	Blackwell et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Documents Country Code [3]- Number [4]- Kind Code [5] (*if known*)	Publication Date DD-MMM-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [6]
	8	GB 2209229	04-May-1989	Pearce-Harvey et al.		
	9	EP 2383608	02-Nov-2011	Wu		
	10	GB 2424525	27-Sep-2006	Rafter et al.		
	11	GB 2482562	08-Feb-2012	Hjerde		
	12	JP H0448588	18-Feb-1992	Iwata		
	13	WO 01/05195	18-Jan-2001	Lys et al.		
	14	WO 2005/052751	09-Jun-2005	Chemel et al.		

Examiner Signature		Date Considered	

[*] EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of copy of this form with next communication to applicant.

[1] Applicant's unique citation designation number (optional).

[2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3).

[3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3).

[4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

[5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible.

[6] Applicant is to place a check mark here if English language translation is attached.

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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (*use as many sheets as necessary*)				Complete if Known	
				Application Number	15/481,460
				Filing Date	April 07, 2017
				First Named Inventor	GAMMONS Roderick Allen et al
				Group Art Unit	2844
				Examiner Name	
Sheet	2	Of	2	Attorney Docket Number	69726

OTHER PRIOR ART – NON PATENT LITERATURE DOCUMENTS

Examiner Initials	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	15	European Search Report and the European Search Opinion Dated 01 August 2017 From the European Patent Office Re. Application No. 17165609.3. (7 Pages)	
	16	Patents Act 1977: Combined Search and Examination Report Under Sections 17 and 18(3) Dated 13 June 2016 From the Intellectual Property Office of the United Kingdom Re. Application No. GB1606907.2. (7 Pages)	
	17	Patents Act 1977: Examination Report under Section 18(3) Dated 30 August 2017 From the Intellectual Property Office of the United Kingdom Re. Application No. GB1606907.2 (3 Pages)	

Examiner Signature		Date Considered	

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[1] Applicant's unique citation designation number (optional).

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[3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3).

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	§		
	§		
GAMMONS Roderick Allen et al	§		
	§	Confirmation No.:	5642
Serial No.: 15/481,460	§		
	§		
Filed: April 07, 2017	§	Group Art Unit:	2844
	§		
For: LIGHTING SYSTEM AND CONTROL THEREOF [CineSFX]	§		
	§	Attorney Docket:	69726
Examiner:	§		

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a PTO Form 1449 which lists citations which may be material to the patentability and examination of the above identified application. Also enclosed are copies of the references cited, other than U.S. Patents and U.S. patent applications. These are submitted in compliance with the duty of disclosure defined in 37 CFR 1.56, 37 CFR 1.97 and 37 CFR 1.98. The Examiner is requested to make these citations of official record in this application.

The undersigned states:

A. NO CERTIFICATION OR FEE DUE

☒ This Information disclosure Statement is being filed within three months of filing a national application or entry of a national phase of an international application; or before the mailing date of a first Office action on the merits of the above-identified application. Accordingly, no fee or Certification is believed due. However, if a fee is due, authorization to deduct such fee from the Deposit Account 501407 of the undersigned is hereby provided.

B. CERTIFICATION

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or

That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement.

C. FEE

☐

☒ No Fee is Due.

This Information Disclosure Statement under 37 CFR 1.56 is not to be construed as a representation that a search has been made, that additional matter which is material to the examination of this application does not exist, or that any one or more of the citations listed constitutes prior art as defined by 35 U.S.C. 102.

It is respectfully requested that the Examiner consider the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims, and sign the enclosed form PTO-1449 to evidence that the cited information has been fully considered by the Patent and Trademark Office during the examination of this application. Notwithstanding any statements by the Applicant, the Examiner is urged to form his/her own conclusion regarding the relevance of the cited information.

FOR PATENT TERM ADJUSTMENT CALCULATION PURPOSES ONLY:

Unless indicated otherwise, to the best of our knowledge and procedures, each item of information contained in the information disclosure statement was first known no more than thirty days prior to the filing of the information disclosure statement, either by the inventor named in the application, Attorney or agent who prepares or prosecutes the application, and every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, the applicant, an assignee, or anyone to whom there is an obligation to assign the application.

Respectfully submitted,

/ Martin D. Moynihan /

Martin D. Moynihan
Registration No. 40338
Telephone: (703)859-9634

Date: 24 November 2017

(12) UK Patent Application (19) GB (11) 2 209 229 (13) A

(43) Date of A publication 04.05.1989

(21) Application No 8720399.8

(22) Date of filing 28.08.1987

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(51) INT CL⁴
F21P 5/02, G05B 15/00

(52) UK CL (Edition J)
G3N NGA N272A N272B N383A N387
F4R RFE RFN R330
U1S S1933

(56) Documents cited
GB 2168138 A **GB 2132329 A** **GB 1434052 A**
GB 1332412 A **EP 0253082 A2** **EP 0060068 A1**
US 3845351 A

(58) Field of search
UK CL (Edition J) **F4R RFE RFJ RFM RFN RL RS, G3N NGA NGBA NGBA1 NGCA NGCA1 NGCA4 NGE2**
INT CL⁴ **F21P**

(54) Remote control system

(57) A control system for the remote control of equipment such as stage lighting or sound equipment 300 comprises a micro computer (101-104) which is used to input commands to the equipment. The setting of one item of equipment (eg, a spotlight) can be set by the user and then the setting(s) of other equipment can be calculated to achieve a user-set co-ordination between the operation of the items of equipment. Control signals are sent to the remote equipment in pulse width modulated form to achieve rapid updating with high noise immunity.

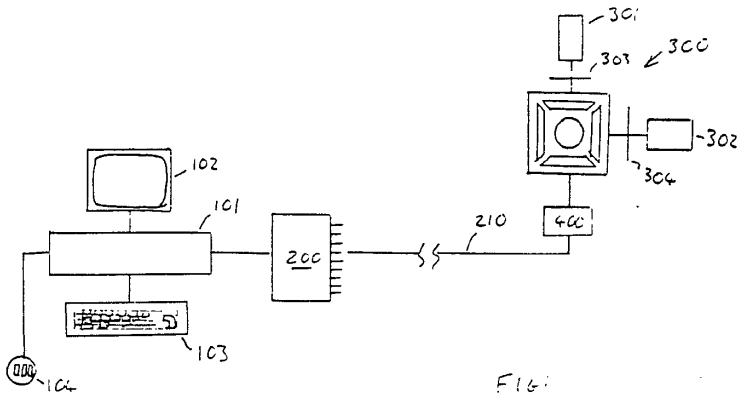


FIG.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

This print takes account of replacement documents submitted after the date of filing to enable the appliction to comply with the formal requirements of the Patents Rules 1982.

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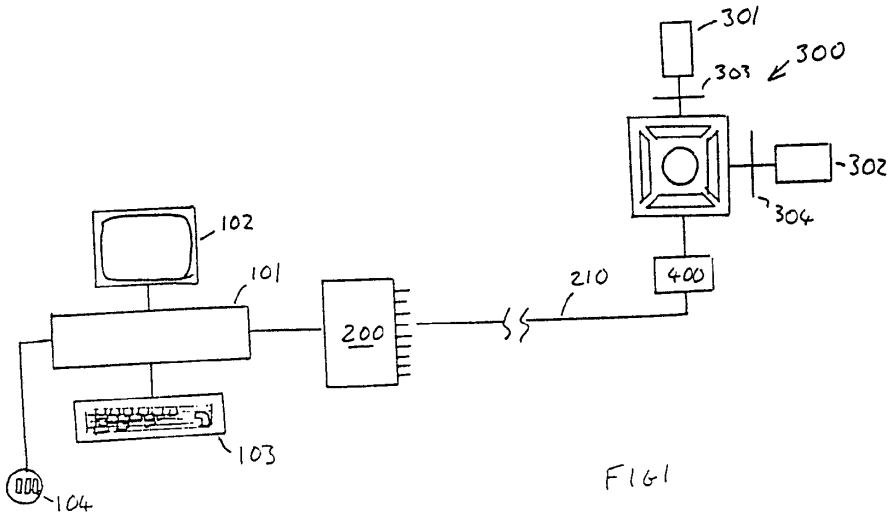


FIG1

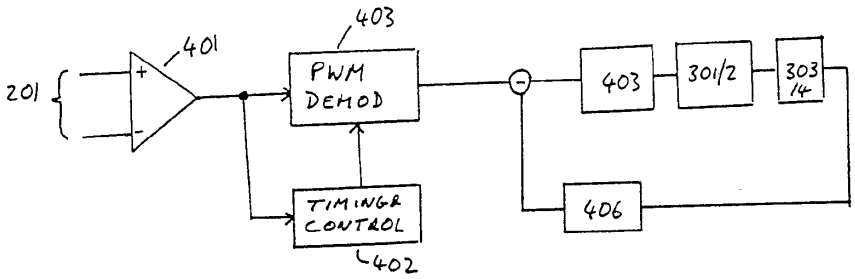
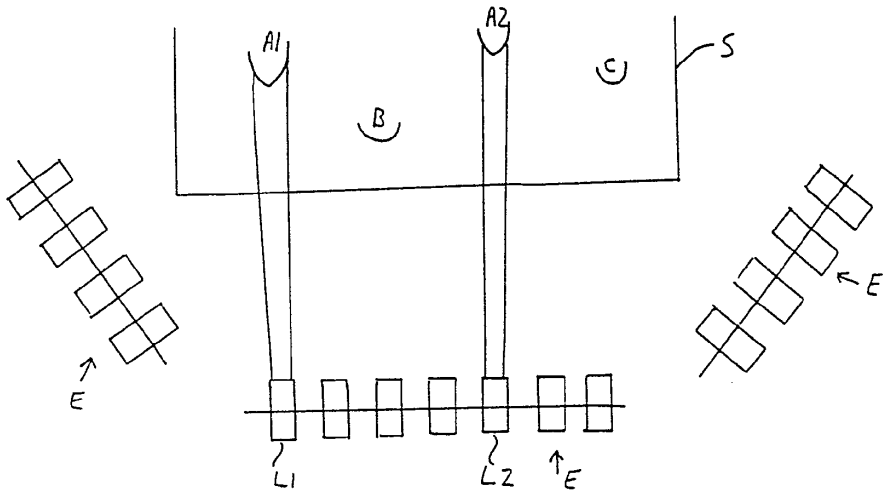


FIG2

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D

FIG 3

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REMOTE CONTROL SYSTEM

The present invention relates to a remote control system, particularly, but not exclusively, for use in controlling lighting, sound and/or other stage equipment for stage performances and similar uses.

It is conventional to control stage lighting equipment from a control desk which is provided with a number of individual controls for to what may be a large number of stage lights. Conventionally, such a desk is provided with facilities for fading in and fading out individual lights or groups of lights.

Over the past few years, stage lighting equipment has become available which has the facility for controlling remotely mechanical aspects of the operation of the individual lights. For example, each light may be provided with motor-driven mechanisms for controlling the pan and/or tilt of the light and other operating parameters such as the iris aperture and focus of the light. Systems have been proposed in which the control desk
incorporates a desk-top computer into which commands for the individual lights can be typed by the operator. Perhaps because of the basically digital nature of the controller and the trend towards the use of digital techniques generally,

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such systems have transmitted the commands to the individual lights as digital data over a wire link, and individual lights have been provided with digital decoders which receive the commands from the control desk, decode and control the electro-mechanical actuators associated with the light in accordance with the decoded commands.

Various problems have been encountered with such systems. The use of digital transmission requires a substantial degree of local "intelligence" at the decoders associated with the individual lights, making the equipment expensive. Secondly, difficulties are encountered in operating such equipment because the operating environment is relatively hostile, both electrically and physically, i.e; the power supplies to the lighting and sound equipment involves large electrical currents which are a source of noise and interference which can cause mis-operation of the digital equipment and, from a physical point of view, amongst other things, the equipment may generate a substantial amount of heat - present stage lighting equipment may operate at power levels of several tens or even hundreds of kilowatts. Thirdly, neither the use of a conventional control desk layout of faders nor input of commands from computer keyboards provides a simple and rapid method of setting up and issuing commands for operating the lights in a coordinated fashion.

The present invention is concerned, inter alia, with reducing the above problems. It is not limited, however, to applications where those specific problems arise.

A first aspect of the present invention provides a control system for controlling operation of a number of remote electrical devices, comprising a user-operable system controller for enabling a user to set operating variables of the remote devices, and generating corresponding control signals for each of the controlled devices, means for transmitting the control signals to the remote devices, and means associated with each of the remote devices for decoding the control signals received from the system controller and setting the operating variable (s) of the associated device as commanded by the control signals, the system controller being operative to accept user-input setting the required value of the operating variable of one of the remote devices and a user-command which instructs the corresponding operating variable of at least one other remote device to be set to a value coordinated with that value, to calculate the required coordinated value of the operating variable of that other remote device or devices and to generate the corresponding command for that other remote device or devices.

In the application of this aspect of the invention to the control of the pan and/or tilt of two or more stage lights,

suppose that the operator requires two spotlights to converge on the same point on the stage or to follow the same path at the same time on the stage. In those circumstances, the system controller is arranged to accept commands from the user setting the position (or sequence of positions) required of one of the spotlights, to calculate and generate the corresponding command signals for that spotlight and transmit them to the spotlight which has control circuitry associated with it which de-codes the commands and operates the spotlight accordingly. The system controller further accepts a command from the user as to the manner in which the operation of the second spotlight is to be coordinated with that of the first (as by being directed at the same spot or following the same path), calculates the required value or sequence of values of the operating variable (eg; pan and/or tilt) of the second spotlight required to achieve the instructed coordination and then generates and transmits those commands to the second spotlight, simultaneously with the first spotlight, or not depending on the coordination required. Facilities in the controller may be provided for enabling the user to see the effect of a "test run" of the command or commands to the first spotlight before the system controller generates the coordinated commands for the second one.

A second aspect of the present invention provides a control system for controlling the operation of one or more remotely

located lighting, sound or other stage equipment comprising a user/operable system controller for user/setting operating variables of the remote equipment and for generating corresponding command signals to the control equipment, means for transmitting the control signals to the remote equipment, and means associated with the remote equipment for decoding the command signals received from the system controller and setting the operating variable (s) of the associated device accordingly, the required value of the operating variable being encoded for transmission as the pulse-width modulation of pulses in a train of pulses transmitted to the remote device.

For the or each remote item of equipment, a number of operating variables (eg; in the stage lighting application, the pan and/or tilt of a stage light), they be controlled by the system controller. In those circumstances, the command signals for each variable may be time-interleaved in a cyclical fashion, so that the pulse train transmitted comprises a cyclical succession of pulse-width modulated pulses representing commands for respective operating variables of the particular remote device. It has been found that such an arrangement provides a good degree of immunity from noise and other interference in the hostile stage environment, enables the individual remote devices to be controlled by circuitry which does not have to possess a

substantial degree of local intelligence and enables the commands for each device to be updated very frequently without requiring a very high data transmission rate.

A control system incorporating both of the above aspects of the present invention will now described by way of non-limitative examples reference to the accompanying drawings in which:-

Figure 1 is a schematic block diagram of a control system in accordance with both aspects of the present invention;

Figure 2 is a schematic block diagram of the de-coder associated with one of the remotely controlled devices in the system of figure 1;

Figure 3 is a schematic plan view of a stage showing how the system may be used to coordinate the operation of two or more stage lights to achieve a required effect.

Before describing in detail the illustrated embodiment of the invention, reference will be made to Figure 3 which illustrates one typical way in which it may be used.

In Figure 3, S denotes a stage on which a performance is to take place, lit by stage lighting equipment E which includes,

amongst others, spotlights L1, L2 which are currently directed at areas A1 and A2 of the stage. The lighting equipment operates under the control of a lighting (and optionally, sound) control desk D. The spotlights L1, L2, are of a type having electromechanical actuators to set their pan and tilt angles.

Suppose that the operator wishes the spotlights L1, L2 to pan and tilt in synchronism so that they end up converging at point B. The illustrated embodiment is provided with control facilities whereby a computer (100 in Figure 1) at the desk D has data as to the current and required positions of the spotlights L1, L2 and can calculate and transmit to each of the two spotlights a sequence of position commands which will result in their beams converging at the required position B at the same time. Even where the positions of the two spotlights relative to the stage are not symmetrical, given data as to their actual positions, the computer can calculate the required sequences of movements of the two spotlights to coordinate their actions as required.

As a second example, the operator might want both of the spotlights to move in synchronism from position B to a position C and again it can calculate the required sequences of position commands for the two lights so that they move in the required way, even allowing for assymetries in their

positions.

Where coordination of the operation (e.g. the movements) of two or more such lights is required, the present invention proposes a method of operation which does not require the operator to programme each of the lights individually. Specifically, it is proposed that the software of the computer of the desk D is arranged so that it first accepts a command (or series of commands) from the user indicating the action(s) required of one of the devices to be controlled - in this case the lights (say, L1 in Figure 3) and then a command in respect of one or more of the other devices indicating the coordinated action required (e.g. in the case of light L2, arrive at C at the same time or move in a manner to keep its beam parallel, say, to that of L1). Any number of other required coordinated actions of the controlled devices may be handled in a similar way.

Referring now to Figure 1, this shows the overall arrangement of the illustrated embodiment. The control desk D of Figure 3 is provided with a desk-top computer 100 (e.g. an IBM PS2 System 50 PC) which comprises a system unit 101, VDU 102, keyboard 103 and two-axis input device 104 such as a "mouse", trackball or lightpen. The computer 100 operates under the control of a suitably written application program running under a convenient operating system such as MS Windows. The

VDU 102 can display a map in plan or perspective of the stage and the lighting and other equipment which is to be controlled and the input device 104 can be used to select lights and other items of equipment whose operation is to be controlled and to call up "icons" or menu-bars to pre-programme or operate in real time the items in question. The device 104 and/or the keyboard 103 can further be used to control the operating mode of the software, establish the required settings or operation of the items of equipment to be controlled and so forth.

The computer 100 calculates the required commands for each of the lights, etc., which are to be controlled and outputs them via a standard high-speed parallel communications port to a transmitter 200 which distributes the commands across a number of output channels for transmission via cables such as 210 to the individual items (or groups of items, where appropriate). One such item, a pan and tilt spotlight is shown at 300. For functions which do not register a change between successive cycles (i.e. the instructed value does not change), the previous value is retransmitted.

The transmitter 200 acts in effect as a time-division demultiplexer, distributing the serially generated command signals across its N output channels. N may be, say, 40, with, say, 9 functions (per light or other controlled device) on

each channel. The pulse rate on each channel may be such that, say, 40 or 50 cycles of the various function signals on each channel occur per second. The transmitter 200 also serves to produce the appropriate pulse width modulated signals for transmission and incorporates suitable line drivers for driving the cables 210. These may be screened twisted wire pairs to which a balanced drive signal is applied so as to reduce the sensitivity to electrical noise.

The spotlight 300 has electronically controlled pan and tilt DC electric motors 301, 302 which are actuated by circuitry 400 as required in accordance with the PWM signals received via the associated cable 210. The control signal comprises a cyclically repeating series of PWM pulses; each of the pulses in the series may represent the required setting of a different operating parameter of the device (in this case, the spotlight) under control. In the case of a spotlight, the parameters can include: pan & tilt angles, iris setting, which one of a number of colour filters is to be in effect, lamp power and so forth (alternatively the lamp power may be controlled by conventional triac or SCR phase control of the mains supply to the lamp). The width modulation (and subsequent demodulation and position servo) is preferably such as to allow an overall resolution of 11 bits or more in positional commands, although in certain applications lower resolutions may be acceptable.

Figure 2 illustrates part of the control circuitry 400 associated with the light 300. A differential amplifier 401 whose inputs are connected to the two wires of the twisted pair signal cable 210 produces an output voltage whose waveform is the PWM pulse signal containing the commands for the light 300. This signal is applied to a timing signal generating circuit 402 which generates a clock signal used to identify each of the PWM pulses in the repeating series and to route them to corresponding decoding circuits. One such circuit is shown at 403 and is operative to convert one of the pulses in the series (say, the commanded tilt angle) to a DC voltage corresponding to the commanded value which is sampled and held to produce a DC level Vc which indicates the commanded value. This decoding may take place in any suitable fashion. For example, an analogue or quasi-analogue ramp may be started as the PWM signal crosses zero (or reaches some other preset value) going in one direction and by sampling and holding the value of the ramp when the PWM pulse crosses zero going in the other direction, a DC voltage corresponding to the demanded value can be derived. Alternatively, a digital code can be derived directly from the width-modulated pulse and converted to analogue by a D/A converter.

The voltage Vc is applied as a set point signal to the set point input of a servo circuit 404 which in the cases of the

pan and tilt angles operates as a position servo. A drive amplifier 405 applies to the pan or tilt motor 301/302 a DC drive voltage proportional to the difference between the set-point signal Vc and an error voltage signal Ve derived by analogue-to-digitally converting in D-to-A circuit 406 the output of a sensor reading an optical position encoder disk 303/304 (or other position detector such as a potentiometer) on the output shaft of the motor 301/302. The motor is thus operated to servo the pan or tilt angle, as appropriate, to the position commanded by the incoming PWM pulse from the computer 100.

The demultiplexing of the pulses in the incoming train may take place before or after each of the PWM pulses is converted to a DC voltage. Demultiplexing after conversion has the advantage of only requiring one PWM decoder; the succession of sampled and held levels can then be distributed across the various output channels by demultiplexing them via analogue switches operated by the timing circuit 402 to individual sample and hold circuits associated with each of the output channels.

Circuits such as 404 may be provided for each of the controllable analogue functions of the light 300 which it desired to control. Further, the light 300 may have one or more "digital" functions which only assume one of a finite

number of states (e.g. the opening or closing of shutters) or the position of a colour filter wheel, and PWM command pulses to control these states may be incorporated in the PWM pulse train. Other functions may be controlled in the same way; for example it may be desirable to have "calibration" commands which cause the light's various functions to be reset to a predetermined initial state (e.g. the pan and tilt angles are set to values at one or other end of the operating range.

The use of the PWM pulse train provides good noise immunity, avoids the need for local "intelligence" in the circuitry at each of the devices being controlled and complex two-way digital signalling protocols, and, perhaps most importantly, enables the commanded values of each of the controlled parameters of an individual light to be updated at a high rate.

The system above described, as well as overcoming the problem described above of existing systems has a number of advantages, including:-

1) The use of PWM enables a speed of response which can provide "instant" effects.

2) By avoiding have local intelligence at the controlled devices it avoids the need for error checking which slows the speed of transmission.

3) The speed of initialising the system is greatly reduced

-existing systems may take several minutes.

4) Interfacing with other apparatus is easy and they can be controlled in the same way by the software, using icons to represent them.

5) The reliability and flexibility of the system is increased, while the cost is decreased.

6) The intelligence of the system is provided by an industry-standard, widely available and supported computer.

7) Language problems on the part of the operator are largely avoided by the use of a graphical representation of the controlled environment and by the other facilities available in a computer windowing environment.

8) Interfacing with existing "off the shelf" controllers such as MIDI interfaces is easily carried out.

Although, in the above, the invention has been described with reference to the control of stage lighting it may, of course, be applied to a wide range of stage and other equipment, including cameras and stage effects equipment and sound equipment.

CLAIMS

1. A control system for controlling operation of a number of remote electrical devices, comprising a user-operable system controller for enabling a user to set operating variables of the remote devices, and generating corresponding control signals for each of the controlled devices, means for transmitting the control signals to the remote devices, and means associated with each of the remote devices for decoding the control signals received from the system controller and setting at least one operating variable of the associated device as commanded by the control signals, the system controller being operative to accept user-input setting the required value of the operating variable of one of the remote devices and a user-command which instructs the corresponding operating variable of at least one other remote device to be set to a value co-ordinated with that value, to calculate the required co-ordinated value of the operating variable of that other remote device or devices and to generate the corresponding command for that other remote device or devices.

2. A control system according to claim 1, wherein the system controller is operative to accept a user command designating the manner in which the operation of the at least one other device is to be co-ordinated with that of the one remote device.

3. A system according to claim 1 or 2 in which the remote devices comprise stage lighting or stage effects equipment, sound equipment and/or cameras.

4. A system according to claim 3 wherein the remote devices include devices for the control of the pan and/or tilt of two or more stage lights.

5. A system according to claim 4 wherein the stage lights include spot lights the system controller is arranged to accept commands from the user setting the position, or sequence of positions, required of one of the spotlights, to calculate and generate the corresponding command signals for that spotlight and transmit them to the spotlight, the

spotlight having control circuitry associated with it which decodes the commands and operates the spotlight accordingly.

6. A system according to claim 5 wherein the system controller is arranged to accept a command from the user as to the manner in which the operation of the second spotlight is to be co-ordinated with that of the first to direct the second spotlight at the same spot as the first spotlight or following the same path, to calculate the required value or sequence of pan and/or tilt of the second spotlight required to achieve the instructed co-ordination and to then generate and to transmit those commands to the second spotlight.

7. A control system for controlling the operation of one or more remotely located lighting, sound or other stage equipment comprising a user/operable system controller for user/setting operating variables of the remote equipment and for generating corresponding command signals to the control equipment, means for transmitting the control signals to the remote equipment, and means associated with the remote

equipment for decoding the command signals received from the system controller and setting at least one operating variable of the associated device accordingly, the required value of the operating variable being encoded for transmission as the pulse-width modulation of pulses in a train of pulses transmitted to the remote equipment.

8. A system according to claim 7 wherein there are a number of operating variables associated with a remote equipment and the system controller is operative to time-interleave the command signals for each variable for that remote equipment may be time-interleaved in a cyclical fashion, so that the pulse train transmitted comprises a cyclical succession of pulse-width modulated pulses representing commands for respective operating variables of that particular remote equipment.

9. A control system according to claim 7 or 8 wherein the system controller is arranged to enable a user to set operating variables of the remote equipment, and generating corresponding control signals for each of the controlled

equipment, means for transmitting the control signals to the remote equipment, and means associated with each of the remote equipment for decoding the control signals received from the system controller and setting at least one operating variable of the associated equipment as commanded by the control signals, the system controller being operative to accept user-input setting the required value of the operating variable of one of the remote equipment and a user-command which instructs the corresponding operating variable of at least one other remote equipment to be set to a value co-ordinated with that value, to calculate the required co-ordinated value of the operating variable of that other remote equipment and to generate the corresponding command for that other remote equipment.

10. A control system according to claim 1, wherein the system controller is operative to accept a user command designating the manner in which the operation of the at least one other equipment is to be co-ordinated with that of the one remote equipment.

11. A system according to claim 1 or 2 in which the remote equipment comprise stage lighting or stage effects equipment, sound equipment and/or cameras.

12. A system according to claim 3 wherein the remote equipment includes equipment for the control of the pan and/or tilt of two or more stage lights.

13. A system according to claim 4 wherein the stage lights include spot lights the system controller is arranged to accept commands from the user setting the position, or sequence of positions, required of one of the spotlights, to calculate and generate the corresponding command signals for that spotlight and transmit them to the spotlight, the spotlight having control circuitry associated with it which decodes the commands and operates the spotlight accordingly.

14. A system according to claim 5 wherein the system controller is arranged to accept a command from the user as to the manner in which the operation of the second spotlight

is to be co-ordinated with that of the first to direct the second spotlight at the same spot as the first spotlight or following the same path, to calculate the required value or sequence of pan and/or tilt of the second spotlight required to achieve the instructed co-ordination and to then generate and to transmit those commands to the second spotlight.

15. A control system according to any one of claim 2 to 6 or any one of claims 10 to 15 wherein the system controller has associated with it a display for displaying a visual representation of a stage area and equipment or devices to be controlled.

16. A control system constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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(54) Digital imaging apparatus

(57) A digital imaging apparatus (110) is disclosed including: a light source module (240); and a light source controller (230) for receiving an image control signal and setting a radiation pattern of the light source module (240) to be corresponding to the image control signal.

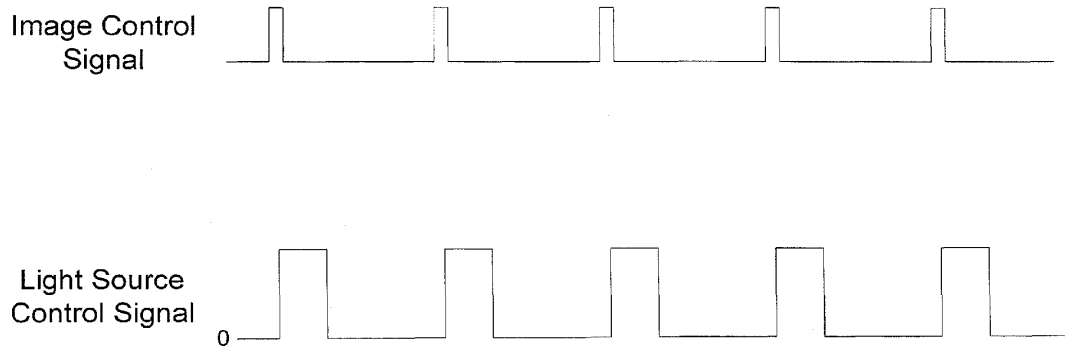


FIG. 3

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Description

[0001] The present disclosure generally relates to a digital imaging apparatus according to the pre-characterizing clause of claim 1.

[0002] Digital imaging technologies are widely applied in various applications, such as digital still cameras, digital video recorders, digital microscopic measurements, image object recognization operations, or the like.

[0003] Image quality is greatly influenced by the digital imaging performance, especially for the image of object details. Poor lighting conditions usually result in image defects such as images with insufficient brightness or contrast. In addition, relative movement between the digital imaging device and a target object could also easily cause motion blur or related problems. These situations often lead to adverse effect to the image quality of object details.

[0004] Clear image of object details, however, is crucial to many applications, such as digital microscopic photography, microscopic measurements, image recognization operations, auto-inspection systems, or the like. It may easily cause erroneous results in subsequent processes or judgments if the clearness of image details is insufficient or the image details are blurred, thereby reducing the system performance and reliability.

[0005] This in mind, the present invention aims at providing a digital imaging apparatus that improves the image quality of the details of the sensed image, thereby increasing the accuracy and imaging reliability.

[0006] This is achieved by a digital imaging apparatus according to claim 1. The dependent claims pertain to corresponding further developments and improvements.

[0007] As will be seen more clearly from the detailed description following below, the claimed digital imaging apparatus includes a light source controller that is coupled with a light source module for receiving an image control signal and setting a radiation pattern of the light source module to be corresponding to the image control signal.

[0008] In the following, the invention is further illustrated by way of example, taking reference to the accompanying drawings. Thereof

[0009] Fig. 1 is a simplified functional block diagram of an object inspection system in accordance with an exemplary embodiment,

[0010] Fig. 2 is a simplified functional block diagram of a digital imaging apparatus in accordance with an exemplary embodiment, and

[0011] Fig. 3 through Fig. 5 are simplified schematic diagrams of light source control signals generated by a light source controller of Fig. 2.

[0012] Reference will now be made in detail to exemplary embodiments of the invention, which are illustrated in the accompanying drawings. The same reference numbers may be used throughout the drawings to refer to the same or like parts or operations.

[0013] Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, vendors may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not in function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...." Also, the phrase "coupled with" is intended to compass any indirect or direct connection. Accordingly, if this document mentioned that a first device is coupled with a second device, it means that the first device may be directly connected to the second device (including through an electrical connection or other signal connections, such as wireless communications or optical communications), or indirectly connected to the second device through an indirect electrical connection or signal connection via other intermediate device or connection means.

[0014] Fig. 1 shows a simplified functional block diagram of an object inspection system 100 in accordance with an exemplary embodiment. As shown in Fig. 1, the object inspection system 100 comprises a digital imaging apparatus 110, a host device 120, a display 130, and a supporting device 140. The digital imaging apparatus 110 and the display 130 are coupled with the host device 120. In this embodiment, the host device 120 comprises a processor 122 and a storage module 124, wherein the storage module 124 may be used for storing computer programs and image data required for the operations of the object inspection system 100.

[0015] The digital imaging apparatus 110 may be implemented with a digital camera, digital video recorder, digital microscope, and any other apparatus with image sensing capability. The operations of the digital imaging apparatus 110 will be described further in the following.

[0016] Fig. 2 is a simplified functional block diagram of the digital imaging apparatus 110 in accordance with an exemplary embodiment. In this embodiment, the digital imaging apparatus 110 comprises a control circuit 210, an image sensing circuit 220, a light source controller 230, and a built-in light source module 240. As shown, the image sensing circuit 220 and the light source controller 230 are coupled with the control circuit 210, and the built-in light source module 240 is coupled with the light source controller 230.

[0017] In operations, the control circuit 210 is coupled with the host device 120 through a predetermined transmission interface, such as USB or IEEE 1394, and receives electricity required for the operations of the digital imaging apparatus 110 from the host device 120. In one embodiment, the built-in light source module 240 of the digital imaging apparatus 110 may be implemented with LED devices to reduce required power consumption.

[0018] The image sensing circuit 220 may comprise one or more CMOS (Complementary Metal Oxide Semiconductor) sensors, CCD (Charge Coupled Device) sensors, CMOS/CCD hybrid sensors, CID (Charge Injection Device) sensors, or other optical sensing components,

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for sensing images of a target object 102 positioned on the supporting device 140 to generate corresponding image signals. In operations, the image sensing circuit 220 also generates image synchronization signals, such as frame synchronization signals, V-sync signals, and/or H-sync signals. The image sensing circuit 220 transmits the generated image synchronization signals together with the object image signals to the control circuit 210.

[0019] As described previously, poor lighting conditions during the operations of the digital imaging apparatus 110 or relative movement between the digital imaging apparatus 110 and the target object 102 could adversely affect the quality of resulting image of the target object 102, especially for the object details. For example, the object inspection system 100 may encounter slight vibrations due to some environmental factors, such as vibration generated by the operation of mechanical components during the transportation of target objects conducted by the supporting device 140. Such vibration would cause relative movement between the digital imaging apparatus 110 and the target object 102 when the digital imaging apparatus 110 is sensing images of the target object 102.

[0020] In order to improve the imaging quality of the digital imaging apparatus 110, the image sensing circuit 220 of one embodiment generates and transmits an image control signal to the light source controller 230 during the image sensing operations. The image control signal is utilized for indicating the time points or period of an image acquisition operation conducted by the image sensing circuit 220, and is not the ordinary clock signal employed for the operations of the light source controller 230. In implementations, the image control signal may be implemented with the aforementioned image synchronization signal, such as the frame synchronization signal, V-sync signal, or H-sync signal. Alternatively, the image control signal may be implemented with a signal synchronized with the image synchronization signal and having a frequency that is multiple times of the frequency of the image synchronization signal.

[0021] When receives the image control signal generated by the image sensing circuit 220, the light source controller 230 generates a light source control signal having a frequency corresponding to that of the image control signal to control the radiation pattern of the light source module 240. In one embodiment, as shown in Fig. 3, the light source controller 230 generates a light source control signal synchronized with the image control signal and having the same frequency as the image control signal.

[0022] In the embodiment shown in Fig. 3, the light source module 240 illuminates when triggered by the edges of the light source control signal. If the image control signal is implemented with the frame synchronization signal or V-sync signal, then the light source module 240 would thus have a lighting frequency the same as the image acquisition frequency of the image sensing circuit 220, and only radiate during the image acquisition operation conducted by the image sensing circuit 220.

[0023] In another embodiment, as shown in Fig. 4, the light source controller 230 generates a light source control signal synchronized with the image control signal and having the same frequency as the image control signal. A difference between this embodiment and the previous embodiment of Fig. 3 is that in the embodiment of Fig. 4 the light source controller 230 maintains the light source control signal at a predetermined active level (such as a first predetermined voltage) or above. However, when the light source controller 230 is triggered by the edges of the image control signal, the light source controller 230 pulls up the pulse level of the light source control signal (e.g., pulls it up to a second predetermined voltage), or increases the pulse width of the light source control signal. As a result, the light source module 240 illuminates continuously, but enhances the intensity of light output when triggered by the edges of the image control signal. For example, the light source controller 230 may apply an overshot voltage to the light source control signal to pull up the pulse level (or to increase the pulse width) of the light source control signal at each time the light source controller 230 is triggered by the edge of the image control signal.

[0024] Thus, if the image control signal is implemented with the frame synchronization signal or V-sync signal, then the light source module 240 outputs more beams to illuminate the target object 102 during the image acquisition operation conducted by the image sensing circuit 220.

[0025] In another embodiment, as shown in Fig. 5, the light source controller 230 generates a light source control signal synchronized with the image control signal and having a frequency that is an integer times of the frequency of the image control signal. If the image control signal is implemented with the frame synchronization signal or V-sync signal, the then lighting frequency of the light source module 240 would be the integer times of the image acquisition frequency of the image sensing circuit 220. Accordingly, each time the image sensing circuit 220 conducts the image acquisition operation, the light source module 240 would correspondingly output beams to illuminate the target object 102.

[0026] In another embodiment, the image control signal is implemented with the H-sync signal, and the light source controller 230 generates a light source control signal synchronized with the H-sync signal and having a frequency less than that of the H-sync signal. For example, the light source controller 230 may generate a light source control signal synchronized with the H-sync signal and having a frequency the same as the V-sync signal or the frame synchronization signal. By this way, the lighting frequency of the light source module 240 would become the same as the image acquisition frequency of the image sensing circuit 220. Therefore, the light source module 240 radiates to illuminate the target object 102 during the image acquisition operation conducted by the image sensing circuit 220.

[0027] In some of the foregoing embodiments, the light

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source control signal generated by the light source controller 230 has a duty cycle less than 100%, so the light source module 240 would illuminate only when triggered by the edges of the light source control signal but would not keep illuminating all the time. Power required for the operations of the digital imaging apparatus 110 can be thus reduced.

[0028] In implementations, the image control signal generated by the imaging sensing circuit 220 may have a frequency lower than that of the image synchronization signal. In one embodiment, for example, the image control signal generated by the imaging sensing circuit 220 is half of that of the image synchronization signal. Under this situation, the light source controller 230 may generate a light source control signal having a frequency that is twice of that of the image control signal so that the generated light source control signal is synchronized with the image acquisition operation conducted by the image sensing circuit 220.

[0029] In previous embodiments, the image control signal is generated by the image sensing circuit 220. This is merely an example and not intend to restrict the practical implementations of the digital imaging apparatus 110. For example, the image control signal may be instead generated by the control circuit 210 and then transmitted to the light source controller 230. In one embodiment, the control circuit 210 may utilize the frame synchronization signal or V-sync signal transmitted from the image sensing circuit 220 to be an image control signal and then transmit it to the light source controller 230. In another embodiment, the control circuit 210 may first upconvert or downconvert the frequency of the frame synchronization signal or V-sync signal transmitted from the image sensing circuit 220, and utilize the frequency upconverted or down-converted signal to be an image control signal and then transmit it to the light source controller 230. In yet another embodiment, the control circuit 210 first down-converts the frequency of the H-sync signal transmitted from the image sensing circuit 220, utilizes the frequency down-converted signal to be an image control signal, and then transmits it to the light source controller 230.

[0030] The way the light source controller 230 generates a light source control signal according to the image control signal generated by the control circuit 210 to control the radiation pattern of the light source module 240 is similar to the previously described embodiments. For the sake of brevity, similar descriptions will not be repeated here.

[0031] From one aspect of the circuitry functions, the aforementioned image sensing circuit 220 or control circuit 210 can be regarded as an image synchronization signal generator for generating an image synchronization signal.

[0032] As illustrated in the foregoing embodiments, the light source controller 230 controls the radiation pattern of the light source module 240 according to the image control signal or image synchronization signal generated from the image sensing circuit 220 or control circuit 210, so that the light source module 240 either illuminates only during the image acquisition operation conducted by the image sensing circuit 220 or enhances the intensity of light output during the image acquisition operation conducted by the image sensing circuit 220. This approach offers a sufficient lighting condition for the image sensing circuit 220 during the image acquisition operation so as to mitigate or avoid the imaging problems such as dark images or insufficient contrast.

[0033] As a result, the time of exposure required for the image acquisition operation of the image sensing circuit 220 can be shortened, thereby significantly mitigating the adverse effect to the image quality caused by the relative movement between the digital imaging apparatus 110 and the target object 102. Thus, the digital imaging quality for both still images and real-time dynamic images can be greatly improved by using the approaches disclosed above.

[0034] In implementations, the flicker of the light source module 240 will not be sensed by human eyes if the light source controller 230 controls the light source module 240 to have a lighting frequency of 60 Hz or above.

[0035] The control circuit 210 then transmits the image signals corresponding to the target object 102 generated by the image sensing circuit 220 to the host device 120. The processor 122 of the host device 120 conducts image recognization operations, image measurements, image analyzing operations, or other subsequent processes on part of or the entire sensed image to determine whether the target object 102 complies with predetermined quality control requirements. Since the digital imaging apparatus 110 described above is capable of greatly improving the image quality of the details of the sensed image, mistakes that may be made by the processor 122 in processing or determining the images can be effectively reduced, thereby increasing the accuracy and reliability of the object inspection system 100.

[0036] The processor 122 may also display the images sensed by the digital imaging apparatus 110 or image inspection results generated by the processor 122 on the display 130, so that a quality control operator can monitor the quality inspection procedure or related image analysis parameters for the target object 102. When the inspection for the target object 102 is complete, the processor 122 instructs the supporting device 140 to move to or switch to a next target object to be inspected so as to repeat the aforementioned operations. In some embodiments where the object inspection system 100 is designed to operate automatically, the display 130 may be omitted.

[0037] In the foregoing descriptions, the implementations of the digital imaging apparatus 110 are described as employed in the object inspection system 100. However, such descriptions are exemplary only and shall in no way be interpreted to limit the applications of the present invention. The disclosed digital imaging appara-

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tus 110 has practical applications in many fields including, but not limited to, automotive applications, medicine-related applications, industrial applications, educational applications, and personal hobby applications.

[0038] In addition, when the digital imaging apparatus 110 is used in hand-held fashion, the way the light source controller 230 controls the radiation pattern of the light source module 240 described previously effectively mitigates or reduces the adverse effect to the imaging quality of the digital imaging apparatus 110 caused by hand vibration or movement, thereby achieving better hand vibration proof effect.

[0039] For completeness, various aspects of the invention are set out in the following numbered clauses:

[0040] 1. A digital imaging apparatus comprising:

a light source module;
an image synchronization signal generator for generating an image synchronization signal; and
a light source controller, coupled with the light source module and the image synchronization signal generator, for generating a light source control signal having a frequency corresponding to the image synchronization signal and synchronized with the image synchronization signal to control the light output of the light source module.

[0041] 2. The digital imaging apparatus of clause 1, wherein the image synchronization signal comprises a frame synchronization signal, a vertical synchronization signal, or a horizontal synchronization signal.

[0042] 3. The digital imaging apparatus of clause 2, wherein the light source control signal and the image synchronization signal have the same frequency.

[0043] 4. The digital imaging apparatus of clause 2, wherein a frequency of the light source control signal is multiple times of that of the image synchronization signal.

[0044] 5. The digital imaging apparatus of clause 2, wherein a frequency of the image synchronization signal is multiple times of that of the light source control signal.

[0045] 6. The digital imaging apparatus of clause 1, wherein the image synchronization signal generator comprises an image sensing circuit for sensing images of a target object.

[0046] 7. The digital imaging apparatus of clause 1, wherein the image synchronization signal generator comprises a control circuit and the control circuit receives electricity required for the operations of the digital imaging apparatus from an external device.

[0047] 8. The digital imaging apparatus of clause 1, wherein the light source controller pull up the pulse level of the light source control signal or increases the pulse width of the light source control signal when triggered by an edge of the image synchronization signal.

[0048] 9. A digital imaging apparatus comprising:

a light source module; and
a light source controller for receiving an image control signal and setting a radiation pattern of the light source module to be corresponding to the image control signal.

[0049] 10. The digital imaging apparatus of clause 9, wherein the light source controller sets a lighting frequency of the light source module to be substantially the same as the frequency of the image control signal.

[0050] 11. The digital imaging apparatus of clause 9, wherein the light source controller sets a lighting frequency of the light source module to be a multiple times of the frequency of the image control signal.

[0051] 12. The digital imaging apparatus of clause 9, wherein the light source controller sets a lighting frequency of the light source module so that the frequency of the image control signal is a multiple times of the lighting frequency of the light source module.

[0052] 13. The digital imaging apparatus of clause 9, further comprising:

an image sensing circuit for generating the image control signal, wherein the image control signal corresponds to the time points or period of an image acquisition operation conducted by the image sensing circuit.

[0053] 14. The digital imaging apparatus of clause 9, further comprising:

a control circuit for generating the image control signal and receiving electricity required for the operations of the digital imaging apparatus from an external device.

[0054] 15. The digital imaging apparatus of clause 9, wherein the image control signal corresponds to the time points or period of an image acquisition operation conducted by an image sensing circuit, and the light source controller controls the light source to illuminate or to enhance the intensity of light output during the image acquisition operation conducted by the image sensing circuit.

[0055] 16. An object inspection system comprising:

a supporting device for supporting a target object;
an image sensing circuit for sensing images of the target object and generating an image synchronization signal;
a host device coupled with the image sensing circuit for conducting image processing operations on part of or the entire image sensed by the image sensing circuit;
a light source module;
a light source controller, coupled with the image sensing circuit and the light source module, for generating a light source control signal having a duty circle less than 100% according to the image synchronization signal to control the light output of the

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light source module; and
a control circuit for receiving electricity required for the operations of the image sensing circuit, the light source module, and the light source controller from the host device.

[0056] 17. The object inspection system of clause 16, wherein the light source controller controls the light source module to illuminate during the image acquisition operation conducted by the image sensing circuit.
[0057] 18. The object inspection system of clause 16, wherein the light source controller controls the light source module to enhance the intensity of light output during the image acquisition operation conducted by the image sensing circuit.
[0058] 19. The object inspection system of clause 16, wherein the light source control signal is synchronized with the image acquisition operation conducted by the image sensing circuit.
[0059] 20. The object inspection system of clause 19, wherein the light source control signal has a frequency corresponding to an image acquisition frequency of the image sensing circuit.
[0060] All combinations and sub-combinations of the above-described features also belong to the invention.

Claims

1. A digital imaging apparatus (110) comprising:

   a light source module (240); and

   characterised by:

   a light source controller (230) for receiving an image control signal and setting a radiation pattern of the light source module (240) to be corresponding to the image control signal.

2. The digital imaging apparatus (110) of claim 1, **characterised in that** the light source controller (230) sets a lighting frequency of the light source module (240) to be substantially the same as the frequency of the image control signal.

3. The digital imaging apparatus (110) of claim 1, **characterised in that** the light source controller (230) sets a lighting frequency of the light source module (240) to be a multiple times of the frequency of the image control signal.

4. The digital imaging apparatus (110) of claim 1, **characterised in that** the light source controller (230) sets a lighting frequency of the light source module (240) so that the frequency of the image control signal is a multiple times of the lighting frequency of the light source module.

5. The digital imaging apparatus (110) of claim 1, **characterised by**:

   an image sensing circuit (220) for generating the image control signal, wherein the image control signal corresponds to the time points or period of an image acquisition operation conducted by the image sensing circuit (220).

6. The digital imaging apparatus (110) of claim 1, **characterised by**:

   a control circuit (210) for generating the image control signal and receiving electricity required for the operations of the digital imaging apparatus (110) from an external device (120).

7. The digital imaging apparatus (110) of claim 1, **characterised in that** the image control signal corresponds to the time points or period of an image acquisition operation conducted by an image sensing circuit (220), and the light source controller (230) controls the light source to illuminate or to enhance the intensity of light output during the image acquisition operation conducted by the image sensing circuit (220).

8. The digital imaging apparatus (110) of claim 1, **characterised in that** the image control signal comprises a frame synchronization signal, a vertical synchronization signal, or a horizontal synchronization signal.

9. The digital imaging apparatus (110) of claim 1, 2, 3, 4, 5, 6, 7, or 8, **characterised in that** the light source controller (230) generates a light source control signal having a frequency corresponding to the image control signal and synchronized with the image control signal to control the light output of the light source module (240).

10. The digital imaging apparatus (110) of claim 9, **characterised in that** the light source control signal and the image control signal have the same frequency.

11. The digital imaging apparatus (110) of claim 9, **characterised in that** a frequency of the light source control signal is multiple times of that of the image control signal.

12. The digital imaging apparatus (110) of claim 9, **characterised in that** a frequency of the image control signal is multiple times of that of the light source control signal.

13. The digital imaging apparatus (110) of claim 9, **characterised in that** the light source controller (230) pulls up the pulse level of the light source control

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signal or increases the pulse width of the light source control signal when triggered by an edge of the image control signal.

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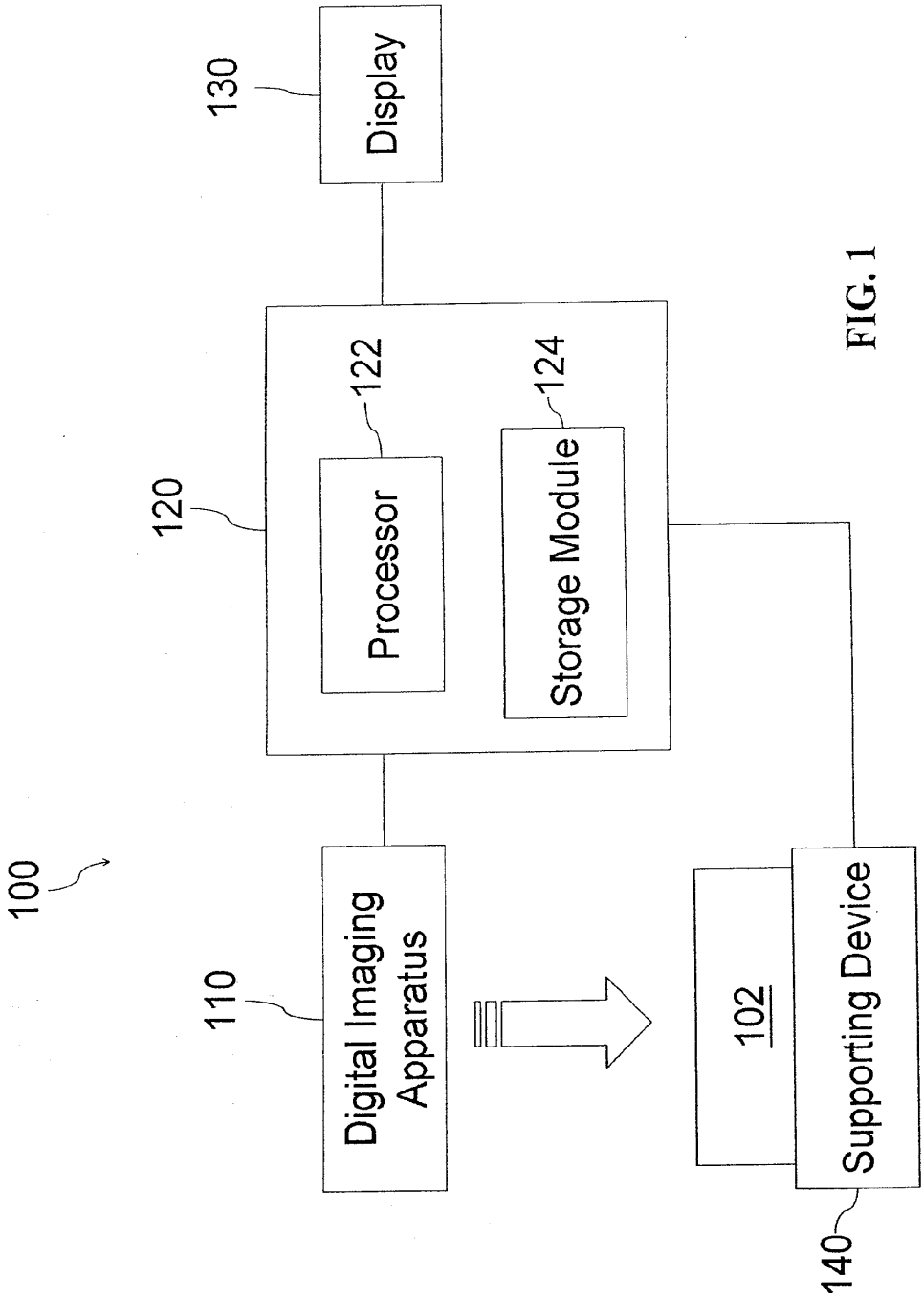


FIG. 1

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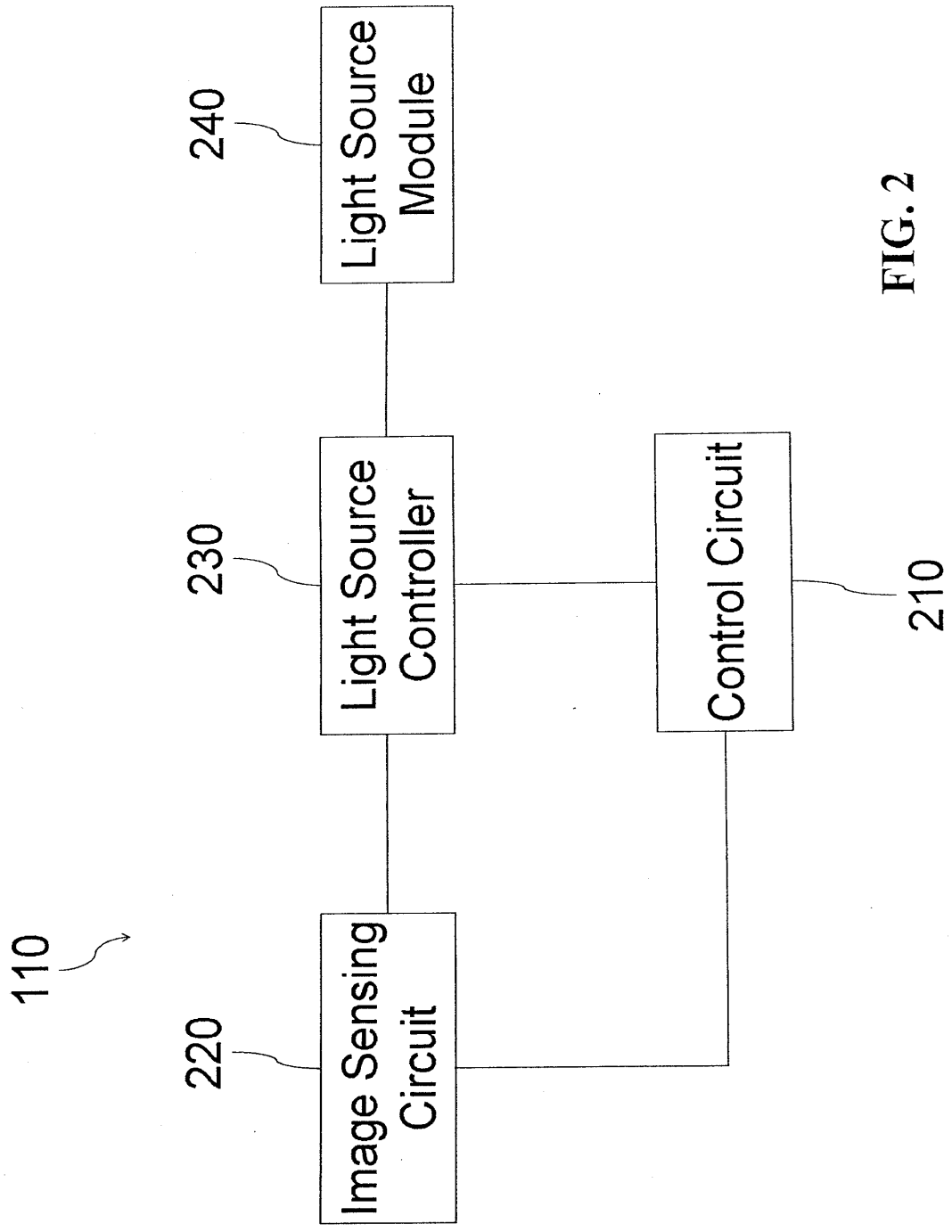


FIG. 2

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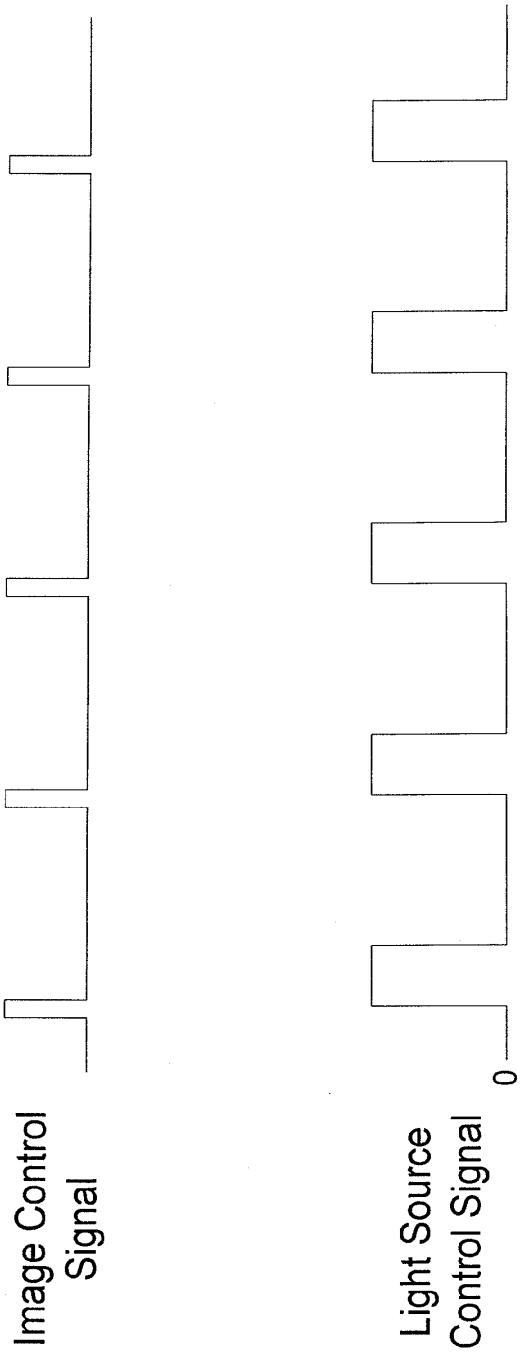


FIG. 3

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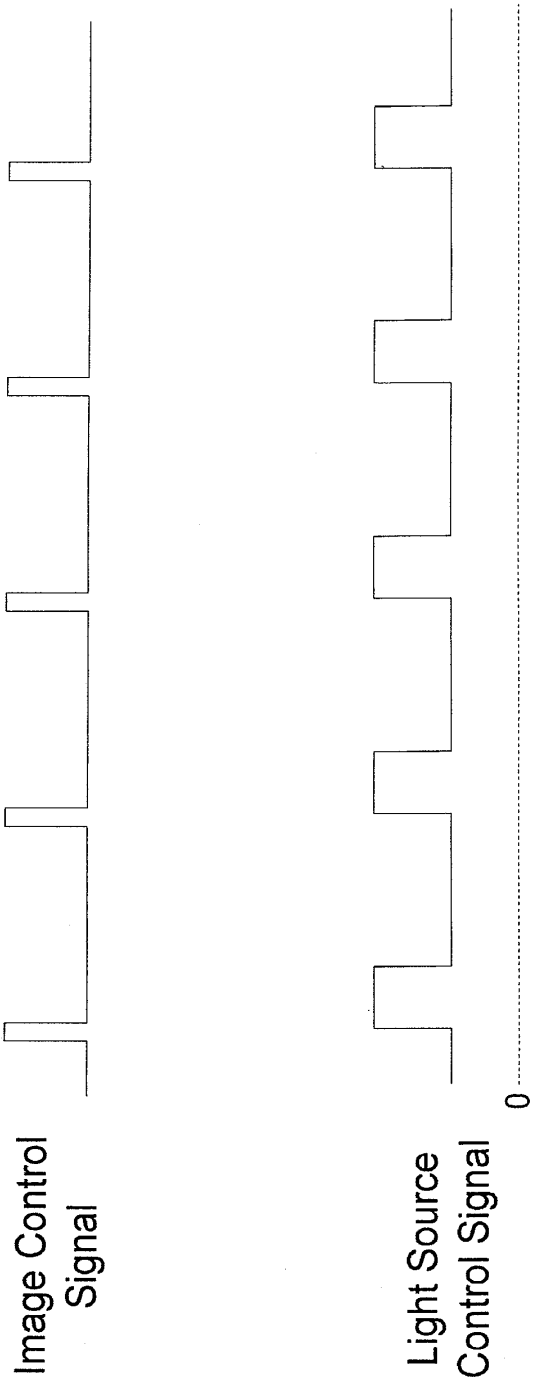


FIG. 4

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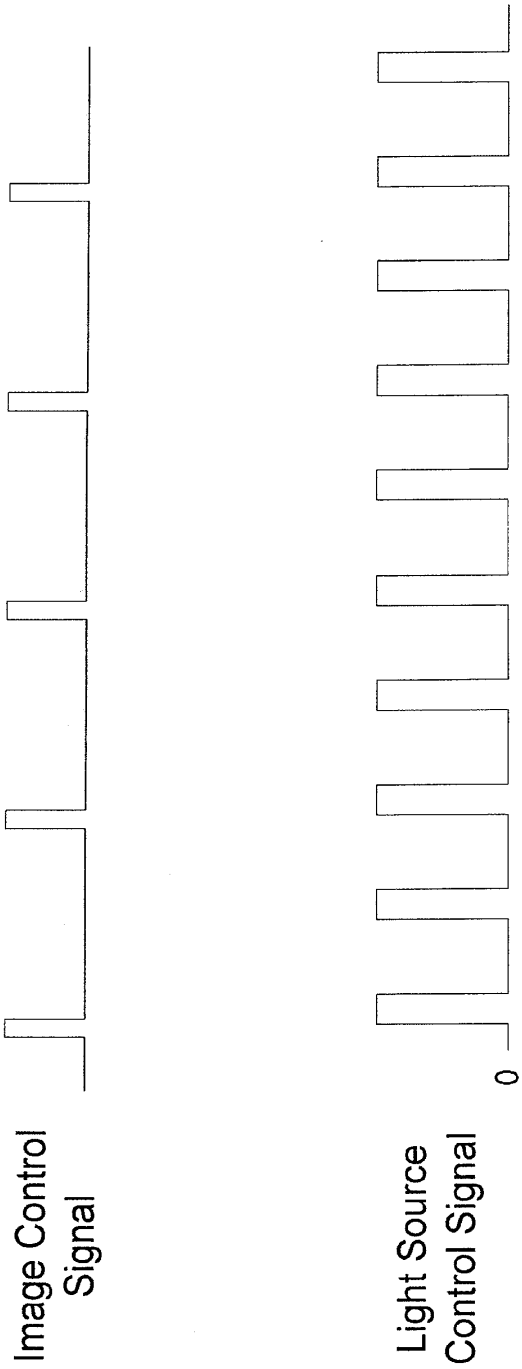


FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 8318

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2003 348463 A (SONY CORP) 5 December 2003 (2003-12-05) * abstract * * figures 1-7 * * paragraph [0063] - paragraph [0113] *	1-3,5,6, 8-11	INV. G03B15/05 H04N5/225
X	US 7 126 640 B1 (TAKEI HIROFUMI [JP]) 24 October 2006 (2006-10-24) * column 7, line 1 - column 9, line 2 * * figure 7 *	1-3, 8-10,13	
X	US 2005/231633 A1 (YUYAMA MASAMI [JP] ET AL) 20 October 2005 (2005-10-20) * paragraph [0016] * * paragraph [0044] - paragraph [0061] * * figures 1,3,8 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC) G03B H04N H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 March 2011	Breccia, Luca

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 17 8318

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24-03-2011

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H05B 33/08 (2006.01) G08B 15/00 (2006.01)

(52) UK CL (Edition X):
H2H HLL3

(56) Documents Cited:
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US 5032766 A

(58) Field of Search:
UK CL (Edition X) H2H
INT CL G08B, H05B
Other: WPI, EPODOC

(54) Abstract Title: **Television simulating system**

(57) A television simulating device 1 comprises an array of eight blue light emitting diodes (LEDs) 5 on an LED mounting 2. The LEDs 5 are controlled by an LED control circuit (11, see figure 7) to flash or pulsate in a random fashion to simulate the lighting effect of television. A timer 3 is coupled with a transformer 4. A method of deterring intruders by providing such a television simulating device 1 in a room in a building is also disclosed.

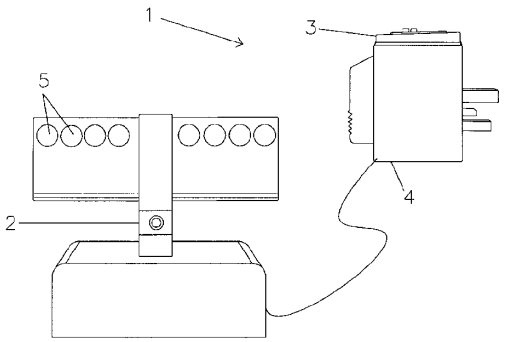


FIGURE 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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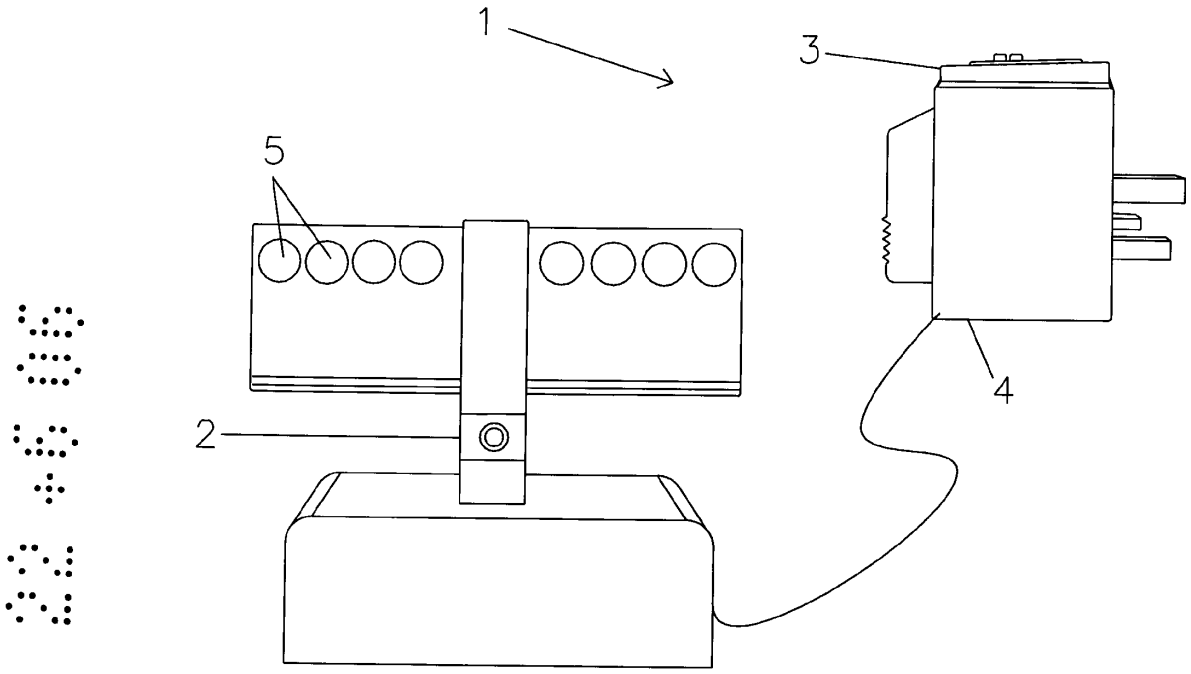


FIGURE 1

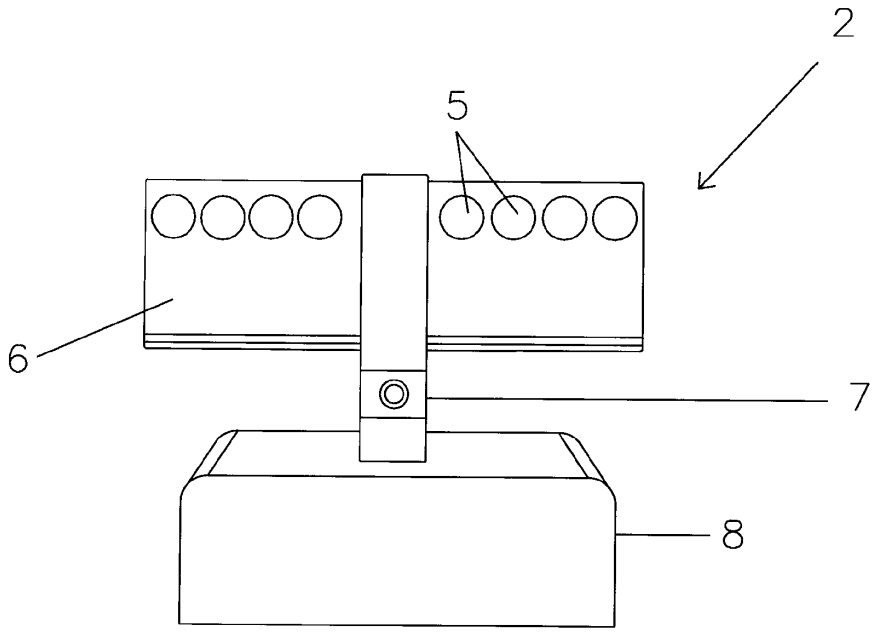


FIGURE 2

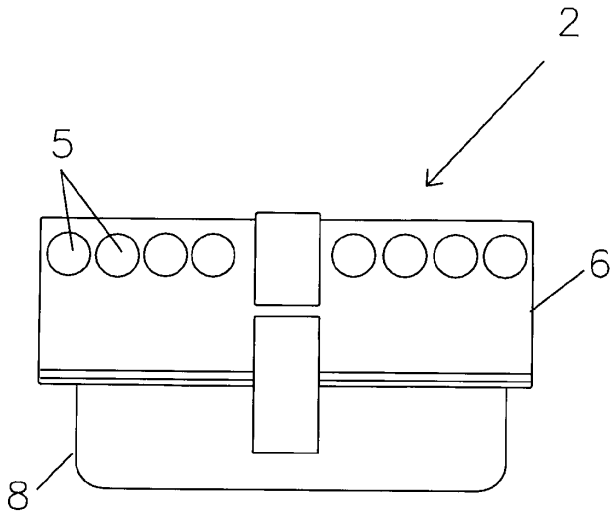


FIGURE 3

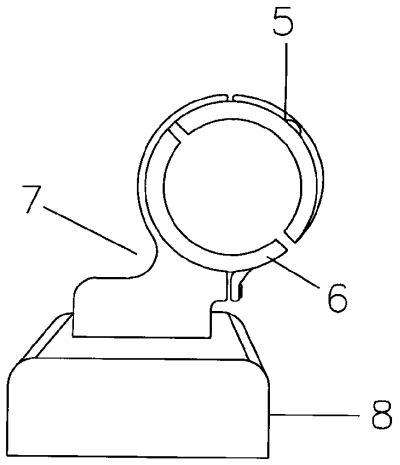


FIGURE 4

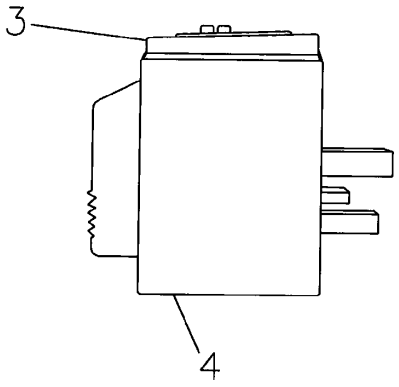


FIGURE 5

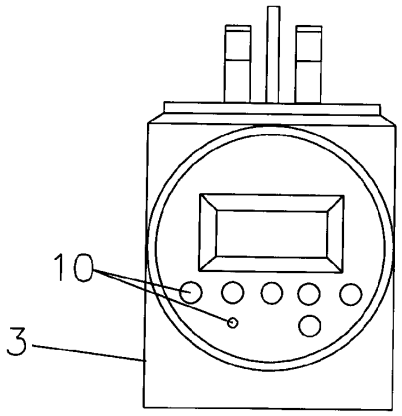


FIGURE 6

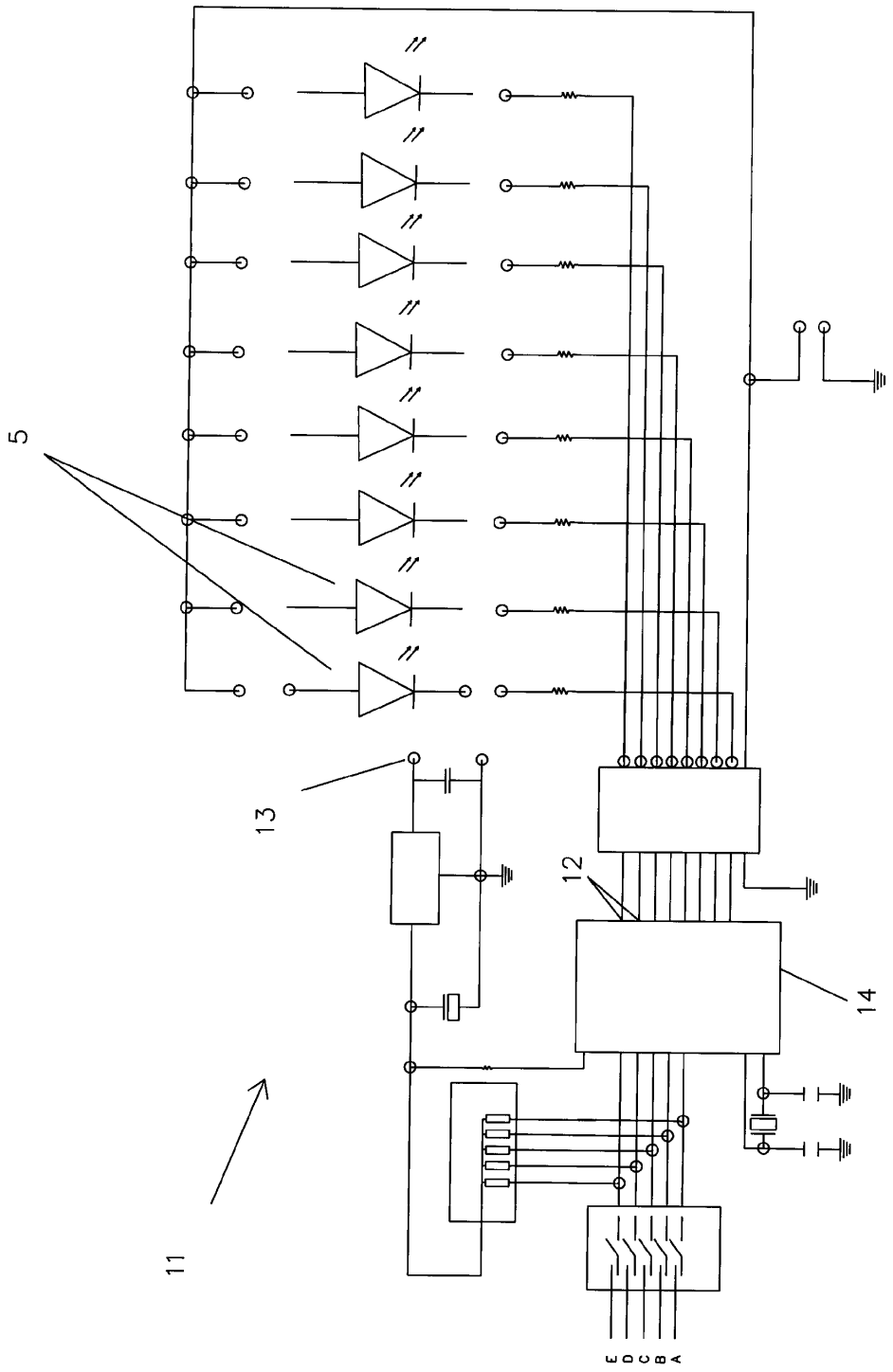


FIGURE 7

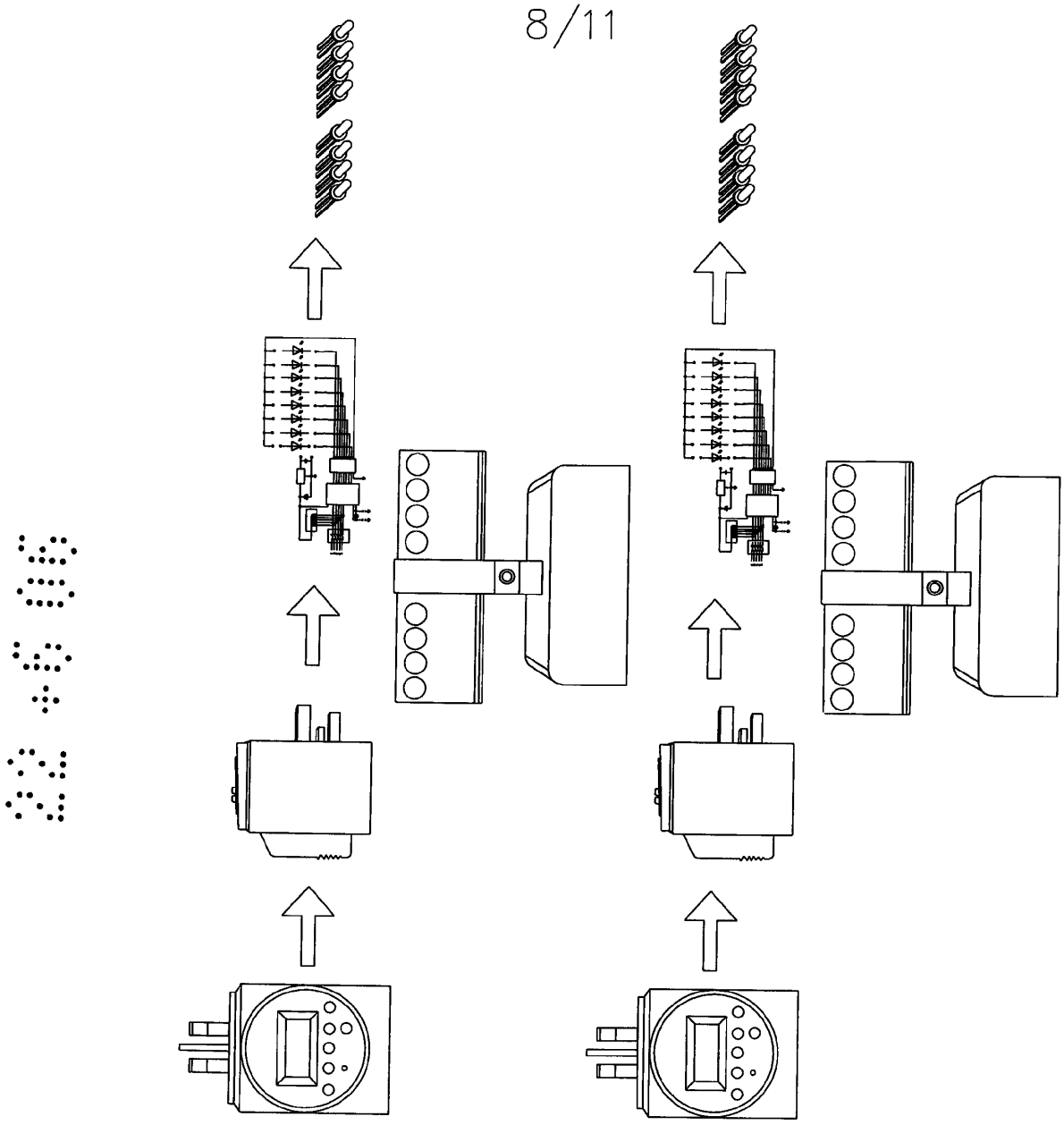


FIGURE 8

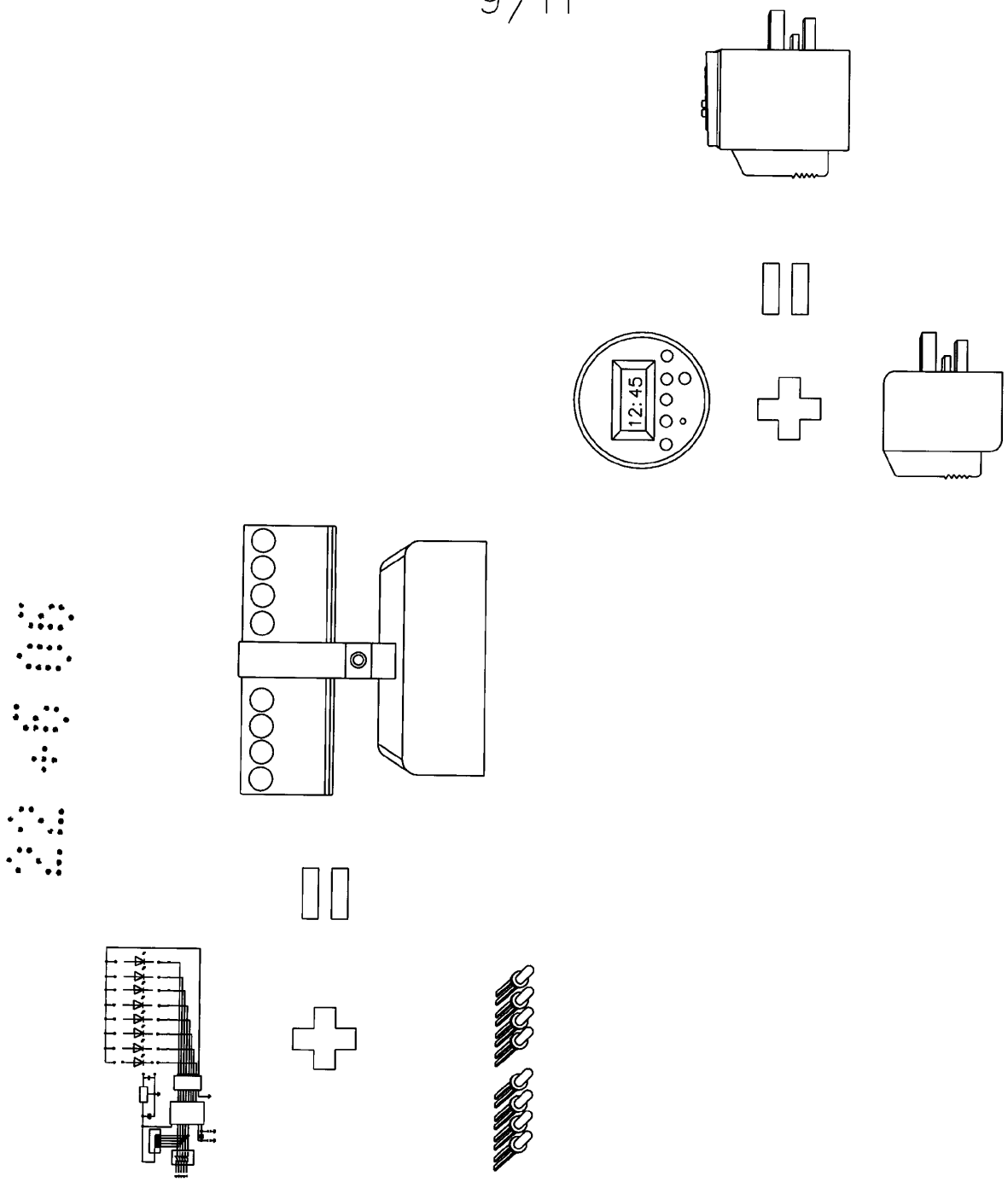


FIGURE 9

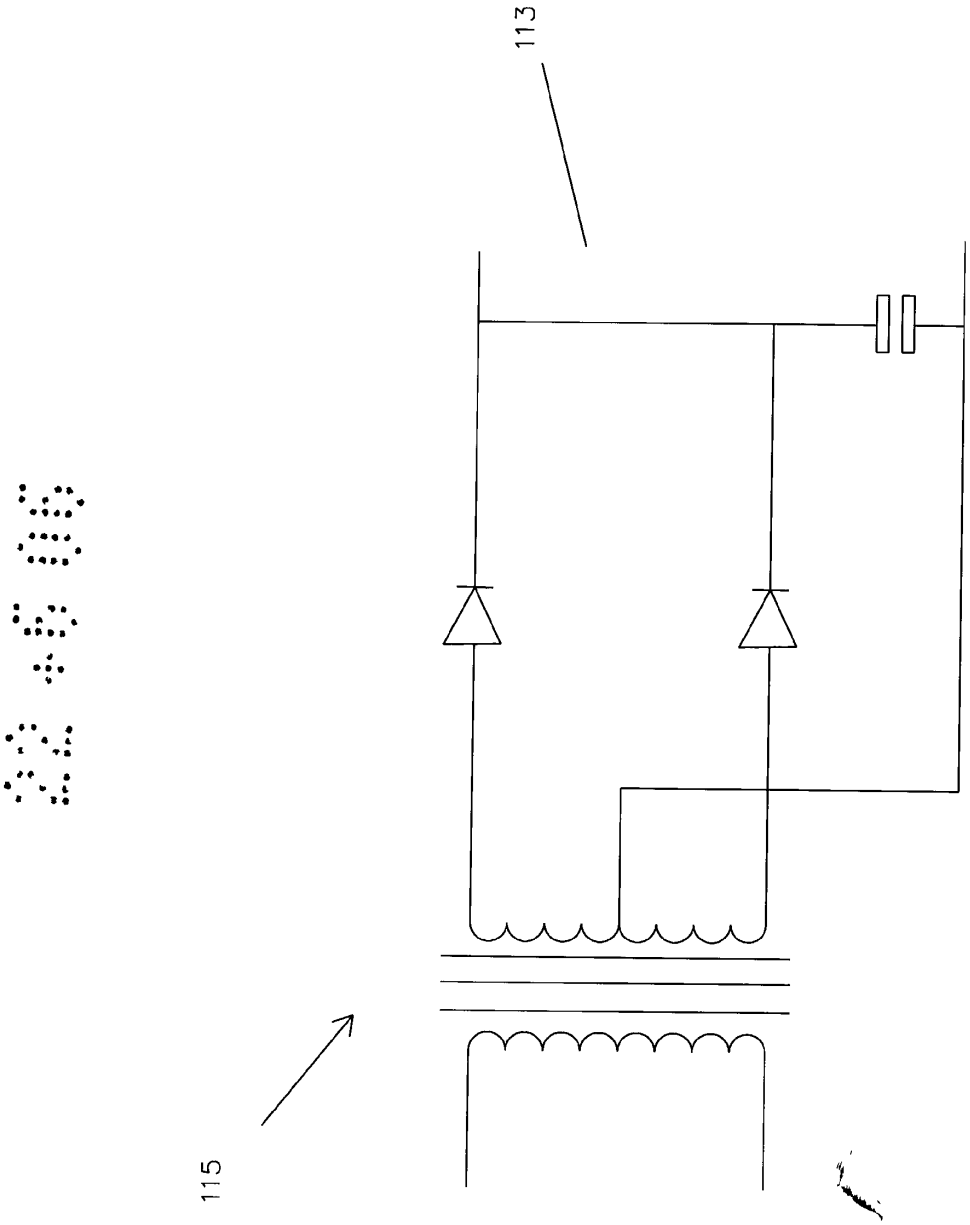


FIGURE 10

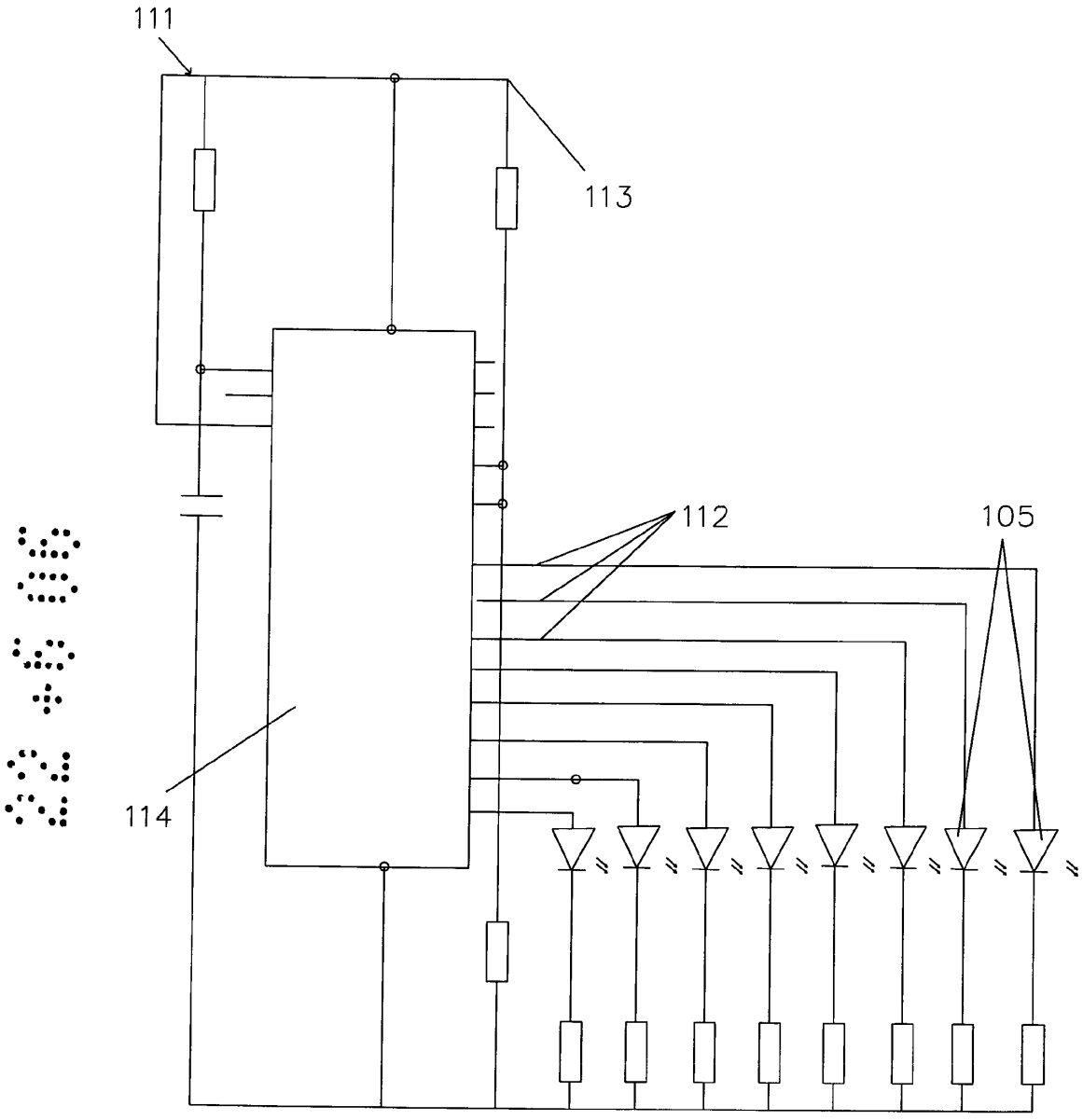


FIGURE 11

TELEVISION SIMULATING SYSTEM

There are many instances when the creation of the lighting effect of a television or other visual display screen can be useful. For example it can be used as a deterrent to potential intruders. It may also be useful during recording or performing of various visual shows, presentations or programmes where the lighting effect of a television or other visual display screen must be visible in a particular scene or part of the display. Usually this lighting effect is created using the actual television or visual display screen.

Nowadays, home security and the security of workplaces etc. is a high priority for many people.

It is particularly pertinent to protect the security of the home or workplace when it is unoccupied.

In particular, security in elderly people's homes is of concern since there are generally a small number of people living in such homes and often the elderly person lives alone. This can lead to a low level of activity entering and exiting such homes which can increase the likelihood of intrusion. Elderly persons are also vulnerable to attack if they disturbed burglars.

One method of protecting a home or workplace from the risk of intrusion by burglars etc. is by deterring potential intruders. One way of achieving this is by artificially creating an illusion that the building is occupied. There are a number of possible ways to accomplish this.

Many people leave lights or lamps switched on in their home while it is unoccupied. Alternatively, these lights or lamps may be switched on using a timer so that they are automatically switched on and off at specific time intervals. However, many burglars are now familiar with this system and are not as deterred by this means of security. Furthermore, the use of such lighting illuminates rooms in the home and can enable a potential intruder to determine whether the home is actually occupied or to examine the contents of the home. This lighting can also facilitate navigation of the home if the burglars get inside. Moreover, the

intruders are not required to make use of their own lighting means or switch on lights in the home. These actions can attract attention and arouse suspicion which intruders usually wish to avoid.

Another means of deterring potential intruders is to leave the television switched on, which can give the impression that there is activity in the home and people are present. However, the television itself may heat up to an extent and can constitute a safety hazard if it is left on over a considerable length of time. There are also timer switches which may be used to control the power supply to the television, to turn it on and off at specific intervals of time in a similar way to the lighting systems described above. However, this can also constitute a safety hazard due to the amount of power required to switch the television on. The television can also heat up when left on for a significant period of time. The safety of the system is also dependent on both the safety of the timer device and the safety of the television itself which increases the overall safety risk. Furthermore, the television tends to dissipate a considerable amount of power when left on and can be costly.

Often the lighting effect of a television or other visual display screen is required in a background stage setting or display. For example a particular scene may require that a room be lit by a television or other visual display screen. It is usually necessary to create this lighting effect by actually

positioning a television on the set. However, televisions can be heavy and cumbersome to move in between different scenes or before the scene commences. Televisions are also valuable pieces of equipment and it may not be desirable to store such equipment.

The object of the present invention is to provide a television simulating device which can mimic the lighting effect of a television or other visual display screen in a room. From observations, a blue coloured light or blue glow is produced by the television in a room irrespective of the colour composition of the image on the television screen. The television simulating device of the present invention uses high intensity blue light emitting diodes (LEDs) or other suitable lighting means to artificially mimic this blue glow.

The television simulating device may be used to act as a deterrent for potential intruders by placing it at a position in the home where a television usually resides or where a television might reside. The device may also be useful in a theatre stage or on a television studio set to mimic the lighting effect of a television, in particular, where a view or camera shot of the television screen itself is not required. The device is particularly effective when there is a low level of peripheral lighting, since the blue glow is more visible with minimal background lighting.

The television simulating device demands minimal power supply to operate and is highly efficient. The device can safely be left active over long periods of time and does not heat up to a considerable degree even if left on for a substantial period of time. The television simulating device is also compact, easily portable and simple to install. The device can also operate independently of other electrical appliances in the home and has low power consumption.

In accordance with a first aspect of the present invention, there is provided a television simulating device comprising lighting means being controlled by controlling means to simulate the lighting effect of television.

Preferably, the lighting means is capable of emitting a blue coloured light or a light which simulates the lighting effect of television.

Preferably, the lighting means has a brightness level being adjustable between an on position and an off position by the controlling means.

Preferably, the lighting means comprises at least one light source.

Preferably, the brightness level of the at least one light source is adjustable between the on position and the off position in a perceived random pattern

with respect to at least one other at least one light source.

Preferably, the at least one light source is a light emitting diode.

More preferably, the at least one light source is a high intensity blue light emitting diode.

Desirably, the at least one light source is a blue ultra bright light emitting diode.

Preferably, the television simulating device is connected to a power supply.

Preferably, the power supply is a direct current power supply.

Advantageously, the power supply to the television simulating device is controlled by a timer.

Preferably, the at least one light source is mountable on a light mounting.

Desirably, the television simulating device operates independently.

In accordance with a second aspect of the present invention, there is provided a method of deterring potential intruders comprising the steps of:

providing at least one television simulating device in accordance with the first aspect of the present invention in a room in a building; and

activating the television simulating device so that it simulates the lighting effect of television in the room.

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a television simulating device of the present invention;

Figure 2 is a schematic representation of a front perspective view of a LED mounting;

Figure 3 is a schematic representation of a plan view of the LED mounting of Figure 2;

Figure 4 is a schematic representation of a side perspective view of the LED mounting of Figures 2 and 3;

Figure 5 is a schematic representation of a side perspective view of a timer and a transformer;

Figure 6 is a schematic representation of a plan view of the timer and the transformer of Figure 5;

Figure 7 is a circuit diagram of the LED control circuit;

Figure 8 is a flow diagram comprising photographs illustrating the state of components of the television simulating device in an off mode and the state of components of the television simulating device in an on mode;

Figure 9 is a flow diagram comprising photographs illustrating the assembly and operation of the television simulating device;

Figure 10 is a circuit diagram of a full wave rectifier; and

Figure 11 is a circuit diagram of an LED control circuit.

Figure 1 shows a television simulating device (1) having a LED mounting (2) connected to a transformer (4). The transformer (4) is coupled with a timer (3). Eight LEDs (5) are mounted on the LED mounting (2). When the timer (3) is set to off in the time cycle, the television simulating device is off and the LEDs (5) are unilluminated. When the timer (3) is set to on in the time cycle, the television simulating device is on and the LEDs (5) are illuminated in a brightness sequence. A LED control circuit (not shown) controls the brightness sequence of the LEDs (5) causing them to flash and/or pulsate randomly, with respect to one another, when the

power is on. It was found that high intensity blue LEDs work particularly well to emulate the lighting effect of a television. For example eight 5mm blue LEDs (5) with intensity 5900 mcd can be used. In fact any kind of LED including low intensity, standard, super bright, ultra bright or hyper bright light emitting diodes may also be used.

It is imperative that the LED control circuit (not shown) causes the LEDs (5) to flash and/or pulsate in a random fashion with respect to one another in order to accurately simulate or mimic the lighting effect of the television on the walls of the room and as perceived from part of the room or outside the room. The use of LEDs (5) to simulate or mimic this lighting effect is particularly advantageous since LEDs (5) tend to have relatively low power consumption and do not tend to heat up to a large extent when flashing and/or pulsating over significant periods of time.

Figures 2, 3 and 4 show the LED mounting (2), eight LEDs (5) being linearly mounted on top of a cylindrical LED mounting head (6) being supported by an aluminium stand (7) and an aluminium base (8). The aluminium stand (7) clamps the cylindrical mounting head (6) in place. The aluminium stand (7) may be loosened to enable the cylindrical LED mounting head (6) to be horizontally rotated to adjust the direction that the LEDs (5) face. The cylindrical LED mounting head (6) may be clamped in position to face upwards, sidewards, downwards or

any direction through 360 degrees. This enables the user to manually control the direction the light from the LEDs (5) is directed. The cylindrical LED mounting head (6) may be adjusted, as appropriate, so that the light from the LEDs (5) bounces off a particular wall, a ceiling or a floor. This is particularly useful if the television simulating device (1) is placed in an upstairs room and the lighting effect is more visible to people outside if the light from the LEDs (5) is reflected off the ceiling. The light from the LEDs (5) may also be easily directed toward a particular wall in the same manner. The LED control circuit (not shown) is mounted in the aluminium base (8). It will be appreciated that the LED mounting (2) can be made of plastic or any other suitable material which affords the requisite properties. The eight LEDs (5) are held in place by the LED mounting (2) and can also be affixed in the LED mounting (2) using glue.

Figure 5 shows the timer (3) coupled with the transformer (4). The timer (3) controls the power supply from the transformer (4) as described above.

Figure 6 shows a front face of the timer (3), the timer (3) being coupled with the transformer (4). The timer (3) comprises an electronic display (9) and various control buttons (10) which enable the timer (3) to be manually set. The time that the power is activated and the time that the power is deactivated may be stored in the timer (3) by setting the times using the control buttons (10).

The timer (3) may also be reset using these control buttons (10).

Figure 7 shows a circuit diagram of the LED control circuit (11). The LED control circuit (11) is a micro controller which can be powered by a 12 volt power supply (13) from the transformer (not shown). The LED control circuit (11) powers the LEDs (5) so that the LEDs slowly increase and decrease in brightness in a perceptually random fashion with respect to one another.

There are five dual in line switches (A, B, C, D and E) which define a total of thirty two possible display options. Switch A and switch B control the speed of the flashing of the LEDs (5) from fully on to fully off to fully on again. The switch settings for speed are shown in Table 1 below. Switch C and switch D control the depth of modulation, as shown in Table 2. The modulation depth dictates how far from fully on the LED goes towards off. For example, selecting a central portion of the brightness array gives a pulsating effect rather than an on/off flash. Switch E selects between two brightness profiles, as shown in Table 3. One of the brightness profiles is smooth and the other brightness profile has a built-in high speed flash. The speed of these profiles is related to the mode set by the other switches (A, B, C and D).

Table 1:

Switch A	Switch B	Speed
0	0	Fast
1	0	Medium Fast
0	1	Medium Slow
1	1	Slow

Table 2:

Switch C	Switch D	Modulation (%)
0	0	100
1	0	50
0	1	25
1	1	12.5

Table 3:

Switch E	Profile
0	Smooth
1	Flash

All of the switches (A, B, C, D and E) can be in a fixed state setting for the duration of the activation of the device (1). The settings are modified to ensure that the device (1) closely mimics the lighting effect of a television. The switch (A, B, C, D and E) settings ensure that the LEDs (5) pulsate at the same speed, modulation and pattern. However, at least two of the LEDs (5) pulsate at different times in a random pattern. It was found that the following switch (A, B, C, D and

E) settings worked particularly well to mimic the lighting effect of a television:

Switch A	1
Switch B	1
Switch C	0
Switch D	0
Switch E	0

The above settings correspond to a slow speed, 100% modulation and a smooth brightness profile.

There are eight outputs (12) which respectively control each of the eight LEDs (5). It is possible to connect more LEDs to the basic eight LEDs (5) in order to increase the overall number of LEDs. This means that groups of LEDs will operate in the same manner. The circuit is capable of powering a large number of LEDs. However, it was found that the use of eight LEDs (5) minimised the size of the device (1) and the voltage required to power the LED control circuit (11).

The LED outputs (12) from a programmable integrated circuit (14) control the brightness of the LEDs (5) using pulse width modulation. The mark/space ratio is used to vary the brightness of the LEDs (5) from fully on to fully off. Higher mark/space ratios generate higher values of brightness of the light emitted from the LEDs (5). Each mark is obtained from an array stored in the programmable integrated circuit (PIC) memory. This array defines the LED

brightness profile which controls the brightness sequence of the LEDs (5). One complete cycle of the LED (5) from off to maximum on and back to off again is generated as the program reads values from the whole array. Each LED output (12) has a slightly different array length, giving a continual shift in phase between the respective LED outputs (12) and an apparently random pattern of brightness of the LEDs (5). Each value of mark/space is repeated a number of times to regulate the speed of flashing or pulsating.

Figure 8 shows photographs of components of the television simulating device (1) and details the state of the components when the television simulating device (1) is on and off. When the television simulating device (1) is in an off state, the timer (3) is set to a predetermined off position and the transformer (4) is not powered on. Therefore, the circuit (11) is not activated and the LEDs (5) are un-illuminated. When the television simulating device (1) is on, the timer (3) is set to a predetermined on position and the transformer (4) receives 240 Volts AC and transforms it to 12 Volts DC. This 12 Volt power supply (13) activates the circuit (11) and each of the outputs (12) from the programmable integrated circuit (14) control the brightness of the respective LEDs (5). The LEDs (5) flash and/or pulsate in a random pattern, with respect to one another, and emit blue light to create the blue glow in a room similar to that created by a television.

Figure 9 shows photographs of components of the television simulating device (1). The high intensity blue LEDs (5) are connected to each of the eight outputs (12) of the LED control circuit (11). The LED control circuit enables each of the LEDs (5) to flash in a random fashion with respect to the other LEDs (5). The LEDs (5) are mounted in the metal LED mounting (2). The LED mounting (2) contains the LED control circuit (11) and the LEDs (5) are mounted on top of the LED mounting (5). The timer (3) is a twenty-four hour, seven day digital timer (3) which means that the power supply to the LED control circuit (11) may be set on at a specific time of the day and set off at a specific time of the day. The timer (3) may be connected the transformer (4) which converts the mains alternating current (AC) supply to 12 Volts direct current (DC). The housing containing the timer (3) and the transformer (4) is made from plastic.

Figure 10 shows a conventional full wave rectifier (115) used to provide a DC power supply (113).

Figure 11 shows a circuit diagram of an LED control circuit (111) similar to the LED control circuit (11) shown in Figure 7. The LED control circuit (111) is a micro controller which can be powered by the DC power supply (113). The LED control circuit (111) powers the LEDs (105) so that the LEDs slowly increase and decrease in brightness in a perceptually random fashion with respect to one

another. LED outputs (112) from a programmable integrated circuit (114) control the brightness of the LEDs (105).

It will be appreciated that the timer functionality, which is provided by a separate timer device (3) in the television simulating device (1) shown in Figure 1, may be incorporated into the LED control circuit (111) in place of using a separate timer. Typically, a timing delay is programmed into the integrated circuit (114) of the LED control circuit (111) to deactivate all the LEDs (105) so that they remain in the off position for an extended period of time. Generally, this extended period of time is during daylight hours when the lighting effect of the television is likely to be less visible.

It will also be appreciated that the speed, modulation and pattern of the flashing LEDs can be programmed into the integrated circuit (114).

It will be appreciated that a light dependent resistor may be used to determine the surrounding lighting conditions and activate the LEDs (5, 105) to simulate the lighting effect of television when the surroundings are sufficiently dark.

It will also be appreciated that the LEDs (5, 105) can comprise two white LEDs, two blue LEDs, 2 green LEDs and two blue LEDs.

While various embodiments of the invention have been described, it will be apparent to those skilled in the art once given this disclosure that various modifications, changes, improvements and variations may be made without departing from the scope of the invention.

Claims

1. A television simulating device comprising lighting means being controlled by controlling means to simulate the lighting effect of television.

2. A television simulating device as claimed in claim 1, wherein the lighting means is capable of emitting a blue coloured light or a light which simulates the lighting effect of television.

3. A television simulating device as claimed in claim 1 or claim 2, wherein the lighting means has a brightness level being adjustable between an on position and an off position by the controlling means.

4. A television simulating device as claimed in any of claims 1 to 3, wherein the lighting means comprises at least one light source.

5. A television simulating device as claimed in claim 4, wherein the brightness level of the at least one light source is adjustable between the on position and the off position in a perceived random pattern with respect to at least one other at least one light source.

6. A television simulating device as claimed in claim 4 or claim 5, wherein the at least one light source is a light emitting diode.

7. A television simulating device as claimed in any of claims 4 to 6, wherein the at least one light source is a high intensity blue light emitting diode.

8. A television simulating device as claimed in any of claims 4 to 7, wherein the at least one light source is a blue ultra bright light emitting diode.

9. A television simulating device as claimed in any of claims 1 to 8, wherein the television simulating device is connected to a power supply.

10. A television simulating device as claimed in claim 9, wherein the power supply is a direct current power supply.

11. A television simulating device as claimed in claim 9 or claim 10, wherein the power supply to the television simulating device is controlled by a timer.

12. A television simulating device as claimed in any of claims 4 to 11, wherein the at least one light source is mountable on a light mounting.

13. A television simulating device as claimed in any of claims 1 to 12, wherein the television simulating device operates independently.

14. A method of deterring potential intruders comprising the steps of:

providing at least one television simulating device as claimed in any of claims 1 to 13 in a room in a building; and

activating the television simulating device so that it simulates the lighting effect of television in the room.

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Application No:	GB0605732.7	**Examiner:**	Peter Keefe
Claims searched:	All (1-14)	**Date of search:**	11 July 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-14	US 5252947 A MARCIANO figures 1-3; column 2 line 13-column 3 line 2
X	1-14	GB 2318461 A CUMBERLAND p2 line 24-p3 line 8
X,&	1-10, 12-14	GB 2398860 A CRUET COMPANY p2 lines 4-25; p5 lines 29-30
X,&	1-10, 12-14	GB 2398862 A CRUET COMPANY p2 line 13-p3 line 13; p7 lines 17-18
A		US 5032766 A GUNDLACH, LUNDGREN, IRWIN

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

H2H

Worldwide search of patent documents classified in the following areas of the IPC

G08B; H05B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

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H04N 5/235 (2006.01)

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INT CL **F21V, G03B, H04N**
Other: **EPODOC, WPI**

(54) Title of the Invention: **Light control device**
Abstract Title: **Light control device**

(57) In accordance with embodiments there are provided methods and devices for use in photography. In one embodiment the device comprises a variable filter 305 arranged to vary characteristics of light received from a light source 303, the variable filter 305 being arranged to emit the varied light onto a subject 20 of an image being recorded, and a processor 202 arranged to control the variable filter 305. In another the device comprises an interface 204 for receiving a communication identifying camera characteristics, and a processor 202 arranged to vary at least one characteristic of light emitted by a light source 303 in accordance with the camera characteristics. In another the device comprises an interface 204 for receiving one or more communications identifying a plurality of open periods of a camera shutter, and a controller 202 arranged to instruct a light source 303 to emit light in accordance with the camera shutter open periods. In another the device comprises a light receiving part arranged to receive a coloured light, and a light colour compensator arranged to compensate colour characteristics of light to be emitted by a light source 305 in accordance with the received light.

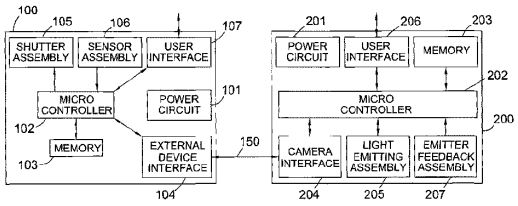


Fig. 2

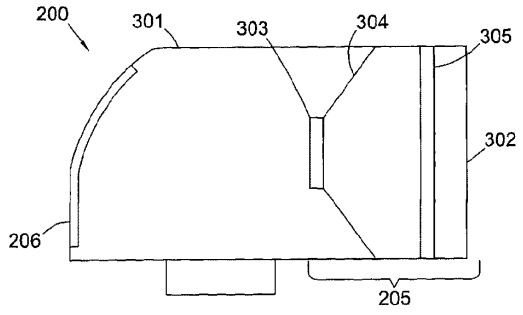


Fig. 3

GB 2482562 A

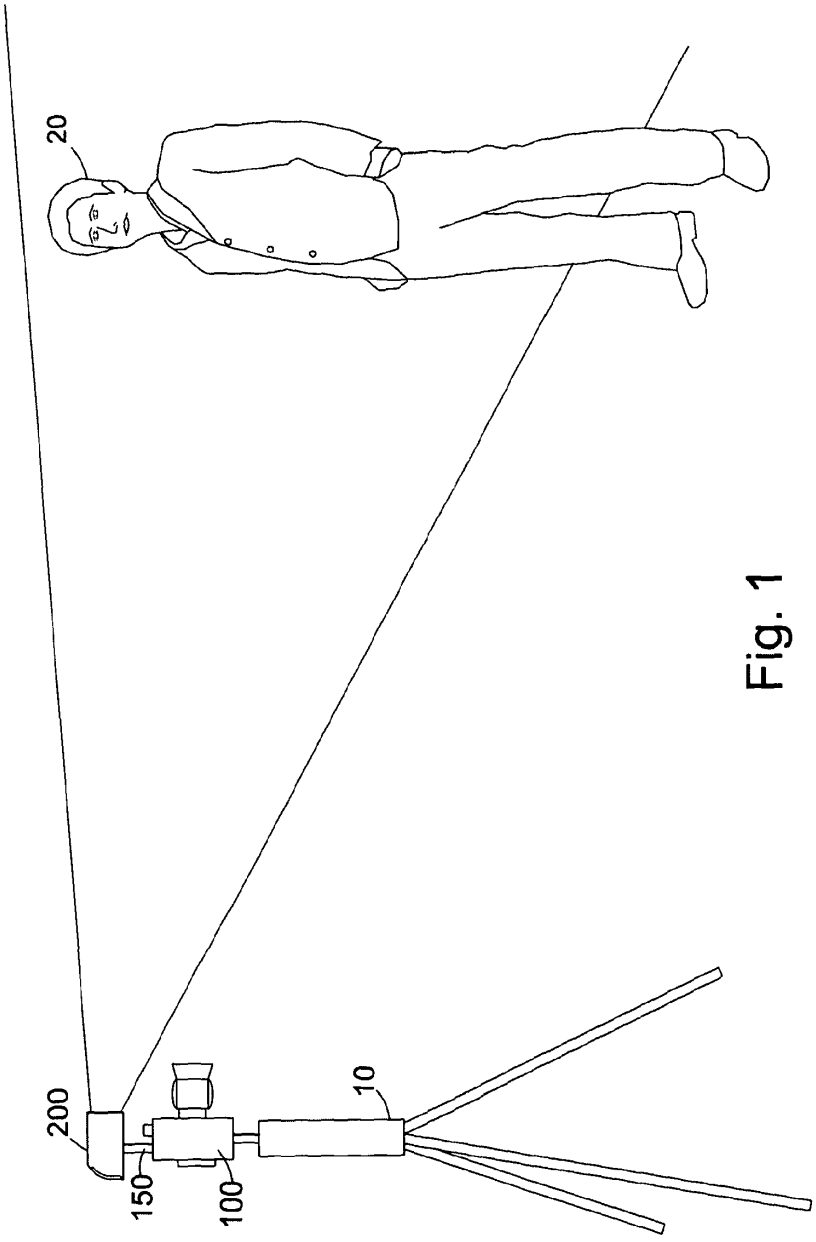


Fig. 1

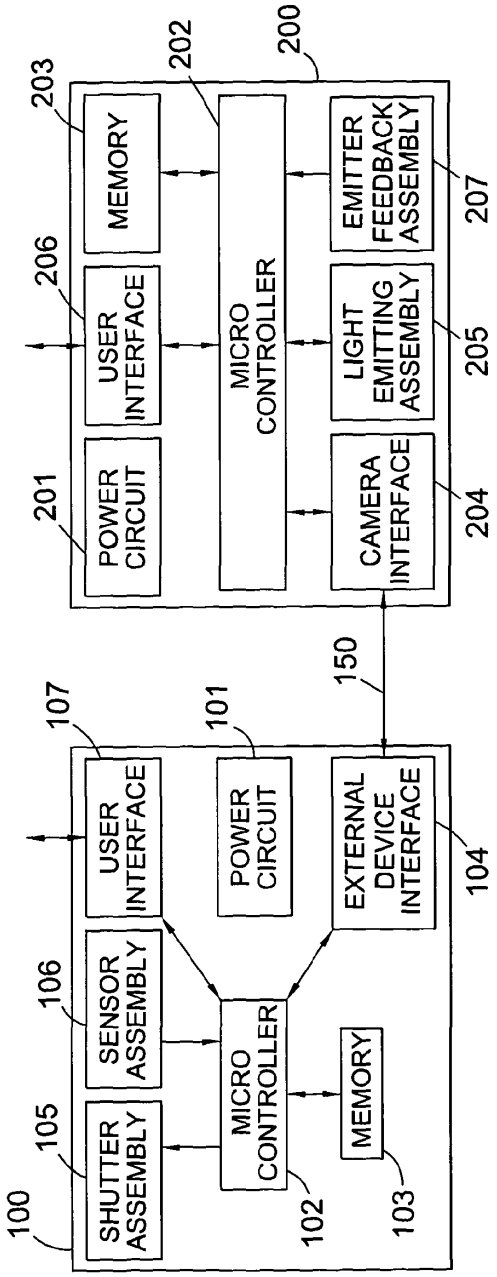

100
SHUTTER ASSEMBLY
105
SENSOR ASSEMBLY
106
USER INTERFACE
107
MICRO CONTROLLER
102
MEMORY
103
POWER CIRCUIT
101
EXTERNAL DEVICE INTERFACE
104
150
CAMERA INTERFACE
204
LIGHT EMITTING ASSEMBLY
205
EMITTER FEEDBACK ASSEMBLY
207
MICRO CONTROLLER
200
MEMORY
203
USER INTERFACE
206
POWER CIRCUIT
201
202

Fig. 2

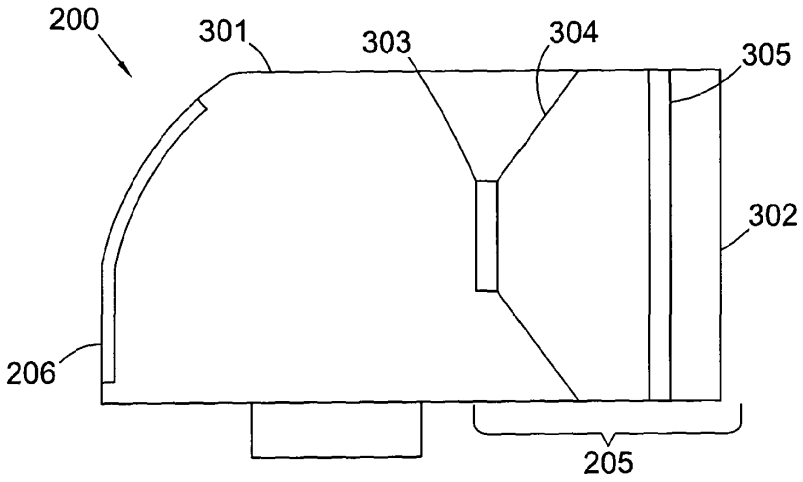


Fig. 3

Light Control Device

The present invention relates to a light control device. More specifically, the present invention relates to a device and corresponding method for controlling the emission of light by a light source used in conjunction with a camera or such like.

Photography is a technique using a camera for capturing images, which generally refers to capturing still images such that they can be viewed again after the event took place. Photography can also refer to the capturing of moving images, however, the process of capturing moving images can also be referred to as film.

In photography, both for still and moving images, the lighting of a subject being captured in the photograph is very important. When a still camera or digital video camera records an image it does this by exposing a digital sensor to light through a lens that forms an image on the sensor (or in the case of analogue photography to a film stock such as celluloid film). The amount of light that reaches the sensor is in part determined by the transmittance of the lens assembly and in part by the exposure time. The apparatus that regulates the exposure time is called the camera shutter.

The camera shutter regulates exposure time by opening and closing the light path for a precise amount of time. The most common type of shutter is the focal plane shutter, which consists of two curtains. When the exposure starts, the first curtain called the front curtain opens, and when the exposure time is over the second curtain called the rear curtain closes. In conventional cameras, the direction of travel of the curtains is vertical (or along the shortest axis). The exposure time is generally a very short instance in time. Commonly used exposure times range from 1/60 second to 1/1000 second, but the capability of many cameras typically extends well beyond these in both directions.

For exposure times longer than 1/200 second (typical), there is a period when the entire sensor is exposed with no part of the front or rear curtain covering the sensor. For exposure times shorter than 1/200 second (typical), since the curtain travel takes a finite amount of time, the rear curtain must start to close before the front curtain is fully open. In this case the entire sensor is not exposed at any one time, rather the two shutter curtains form a slit that moves across the sensor, thereby exposing light to

portions of the sensor as the slit moves across the sensor. The shorter the exposure time, the narrower the slit. The parallel movement of the curtains ensures that all areas of the sensor receive the same amount of light.

While movement of the slit controls the amount of light passing onto the photographic sensor of the camera, the light which can reach the sensor is also affected by the light which is applied to the subject being photographed. Furthermore, the lighting applied to the subject being photographed will affect how the subject looks in the photograph. Hence, lighting applied to a subject being photographed is of utmost importance in photography.

In general, lighting is used to ensure that a photograph is clear and that the subject being captured can be seen. In other words, lighting is used in order to achieve proper exposure. Furthermore, in order to achieve a desired image, photographers use a variety of means to adjust how light falls on to the subject of interest. While, altering the position of a subject in respect of natural light emitted from the sun is a common way to adjust the lighting applied to a subject being photographed it is also common practice to utilise artificial lighting, and in particular photography specific lighting, such as spot lights, flood lights, and photographic flashes. Other means for adjusting the lighting applied to a subject include use of light shaping tools like reflectors, diffusers, or gobos (items that obstruct the light) to adjust how the subject is lit.

Often spot lighting and photographic flashes are provided in order to provide light to parts of a subject that would otherwise be in shade, or insufficiently well lit. Photographic lighting can also be used in order to provide a 'mood' to a photograph, for example, by adding a light of a particular colour, or from a particular direction.

It has in recent years, particularly due to prominence of digital photography, become popular for photographers to enhance images further after the exposure by using post-production techniques. Such post-production techniques can be used in order to change the tonal qualities of the image, brighten or darken particular parts of the image and so forth. Such post-production techniques allow for the apparent lighting of the photograph to be adjusted after the exposure takes place, thus providing photographers with even more control over the photograph. These techniques allow photographers to enhance photographs, in particular, enhance the lighting of a

photograph. This may allow for interesting lighting effects to be produced which would not usually be possible by use of natural lighting or photographic lighting.

While post-processing provides photographers with a great amount of control over their images, it is a common myth that 'anything' is possible in post-processing. This is not the case. In extreme cases an image can be enhanced to such a degree that it is basically re-drawn by hand by a painter or illustrator. However, such techniques are time consuming and can therefore be financially expensive.

While current post-production techniques provide photographers with a great deal of control over the look of a final image, there is always a need amongst photographers for ways of creating new looks, and also for making effects applied to photographs more natural without having to use such expensive and time-consuming post-production techniques.

The present invention aims to at least partly mitigate some of the above mentioned problems.

In accordance with an aspect of the present invention, there is provided a device for use in photography, the device comprising: a variable filter arranged to vary characteristics of light received from a light source, the variable filter being arranged to emit the varied light onto a subject of an image being recorded; and a processor arranged to control the variable filter.

The variable filter may comprise a plurality of variable filter elements arranged in an array, each filter element arranged to vary the characteristics of the light passing therethrough.

The variable filter may be arranged to vary colour characteristics of the light.

The variable filter may be arranged to vary intensity characteristics of the light.

The device may further comprise an optical assembly arranged to focus the light emitted from the variable filter.

The processor may further comprise a tracking means arranged to track a position of a feature of the subject of the image being recorded and control the variable filter to vary the characteristics of the light in accordance with the tracking of the feature.

The processor may be arranged to control the variable filter to vary the characteristics of the light in accordance with the tracking of the feature by applying the same light characteristics to the feature when the feature moves position.

In accordance with another aspect of the present invention there is provided a device for use in photography, the device comprising an interface for receiving a communication identifying camera characteristics; and a processor arranged to vary at least one characteristic of light emitted by a light source in accordance with the camera characteristics.

The camera characteristics may include information identifying a camera shutter opening time, and the processor may be arranged to vary the at least one characteristic of the light each time new information identifying a camera shutter opening time is received.

The camera characteristics may include information identifying a camera shutter opening period and the processor may be arranged to vary the at least one characteristic of the light during the camera shutter opening period.

The at least one characteristic of the light varied by the processor may include a colour characteristic of the light.

The at least one characteristic of the light varied by the processor may include an intensity of the light.

At least one characteristic of the light may be varied spatially.

The device may further comprise a light source arranged to emit light; and a filter arranged to vary the at least one characteristic of the light.

The filter may be a matrix of variable filter elements.

In accordance with yet another aspect of the present invention there is provided a device for use in recording video images, the device comprising: an interface for receiving one or more communications identifying a plurality of open periods of a camera shutter; and a controller arranged to instruct a light source to emit light in accordance with the camera shutter open periods.

The controller may be arranged to instruct the light source to emit light throughout the period when the camera shutter is open.

The one or more communications may identify a camera shutter opening time and a camera shutter opening period.

The one or more communications may also identify a frequency of camera shutter opening.

The controller may be arranged to instruct the light source to emit light during a portion of the period that the camera shutter is closed.

In accordance with a further aspect of the present invention there is provided a device for ambient light colour compensation, the device comprising: a light receiving part arranged to receive a coloured light; and a light colour compensator arranged to compensate colour characteristics of light to be emitted by a light source in accordance with the received light.

The light colour compensator may be arranged to compensate for the colour characteristics of the light to be emitted such that the light to be emitted has the same colour characteristics as the received light.

The light receiving part may comprise: a red light sensor arranged to receive red light; a green light sensor arranged to receive green light; a blue light sensor arranged to receive blue light; and a white light sensor arranged to receive all colours of light, wherein the white light sensor is used to determine a received light intensity.

The received light may be ambient light falling on a subject to be photographed.

The light colour compensator may be arranged to apply an offset of green and/or magenta to the light to be emitted in order to further correct for the colour of light when the colour of light is defined in terms of colour temperature.

The device may be arranged to turn off the light source while taking a measurement.

In accordance with yet a further aspect of the present invention there is provided a device including two or more of the above devices.

The device may be an illumination device including a light source.

The device may be a camera.

In accordance with an aspect of the invention there is provided a method for use in photography, the method comprising: varying, at a variable filter, characteristics of light received from a light source such that the varied light is emitted onto a subject of an image being recorded; and controlling, at a processor, the variable filter.

The variable filter may comprise a plurality of variable filter elements arranged in an array, each filter element arranged to vary the characteristics of the light passing therethrough.

The varying characteristics of the light may comprise varying colour characteristics of the light.

The varying characteristics of the light may comprise varying intensity characteristics of the light.

The method may further comprise focusing, at an optical assembly, light emitted from the variable filter.

The method may further comprise tracking, at a a tracking means, a position of a feature of the subject of the image being recorded; and controlling the variable filter to vary the characteristics of the light in accordance with the tracking of the feature.

The step of controlling may comprise controlling the variable filter to vary the characteristics of the light in accordance with the tracking of the feature by applying the same light characteristics to the feature when the feature moves position.

In accordance with another aspect of the present invention there is provided a method for use in photography, the method comprising: receiving a communication identifying camera characteristics; and varying at least one characteristic of light emitted by a light source in accordance with the camera characteristics.

The camera characteristics may include information identifying a camera shutter opening time, and the method further comprises varying the at least one characteristic of the light each time new information identifying a camera shutter opening time is received.

The camera characteristics may include information identifying a camera shutter opening period and the method may further comprise varying the at least one characteristic of the light during the camera shutter opening period.

The at least one characteristic of the light which is varied may include a colour characteristic of the light.

The at least one characteristic of the light which is varied may include an intensity of the light.

The at least one characteristic of the light may be varied spatially.

In accordance with yet another aspect of the present invention there is provided a method for use in recording video images, the method comprising: receiving one or more communications identifying a plurality of open periods of a camera shutter; and instructing a light source to emit light in accordance with the camera shutter open periods.

The light source may be instructed to emit light throughout the period when the camera shutter is open.

The one or more communications may identify a camera shutter opening time and a camera shutter opening period.

The one or more communications may also identify a frequency of camera shutter opening.

The method may further comprise instructing the light source to emit light during a portion of the period that the camera shutter is closed.

In accordance with a further aspect of the present invention, there is provided a method for ambient light colour compensation, the method comprising: receiving a coloured light; and compensating colour characteristics of light to be emitted by a light source in accordance with the received light.

The step of compensating for the colour characteristics of the light to be emitted may be performed such that the light to be emitted has the same colour characteristics as the received light.

The received light may be ambient light falling on a subject to be photographed.

The method may further comprise applying an offset of green and/or magenta to the light to be emitted in order to correct for the colour of light when the colour of light is defined in terms of colour temperature.

The method may further comprise turning off the light source while taking a measurement.

In accordance with another aspect of the present invention there is provided a method including two or more of the above mentioned method steps.

In accordance with yet a further aspect of the present invention there is provided a carrier medium carrying computer readable code for configuring a suitable computer as the apparatus of any of the devices mentioned above.

In accordance with yet another aspect of the present invention there is provided a carrier medium carrying computer readable code for controlling a suitable computer to carry out the method of any of the method steps mentioned above.

Embodiments of the present invention relate to modulating a light source for use in photography. In particular, the light may be modulated spatially and/or over a period of time. Furthermore, the modulation may take place in accordance with the opening and closing of a camera shutter in order to save energy. Furthermore, the modulation may take place in order to compensate for ambient light.

Embodiments of the present invention relate to modulating the emission of light while the two shutter curtains moves across the sensor at speeds slower than or faster than 1/200 seconds (typ) in such a way that the subject is unevenly illuminated by the light source.

In accordance with embodiments of the present invention, for long exposure times, i.e. longer than 1/200 second (typ), modulating the light will allow the photographer to achieve various effects, for example capture several impressions of a moving object in a single frame, and to have the individual impressions individually exposed. The photographer may also be able to capture an impression of movement (blur) while still having the subject of interest appear sharp. This effect can be used for artistic or technical purposes.

In accordance with embodiments of the present invention, for short exposure times, i.e. shorter than 1/200 second (typ), modulating the light will allow the photographer to e.g. put a colour gradation on or behind the subject of interest, or a hairline light that varies in colour or intensity. Ambient light hitting the subject will be evenly exposed, while the emission of light from the light source can be modulated. This effect can be used for artistic or technical purposes.

Embodiments of the present invention relate to a situation where the quality of the light is made to vary at high speeds during the exposure.

Embodiments of the present invention allow for the colour of the emitted light to be modulated during the exposure.

Embodiments of the present invention allow for the colour temperature to be modulated during the exposure.

Embodiments of the present invention allow for the intensity of the light to be modulated during the exposure.

Embodiments of the present invention allow for both colour and intensity to be simultaneously and individually modulated during exposure.

Embodiments of the present invention allow for both colour temperature and intensity to be simultaneously and individually modulated during exposure.

Embodiments of the present invention allow for the modulation of light to be slow or rapid, thereby creating different effects.

Embodiments of the present invention allow for the modulation of light to be linear or non-linear across the exposure.

Embodiments of the present invention allow for the lighting to provide a strobing effect.

Embodiments of the present invention provide a system having a light source which has the ability to vary aspects of its light emission (intensity, colour or colour temperature) at high speeds, and can do this synchronised to the movement of a camera shutter.

Embodiments of the present invention relate to photographic devices, that is illumination devices, cameras, camcorders, or any other photographic equipment arranged to perform any of the above functionality.

Embodiments of the present invention are arranged to illuminate a subject to be photographed. A subject may be a person scene, object or such like. Further embodiments of the present invention are arranged to track features of the subject, for example of the subject is a traffic scene, a specific car may be the feature, or if the subject is a person the face of the person may be the feature.

The present invention shall now be described with reference to the drawings, in which:

Figure 1 illustrates a scenario for use of a first embodiment of the present invention;
Figure 2 illustrates a system provided in accordance with a first embodiment of the present invention; and
Figure 3 illustrates a cross-sectional view of an illumination device.

Throughout this specification like reference numerals refer to like parts.

Figure 1 provides an overview of a first embodiment of the present invention. In this first embodiment of the present invention a camera 100 is mounted on a tripod 10 for taking a photograph of a subject 20, which in this case is a person. It will be appreciated that the subject could be anything; for example, a person, an object, or a scene. An illumination device 200 is mounted on the camera 100. It will be appreciated that any suitable mounting means could be provided, for example, the illumination device 200 could be mounted separately from the camera 100.

The camera 100 and illumination device 200 are communicatively coupled via a communications channel 150, which in this case is a cable connector. It will be appreciated that the communications channel could take many forms, including various different types of wired connectors and wireless connection means. For example, the communication between the camera 100 and illumination device 200 may occur through connectors in the camera hotshoe. Alternatively, the communication may occur optically via a built in or separate flash mounted on the camera. In yet another embodiment the communication may occur via a separate wireless radio transmitter/receiver. In a further embodiment a separate sync wire between the camera 100 and the illumination device 200 may be used.

In operation the camera 100 is arranged to provide control signals to the illumination device 200 such that operation of the illumination device 200 is synchronised with operation of the camera 100. As a consequence, various functions of the present invention can be achieved.

Figure 2 illustrates a system provided in accordance with a first embodiment of the present invention.

In Figure 2, a representation of the functional components of camera 100 and illumination device 200 is shown. The camera 100 includes a power circuit 101, a microcontroller 102, a memory 103, an external device interface 104, a shutter assembly 105, a sensor assembly 106 and a user interface 107. The illumination device 2 is shown to include a power circuit 201, microcontroller 202, memory 203, camera interface 204, light emitting assembly 205 and user interface 206.

The arrangement of the system of this first embodiment of the present invention shall now be explained in more detail.

The power circuit 101 is arranged to provide power to each of the components of the camera 101. In this embodiment of the present invention the power circuit is a battery, however, any form of power supply, internal or external, could be utilised.

The power circuit includes, a power supply switch, a power control circuit and a power supply. The power supply switch is arranged such that when the switch is in an ON position the power control circuit can regulate the voltage from the power supply to the other components of the camera 100.

The microcontroller 102 controls the operation of the camera 100. In particular, the microcontroller 102 acts as the central processor and is capable of processing information received from the user interface, and also adjusting parameters of the shutter assembly 105 accordingly. For example, the microcontroller 102 is arranged to perform shutter speed control. Furthermore, the microcontroller 106 is arranged to receive image data from the sensor assembly and store this information in memory 103. The memory 103 represents the memory used by the camera both for data storage and for processing performed by the camera 100. It will be appreciated that separate memory components could be provided for each part of this functionality.

The external device interface 104 is arranged to provide a port through which the camera 100 can communicate with external devices such as illumination devices. The microcontroller 102 is able to send control signals via the external device interface 104

to the illumination device 200. Furthermore, image data can be streamed from camera to illumination device for certain functionalities, such as the use of multiple illumination devices, as discussed below.

The shutter assembly 105 is a standard shutter assembly as described above in respect of the prior art. In particular, it is standard dual curtain assembly. However, it will be appreciated that other types of shutter assembly could be utilised. The shutter assembly 105 also includes the necessary control circuitry for operating the curtains.

The sensor assembly 106 includes a CMOS or CCD imaging element, a microcontroller for managing the operation of the imaging element, and a memory for storing the recorded image information. The sensor assembly is arranged such that it is capable of determining characteristics of the light being photographed. Hence, the light being sensed may just be the ambient light, it may be a combination of the ambient light and light emitted from a photographic illumination device, or it may be the photographic light alone.

The user controls the camera 100 via its user interface 107. The user interface 107 is provided with a graphical user interface (GUI) thus providing the user with a display screen and controls such that the user is able to adjust parameters of the camera 100, and thus parameters of photographs to be taken by the camera 100. The user interface may also include one or more buttons, dials or such like for controlling parameters of the camera, in addition to operating the camera shutter. While the camera described in respect of this embodiment of the invention has various features including a graphical user interface, it will be appreciated that in alternative embodiments the only requirements for use with the illumination device of embodiments of the present invention is a way to adjust shutter speed and a flash hotshoe.

Now referring to the illumination device 200, the power circuit 201 takes the same form as that provided for the camera. However, it is noted that in alternative embodiments of the invention the illumination device could be powered by the camera, thus only requiring a power receiving interface instead of a full power circuit.

The microcontroller 202 of the illumination device 200 is arranged to control each of the components of the illumination device 200, and also perform any processing as necessary. In particular, the microcontroller 202 can receive control signals from the user interface 206, the camera interface 204, and the optical trigger in order to control the light emitting assembly accordingly. The functionality of the microcontroller is discussed in more detail below. It is noted that the camera interface 204 is a general purpose interface providing a communication port for connecting with various remote devices.

The memory 203 is connected to the microcontroller 202 and is used to store any data necessary for performing the operations of the illumination device.

The camera interface 204 provides a means for allowing for the illumination device to communicate with the camera 100. In particular, the camera interface 204 is arranged to receive control signals from the camera 100 and pass these on to the microcontroller 202 such that the microcontroller can transform these control signals into signals suitable for controlling the light emitting assembly 205. The camera interface 204 may receive such controls signals via a wired or wireless connection as discussed above in respect of Figure 1.

The light emitting assembly 205 includes an array of light emitting elements for emitting light. Such a light-emitting array comprises a plurality of light emitters including a red, green, blue and either amber or white emitter. The light emitters may be four or more high power LEDs (Light Emitting Diode) each of a different colour, red, green, blue and either amber or white. The relative intensity of the four colours is changed by the microcontroller in order to produce a light of any colour. The emitters are mounted in close proximity to each other. The light emitting assembly may form part of an optical assembly consisting of various lenses and diffusers designed to create an even light from the emitter array.

The LEDs are driven to about 10W in continuous mode. However, it is noted that when the LEDs are in flash mode they are in some circumstances driven with higher power. The reason for a 10W limit is primarily due to limitations in battery capacity and heat dissipation for a small portable device. As such a much higher powered device could be built by using larger and/or more emitters, a bigger case, and mains powered.

The lighting-emitting array may be provided by close mounted individual LED chips and multi-die emitters where four or more diodes sit on a common die. The advantage of multi-die is that better colour mixing can be achieved since the emitters sit closer together. A collating optical lens assembly will generally preserve the relative entrance angle of the light through the system. As the emitters have different colours, the light reaching the subject may not be a perfectly even light, but show colour fringing. The centre spot may be an even 'white', but the edges may show a colour cast reflecting the position of the individual emitters within the optic assembly. In order to mix the colours better, the light has to be diffused. Diffusion introduces a loss of optical efficiency. The closer the emitters are positioned relative to each other, the less diffusion is necessary and the better the optical efficiency can be.

Each individual LED can be driven by a switch mode current sink in order to achieve improved power efficiency and colour stability. A PWM driver circuit shunts the current sink and turns on and off the individual LED about 25000 times each second. The length of each pulse then determines the light output. Furthermore, the length of the pulses is continuously adjusted to compensate for drift in the emitters.

The current is not simply regulated through the LEDs because the colour of the LEDs shifts slightly when the current changes. Consequently, when the emitted light is dimmed, the light would become a little greener, for example, and such colour shifting is generally seen as unacceptable.

The emitter assembly also includes two sensors that feed back to the microcontroller. A temperature sensor to guard against thermal runaway, and an optical sensor that is used to compensate for drift.

Overall, the light emitting assembly is arranged to emit light powerful enough to provide improved illumination of a subject. The light emitting assembly 205 is arranged to emit light responsive to control signals from the microcontroller 202. In particular, the light emitting assembly 205 can vary its luminance levels over a period of time in accordance with the received instructions.

The light emitting assembly may also include a variable electronically controlled filter along with the light emitting device. This is discussed in more detail below, with respect to Figure 3.

The arrangement of the light emitting assembly 205 within the illumination device 200 is illustrated in the cross-sectional diagram of Figure 3.

In Figure 3, the illumination device 300 includes a casing 301, which encloses the other portions of the device except for the emission surface 302 which is transparent. The light emitting assembly 205 is all arranged inside the casing 301, such that light is emitted out from the emission surface 302.

The light emitting assembly 205 includes the emitter array 303 which is arranged to emit light as discussed above. An optical assembly 304 is provided in order assist in projection and channelling of the light through the emission surface 302. In this first embodiment of the present invention the optical assembly 304 includes a TIR optic consisting of a multitude of optical surfaces designed to collate the light and shape it into a suitable beam. The TIR optic also includes diffusion surfaces to help with colour mixing. The optical assembly 304 also includes a movable Fresnel lens, arranged in front of the TIR optic, designed to 'zoom' or alter the beam spread. Furthermore, the filter 305 is provided between the emitter array 303 and the emission surface 302, such that it can control or vary characteristics of the emitted light passing therethrough.

Also shown in Figure 3 is the user interface 206, which allows for the user to control the illumination device 200. In Figure 3 the user interface is provided on the back surface of the illumination device. However, it will be appreciated that the user interface could be provided on a separate device, either proprietary or part of another device such as a laptop. In the case where the user interface is a remote device it may be connected via wire or wireless like WiFi or Bluetooth.

The user interface 206 may be a graphical user interface which allows the user to set parameters of the illumination device 200. A display is provided along with a means for the user to input controls and information. This may be a touch screen display or alternatively some form of keypad, provided alongside a separate display screen. In particular, it is necessary that such controls are suitable for a user to select particular

light emission settings, as well as perform the necessary steps to synchronise the illumination device with the camera, in the event that such steps are not performed automatically. Furthermore, the display should, for certain embodiments, be capable of providing a graphical representation of the scene being photographed, and be able to provide the user control over the lighting applied to that scene.

The filter 305 is arranged to reduce light intensity emitted towards certain positions of the subject, as well as change the colour, or colour temperature emitted towards certain portions of the subject. Such characteristics can be varied both spatially and over time. The filter 305 may take the form of a matrix of binary shutters that can open/close to obstruct or pass light through, or could take the form of a liquid crystal construction. A liquid crystal based structure would be arranged with a gradual opacity to achieve such control of the light, in terms of position and intensity. Furthermore, in order to achieve colour variation the filter may comprise three layered liquid crystal devices, one for filtering red light, one for filtering green light and the other for filtering blue light. Alternatively, a binary state reflective type filter could be used, which would be made out of a matrix of microscopic mirrors (DLP). In any case it may be necessary to employ separate filters to deal with intensity modulation and colour modulation. A filter with gradual opacity would regulate the light by changing the opacity of each 'pixel'. In a binary state filter the apparent opacity would change by changing the duration of high-speed light pulses. Which ever system is utilised, the filter, or the combination of the light source and the filter, allows for the intensity of each of the red, green and blue colours to be varied for each pixel.

Since the filter may be capable of altering colour characteristics of the emitted light, in alternative embodiments of the invention a white light source replaces the coloured LED array. As such, all control over the light is carried out at the filter. In such embodiments it is possible for the filter to be separate from the light source. For example, a standard light source could be provided and utilised alongside the filter, along with the required control circuitry. Such embodiments may allow for a brighter and/or more energy efficient light sourse to be utilised.

Since the filter can be a separate item, a large liquid crystal based filter could be utilised in order to provide a single large light source. For example, the filter could form a $3m^2$ panel. In order to illuminate the panel it would be possible to use a high power

light source directly behind the panel, or in order to reduce the space required by the device, a reflector could be used in order to expand or spread the width of the light emitted from the light source.

In yet a further embodiment of the invention, the aforementioned light source may vary characteristics of the light it emits, such as the colour, and as such the filter may not be required.

In a further embodiment of the invention an LED panel is utilised in place of the above mentioned light source and filter. As such a coloured LED array can be used to represent each individual pixel of the light source. The modulation effects can then be applied across the pixels of the LED panel. In order to improve performance it may be necessary to include a specialist optical assembly, such as a lens arrangement, in order to ensure that the LED panel provides a focussed light source, as required for lighting up a subject in photography.

The various uses and functionalities of the first mentioned embodiment of the present invention shall now be described with reference to the figures.

The first parameter of light that can be controlled by the light emitting assembly is the intensity. For photography, the intensity of emitted light can be regulated in exposure value (EV) steps. Full steps, half steps, 1/3 steps, or 1/10 steps where each full step corresponds to a full step increase or decrease of camera aperture or shutter speed. One full step equals a halving or doubling of light intensity. Alternatively, for video it is quite common to use a continuous 0-100 scale. The photographer can then choose the preferred scale according to his or her preferences.

The overall intensity of light emitted can be varied by changing the intensity of light emitted by the light emitters themselves. However, the filter allows for positional intensity changes to be provided in addition to universal changes, as discussed below.

The filter can act to block or reduce the intensity of light emitted by the light emitting assembly such that certain areas of the light projected onto a subject have reduced light levels. In particular, certain portions of the filter can be arranged to block light while others are arranged to pass light. In further embodiments, some of the light can

be partially passed or partially blocked. As such the filter can provide different levels of light intensity to different areas of the scene being photographed.

An example of a useful application of variations in positional intensity shall now be discussed. Control of the variations in light intensity can be achieved by using a light sensor, which may be provided from the camera or on the device itself, which receives light from the exact same area as the area that the light emitted by the light emitting assembly is projected onto. Alternatively, the device can receive an image feed from the camera used for capturing the image. Hence, this camera can take in an image of the scene to be photographed. Some parts of the scene will be lighter, some will be darker. The photographer can then brighten dark areas without affecting the brightness of the light areas. The image from the light sensor can be used to determine which areas are dark and which areas are bright. Based on this information the microcontroller of the device can control the emitted light such that the intensity of light projected onto the parts of the scene that are dark is greater than the intensity of light projected onto those parts that are already light. In order to achieve this, the microcontroller can take the image from the image sensor invert the image intensity and emit light accordingly. Thus, the dark areas are illuminated more than the light areas. As such the dark areas of the scene can be brightened without adding unwanted glare or brightness to other areas of the scene.

The light emitting assembly is also capable of varying colour. As mentioned above, the emitting elements are capable of emitting light of any colour by selecting a ratio of the different coloured LEDs. Furthermore, the intensity of each colour can be controlled by controlling each LED individually. The user can apply an overall colour setting, which is applied universally to the light source. Colour can be changed by entering a set of colour coordinates in one of common colour spaces like RGB, Lab, HLS, etc. Colour can also be selected from a list of named colours like "Summer Green", "Dark orange", etc. Obviously, in alternative embodiments, these colours could be varied by the filter. Furthermore, as mentioned above, the intensity of each colour for each pixel can be controlled independently.

Another colour parameter that the user can set is the colour temperature, CT (or more technically accurate, the Correlated Colour Temperature). CT is also called white balance. The colour temperature can be regulated by entering the desired colour

temperature along a continuous scale. The scale boundary depends somewhat on the colour coordinates for the particular emitters used, but would typically be from 2000 to 10000 Kelvin. The CT can also be regulated by selecting from a list of predefined named values, for example Daylight, Cloudy, Fluorescent and so forth, where the Daylight setting would be a CT of 5600 Kelvin. The CT can also be changed by adding an electronic 'compensating gel'. Many photographers are accustomed to adding gelatine filters to their lights, and to accommodate those who are accustomed to working this way, the device lets the photographer select from a list of common filters like CTO, CTB, or Plusgreen. The device will then adjust the CT of the emitted light to a value equal to the effect of adding a physical gelatine filter. The colour can be changed either by adjusting the colour emitted by the emitter array 303 or by applying a universal colour adjustment to the filter 305.

In respect of both the overall colour and colour temperature, the selected colour can be achieved by varying either the light emitters or the filter 305.

The filter allows for further control over the emitted light, in particular, in respect of colour positioning. Such colour positioning is also achievable if a light source panel array, as discussed above, is utilised in place of the light source and filter combination. For example, a colour gradient can be applied which varies the colour across the image. It may be that the colour is set up to gradually change from top to bottom or left to right, in order provide the effect of a light source from a particular direction. It is noted that light intensity gradation can be applied in a similar way. Further examples of more complex uses of the colour variation capabilities provided by the filter are set out below.

The filter array can provide specific positional coloured light. For example, if it is desired to provide a blue line of light across the subject this can be achieved in accordance with an embodiment of the present invention.

The user display can be used in order to control the 'painting' of light onto the position of the scene as desired. In particular, the image sensor records an image of the scene, and the position of the light source(s) with respect to the scene has thus been determined. The microcontroller is then able to allow input from a user onto the user display, or any other user interface, to identify regions where the line of blue light

should be provided. In such a case the microcontroller is able to control both the light emitters and the filter such that the blue light is provided. This can be achieved by the emitters emitting a white light, and the filter providing a blue filter to specific portions of the light such that the blue line specified by the user is project onto the scene.

While the above example of 'painting light' is applied to blue light, it will be appreciated that any light parameter, such as colour and intensity with respect to position, could be altered using this technique.

Another parameter adjustable by the user is the light mode. A video mode can be selected where the device emits a continuous light suited to recording of moving images. The meaning of continuous light also includes the case where the light is turned off during the time when the camera shutter is closed, for the purpose of saving energy. The other light mode is flash, where the device emits a flash. In flash mode the device may emit a constant low power modelling light used to aid the photographer in positioning the light.

The emitter feedback assembly 207 may include a light sensing device, which is used for calibrating the light emitting assembly, in addition to providing feedback useful for certain processes performed by the illumination device 200. This light sensing device could be the same light sensing device as that used above in respect of recording the image for user control over the projected light. However, separate sensors for the specific applications could also be provided. Such a light sensing device may be a broad-spectrum high-speed photodiode that produces a current relative to the amount of light that hits the sensor surface. This current is converted to a voltage, amplified and fed to an analogue-digital converter on the microcontroller. In order to perform a reading the microcontroller turns on one single emitter, for example the red one, reads the voltage from the sensor, then turns on the green, reads the voltage from the sensor and so on. Since this is a high-speed sensor, the entire measurement cycle can be performed in less than 100µs. This measurement cycle can form part of the general PWM control, in a way that the output can be continuously monitored without affecting the quality of the light. Such feedback is useful because the luminance and the colour (the centre wavelength) of each emitter change with age and temperature in a highly non-linear fashion. The feedback sensor helps to stabilise such a high-quality light source.

The emitter feedback assembly may also include the circuitry necessary to process the emitter feedback functionality, however, in this first embodiment of the invention such functionality is integrated within the microcontroller.

The operation of the system illustrated in the Figures shall now be described.

The microcontroller 202 is the main processor and controller of the illumination device 200. The microcontroller 202 is arranged to initialise each of the circuits of the illumination device such that they are in a ready state, that is in a state ready to perform any functionality provided by the illumination device 200. Once the illumination device 200 is initialised it awaits input from the user via the user interface 206 or from the camera via the camera interface 204. The camera 100 can be initialised in a similar way.

Periodically, the illumination device may be calibrated. In particular, because luminance of light emitting sources can vary, and generally degrade overtime, it is advantageous to regularly perform a calibration such that a user of the illumination device obtains expected luminance levels. In this embodiment of the present invention the luminance calibration is performed every time that the illumination device 200 is initialised. However, in alternative embodiments this calibration could be limited to an automatic weekly or monthly occurrence, or alternatively only take place upon specific instructions from the user. Furthermore, calibration could be performed whenever there is a change in a monitored parameter, such as temperature, which could affect the device performance. It will be appreciated that in some circumstances a calibration may not be necessary.

When the calibration takes place the microcontroller 202 instructs the light emitting assembly to cycle through each emitter. That is, each light emitting element of the the light emitting array emits light on its own, with each light emitting element of the emitter array doing this sequentially. The emitter feedback assembly 207 is arranged to capture a part of the emitted light and this captured light is used to calibrate the light emitting elements. In particular, the emitter feedback assembly 207 feeds back the luminance level to the microcontroller 202, which in turn compares the received light level with the expected light level. Furthermore, the microcontroller is able to relate

each light level received from the emitter feedback assembly 207 with a particular emitter of the emitter array of the light emitting assembly 205. Hence, if any of the luminance levels are deemed incorrect then the microcontroller 202 can reset the luminance by adjusting the ON time of the specific light emitting element. Consequently, a fully calibrated emitter array is achieved which emits a stable and constant light.

When the calibration is complete and no instructions to emit light from the light source are received, the light emitting assembly 205 keeps the light emitting elements, or emitters, in an OFF state. At this point the camera interface 204 and the user interface 206 are set to listen for commands from the camera. The state of the device can be displayed for the user via the user interface 206.

At this point the user is able to set the parameters of both the camera 100 and the illumination device 200 via the respective user interfaces. Such settings will control the appearance of the photo taken. The type of settings available were discussed in detail with respect to Figure 1, however, further detail is provided below. It will be appreciated that these settings may include a plurality of preset functions, or may provide specific control for the user to set individual parameters.

At a time when a camera shutter button of the user interface 107 of the camera 100 is engaged, the camera 100 sends a light emission control signal to the illumination device via the external device interface 104 and the camera interface 204. This light emission control signal is a request for the illumination device 200 to control emission of light from the emitters of the light emitting assembly 205. This first control signal is simply a pre-flash message, and instructs the illumination device to emit a short flash. During this pre-flash, the camera measures how much light is reflected from the scene and determines the appropriate exposure. The pre-flash, relay of information ready for re-calculation for the main flash, and the main flash itself all occur very quickly and as such only a single flash would be observed in most cases. It is noted that the sensor assembly 106 of the camera 100 can detect the emitted light. In alternative embodiments of the invention the pre-flash is not carried out.

Once the settings for the photograph are determined by the camera 100, the camera 100 will send a communication message to the illumination device 200. The

communication message may contain a channel number, a shutter speed, a flash duration, a guide number (GN) and/or a variety of other commands from the camera to exchange information about the intended exposure.

When the illumination device 200 receives a communication message from the camera indicating that the camera shutter is opening, the microcontroller of the illumination device instructs the light emitting assembly to start emitting light according to the settings made by the photographer and/or the camera.

The sensor assembly 106 of the camera is then able to receive light including light originating from the illumination device and reflected from the subject 20. The overall photograph taken by the camera can then be stored in memory 103.

In accordance with this first embodiment of the present invention the functionality of the light emitting assembly 205, and the different types of emission possible via the light emitting assembly 205 shall be discussed.

As mentioned above, prior to the exposure the photographer will have entered instructions into the illumination device 200, which include specific control signals and parameters to be applied to the light emitting assembly.

The light emitting assembly 205 is arranged such that it is able to modulate the colour of the light emitted by the emitter array over the exposure time. Furthermore, the light emitting assembly 205 is arranged such that it is able to modulate the colour temperature or the light intensity of the light emitted by the emitter array spatially across the image during the exposure time, or any combination thereof. Such modulation was discussed in more detail with respect to Figure 1.

The illumination device is set up so that the user may individually control the parameters of the above-mentioned functions. For example, the user may control the modulation rate, the range of colour modulation or colour temperature modulation. The illumination device also provides a set of predefined effects having each of these characteristics pre-set. The user may then select one or more of these effects accordingly. Also, the user may apply or 'paint' light onto specific areas of the scene to be photographed, as discussed in more detail above.

In use, prior to exposure, the illumination device 200 receives a communication from the camera 100 as to what amount of light is required to achieve the desired exposure value. This exposure value will have been determined as mentioned above. The microprocessor unit uses this information to calculate an equivalent relative light level. Consequently, when such a time comes that the camera sends a trigger signal to the device indicating that the exposure is starting, the device may not emit a single shot flash, but may emit a changing light during the time period when the shutter is open. When the exposure is over, the illumination device 200 returns to its standby ready mode.

The affect that these effects of the present invention have on the resulting image varies depending on the settings entered by the photographer, the shutter speed of the camera, the relative positioning of the camera 100 and illumination device 200 in relation to the subject 20. The actual perceived effects include but are not limited to: colour gradation effects, strobe effects, a combination of blur and sharpness, and a variation in exposure across the image.

The above-mentioned first embodiment of the present invention talks specifically about use of the present invention when taking still photographs. While such techniques could be applied constantly across a plurality of frames of a moving image, in accordance with a second embodiment of the invention uses specific to video recording shall be described. All those parts of the invention not described herein can be assumed to be the same as the first embodiment.

Video images are the result of a series of still images, taken at a rate such that when played back at the rate they were taken a smooth constant image stream is observed. The frequency of images taken for video images is typically between 24 and 30 frames per second.

When used in video embodiments of the present invention are able to modulate the light over a series of video frames. Different modulation or variation of light characteristics can be provided between each frame, and this modulation may be linear or non-linear, repeating or non-repeating. Some of these effects are discussed below.

A short ramp-up of light intensity with a slow decay during the exposure of each individual frame gives a restlessness and disharmony to, for example, a city scene. Such techniques are great for scenes that portray urgency. Furthermore, a casual viewer may experience the scene as having higher intensity or uneasiness, but will probably not be able point to the exact cause.

A slow-strobing effect can be achieved by, for example, strobing on every other or third frame. Hence, strobing involves varying the light intensity between consecutive frames, or for example on 1 of every x frames. When such a technique is used in lighting something moving through a scene the subject will look unnatural, out of place, on the verge of flickering.

Combining intra-frame modulation techniques with modulation over many frames enables the photographer to, for example, smoothly fade in or out an effect on any part of the scene that is lit by the device.

The above described techniques are a selection of many such techniques which could be applied in accordance with embodiments of the present invention.

This second embodiment of the present invention is, therefore, able to provide a photographer with further available effects. In particular, effects such as simulation of flickering light from a campfire, a TV-set, or a neon tube can be achieved. Furthermore, a number of other lighting effects that may be desirable when recording moving images can be achieved.

While this second embodiment discusses the use of changing modulation characteristics between frames of a video, the same techniques could be used for a series or sequence of still images.

In accordance with a third embodiment of the present invention several illumination devices are used in conjunction. In particular, the illumination devices can be spaced apart and operated together in synchronisation in order to simulate a moving or larger light source. Hence, the photographer may use more than one device to achieve improved or alternative effects.

For example, take the simple example of a campfire. The photographer wants to record a video scene with a couple of actors around a campfire. The natural light from the campfire itself is not suitable for illuminating the actors; it is not strong enough for a proper exposure in camera. So for the actual close-ups, the photographer arranges for a stronger light source. The colour of the light coming from a campfire will vary slightly over time. This effect is possible to simulate well with a single device set to vary the colour gradually within a range with some amount of stochastic motion similar to an actual campfire. A campfire also has a certain physical size; it is not a point sized light source as the device is. If the actors were placed around a campfire in such a way that they cast a shadow onto something, their shadow would flicker somewhat depending on how large the campfire is and how windy it is. A single point sized light source would not be able to simulate the moving shadows, but two or more lights would. Two or more lights could be set to simulate a campfire independently, or they might be synchronised through the external interface.

In practice, this embodiment of the invention can be implemented by a photographer having a laptop where he or she can see the image from the camera. This is a constant feed, like a video feed. The laptop is also connected to a plurality of illumination devices. One of the microcontrollers or microprocessors in this system acts as a master. For example, the microprocessor of the laptop may act as a master, with the equivalent component of the camera / illumination device acting as a slave.

Each of the light sources provided can have an associated light sensor or device camera. By combining the images received from the device cameras, the system is able to determine which parts of the subject are lit by which illumination device. The user is then able to view a representation of the illuminated scene, and the affect of each of the light sources on a single user display screen. Each illumination device can then control the intensity, colour and position of light emitted onto the scene. As such embodiments of the present invention allow for a very finely grained control over the emitted light.

The master can determine how each illumination device affects the scene or subject of interest by any combination of three methods:

1. A diagram of the relative positioning of the illumination devices with respect to the subject, as entered into the system by the operator. In alternative embodiments of the invention the positioning of the illumination devices may be automatically determined by triangulating via wireless radio or such like.

2. By evaluating the images from the cameras built into the illumination devices. Each device sees the scene from a different angle and these images are combined to build a three dimensional representation of the scene.

3. The master commands each device in turn to illuminate the scene or subject by scanning a spot of light from e.g. left to right and/or top to bottom or vice versa. The scanning is done by changing the opacity of the filters correspondingly. The master then sees how each spot of light affects the scene or subject.

The master then has an internal representation of the scene where it is known how each 'pixel of light' from each emitter affects the lighting. The operator can then alter any aspect of the lighting by interacting with the display. Light in areas that form hotspots can be toned down. Unwanted reflections from the forehead of a subject is an example of such an unwanted hotspot. Other typical uses are to increase or decrease the illumination of the background and change its colour. Also, the device may be used to 'paint light' onto a subject in order to change the dynamics and mood of the lighting.

While the above example provides a laptop as the master, it will be appreciated that a laptop is not required. One of the plurality of illumination devices used could act as the master and the user could control all of the illumination devices from the master illumination device.

When an illumination device, or a plurality of illumination devices, is used to illuminate an object that may move, for example a person, feature tracking may be used to constantly correct the internal representation of the scene. If a particular lighting is applied to a particular part of the subject, say a shoulder, feature tracking can help the system maintain the same lighting of the shoulder even when the person moves.

The embodiments of the invention described above, therefore, provide the photographer with control over an image at the point of taking the photo. While post-

production techniques can be used to provide some of these effects, such techniques are expensive to provide because they require specialised technical personnel to carry them out. Hence, an image that requires substantial work in post-production is typically of less value to the customer. The above described embodiments of the invention thus provide means for providing lighting effects without the need for extensive and costly post-production techniques.

In accordance with yet another embodiment of the present invention the emission of light by the illumination device can be synchronised with the opening and closing of the camera shutter in order to save energy.

When a camera records video, it records a number of frames in quick succession. As mentioned previously, the frequency is typically between 24 and 30 frames per second for normal video, but may go significantly slower or faster depending on technical or artistic factors. If the frame rate is, say, 24 frames per second, there is approximately 42 ms between each individual exposure. The exposure time for each individual frame must be shorter than the time between each frame, but is otherwise independent of the frame rate.

The exposure time is set by the camera or by the photographer to a suitable value in order to get the desired exposure based on the available light, in addition to other factors. Typical exposure times may be 1/60 s, 1/125 s or 1/250 s. So in a typical scenario the shutter may be open for 4 to 16 ms during each 42 ms period.

This embodiment of the present invention thus provides an illumination device arranged to only emit light when the shutter is open. Given that when recording video a constant light source is provided, this embodiment saves significant amounts of energy compared to known techniques because light is only emitted during those periods that the shutter is open. As a consequence, the illumination device can be emitting light for much less of the time than systems that employ a constant light source. Energy saving is equal to the ratio of frame rate to exposure time. For a frame rate of 24 fps and a shutter time of 1/60 second, the energy saving is roughly 59%. Hence, for a shutter time of 1/250 second, the energy saving is roughly 88%.

One problem with this energy saving technique is that the frequency at which the illumination device is turned ON/OFF may be visible to the human eye. Humans have individual and varying sensitivity to light flicker. In order to prevent the illumination device causing a flicker, which may be seen as a nuisance by some people, a further embodiment of the present invention involves the device emitting one or more additional light emissions, or blind fires, during the time when the camera shutter is closed. That is, light is emitted for a period shorter than the amount of time the camera shutter is shut, but a significant amount of time such that the frequency of emitted light is increased. This so called flicker reduction mode of the illumination device therefore increases rate at which the flashes take place, thus increasing to the frequency to a rate, for example 48Hz, 72Hz or 96Hz for a 24Hz frame rate, which will not be observable by the human eye. This flicker reduction mode eradicates flicker problems without unduly increasing the time the illumination device is ON.

It will be appreciated that the concept of turning ON/OFF of the light source in synchronisation with the camera shutter can be applied with or without use of the modulation effects and features of previously discussed embodiments. In particular, this energy saving technique could be applied to any technique in order to help reduce energy consumption.

In yet another embodiment of the present invention an ambient light colour compensation mechanism is provided which includes an ambient light sensor and a colour adjusting means. In particular, this embodiment of the present invention relates to adjusting colour temperature in order to correct for photographic discrepancies that can occur when artificial lighting is used, as discussed in more detail below.

Colour temperature is a characteristic of visible light that has important applications in photography and related fields. The colour temperature of a light source is the temperature of an ideal black-body radiator that radiates light of comparable hue to that light source. The temperature is conventionally stated in units of absolute temperature, Kelvin (K). Higher colour temperatures (5,000 K or more) are called cool colours (blueish white); lower colour temperatures (2,700–3,000 K) are called warm colours (yellowish white through red). Domestic light sources, like an incandescent lamp that emits light as a result of thermal radiation, behaves for practical purposes like a black-body radiator in the context of colour temperature.

The absolute or specific colour temperature of the light source that illuminates a scene is not usually critical. Cameras may automatically find the correct white balance, or if not, the photographer can easily do it in post production. However, a problem arises when a scene is lit by two or more light sources with differing colour temperatures. If a warm (low CT) light falls on a person from one side and a cold (high CT) light from the other side, then there is no white balance to be found where all the colours in the image will be correct or natural looking. If the white balance is adjusted such that anything illuminated by the warm light have natural colours, then anything illuminated by the cold light will look pale and ghostly. If the correct colour balance is set for the cold light, then anything lit by the warm light will turn orange and red.

The abovementioned problem limits the conditions under which photographers can take successful pictures when out on location. It is also a severe problem for video recording such as reporting or news gathering.

This embodiment of the present invention provides an illumination device having additional features to compensate for such ambient light problems. In particular, the ambient light colour compensation mechanism of the illumination device has the ability to

a) vary the colour temperature of light emitted by the luminance device,

b) measure the colour temperature of the existing ambient light, and

c) perform the necessary compensation automatically or manually, wherein automatic compensation involves varying of the colour temperature of the emitted light in response to the measured colour temperature.

The ambient light colour compensation mechanism can be provided as a separate processing device or alternatively its functionality can be provided by the microcontroller 202 of the illumination device 200.

The features of the illumination device in accordance with this embodiment of the present invention shall now be described in detail.

The ambient light colour compensation mechanism of the illumination device has a built in colorimeter. This is an assembly of four light sensors, having a red, a blue, a green

and a clear filter respectively. The colour sensor assembly will typically point in the same direction as the light emitter such that it receives light from where the light emitter will be emitting light. The colour sensor measures the red, green and blue components of the existing or ambient light, and the microcontroller uses this information to calculate a corresponding colour temperature. The clear channel is used to measure the overall light level.

The microcontroller receives information regarding the amount of red, green and blue light from the colour sensor assembly. The microcontroller then combines this into an RGB value. The microcontroller uses a 3x3 correlation matrix to transform these values to CIE XYZ tristimulus values. CIE XYZ colour space is a mathematical representation of the human visual system as it relates to colour. The CIE tristimulus values correspond to the sensitivity of a normalized human eye. The human eye has three types of cone cells for colour vision. These cone cells are sensitive to red, green and blue. The XYZ tristimulus values are the relative amounts of red green and blue that makes up a particular colour, adjusted for the sensitivity of the human eye. The correlation matrix is a formula that is used to transform the light values from the ambient light sensor, which does not precisely match the sensitivity of a human eye, into values that correspond to the sensitivity of a human eye.

From the XYZ tristimulus values a further 3:2 transformation is performed to map the values on to a standard 2-dimensional CIE 1931 colour coordinate system. Lastly a calculation is performed in order to find the correlated colour temperature point on the CIE plancian locus, and the offset in the green or magenta direction.

The green/magenta offset is a value used to correct for the effect that is often present when the existing light is not a result of thermal radiation. For example, the sun or an incandescent light bulb emits light as a result of being heated. Light emitted as a result of thermal radiation falls along the plancian locus and ranges from red-ish white through yellowish to blue-ish white. The plancian locus is the range of colours that a black body emits as its temperature rises. These colours lies along a curve in the CIE colour coordinate system.

White light that is not generated as a result of heating, like e.g fluorescent light which is generated by exiting a gas, typically does not fall exactly on the plancian locus but

somewhere nearby. This light will have an additional green or magenta colour component to it. A fluorescent light may for example have a green tint. Similar to above, this tint may not be noticed by a human eye, but may strongly influence a photographic image. This offset from the plancian locus is taken into account by the illumination device in order to mimic the colour of the existing light as closely as possible.

It will be appreciated that while Colour Temperature is the most common way to describe light specifically intended for illumination, the device can measure light of any colour and emit light of any colour (within the constraints of the particular emitters and sensors used).

In alternative embodiments of the present invention a colour sensor of a different construction is utilised. In particular, a diffraction spectrometer is utilised in order to perform the measurements needed to arrive at the correlated colour temperature.

Once the colour sensor measurement values and the calculated values are obtained, these can be used to adjust the light emitter to emit light with the same correlated colour temperature as measured by the colour sensor. The green/magenta offset calculated by the microprocessor is then added.

As the device is capable of emitting light of any colour (within the constraints of the particular emitters used), the device could also mimic a light source with an emission spectrum that falls outside the definition of white light. For example, a pure red light.

In order to be able to measure the existing or ambient light while simultaneously emitting light, the ambient light colour compensation mechanism of the illumination device instructs all the emitters to be turned off for a short period of time. This can be repeated at regular intervals in order to compensate for variations in ambient colour when recording video or a sequence of photographs. The turn off duration is usually about 40µs (typ). This duration is so short that the human eye or camera will not notice that the emitters were turned off, but is sufficiently long for a measurement to be taken. The resulting small loss in average light output due to such turning off of the emitters can be compensated by increasing the light output by an equal amount in the periods between the measurements. The turn off duration is too short for the analog-digital

(AD) converter to perform a complete measurement, so a sample-and hold circuitry is employed in order for the AD converter to complete the integration over several measurement cycles.

The ambient light colour compensation mechanism can also be used to perform further functionality. For example, a photographer using the device may point the illumination device at another light source such that the device mirrors the colour temperature of the other light source. This may, for example, allow for good natural light colour to be achieved because the ambient light colour compensation mechanism can provide light which is an exact copy of natural day light.

Another functionality of the ambient light colour compensation mechanism is that it allows for a photographer to set the illumination device to automatically adjust its correlated colour temperature to the dominant colour temperature in the scene. Alternatively, the photographer could set the device to accentuate a prominent colour temperature in a scene, such the colour emitted by an open fire.

In the following, photography should be taken to mean both still photography and moving images (video). Photographer should be taken to mean both still photographer and videographer.

The camera 100 may be any type of camera which is capable of linking up with an external illumination device or flash. In particular, the camera must have an interface circuit such that the operation of the camera and device can be synchronised. A HDSLR may be preferable, but any camera could be used.

Each of the components of the camera and illumination device may be provided on a respective circuit board or integrated within the individual device. Furthermore, while certain components have been described as separate entities, and other components as performing multiple functions, it will be appreciated that many functionalities could be combined within a single component, or separated into distinct components as appropriate. Furthermore, the overall functionality of the camera and illumination device could be combined into a single unit.

While the invention has primarily been described with respect to use with a digital camera it will be appreciated that the invention would work equally well with an analogue based photographic recording means.

While the above described embodiments of the invention disclose that the functionality of the present invention is incorporated within an illumination device, it will be appreciated that the functionality could also be incorporated within a camera, video camera, or stand alone device. The functionality of the above described invention could be integrated within a camera with or without an illumination device such as a flash. If the camera does not include an illumination device the camera incorporating the functionality of the present invention is arranged to instruct the illumination device when to illuminate. The functionality could also be provided in a stand alone device separate from a camera and an illumination device. Such a stand alone device is arranged to receive control signals from a camera and convert these control signals into new control signals to control the illumination device in accordance with the various embodiments of the present invention set-out above. Hence, the stand alone device acts as an interface between the camera and illumination device.

The term illumination device refers to a camera flash or any other suitable lighting device for use with a camera, video camera, camcorder, mobile phone camera, or any other image recording device.

The present invention can be implemented in dedicated hardware, using a programmable digital controller suitably programmed, or using a combination of hardware and software.

Alternatively, the present invention can be implemented by software or programmable computing apparatus. This includes any computer, or such like. The code for each process in the methods according to the invention may be modular, or may be arranged in an alternative way to perform the same function.

Each of the functionalities of the invention can in whole, or in part, be implemented by the combination of a processor and associated memory, or by a standard computer system. Furthermore, functions described herein as being implemented as part of a single unit may be provided separately, communicatively coupled across a network.

The present invention can encompass a carrier medium carrying machine readable instructions or computer code for controlling a programmable controller, computer or number of computers as the apparatus of the invention. The carrier medium can comprise any storage medium such as a floppy disk, CD ROM, DVD ROM, hard disk, magnetic tape, or programmable memory device, or a transient medium such as an electrical, optical, microwave, RF, electromagnetic, magnetic or acoustical signal. An example of such a signal is an encoded signal carrying a computer code over a communications network, e.g. a TCP/IP signal carrying computer code over an IP network such as the Internet, or an intranet, or a local area network.

It is appreciated that various features of the invention which are, for clarity, described in the contexts of separate embodiments may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the invention is defined only by the claims.

CLAIMS:

1. A device for use in photography, the device comprising:

a variable filter arranged to vary characteristics of light received from a light source, the variable filter being arranged to emit the varied light onto a subject of an image being recorded; and

a processor arranged to control the variable filter.

2. The device according to claim 1, wherein

the variable filter comprises a plurality of variable filter elements arranged in an array, each filter element arranged to vary the characteristics of the light passing therethrough.

3. The device according to claim 1 or 2, wherein the variable filter is arranged to vary colour characteristics of the light.

4. The device according to any preceding claim, wherein the variable filter is arranged to vary intensity characteristics of the light.

5. The device according to any preceding claim, further comprising:

an optical assembly arranged to focus the light emitted from the variable filter.

6. The device according to any preceding claim, wherein the processor further comprises:

a tracking means arranged to track a position of a feature of the subject of the image being recorded and control the variable filter to vary the characteristics of the light in accordance with the tracking of the feature.

7. The device according to claim 6, wherein the processor is arranged to control the variable filter to vary the characteristics of the light in accordance with the tracking of the feature by applying the same light characteristics to the feature when the feature moves position.

8. A device for use in photography, the device comprising:

an interface for receiving a communication identifying camera characteristics; and

a processor arranged to vary at least one characteristic of light emitted by a light source in accordance with the camera characteristics.

9. The device according to claim 8, wherein the camera characteristics include information identifying a camera shutter opening time, and the processor is arranged to vary the at least one characteristic of the light each time new information identifying a camera shutter opening time is received.

10. The device according to claim 8 or 9, wherein the camera characteristics include information identifying a camera shutter opening period and the processor is arranged to vary the at least one characteristic of the light during the camera shutter opening period.

11. The device according to any one of claims 8 to 10, wherein the at least one characteristic of the light varied by the processor includes a colour characteristic of the light.

12. The device according to any one of claims 8 to 11, wherein the at least one characteristic of the light varied by the processor includes an intensity of the light.

13. The device according to any one of claims 8 to 12, wherein at least one characteristic of the light is varied spatially.

14. The device according to any one of claims 8 to 13, further comprising:

a light source arranged to emit light; and

a filter arranged to vary the at least one characteristic of the light.

15. The device according to claim 14, wherein the filter is a matrix of variable filter elements.

16. A device for use in recording video images, the device comprising:

an interface for receiving one or more communications identifying a plurality of open periods of a camera shutter; and

a controller arranged to instruct a light source to emit light in accordance with the camera shutter open periods.

17. The device according to claim 16, wherein the controller is arranged to instruct the light source to emit light throughout the period when the camera shutter is open.

18. The device according to claim 16 or 17, wherein the one or more communications identifies a camera shutter opening time and a camera shutter opening period.

19. The device according to claim 18, wherein the one or more communications also identifies a frequency of camera shutter opening.

20. The device according to any one of claims 16 to 19, wherein the controller is arranged to instruct the light source to emit light during a portion of the period that the camera shutter is closed.

21. A device for ambient light colour compensation, the device comprising:

a light receiving part arranged to receive a coloured light; and

a light colour compensator arranged to compensate colour characteristics of light to be emitted by a light source in accordance with the received light.

22. The device according to claim 21, wherein the light colour compensator is arranged to compensate for the colour characteristics of the light to be emitted such that the light to be emitted has the same colour characteristics as the received light.

23. The device according to claim 21 or 22, wherein the light receiving part comprises:

a red light sensor arranged to receive red light;

a green light sensor arranged to receive green light;

a blue light sensor arranged to receive blue light; and

a white light sensor arranged to receive all colours of light, wherein the white light sensor is used to determine a received light intensity.

24. The device according to any one of claims 21 to 23, wherein the received light is ambient light falling on a subject to be photographed.

25. The device according to any one of claims 21 to 24, wherein the light colour compensator is arranged to apply an offset of green and/or magenta to the light to be emitted in order to further correct for the colour of light when the colour of light is defined in terms of colour temperature.

26. The device according to any one of claims 21 to 25, wherein the device is arranged to turn off the light source while taking a measurement.

27. A device including two or more of:
the device of any one of claims 1 to 7;
the device of any one of claims 8 to 16;
the device of any one of claims 16 to 20; and
the device of any one of claim 21 to 26.

28. The device according to any preceding claim, wherein the device is an illumination device including a light source.

29. The device according to any preceding claim, wherein the device is a camera.

30. A method for use in photography, the method comprising:
varying, at a variable filter, characteristics of light received from a light source such that the varied light is emitted onto a subject of an image being recorded; and
controlling, at a processor, the variable filter.

31. The method according to claim 30, wherein
the variable filter comprises a plurality of variable filter elements arranged in an array, each filter element arranged to vary the characteristics of the light passing therethrough.

32. The method according to claim 30 or 31, wherein the varying characteristics of the light comprises varying colour characteristics of the light.

33. The method according to any one of claim 30 to 32, wherein the varying characteristics of the light comprises varying intensity characteristics of the light.

34. The method according to any one of claims 30 to 33, further comprising:

focusing, at an optical assembly, light emitted from the variable filter.

35. The method according to any one of claims 30 to 34, further comprising:

tracking, at a a tracking means, a position of a feature of the subject of the image being recorded; and

controlling the variable filter to vary the characteristics of the light in accordance with the tracking of the feature.

36. The method according to claim 35, wherein the step of controlling comprises controlling the variable filter to vary the characteristics of the light in accordance with the tracking of the feature by applying the same light characteristics to the feature when the feature moves position.

37. A method for use in photography, the method comprising:

receiving a communication identifying camera characteristics; and

varying at least one characteristic of light emitted by a light source in accordance with the camera characteristics.

38. The method according to claim 37, wherein the camera characteristics include information identifying a camera shutter opening time, and the method further comprises varying the at least one characteristic of the light each time new information identifying a camera shutter opening time is received.

39. The method according to claim 37 or 38, wherein the camera characteristics include information identifying a camera shutter opening period and the method further comprises varying the at least one characteristic of the light during the camera shutter opening period.

40. The method according to any one of claim 37 to 39, wherein the at least one characteristic of the light which is varied includes a colour characteristic of the light.

41. The method according to any one of claims 37 to 40, wherein the at least one characteristic of the light which is varied includes an intensity of the light.

42. The method according to any one of claims 37 to 41, wherein the at least one characteristic of the light is varied spatially.

43. A method for use in recording video images, the method comprising:

receiving one or more communications identifying a plurality of open periods of a camera shutter; and

instructing a light source to emit light in accordance with the camera shutter open periods.

44. The method according to claim 43, wherein the light source is instructed to emit light throughout the period when the camera shutter is open.

45. The method according to claim 43 or 44, wherein the one or more communications identifies a camera shutter opening time and a camera shutter opening period.

46. The method according to claim 45, wherein the one or more communications also identifies a frequency of camera shutter opening.

47. The method according to any one of claims 43 to 46, further comprising instructing the light source to emit light during a portion of the period that the camera shutter is closed.

48. A method for ambient light colour compensation, the method comprising:

receiving a coloured light; and

compensating colour characteristics of light to be emitted by a light source in accordance with the received light.

49. The method according to claim 48, wherein the step of compensating for the colour characteristics of the light to be emitted is performed such that the light to be emitted has the same colour characteristics as the received light.

50. The method according to claim 48 or 49, wherein the received light is ambient light falling on a subject to be photographed.

51. The method according to any one of claims 48 to 50, further comprising applying an offset of green and/or magenta to the light to be emitted in order to correct for the colour of light when the colour of light is defined in terms of colour temperature.

52. The method according to any one of claims 48 to 51, further comprising turning off the light source while taking a measurement.

53. A method including two or more of:
the method steps of any one of claims 30 to 36;
the method steps of any one of claims 37 to 42;
the method steps of any one of claims 43 to 47; and
the method steps of any one of claim 48 to 52.

54. A carrier medium carrying computer readable code for configuring a suitable computer as the apparatus of any of claims 1 to 29.

55. A carrier medium carrying computer readable code for controlling a suitable computer to carry out the method of any one of claims 30 to 53.

Application No:	GB1013323.9	**Examiner:**	Richard Nicholls
Claims searched:	1-7,27-29,30-36,53-55	**Date of search:**	30 December 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 and 30 at least	JP2010085952 A (HITACHI) see especially the abstract
X	1 and 30 at least	JP2003207825 A (FUJI) see especially the abstract
X	1 and 30 at least	JP2002244181 A (NIKON) see especially the abstract
X	1 and 30 at least	EP0678701 A1 (PANAVISION) see especially variable filter 50
X	1 and 30 at least	WO93/24786 A1 (PANAVISION) see especially variable filter 50

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F21V; G03B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
None		

Application No: GB1013323.9 **Examiner:** Richard Nicholls

Claims searched: 16-20,27-29,43-47,53-55 **Date of search:** 30 December 2010

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	16 and 43 at least	JP2006349833 A (CANON) see especially the abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G03B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
None		

Application No: GB1013323.9 **Examiner:** Richard Nicholls

Claims searched: 21-26,27-29,48-52,53-55 **Date of search:** 30 December 2010

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	21 and 48 at least	EP2148503 A1 (RIM) see especially figure 6
X	21 and 48 at least	US2003/007800 A1 (FUJI) see especially figure 11
X	21 and 48 at least	GB2292498 A (SAMSUNG) see whole document
X	21 and 48 least	US5815204 A (ASAHI) see especially the abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G03B; H04N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
G03B	0015/05	01/01/2006
G03B	0011/00	01/01/2006
H04N	0005/235	01/01/2006

Application No: GB1013323.9 **Examiner:** Richard Nicholls

Claims searched: 8-15,27-29,37-42,53-55 **Date of search:** 30 December 2010

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Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
		None

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G03B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
G03B	0015/05	01/01/2006
G03B	0011/00	01/01/2006
H04N	0005/235	01/01/2006

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PN - JPH0448588 A 19920218

TI - APPARATUS FOR LIGHTING EFFECT

AB - PURPOSE:To easily make an effect control in a lighting loads with a large capacity based on a step time which is for a short standard period effective by setting lighting time of lighting loads individually and assisting by electric power. CONSTITUTION:A lighting effect apparatus 1 consists of an operational part 2, a controlling part 3, and a light modulating signal output part 4. The operational part 2 can instruct setting, recognition, correction and reproduction of various kinds of data to achieve effect control. A central processing circuit (CPU), a memory, and a timer are contained in the controlling part 3. The operational part 2 saves and takes out data and carries out light modulating calculating by an order by the controlling part 3. The light modulating signal output part 4 sends light modulating data obtained in the controlling part 3 to a light modulating unit 8 through a signal line 7. The light modulating unit 8 lights one or a plurality of lighting loads L1-L4 under control, for each of channels CH1-CH4, based on the received light modulating data, respectively.

CCA - Y02B20/42

FI - F21P5/00&A; F21S2/00&621; F21Y101/00; H05B37/02&F; H05B37/02&N

FT - 3K060/AA06; 3K060/CA01; 3K060/CB08; 3K060/CB09; 3K060/CD08; 3K060/EA01; 3K073/AA14; 3K073/AA42; 3K073/AA47; 3K073/AA57; 3K073/AA62; 3K073/AA66; 3K073/CA01; 3K073/CE06; 3K073/CE10; 3K073/CE12; 3K073/CE13; 3K073/CE14; 3K073/CG15; 3K073/CH23; 3K073/CJ14; 3K073/CJ17; 3K243/GA06; 3K243/GB01; 3K243/JA01; 3K243/JB08; 3K243/JB09; 3K243/JD08; 3K273/PA05; 3K273/QA07; 3K273/QA29; 3K273/RA02; 3K273/RA08; 3K273/RA12; 3K273/RA13; 3K273/TA03; 3K273/TA15; 3K273/TA27; 3K273/TA28; 3K273/TA52; 3K273/TA62; 3K273/UA02; 3K273/UA12; 3K273/UA14; 3K273/UA18; 3K273/UA24

PA - MATSUSHITA ELECTRIC WORKS LTD

IN - YAMAGUCHI YASUSHI; IWATA NOBUO

AP - JP19900156402 19900614

PR - JP19900156402 19900614

DT - I

⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平4−48588

⑤Int.Cl.[5]	識別記号	庁内整理番号
H 05 B 37/02	N	7913−3K
F 21 P 5/00	A	8715−3K
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⑬公開　平成4年(1992)2月18日

審査請求　未請求　請求項の数 1　(全9頁)

⑭発明の名称　照明効果装置

⑳特　願　平2−156402

㉒出　願　平2(1990)6月14日

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明　細　書

1．発明の名称

照明効果装置

2．特許請求の範囲

複数の照明負荷と、

予め定める単位時間の倍数の間隔をあけて、前記各照明負荷を調光制御すべき時刻を設定するための基準時刻設定手段と、

前記各照明負荷毎の基準時刻に関して、点灯する時間を前記各照明負荷毎に個別的に設定する手段と、

前記照明負荷を前記基準時刻に関して、前記時間設定手段によって設定された時間だけ、電力付勢する手段とを含むことを特徴とする照明効果装置。

3．発明の詳細な説明

産業上の利用分野

本発明は、舞台やコンサート等で使用されるいわゆるエフェクト制御の機能を有する照明効果装置に関する。

従来の技術

舞台やコンサート等では、ライトなどの照明負荷の明るさ、および複数の照明負荷の組み合わされた照明状態を激しく変化させるエフェクト制御が使用される。このようなエフェクト制御を実現することができる従来からの照明効果装置51の全体構成を第7図に示す。照明効果装置51には、操作部52、制御部53、調光信号出力部54等が含まれる。操作部52は、エフェクト制御を実現するための各データの設定、確認、修正および再生を指示することができる。さらに、操作部52にはステップ時間設定手段55が接続されており、エフェクト制御を実現するための基準時間であるステップ時間を設定することができる。制御部53は、操作部52からの指示によって、データの保存、取出し、調光演算等を行う。調光信号出力部54は、制御部53からの出力に応答し、調光信号を導出し、信号線57を介して調光ユニット58に与える。調光ユニット58は、与えられた調光信号に応答して、各エフェクトチャネル

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ＣＨ５１～ＣＨ５４毎に接続される１または複数の照明負荷Ｌ１～Ｌ４を電力付勢する。エフエクト制御のためのデータは、各エフエクトチヤネルＣＨ５１～ＣＨ５４毎に、ステツプ時間を基準として設定される。このステツプ時間は、予め定める最小ステツプ時間の倍数で設定される。最小ステツプ時間が、たとえば２５ｍｓｅｃであるとき、これを４回計数することによつて、１００ｍｓｅｃのステツプ時間が設定される。このように、ステツプ時間の設定は、実際には、予め定める基準時間である、最小ステツプ時間の複数倍となるように定められる。

第８図は、照明効果装置５１の操作部５２の一部を示す平面図である。設定されたエフエクト制御を再現するための再生時に操作するエフエクト再生部５２ａには、４組のエフエクト再生操作部が設けられている。各エフエクト再生操作部には、操作用押釦６２ａ～６２ｄ、マスタフエーダ６１ａ～６１ｄおよびステツプ時間調整用ホイル５５ａ～５５ｄがそれぞれ設けられている。操作用押釦６２ａ～６２ｄによつて、そのエフエクト再生操作部における動作モードを設定する。マスタフエーダ６１ａ～６１ｄは、エフエクト制御を実行中の照明負荷の調光レベルを一律に制御する。ステツプ時間調整用ホイル５５ａ～５５ｄは、エフエクト制御を再生中にステツプ時間を調整する。このステツプ時間を短くすると、エフエクト制御の再生は短時間で行われるようになる。エフエクト再生部５２ａには、さらにテンキー６３やＬＥＤ表示器６４が設けられ、エフエクト制御を再生するための割付けなどを行うことができる。この操作パネル５９には、エフエクト制御を設定するためのデータを入力することができるエフエクト入力部５２ｂが設けられている。エフエクト入力部５２ｂには、モードキー６５、テンキー６６、セツトキー６７および表示器６８などが含まれる。

第９図は、第８図の操作パネル５９における操作によつて設定されたエフエクト制御の再生例を示す。第９図（１）はチヤネルＣＨ５１、第９図（２）はチヤネルＣＨ５２、第９図（３）チヤネルＣＨ５３、第９図（４）はチヤネルＣＨ５４の調光レベルをそれぞれ示す。第９図においては、ステツプ時間１００ｍｓｅｃ毎に、チヤネルＣＨ５１から順次的に照明負荷が点灯される。このような照明負荷の点灯状態の変化が種々の順序や時間間隔で行われるので、舞台上などに様々な照明効果を発生させることができる。

第１０図は従来からの装置におけるエフエクト制御を実現するための、制御部５３における動作を説明するためのＰＡＤ図と呼ばれるフローチヤートである。この制御部５３における動作は、２５ｍｓｅｃ毎の割込み動作によつて行われる。エフエクト制御の再生は、エフエクト制御を実行している或る時刻での照明状態であるエフエクトを示す再生エフエクト番号順に行われる。割込み動作が開始されると、ステツプｎ１において、再生エフエクト番号ｉ毎の処理が、エフエクト番号Ｉからたとえば４まで順次的に行われる。各再生エフエクト番号ｉ毎に、ステツプｎ２において、そのエフエクト番号によつて再生が指示されているかどかが判別される。エフエクト再生が行われていないときは、ステツプｎ１に戻り次の再生エフエクト番号についての処理が行われる。エフエクト再生が行われているときは、ステツプｎ３に移り、ステツプ時間を計算するための変数ＳＣｉの値が１だけ増加される。なお、変数ＳＣｉの初期値は零である。次にステツプｎ４に移り、変数ＳＣｉの値が、予め定めるＳＣｉの最大値ＳＣｉｍａｘ以上になつたかどうかが判別される。この結果、１ステツプ時間が完了したと判断されれば、ステツプｎ５に移り、変数ＳＣｉの再初期化と、エフエクト番号ｉの現在再生中のステツプ番号を示す変数ＳＴｉを増加する操作が行われる。なお、変数ＳＴｉの初期値は１である。その後ステツプｎ６において、変数ＳＴｉが予め定めるエフエクト番号ｉの最大のステツプ番号ＳＴｍａｘを越えたかどうかが判別される。越えているときにはステツプｎ７に移り、変数ＳＴｉが１に再初期化される。このようにしてステツプｎ４に関連する動作が終了すると、ステツプｎ８において、チヤネ

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ル番号ｋ１から最大値であるＣＨｍａｘまで変化させて、各チャネル番号ｋ毎に、ステップｎ９において調光レベルが算出される。ステップ時間の調整は、第８図示のステップ時間調整用ホイル５５ａ～５５ｄを操作して、第１０図におけるＳＣｉｍａｘの値を設定することによつて行われる。

発明が解決しようとする課題

従来では、ステップ時間を短くすると照明負荷が点灯する時間も短く制御される。しかし、照明負荷は白熱灯などを使用するので、特にその容量が大きいとき、短い時間では設定された調光レベルに達しないので充分なエフェクト制御の効果が得られないという問題がある。

本発明の目的は、大きな容量の照明負荷に対して、短い基準時間であるステップ時間に基づくエフェクト制御の効果を容易に実現することができる照明効果装置を提供することである。

課題を解決するための手段

本発明は、複数の照明負荷と、

予め定める単位時間の倍数の間隔をあけて、前記各照明負荷を調光制御すべき時刻を設定するための基準時刻設定手段と、

前記各照明負荷毎の基準時刻に関して、点灯する時間を前記各照明負荷毎に個別的に設定する手段と、

前記照明負荷を前記基準時刻に関して、前記時間設定手段によつて設定された時間だけ、電力付勢する手段とを含むことを特徴とする照明効果装置である。

作　用

本発明に従えば、複数の照明負荷は、予め定める単位時間の倍数で基準時刻が設定され、調光制御される。この各照明負荷毎の基準時刻に関して、各照明負荷を点灯する時間は個別的に設定して電力付勢することができる。したがつて、点灯した照明負荷に対して、設定された調光レベルに達するまでの時間を与えるように設定することによつて、予め定める単位時間が短くなつても、大きな容量の照明負荷に対して充分な時間の電力付勢を行うことができる。

実施例

第１図は、本発明の一実施例の全体構成を示すブロック図である。照明効果装置１には、操作部２、制御部３および調光信号出力部４が含まれる。操作部２は、エフェクト制御を実現するための各種データの設定、確認、修正および再生を指示することができる。制御部３には、中央処理回路（ＣＰＵ）、メモリおよびタイマなどが含まれる。操作部３は制御部２からの指示によつて、データの保存、取出し、調光演算等を行う。調光信号出力部４は、制御部３で得られた調光データを信号線７を介して調光ユニット８に送出する。調光ユニット８は、受信した調光データによつて、各チャネルＣＨ１～ＣＨ４毎に、１または複数の照明負荷Ｌ１～Ｌ４をそれぞれ調光制御する。すなわち、調光信号出力部４および調光ユニット８は、電力付勢手段を構成する。

第２図は、本実施例における操作部２の表示パネルの一部を示す平面図である。エフェクト再生部２ａには、４つのエフェクト再生操作部が設けられている。各エフェクト再生操作部には、操作用押釦１２ａ～１２ｄ、マスタフェーダ１１ａ～１１ｄ、ステップ時間調整用ホイル５ａ～５ｄおよびステップ長調整用ホイル６ａ～６ｄがそれぞれ設けられている。エフェクト制御として設定されるデータは、たとえば１００種類を制御部３のメモリにストアすることができる。それらのデータを、テンキー１３を操作して指定し、各操作用押釦１２ａ～１２ｄの右上の矢印キーを押圧することによつて、その操作用押釦が設けられているエフェクト再生操作部に割付けることができる。操作用押釦１２ａ～１２ｄの左上のＳの表示されているキーを押圧することによつて、割付けられたエフェクト制御が、記憶されたデータに基づいて再現される再生が開始される。各操作用押釦１２ａ～１２ｄの左下にＣが表示されている押釦を押圧すると、割付けられたエフェクト制御が１ステップずつ実行される。これによつて、設定されたデータの確認を行うことができる。ＬＥＤ表示器１４は、テンキー１３によつて入力されたデー

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タを表示する。ステップ時間調整用ホイル５ａ～５ｄを操作することによつて、ステップ時間を増減することができる。ステップ長調整用ホイル６ａ～６ｄを操作することによつて、点灯状態にある照明負荷を電力付勢する時間を調整することができる。これらの調整用ホイルは、エンコーダホイルの回転軸を回転駆動することができ、回転方向によつて、時間の増減を行う。

エフエクト入力部２ｂでは、モードキー１５によつてエフエクトデータの設定や修正やその他調光装置としての動作モードの設定を行う。データは、テンキー６６によつて設定し、セットキー６７によつて入力する。すなわち、これらの入力キー６６，６７は、基準時刻設定手段を構成する。入力されたデータなどの表示は表示器６８によつて行われる。

第３図は、エフエクト制御を実現するために設定されるデータの一例を示す。データの設定は、基準時刻であるステップ毎に、照明負荷を駆動するチャネル毎の調光レベルを設定することによつて行う。第３図のように設定されたデータは、第９図示のエフエクト制御を実現することを目的とする。しかし、ステップ時間調整用ホイル５ａ～５ｄを調整して各基準時刻間の間隔であるステップ時間を短くすると、前述のように各照明負荷が電力付勢される時間が不足するようになる。

第４図は、本実施例によるエフエクト制御を再生中の波形図を示す。第４図（１）はチャネルＣＨ１、第４図（２）はチャネルＣＨ２、第４図（３）チャネルＣＨ３、および第４図（４）はチャネルＣＨ４に導出される調光信号をそれぞれ示す。第４図に斜線を施して示す部分は、ステップ長調整ホイルを操作することによつて、各照明負荷を点灯する時間が延長される部分を示す。すなわち、ステップ長調整用ホイルは時間設定手段であつて、このように、各照明負荷が点灯する時間を延長することができる。

第５図は、本実施例における制御部３の動作を説明するためのＰＡＤ図と呼ばれるフローチャートである。操作部３における中央処理回路は、タイマによつて予め定める一定の時間、たとえば２５ｍｓｅｃ毎に割込みを受ける。この割込みがあると、ステップｍ１において再生する照明状態であるエフエクトが、番号１から４まで繰返して読出される。各再生エフエクト番号ｉ毎に、ステップｍ２においてエフエクト再生中であるかどうかが判断される。エフエクト再生中でないときは、ステップｍ１に戻り、次の再生エフエクト番号ｉに移る。ステップｍ２においてエフエクト再生中であるときは、ステップｍ３に移り、チャネル番号ｋが１から最大のチャネル番号ＣＨｍａｘに変化するまでの処理が繰返して行われる。各チャネル番号ｋに対して、ステップｍ４においては、前回読出した調光レベルＬｋｉが一定値、たとえば零を越えているかどうかが判断される。一定のレベルを越えていないときは、ステップｍ５において、通常処理である処理Ａが行われる。処理Ａの内容は第６図に示し、その説明は後述する。ステップｍ４において、先の調光レベルＬｋｉが一定のレベルを越えているときは、対応する照明負荷が点灯されているときであり、ステップｍ６に移る。ステップｍ６においては、ステップ長調整手段６であるステップ長調整用ホイル６ａ～６ｄによつてステップ長の調整値ｗが調整されているかどうかが判断される。ｗの値が零のときはステップｍ７に移り、ステップｍ５と同様処理Ａが行われる。ステップｍ６においてｗが零よりも大きく、ステップ長調整ホイル６ａ～６ｄが操作されたと判断されたときには、ステップｍ８においては、再生エフエクト番号ｉの１ステップ長を計算するためのチャネル毎の変数で、初期値が零であるＳＣｋｉの値が評価され、ステップｍ９に移る。ステップｍ９においては、変数ＳＣｋｉが、再生エフエクト番号ｉの１ステップの長さを計算するときの最大値であるＳＣｉｍａｘと、ステップ長の調整値ｗとの和以上であるかどうかが判断される。この判断の結果、その和よりも大きくなつているときは、ステップｍ１０においてＳＣｋｉと、ＳＴｋｉとをｗが零のときの値に戻す。このようにしてステップｍ４に関連する処理が終わると、ス

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テップｍ１１に移る。ステップｍ１１においては、再生エフェクト番号ｉに割付けられたエフェクト制御を実現するために設定されたデータからチャネル番号ｋ、ステップ番号ＳＴｋｉに相当する調光レベルを取出し、Ｌｋｉとして出力する。このようにしてステップｍ３におけるチャネル番号ｋによる繰返し動作が終了し、ステップｍ１における再生エフェクト番号ｉに関する繰返し動作が終了すると制御部３における割込み処理は終了する。

第５図は第４図に処理Ａとして示される処理の内容を説明するためのＰＡＤ図である。処理Ａが開始すると、ステップｍａ１において、変数ＳＣｋｉの値が増加され、ステップｍａ２に移る。ステップｍａ２においては、変数ＳＣｋｉの値がその最大値と比較され、１ステップ時間が完了したかどうかが判断される。１ステップ時間が完了したときは、ステップｍａ３に移る。ステップｍａ３においては、ＳＣｋｉが零で再初期化され、変数ＳＴｋｉの値が増加される。その後ステップｍａ４において、ＳＴｋｉの値がその最大値を越えているかどうかが判断される。最大値を越えているときは、ステップｍａ５において、ＳＴｋｉを１で再初期化し、ステップ１に戻す。このようにして処理Ａを終了すると、処理Ａはサブルーチンであるので、読出しもとの処理ステップに復帰する。

以上のエフェクト再生においては、チャネル１からチャネル４までの照明負荷の点灯を繰返して行うエフェクト制御の例を示している。エフェクト制御を再生するためのデータを代えることによって、様々なエフェクト制御を実現することができることは勿論である。たとえば、できるだけ不規則となるような順序で、各チャネルの点灯を行うことができるようにエフェクト制御のためのデータを設定することによって、炎が燃えているような効果を演出することができる。また、本実施例におけるように、ステップ時間調整用ホイル５ａ～５ｄおよびステップ長調整用ホイル６ａ～６ｄを用いることによって、実際に調光演出を行いながら、エフェクト制御を実行し、所望の効果を容するように調整することができる。

発明の効果

以上のように本発明によれば、照明負荷が点灯する時間を個別的に設定して電力付勢することができるので、予め定める単位時間が短く設定されたときでも、各照明負荷を充分な時間電力付勢することができる。したがって、変化の早い照明効果を容易に実現することができる。

４、図面の簡単な説明

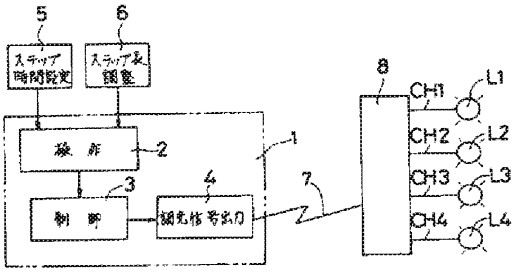
第１図は本発明の一実施例のブロック図、第２図は第１図示の実施例の操作部の一部を示す平面図、第３図は第１図示の実施例において設定されるデータの一例を示す図、第４図は第１図示の実施例によつて導出される調光制御のための信号を示す波形図、第５図は第１図示の実施例の制御部の動作を説明するためのＰＡＤ図、第６図は第５図示の動作中に呼出されるサブルーチンを示すＰＡＤ図、第７図は従来の照明効果装置を示すブロック図、第８図は第７図示の照明効果装置の操作部を示す平面図、第９図は第７図示の照明効果装置から導出される調光制御のための信号を示す波形図、第１０図は第７図示の調光効果装置の動作を説明するためのＰＡＤ図である。

１…照明効果装置、２…操作部、３…制御部、４…出力信号出力部、５…ステップ時間設定手段、５ａ～５ｄ…ステップ時間調整用ホイル、６…ステップ長調整手段、６ａ～６ｄ…ステップ長調整用ホイル、８…調光ユニット、Ｌ１～Ｌ４…照明負荷

代理人　弁理士　西教　圭一郎

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第 1 図



第 3 図

エフェクトデータ1

ステップ / ランプ	1	2	3	4	5
1	100	0	0	0	0
2	0	100	0	0	0
3	0	0	100	0	0
4	0	0	0	100	0

第 2 図

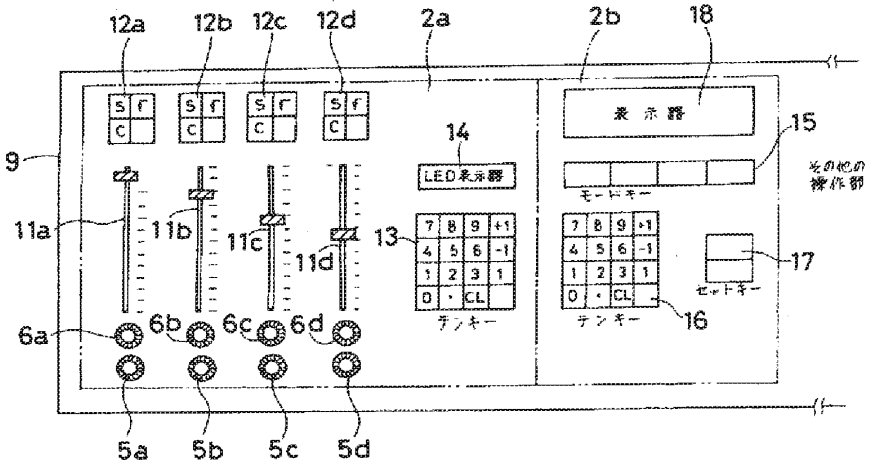
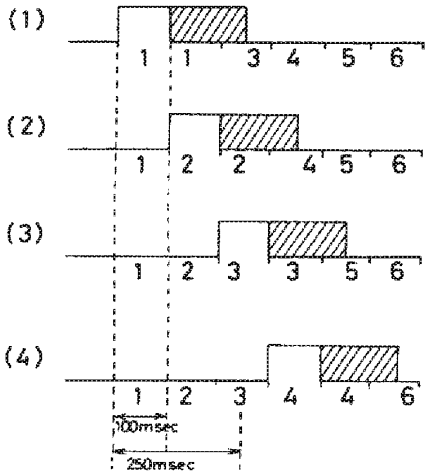
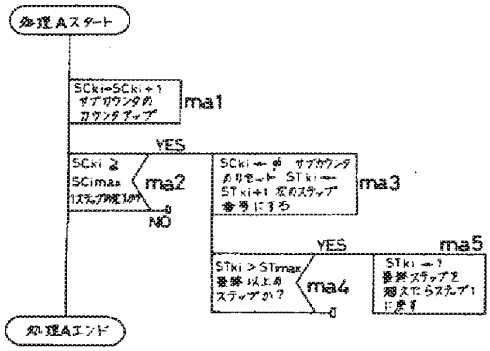


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第 4 図



第 6 図



第 5 図

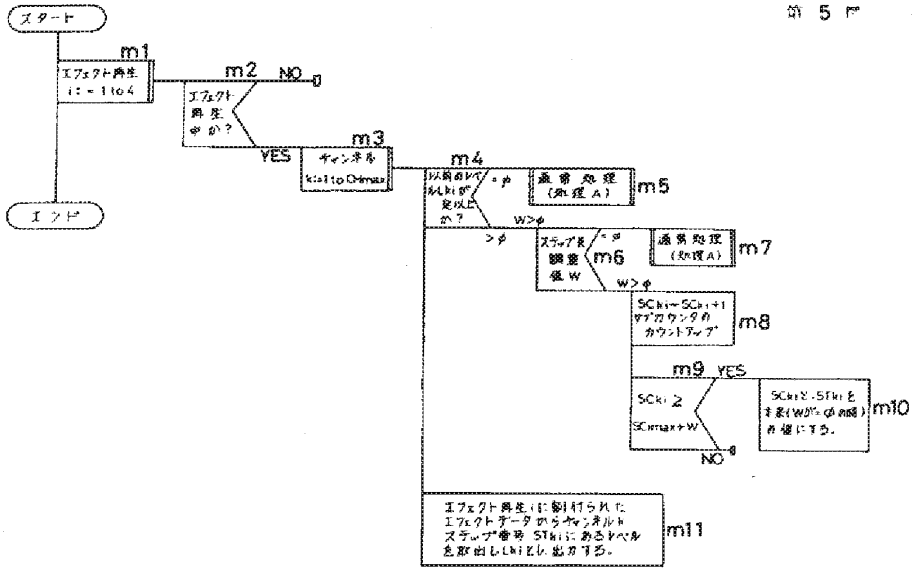
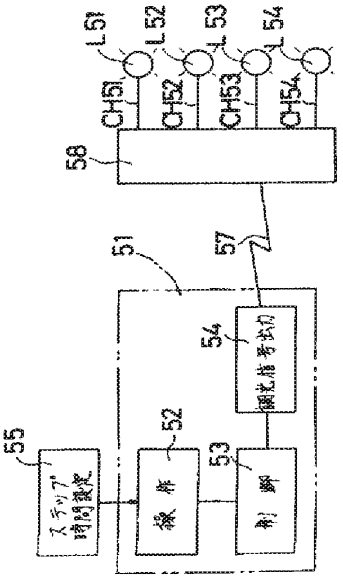
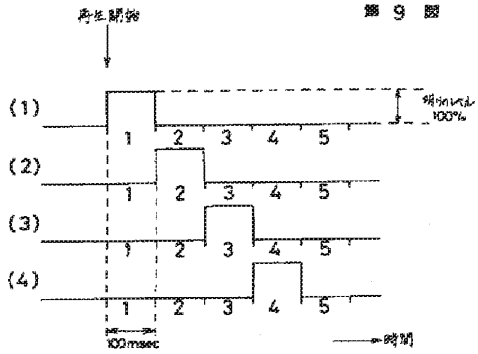


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第7図



第9図



第8図

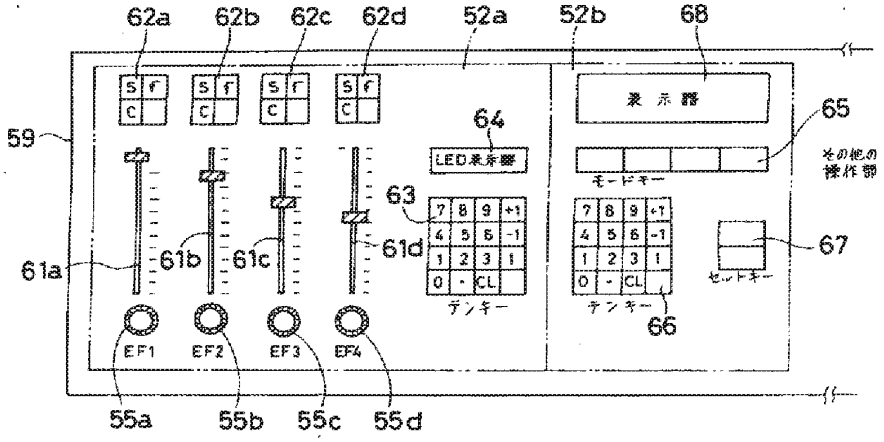


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第 10 図

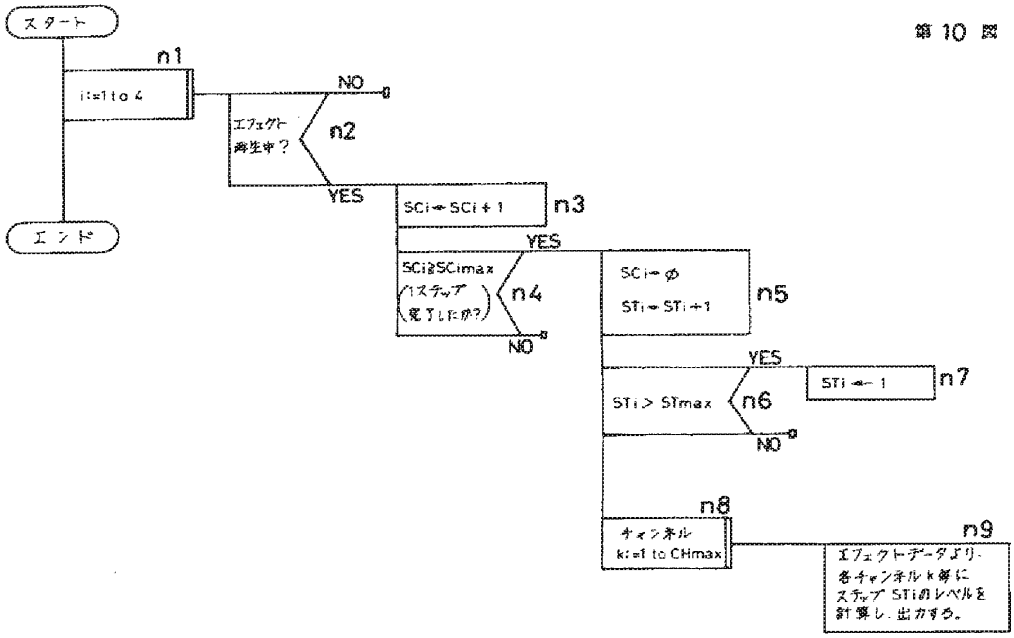


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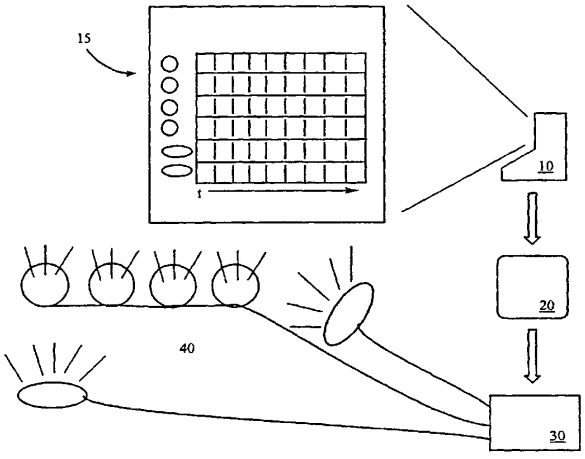
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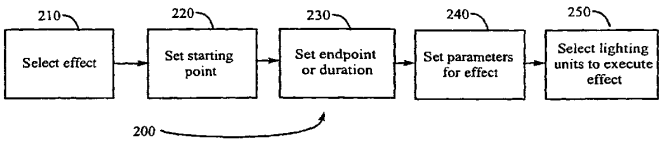
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[Continued on next page]

(54) Title: SYSTEMS AND METHODS FOR AUTHORING LIGHTING SEQUENCES

(57) Abstract: The system and methods described herein relate in part to intuitive methods for creation and design of lighting sequences, e.g., for theatrical, entertainment, or advertising purposes, using a software interface. Additionally, the lighting sequences can be coordinated with control of additional devices. Also described herein is a controller capable of executing programs for lighting sequences and modifying the output and/or execution of the program based on external signals. In this way, the final output can be made responsive to external stimuli, or even interactive.





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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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SYSTEMS AND METHODS FOR AUTHORING LIGHTING SEQUENCES

This application is based on, and claims the benefit of, U.S. Provisional Application No. 60/143,790, filed July 14, 1999.

Field of the Invention

The present invention relates generally to systems and methods for controlling lighting systems, and more particularly to computerized systems and methods for designing lighting sequences and executing such sequences on lighting systems.

Background of the Invention

Most modern-day lighting controllers are designed to control white light (or monochromatic light) in a theatrical or high-end business setting. A light producing monochromatic light, such as white, blue, or red, can be changed primarily along a single dimension – brightness – from off to a maximum brightness. Current controllers permit a user to specify a brightness for each light over time.

This method becomes increasingly more complicated for lights capable of changing the color of emitted light, because the resulting color and intensity is a combination of the intensity of three component primary colors, each of which can be set independent of the others for a particular light. Thus, the output is a function of three dimensions, rather than one, to be specified for each point in time, greatly increasing the effort and time involved in creating an effect. U.S. Patent No. 5,307,295 to Taylor et al. describes a system for creating lighting sequences which simplifies some aspects of creating a lighting sequence, but many of the parameters still need to be specified for each light, much as they would be on a standard lighting console. A more intuitive method for designing lighting sequences would not only simplify and speed up the designing process, but would permit users to design lighting sequences with less training and experience than is often necessary today.

Furthermore, although sequences can be created and played back by traditional methods, the content of the sequences typically progresses with time and is not subject to modification during playback. For example, if a dramatic scene requires a flash of lightning to be simulated at a certain time, this effect is typically achieved either by

meticulously timing the staging to make the programmed flash and the critical moment coincide, or by manually effecting the flash at the critical moment. Such techniques either require considerable reliance on chance or preclude reliance on automation.

A technique that permits an intuitive approach to designing lighting sequences would reduce the time and training required to achieve a desired effect, and would permit colored lights to be operated with a minimal impact on efficiency. Additionally, a method for executing such lighting sequences that promotes flexibility in the reproduction of the sequence will permit increased freedom in an associated performance, or allow use of programmed lighting sequences in situations which are inherently unpredictable.

Summary of the Invention

The systems and methods described herein relate to an intuitive interface for the design of lighting sequences, such as by providing a visual representation of a sequence as it is being designed. Additionally, the systems and methods described herein relate to reproduction of programmed lighting sequences such that the sequence can be modified during playback, e.g., based on external stimuli or cues.

A system for preparing a light sequence according to the principles of the invention may include an authoring interface displaying information representative of a plurality of lighting effects, and a sequence authoring module to permit a user to select a lighting effect, a lighting unit to execute the lighting effect, a start time for the lighting effect, and a stop time for the lighting effect.

A method for preparing a lighting sequence capable of being executed by a processor according to the principles of the invention may include providing a processor interface including information representative of a plurality of lighting effects, receiving information representative of a lighting unit, receiving information representative of a first lighting effect to be executed by the lighting unit, receiving information representative of a start time for the first lighting effect, and receiving information representative of a stop time for the first lighting effect.

In another aspect, a system for controlling a plurality of lighting units according to the principles of the invention may include a data interface for receiving instructions

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for controlling a plurality of lighting units, a signal interface for receiving external signals, a processor for converting said instructions to a data stream and for altering the conversion of said instructions based on the external signals received, and a data output for transmitting the data stream to a plurality of lighting units.

In another aspect, a method for controlling a plurality of lighting units according to the principles of the invention may include receiving instructions for controlling a plurality of lighting units, receiving external signals, converting said instructions to a data stream based on the external signals received, and transmitting the data stream to a plurality of lighting units.

In another aspect, a method for controlling a plurality of lighting units according to the principles of the invention may include receiving instructions including a primary lighting effect and a secondary lighting effect, the secondary lighting effect designated to be executed instead of the primary lighting effect upon a predetermined condition, sending instructions to a lighting unit to execute the primary lighting effect, receiving a signal indicative of the predetermined condition, and sending instructions to the lighting unit to execute the secondary lighting effect.

In another aspect, a method for controlling a plurality of lighting units according to the invention may include receiving instructions for executing a timed sequence of lighting effects, executing the sequence of lighting effects utilizing a plurality of lighting units, receiving an external signal, and altering the execution of the sequence of lighting effects.

Brief Description of the Figures

The following figures depict certain illustrative embodiments of the invention in which like reference numerals refer to like elements. These depicted embodiments are to be understood as illustrative of the invention and not as limiting in any way.

Figure 1 illustrates a system for creating a lighting sequence and executing the lighting sequence on a plurality of lighting units as described herein.

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Figure 2 presents an exemplary method for creating a lighting effect as described herein.

Figure 3 depicts a representative interface for describing an arrangement of lighting units.

Figure 4 represents an alternate interface for graphically reproducing a lighting sequence.

Figure 5 portrays a representative interface for creating a lighting sequence as described herein.

Figure 6 shows one embodiment of a controller for executing a lighting sequence as described herein.

Detailed Description of the Illustrated Embodiments

The description below pertains to several illustrative embodiments of the invention. Although many variations of the invention may be envisioned by one skilled in the art, such variations and improvements are intended to fall within the compass of this disclosure. Thus, the scope of the invention is not to be limited in any way by the disclosure below. The terms "sequence" or "light sequence", as used herein, are intended to refer to sequential displays, as well as non-sequential displays, flow-controlled displays, interrupt driven or event driven displays, or any other controlled, overlapping, or sequential displays with one or more lights.

The systems and methods described herein relate to a system, such as a processor 10 supporting a software application having an interface 15, as depicted in Figure 1, with which a user may create a lighting program 20, which may include one or more lighting sequences, capable of being executed by a lighting controller 30 which controls one or more lighting units 40. The term "sequence" in the context of this disclosure is used to refer to any pattern, show, sequence, arrangement or collection of commands used to operate lighting units or other devices through the system. One of skill in the art would recognize that a sequence would also not need to be an ordered sequence or have a linear design. Sequences comprising non-linear, priority-based, and/or overlapping commands may still comprise a sequence. The software application may be a stand-alone application, such as an executable image of a C++ or Fortran program or other

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executable code and/or libraries, or may be implemented in conjunction with or accessible by a Web browser, e.g., as a Java applet or one or more HTML web pages, etc. Processor 10 may be any system for processing in response to a signal or data and should be understood to encompass microprocessors, microcontrollers, other integrated circuits, computer software, computer hardware, electrical circuits, application-specific integrated circuits, personal computers, chips, and other devices alone or in combination capable of providing processing functions. For example, processor 10 can be any suitable data processing platform, such as a conventional IBM PC workstation operating the Windows operating system, or a SUN workstation operating a version of the Unix operating system, such as Solaris, or any other suitable workstation. Controller 30 may communicate with lighting units 40 by radio frequency (RF), ultrasonic, auditory, infrared (IR), optical, microwave, laser, electromagnetic, or any other transmission or connection method or system. Any suitable protocol may be used for transmission, including pulse-width modulated signals such as DMX, RS-485, RS-232, or any other suitable protocol. Lighting units 40 may be incandescent, LED, fluorescent, halogen, laser, or any other type of light source, e.g., configured so that each lighting unit is associated with a predetermined assigned address either unique to that lighting unit or overlapping the address of other lighting units. In certain embodiments, a single component may be capable both of permitting a user to create a lighting program and controlling the lighting units, and the present invention is intended to encompass this and other variations on the system depicted in Figure 1 which can be used to implement the methods described below. In certain embodiments, the functions of the software application may be provided by a hardware device, such as a chip or card, or any other system capable of providing any of the functions described herein.

According to a method 200 for creating a lighting sequence set forth in Figure 2, a user may select from among a set of predetermined 'stock' effects 210. The stock effects function as discrete elements or building blocks useful for assembling a sequence. Additionally, a user may compose a particular sequence and include that sequence in the stock effects to eliminate the need for creating repeated elements *de novo* each time the effect is desired. For example, the set of stock effects may include a dimming effect and a brightening effect. A user may compose a pulse effect by specifying the alternation of the dimming and brightening effects, and include the pulse effect in the set of stock effects. Thus, each time a pulse effect is thereafter required, the

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stock effect can be utilized without the need for repeatedly selecting dimming and brightening effects to achieve the same goal. In certain embodiments, stock effects may also be created by a user via any programming language, such as Java, C, C++, or any other suitable language. Effects may be added to the set of stock effects by providing the effects as plug-ins, by including the effects in an effects file, or by any other technique suitable for organizing effects in a manner that permits adding, deleting, and altering the set of effects.

Additionally, a user may select an effect and indicate a time at which that effect should begin 220. For example, the user may indicate that a brightening effect should start three minutes after a sequence commences. Additionally, the user may select an ending time or duration for the effect 230. Thus, by indicating that the effect should end five minutes after the sequence commences, or equivalently by indicating that the effect should last for two minutes, a user may set the time parameters of the brightening effect. Additional parameters may be specified by the user, as may be appropriate for the particular effect 240. For example, a brightening or dimming effect may be further defined by an initial brightness and an ending brightness. The rate of change may be predetermined, i.e., the dimming effect may apply a linear rate of dimming over the assigned timespan, or may be alterable by the user, e.g., may permit slow dimming at the beginning followed by a rapid drop-off, or by any other scheme the user specifies. Similarly, a pulse effect, as described above, might instead by characterized by a maximum brightness, a minimum brightness, and a periodicity, or rate of alternation. Additionally, the mode of alternation may be alterable by the user, e.g., the changes in brightness may reflect a sine function or alternating linear changes. In embodiments wherein color-changing lights are employed, parameters such as initial color, final color, rate of change, etc. may be specified by the user. Many additional effects and suitable parameters therefor are known or will be apparent to those of skill in the art, and fall within the scope of this disclosure.

In certain embodiments, a user may specify a transition between two effects which occur in sequence. For example, when a pulse effect is followed by a dimming effect, the pulse effect may alternate less rapidly, grow gradually dimmer, or vary less between maximum and minimum brightness towards the termination of the effect. Techniques for transitioning between these or other may be determined by the user for

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each transition, e.g., by selecting a transition effect from a set of predetermined transition effects, or by setting transition parameters for the beginning and/or end of one or both effects.

In a further embodiment, users may specify multiple lighting effects for the same lighting unit that place effects overlapping in time or in location. These overlapping effects may be used in an additive or subtractive manner such that the multiple effects interact with each other. For example, a user could impose a brightening effect on a pulsing effect the brightening effect imposing the minimum brightness parameter of the pulse to give the effect of pulsing slowly growing to a steady light.

In another embodiment, the overlapping lighting effects could have priorities or cues attached to them which could allow a particular lighting unit to change effect on the receipt of a cue. This cue could be any type of cue, received externally or internally to the system, and includes, but is not limited to, a user-triggered cue such as a manual switch or bump button; a user-defined cue such as a certain keystroke combination or a timing key allowing a user to tap or pace for a certain effect; a cue generated by the system such as an internal clocking mechanism, an internal memory one, or a software based one; a mechanical cue generated from an analog or digital device attached to the system such as a clock, external light sensor, music synchronization device, sound level detection device, or a manual device such as a switch; a cue received over a transmission medium such as an electrical wire or cable, RF signal or IR signal; or a cue received from a lighting unit attached to the system. The priority could allow the system to choose a default priority effect that is the effect used by the lighting unit unless a particular cue is received, at which point the system instructs the use of a different effect. This change of effect could be temporary occurring only while the cue occurs or defined for a specified period, could be permanent not allowing for further receipt of other effects or cues, or could be priority based, waiting for a new cue to return to the original effect or select a new one. Alternatively, the system could select effects based on the state of a cue and the importance of a desired effect. For instance, if a sound sensor sensed sudden noise, it could trigger a high priority alarm lighting effect overriding all the effects otherwise present or awaiting execution. The priority could also be state dependent where a cue selects an alternative effect or is ignored depending on the current state of the system.

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In certain embodiments, the outcome of one effect may be programmed to depend upon a second effect. For example, an effect assigned to one lighting unit may be a random color effect, and an effect assigned to a second lighting unit may be designated to match the color of the random color effect. Alternatively, one lighting unit may be programmed to execute an effect, such as a flashing effect, whenever a second lighting unit meets a certain condition, such as being turned off. Even more complex arrangements, such as an effect which is initiated upon a certain condition of one effect, matches the color of another effect, the rate of a third effect, can be created by this scheme. Other combinations of effects wherein at least one parameter or occurrence of an effect is dependent on a parameter or occurrence of a second effect will be apparent to those of skill in the art and are intended to fall within the scope of this disclosure.

In still other embodiments, the systems and methods described herein permit a lighting sequence to be influenced by external inputs during performance. For example, a lighting sequence or effect may be programmed to start upon receipt of a trigger signal, a sequence or effect may take precedence if a signal is received, a sequence or effect may be designated to repeat or continue until a signal is received, etc. Thus, instead of assigning a discrete start time to an effect or sequence, a user may instead designate that effect or sequence to begin when a certain stimulus is received. Furthermore, during creation, a user may designate two or more effects for overlapping or concurrent time periods and assign the effects different priorities or conditions to determine which effect is executed upon playback. In yet another embodiment, a user may link a parameter for an effect to an external input, including analog, digital and manual inputs, such that the color, speed, or other attribute of an effect may depend on a signal from an external device, measuring, for example, volume, brightness, temperature, pitch, inclination, wave length, or any other appropriate condition. Thus, the selection of a lighting sequence, the selection of an effect, or the selection of a parameter may be determined or influenced by input from an external source, such as a user, chronometer, device, or sensor.

In event-driven embodiments, such as those using external inputs and those using outputs of other effects as inputs, a menu may be provided to define inputs and the consequences thereof. For example, a palette of predetermined inputs may be provided to a user. Each input, such as a specified transducer or the output of another effect, may

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be selected and placed within an authored lighting sequence as a trigger for a new effect, or as a trigger to a variation in an existing effect. Known inputs may include, for example, thermistors, clocks, keyboards, numeric keypads, Musical Instrument Digital Interface ("MIDI") inputs, DMX control signals, TTL or CMOS logical signals, other visual or audio signals, or any other protocol, standard, or other signaling or control technique having a predetermined form whether analog, digital, manual, or any other form. The palette may also include a custom input, represented as, for example, an icon in a palette, or an option in a drop-down menu. The custom input may allow a user to define the voltage, current, duration, and/or form (i.e., sinusoid, pulse, step, modulation) for an input signal that will operate as a control or trigger in a sequence.

For instance, a theatrical lighting sequence may include programmed lighting sequences and special effects in the order in which they occur, but requiring input at specified points before the next sequence or portion thereof is executed. In this way, scene changes may take place not automatically as a function of timing alone, but at the cue of a director, producer, stage hand, or other participant. Similarly, effects which need to be timed with an action on the stage, such as brightening when an actor lights a candle or flips a switch, dramatic flashes of lightning, etc., can be indicated precisely by a director, producer, stage hand, or other participant - even an actor - thereby reducing the difficulty and risk of relying on preprogrammed timing alone.

Input from sensors can also be used to modify lighting sequences. For example, a light sensor may be used to modify the brightness of the lights, for example, to maintain a constant lighting level regardless of the amount of sunlight entering a room, or to make sure a lighting effect is prominent despite the presence of other sources of light. A motion sensor or other detector may be used as a trigger to start or alter a lighting sequence. For example, a user may program a lighting sequence for advertising or display purposes to change when a person approaches a sales counter or display. Temperature sensors may also be used to provide input. For example, the color of light in a freezer may be programmed to be dependent on temperature, e.g., providing blue light to indicate cold temperature, changing gradually to red as the temperature rises, until a critical temperature is reached, whereupon a flashing or other warning effect may begin. Similarly, an alarm system may be used to provide a signal that triggers a lighting sequence or effect for providing a warning, distress signal, or other indication. An

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interactive lighting sequence may be created, e.g., wherein the executed effect varies according to a person's position, movements, or other actions.

In certain embodiments, a user may provide information representative of the number and types of lighting units and the spatial relationships between them. For example, an interface 300 may be provided as depicted in Figure 3, such as a grid or other two-dimensional array, that permits the user to arrange icons or other representative elements to represent the arrangement of the lighting units being used. In one embodiment, depicted in Figure 3, the interface 300 provides to a user a selection of standard types of lighting units 310, e.g., cove lights, lamps, spotlights, etc., such as by providing a selection of types of lighting units in a menu, on a palette, on a toolbar, etc. The user may then select and arrange the lighting units on the interface, e.g., within layout space 320 in an arrangement which approximates the physical arrangement of the actual lighting units.

In certain embodiments, the lighting units may be organized into different groups, e.g., to facilitate manipulation of a large number of lighting units. Lighting units may be organized into groups based on spatial relationships, functional relationships, types of lighting units, or any other scheme desired by the user. Spatial arrangements can be helpful for entering and carrying out lighting effects easily. For example, if a group of lights are arranged in a row and this information is provided to the system, the system can then implement effects such as a rainbow or a sequential flash without need for a user to specify a separate and individual program for each lighting unit. All the above types of implementation or effects could be used on a group of units as well as on single lighting units. The use of groups can also allow a user to enter a single commend or cue to control a predetermined selection of lighting units.

A lighting sequence can be tested or executed on a lighting system to experience the effects created by the user. Additionally, the interface 300 may be capable of reproducing a lighting sequence created by the user, for example, by recreating the programmed effects as though the icons on the interface were the lighting units to be controlled. Thus, if a lighting sequence specified that a certain lighting unit gradually brightens to a medium intensity, upon playback, the icon representing that lighting unit may start black and gradually lighten to gray. Similarly, color changes, flashing, and other effects can be visually represented on the interface. This function may permit a

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user to present a wholly or partially created lighting sequence on a monitor or other video terminal, pause playback, and modify the lighting sequence before resuming playback, to provide a highly interactive method for show creation. In a further embodiment, the system could allow fast-forwarding, reversing, rewinding, or other functions to allow editing of any portion of the lighting sequence. In a still further embodiment, the system could use additional interface features like those known in the art. This can include, but is not limited to, non-linear editing such as that used in the Adobe or such devices or controls as scrolls, drag bars, or other devices and controls.

An alternate interface 400 for reproducing a lighting sequence is presented in Figure 4. Interface 400 includes representations of lighting elements 410 and playback controls 420. Other techniques for visualizing a lighting sequence will be apparent to those of skill in the art and may be employed without departing from the scope and spirit of this disclosure.

An interface capable of representing the lighting sequence may also be used during entry of the lighting sequence. For example, a grid, such as interface 15 of Figure 1, may be employed, wherein available lighting units are represented along one axis and time is represented along a second axis. Thus, when a user specifies that a certain lighting unit gradually brightens to a medium intensity, the portion of the grid defined by that lighting unit, the start time, and the ending time may appear black at one end of the grid portion and gradually lighten to gray at the other end of the grid portion. In this way, the effect can be visually represented to the user on the interface as the lighting sequence is being created. In certain embodiments, effects that are difficult to represent with a static representation, such as flashing, random color changes, etc., can be represented kinetically on the interface, e.g., by flashing or randomly changing the color of the defined grid portion. An example of an interface 500 representing a sequence for an assortment of three lighting units are shown in Figure 5. Time chart 510 visually depicts the output of each of the three lights at each moment in time according to the temporal axis 515. At a glance, the user can readily determine what effect is assigned to any lighting unit at any point in time, simplifying the coordination of effects across multiple lighting units and allowing rapid review of the lighting sequence.

Additionally, Figure 5 depicts a palette 520 which includes the stock effects from which a user may select lighting effects, although other techniques for providing the set

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of stock effects, such as by a menu, toolbar, etc., may be employed in the systems and methods described herein. In palette 520 there are provided icons for stock effects for the lighting of a fixed color effect 552, a cross fade between two color effects 554, a random color effect 558, a color high effect 560, a chasing rainbow effect 565, a strobe effect 564, and a sparkle effect 568. This list is by no means exhaustive and other types of effects could be included as would be obvious to one of skill in the art. To assign an effect to a lighting unit, the user may select an effect from the palette and select a region of the grid corresponding to the appropriate lighting unit or units and the desired time interval for the effect. Additional parameters may be set by any suitable technique, such as by entering numerical values, selecting options from a palette, menu, or toolbar, drawing a vector, or any other technique known in the art, such as the parameter entry field 525. Other interfaces and techniques for entry of lighting sequences suitable for performing some or all of the various functions described herein may be used and are intended to be encompassed by the scope of this disclosure.

The methods described above can be readily adapted for controlling units other than lighting units. For example, in a theatrical setting, fog machines, sound effects, wind machines, curtains, bubble machines, projectors, stage practicals, stage elevators, pyrotechnical devices, backdrops, and any other features capable of being controlled by a computer may be controlled by a sequence as described herein. In this way, multiple events can be automated and timed. For example, the user may program the lights to begin to brighten as the curtain goes up, followed by the sound of a gunshot as the fog rolls over the stage. In a home, for example, a program can be used to turn on lights and sound an alarm at 7:00 and turn on a coffee maker fifteen minutes later. Holiday lighting arrays, e.g., on trees or houses, can be synchronized with the motion of mechanical figurines or musical recordings. An exhibit or amusement ride can coordinate precipitation, wind, sound, and lights in a simulated thunderstorm. A greenhouse, livestock barn, or other setting for growing living entities can synchronize ambient lighting with automated feeding and watering devices. Any combination of electromechanical devices can be timed and/or coordinated by the systems and methods described herein. Such devices may be represented on an interface for creating the sequence as additional lines on a grid, e.g., one line for each separate component being controlled, or by any other suitable means. Effects of these other devices can also be visually represented to the user. For instance, continued use of a smoke machine could

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slowly haze out other grids, a coffee maker could be represented by a small representation of a coffee maker that appears to brew coffee on the interface as the action occurs at the device or the interface can show a bar slowing changing color as feed is dispensed in a livestock barn. Other such static or dynamic effects would be readily apparent to one of skill in the art and are all incorporated within this disclosure.

In certain embodiments, wherein the lighting units are capable of motion, e.g., by sliding, pivoting, rotating, tilting, etc., the user may include instructions for the motion or movement of lighting units. This function may be accomplished by any means. For example, if the lighting unit includes a motor or other system capable of causing movement, the desired movement may be effected by selecting a motion effect from a set of motion effects, as described for lighting effects above. Thus, for example, a lighting unit capable of rotating on its base may be selected, and a rainbow wash effect may be programmed to occur simultaneously with a rotating motion effect. In other embodiments, lighting units may be mounted on movable platforms or supports which can be controlled independently of the lights, e.g., by providing an additional line on a grid interface as described above. Motion effects may also have parameters, such as speed and amount (e.g., an angle, a distance, etc.), that can be specified by the user. Such light/motion combinations may be useful in a wide variety of situations, such as light shows, planetarium presentations, moving spotlights, and any other scenario in which programmable moving lights may be desirable.

Similarly, instructions for controlling objects placed between a lighting unit and an object being illuminated, such as gobos, stencils, filters, lenses, irises and other objects through which light may pass, can be provided by a user according to the systems and methods described herein. In this manner, an even wider array of lighting effects may be designed and preprogrammed for later execution.

One embodiment of the systems and methods described herein is a computer system, such as processor 10 depicted in Figure 1, configured to design or create a lighting sequence according to the systems and methods described herein, e.g., by executing a computer program in a computer language either interpreted or compiled, e.g., Fortran, C, Java, C++, etc. In an additional embodiment, the systems and methods described herein relate to a disk, CD, or other permanent computer-readable storage medium that encodes a computer program capable of performing some or all of the

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functions described above which enable a user to create or design a lighting sequence which can be used to control a plurality of lighting units.

A lighting sequence may be recorded on a storage medium, such as a compact disk, floppy disk, hard drive, magnetic tape, volatile or non-volatile solid state memory device, or any other permanent computer-readable storage medium. The lighting sequence may be stored in a manner that records the effects and their parameters as created by a user, in a manner that converts that format into a format which represents the final data stream, e.g., suitable for directly controlling lighting units or other devices, or in any other format suitable for executing the lighting sequence. In embodiments wherein the sequence is stored as a data stream, the system may permit a user to choose from a selection of data formats such as DMX, RS-485, RS-232, etc. Additionally, lighting sequences may be linked to each other, e.g., such that at the conclusion of one sequence, another sequence is executed, or a master sequence may be created for coordinating the execution of a plurality of subsequences, e.g., based on external signals, conditions, time, randomly, etc. In certain embodiments, a lighting sequence 20 may be executed directly from a processor 10, although in other embodiments, a lighting sequence 20 may be executed using a controller 30 as described below.

A controller 30, as depicted in Figure 6, may be used to execute lighting sequences 20 which have been programmed, designed, or created on a different apparatus. Because the controller 30 may provide a narrower range of functions than the processor used to create the sequence, the controller 30 may contain less hardware and be less expensive than a more complex system which permits authoring, includes a video monitor, or has other auxiliary functionality. The controller 30 may employ any suitable loader interface 610 for receiving a lighting program 20, e.g., an interface for reading a lighting program 20 from a storage medium such as a compact disk, diskette, magnetic tape, smart card, or other device, or an interface for receiving a transmission from another system, such as a serial port, USB port, parallel port, IR receiver, or other connection for receiving a lighting program 20. In certain embodiments, the lighting program 20 may be transmitted over the Internet. The controller 30 may also include an interface for communicating with a plurality of lighting units 40.

A controller 30 may begin execution of a lighting sequence 20 upon loading the lighting sequence 20, upon receiving a command or signal from a user or a device or

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sensor, at a specified time, or upon any other suitable condition. The condition for initiation may be included in the lighting sequence 20, or may be determined by the configuration of the controller 30. Additionally, in certain embodiments, the controller may begin execution of a lighting sequence 20 starting from a point in the middle of the lighting sequence 20. For example, the controller 30 may, upon receiving a request from the user, execute a lighting sequence 20 starting from a point three minutes from the beginning of the sequence, or at any other specified point, e.g., from the fifth effect, etc. The controller 30 may, upon receiving a signal from a user or a device or sensor, pause the playback, and, upon receiving a suitable signal, resume playback from the point of pausing. The controller may continue to execute the lighting sequence 20 until the sequence terminates, until a command or signal is received from a user or a device or sensor, until a specified time, or until any other suitable condition.

A controller 30 may include a memory unit, database, or other suitable module 620 for storing a plurality of predetermined stock effects and instructions for converting those effects into a data format, such as DMX, RS-485, or RS-232, suitable for controlling a plurality of lighting units. The memory module 620 may be preconfigured for a set of stock effects, the memory module 620 may receive effects and instructions from the lighting sequence 20, or the memory module 620 may include a preconfigured set of stock effects which can be supplemented by additional effects stored in lighting sequence 20. Preconfiguring the memory module 620 with a set of stock effects permits a reduction in the memory required to store a lighting sequence 20, because the lighting sequence 20 may omit conversion instructions for effects preconfigured into the controller 30. In embodiments wherein the lighting sequence 20 includes stock effects designed by the author, suitable instructions may be included in lighting sequence 20 and stored in memory module 620, e.g., upon loading or execution of the lighting sequence 20.

The controller 30 may include an external interface 650 whereby the controller 30 can receive external signals useful for modifying the execution of the lighting sequence 20. For example, the external interface 650 may include a user interface, which may in turn include switches, buttons, dials, sliders, a console, a keyboard, or any other device, such as a sensor, whereby a user may provide a command or signal to the controller 30 or otherwise influence the execution or output of the lighting sequence 20.

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The external interface 650 may receive temporal information from one or more chronometers, such as a local time module 660 which functions as a counter for measuring time from a predetermined starting point, such as when the controller 30 is turned on or when the counter is reset, or a date time module 665 which calculates the current date and time. Additionally, the controller 30 may receive commands or signals from one or more external devices or sensors through external input 668. Such devices may be coupled to controller 30 directly, or signals may be received by the controller through an IR sensor or other suitable interface. Signals received by the controller 30 may be compared to or interpreted by a cue table 630, which may contain information relating to the various inputs or conditions designated by the author of the lighting sequence 20 to affect the execution or output of the lighting sequence 20. Thus, if the controller 30 compares an input to the cue table 630 and determines that a condition has been satisfied or a designated signal has been received, the controller 30 may then alter the execution or output of the lighting sequence 20 as indicated by the program.

In certain embodiments, the controller may respond to external signals in ways that are not determined by the contents and instructions of the lighting sequence 20. For example, the external interface 650 may include a dial, slider, or other feature by which a user may alter the rate of progression of the lighting sequence 20, e.g., by changing the speed of the local time counter 660, or by altering the interpretation of this counter by the controller 30. Similarly, the external interface 650 may include a feature by which a user may adjust the brightness, color, or other characteristic of the output. In certain embodiments, a lighting sequence 20 may include instructions to receive a parameter for an effect from a feature or other user interface on the external interface 650, permitting user control over specific effects during playback, rather than over the output or system of lighting units as a whole.

The controller 30 may also include a transient memory 640. The transient memory 640 may store temporary information, such as the current state of each lighting unit under its control, which may be useful as a reference for the execution of the lighting sequence 20. For example, as described above, some effects may use output of another effect to define a parameter; such effects may retrieve the output of the other effect as it is stored in the transient memory 640. Those of skill in the art will recognize

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other situations in which a transient memory 640 may be useful, and such uses are intended to be encompassed by the present disclosure.

The controller 30 may send the data created by the execution of lighting sequence 20 to lighting units by providing the data to a network output 680, optionally through the intermediacy of an output buffer 670. Signals to additional devices may be transmitted through the network out put 680, or through a separate external output 662, as convenient or desirable. The data may be transmitted through data connections such as wires or cables, as IR or RF transmissions, other suitable methods for data transfer, or any combination of methods capable of controlling lighting units and/or other devices.

In certain embodiments, the controller 30 may not communicate directly with the lighting units, but may instead communicate with one or more subcontrollers which, in turn, control the lighting units or another level of subcontrollers, etc. The use of subcontrollers permits distributive allocation of computational requirements. An example of such a system which uses this sort of distributional scheme is disclosed in U.S. Patent No. 5,769,527 to Taylor, described therein as a "master/slave" control system. For the systems and methods described herein, communication between the various levels may be unidirectional, wherein the controller 30 provides instructions or subroutines to be executed by the subcontrollers, or bidirectional, where subcontrollers relay information back to the controller 30, for example, to provide information useful for effects which rely on the output of other effects as described above, for synchronization, or for any other conceivable purpose.

Although the description above illustrates one particular configuration of a controller 30, other configurations for achieving the same or similar functions will be apparent to those of skill in the art, and such variations and modifications are intended to be encompassed by the present invention. The example below more particularly describes an embodiment of a controller 30 such as described above.

The following describes one embodiment of a controller according to the systems and methods described herein, as exemplified in Figure 6, including the design and format of a show representation, management of external inputs and outputs, interpretation and execution of shows, and generation of DMX compliant output. The controller architecture of this embodiment uses a Java-based object-oriented design;

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however, other object-oriented, structured, or other programming languages may be used with the invention.

The controller architecture permits effects to be based on external environmental conditions or other input. An effect is a predetermined output involving one or more lighting units. For example, fixed color, color wash, and rainbow wash are all types of effects. An effect may be further defined by one or more *parameters,* which specify, for example, lights to control, colors to use, speed of the effect, or other aspects of an effect. The *environment* refers to any external information that may be used as an input to modify or control an effect, such as the current time or external inputs such as switches, buttons, or other transducers capable of generating control signals, or events generated by other software or effects. Finally, an effect may contain one or more *states*, so that the effect can retain information over the course of time. A combination of the state, the environment, and the parameters may be used to fully define the output of an effect at any moment in time, and over the passage of time

In addition, the controller may implement effect priorities. For example, different effects may be assigned to the same lights. By utilizing a priority scheme, only the highest priority effect will determine the light output. When multiple effects control a light at the same priority the final output may be an average or other combination of the effect outputs.

A lighting sequence as described above may be deployed as a program fragment. Such fragments may be compiled in an intermediate format, such as by using an available Java compiler to compile the program as byte codes. In such a byte code format, the fragment may be called a sequence. A sequence may be interpreted or executed by the controller 30. The sequence is not a stand-alone program, and adheres to a defined format, such as an instantiation of an object from a class, that the controller 30 may use to generate effects. When downloaded into the controller 30 (via serial port, infrared port, smart card, or some other interface), the controller 30 interprets the sequence, executing portions based on time or input stimuli.

A building block for producing a show is an effect object. The effect object includes instructions for producing one specific effect, such as color wash, cross fade, or fixed color, based on initial *parameters* (such as which lights to control, start color, wash

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period, etc.) and inputs (such as time, environmental conditions, or results from other effect objects). The sequence contains all of the information to generate every effect object for the show. The controller 30 instantiates all of the effect objects one time when the show is started, then periodically sequentially activates each one. Based on the state of the entire system, each effect object can programmatically decide if and how to change the lights it is controlling.

The run-time environment software running on the controller 30 may be referred to as a conductor. The conductor may be responsible for downloading sequences, building and maintaining a list of effect object instances, managing the interface to external inputs and outputs (including DMX), managing the time clock, and periodically invoking each effect object. The conductor also maintains a memory that objects can use to communicate with each other.

The controller 30 may maintain two different, but synchronized, representations of time. The first is LocalTime, which is the number of milliseconds since the controller 30 has been turned on. LocalTime may be represented as a 32-bit integer that will roll over after reaching its maximum value. The other time representation is DateTime, which is a defined structure maintaining the time of day (to seconds resolution) as well as the day, month, and year.

LocalTime may be used by effects for computing relative changes, such as a hue change since last execution in a color wash effect. LocalTime roll-over should not cause effects to fail or malfunction. The conductor may provide utility functions for common operations like time deltas.

An effect object may be an instance of an Effect class. Each effect object may provide two public methods which are subclassed from Effect to produce the desired effect. These are the constructor and the run() methods.

The constructor method may be called by a sequence when an instance of the effect is created. It can have any number and type of parameters necessary to produce the desired effect variations. The authoring software may be responsible for producing the proper constructor parameters when creating the sequence.

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The first argument to the constructor may be an integer identifier (ID). The ID may be assigned by the show authoring software, and may be unique.

The constructor may call super() to perform any conductor-specific initializations.

The effect class may also contain next and prev members, which are used by the sequence and conductor to maintain a linked list of effects. These members may not be accessed internally by the effect methods.

Certain typical effects may be used over and over again. These typical effects may be provided by the conductor, minimizing the storage/download size of sequences. The typical effects may, if desired, be further sub-classed.

A sequence is a convenient means of bundling together all of the information necessary to produce a show. The sequence may have only one required public method, init(), which is called once by the conductor prior to running the show. The init() method may instantiate every effect used by the show, passing the ID and any parameters as constructor arguments. The init() method may then link the effect objects together into a linked list, and return the list to the conductor.

The linked list is maintained through the next and prev members of the effect objects. The prev member of the first object is nil, and the next member of the last object is nil. The first effect is returned as the value of init().

The optional dispose() method will be called when the sequence is deactivated. This method can be used to clean up any resources allocated by the sequence. Automatic processes may be used independently to handle any allocated memory. The base class dispose() will pass through the linked list and free the effect objects, so when dispose() is subclassed, it may be necessary to call super().

The optional public method String getSequenceInfo() can be used to return version and copyright information. It may be desirable to implement some additional getSequence*() routines to return information that may be useful for the controller/user interface.

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A sequence may require additional supporting classes. These may be included, along with the sequence object, in a file such as a JAR (Java ARchive) file. The JAR file may then be downloaded to the conductor. Tools for JAR files are part of the standard Java development tools.

Any DMX communication may be handled by a DMX_Interface class. Each instance of a DMX_Interface controls one DMX universe. The DMX_Interface base class may be sub-classed to communicate over a specific type of hardware interface (serial, parallel, USB).

A *channel* may be a single data byte at a particular location in the DMX universe. A *frame* may be all of the channels in the universe. The number of channels in the universe is specified when the class is instantiated.

Internally, DMX_Interface maintains three buffers, each the length of the number of channels: the last frame of channels that was sent, the next frame of channels waiting to be sent, and the most recent priority of the data for each channel. Effect modules may modify the channel data waiting to be sent via the SetChannel() method, and the conductor may ask for the frame to be sent via SendFrame().

When an effect object sets the data for a particular channel it may also assign that data a priority. If the priority is greater than the priority of the last data set for that channel, then the new data may supercede the old data. If the priority is lesser, then the old value may be retained. If the priorities are equal, then the new data value may be added to a running total and a counter for that channel may be incremented. When the frame is sent, the sum of the data values for each channel may be divided by the channel counter to produce an average value for the highest priority data.

After each frame has been sent, the channel priorities may all be reset to zero. The to-be-sent data may be retained, so if no new data is written for a given channel it will maintain its last value, and also copied to a buffer in case any effect objects are interested.

An exemplary DMX_Interface may implement the following methods:

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A DMX_Interface(int num_channels) method is a constructor that sets up a DMX universe of num_channels (24 .. 512) channels. When subclassed, the method may take additional arguments to specify hardware port information.

A void SetChannel(int channel, int data, int priority) method sets the to-be-sent data (0 .. 255) for the channel if the priority is greater than the current data priority. The method can throw error handling exceptions, such as ChannelOutOfRange and DataOutOfRange exceptions.

A void SetChannels(int first_channel, int num_channels, int data[], int priority) method sets num_channels of to-be-sent data for starting with first_channel from the array data. The method can throw error handling exceptions, such as ChannelOutOfRange, DataOutOfRange, and ArrayIndexOutOfBounds exceptions.

A int GetChannelLast(int channel) method returns the last data sent for the channel. The method can throw error handling exceptions, such as ChannelOutOfRange or NoDataSent exceptions.

A void SendFrame(void) method causes the current frame to be sent. This is accomplished through a separate thread so processing by the conductor will not pause. If a frame is already in progress, it is terminated and the new frame started.

A int FrameInProgress(void), if no frame is currently being sent, returns zero. If a frame is in progress, it returns the number of the last channel sent.

The conductor is the run-time component of the controller that unites the various data and input elements. The conductor may download sequences, manage the user interface, manage the time clock and other external inputs, and sequence through the active effect objects.

The technique for downloading the sequence JAR file into the conductor can vary depending on the hardware and transport mechanism. Various Java tools can be utilized for interpreting the JAR format. In an embodiment, the sequence object and various required classes may be loaded into memory, along with a reference to the sequence object.

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In an embodiment, more than one sequence object may be loaded into the conductor, and only one sequence may be active. The conductor can activate a sequence based on external inputs, such as the user interface or the time of day.

If a sequence is already active, then prior to activating a new sequence, the dispose() method is invoked for the already active sequence.

To activate a sequence, the sequence's init() method is called and run to completion.

Controllers may invoke some method for measuring time. Time values may be accessed via GetLocalTime() and GetDateTime() methods. Other inputs may be enumerated and accessed by a reference integer. The values of all inputs may also be mapped to integers. A GetInput(int ref) method returns the value of input ref, and can throw exceptions, such as a NoSuchInput exception.

The effect list may be created and returned by the sequence's init() method. At fixed intervals the conductor may sequentially call the run() method of each effect object in the list.

The interval may be specific to the particular controller hardware, and may be alterable, e.g., by an external interface. If the effect list execution does not finish in one interval period, the next iteration may be delayed until the following interval time. Effect objects may not need to run every interval to compute changes, but may use a difference between the current time and the previous time.

Effects may be designed to minimize the use of processing power, so the entire effect list can be run quickly. If an effect requires a large amount of computation, it may initiate a low priority thread to do the task. While the thread is running, the run() method may return right away, so the lights will remain unchanged. When the run() method detects that the thread has finished, it may use the results to update the light outputs.

The memory allows different effects to communicate with each other. Like external inputs, memory elements may be integers. Memory elements may be referenced by two pieces of information: the ID of the effect that created the information, and a reference integer which is unique to that effect. The accessor methods are:

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void SetScratch(int effect_id, int ref_num, int value)

int GetScratch(int effect_id, int ref_num)

Both methods can throw error handling exceptions, such as NoSuchEffect and NoSuchReference exceptions.

Effects may run in any order. Effects that use results from other effects may anticipate receiving results from the previous iteration.

Additional routines may include the following.

An int DeltaTime(int last) method computes the change in time between the current time and last.

A DMX_Interface GetUniverse(int num) method returns the DMX_Interface object associated with universe number num. This value should not change while a sequence is running, so it can be cached. The method can throw error handling exceptions, such as NoSuchUniverse exceptions.

An int[] HSBtoRGB(int hue, int sat, int bright) method converts hue (0 - 1535), saturation (0 - 255), and brightness (0 - 255) in to red/green/blue values, which are written to the first three elements of the resulting array. The method can throw error handling exceptions, such as ValueOutOfRange exceptions.

An int LightToDMX(int light) method returns the DMX address of a light with a logical number of light. The method can throw error handling exceptions, such as DMXAddressOutOfRange exceptions.

A void LinkEffects(Effect a, Effect b) method sets a.next = b; b.prev = a.

Each controller may have a configuration file used by the show authoring software. The configuration file may contain mappings between the input reference integers and more useful descriptions of their functions and values, for example, something like: Input 2 = "Slider" range = (0 - 99). The configuration file can also contain other useful information, such as a number of DMX universes.

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The following is an example of code illustrating a lighting sequence authored according to the principles of the invention. It will be understood that the following example is in no way limiting:

Example 1:

```
// An example sequence.
// Runs one strip of 12 cove lights, sequentially numbered starting at address 1
// Input #1 is a binary switch
// The cove runs a continuous color wash
// When the switch is opened, a chaser strobe effect is triggered, which runs a
// white strobe down cove. The effect won't be repeated until the switch is reset.

import java.sequence.*

public class ExampleSequence extends Sequence {
  private int CoveGroup[] = {
    LightToDMX(1), LightToDMX(2), LightToDMX(3), LightToDMX(4),
    LightToDMX(5), LightToDMX(6), LightToDMX(7), LightToDMX(8),
    LightToDMX(9), LightToDMX(10), LightToDMX(11), LightToDMX(12)
  };

  public String getSequenceInfo() {
    return "Example sequence version 1.0";
  }

  public Effect init() {
    super.init();                          // Call base class init

    // Create the effect objects with the appropriate variation params
    washEff = new WashEffect(
      1,                                   // ID
      CoveGroup, 1, 1,                     // Which lights, universe 1, priority 1
      true,                                // Direction = forward
```


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```
            20000);                          // Speed (20 seconds)

        strobeEff = new ChaseStrobeEffect(
            2,                               // ID
            CoveGroup, 1, 2,                 // Which lights, universe 1, priority 2
            1,                               // Trigger input
            true,                            // Direction = forward
            100,                             // Duration of strobe (100 ms)
            400,                             // Time between strobes (400 ms)
            255, 255, 255);                  // Strobe color (white)

        // Link the effects
        LinkEffects(washEff, strobeEff);     // Sets next and prev

        // Return the effect list to the conductor
        return(washEff);
    }

    // Declare all of the effects
    WashEffect washEff;
    ChaseStrobeEffect strobeEff;
}

// WashEffect may be implemented as a stock effect, but we'll implement a simple
// version here for illustration.

public class WashEffect extends Effect {
    private int hue, sat, bright;
    private int last_time;                   // Last time we ran
    private int lights[];
    private DMX_Interface universe;
    private int priority;
    private boolean direction;
```


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```
    private int speed;

    public WashEffect(int id, int lights[], int univ, int prio, boolean dir, int speed) {
      // make copies of variation params and initialize any
      // other variables
      this.lights = lights;
      this.universe = GetUniverse(univ);
      this.priority = prio;
      this.direction = dir;
      this.speed = speed;
      hue = 0;
      sat = 255;
      bright = 255;
      last_time = 0;
      super(id);
    }
```

All articles, patents, and other references set forth above are hereby incorporated by reference. While the invention has been disclosed in connection with the embodiments shown and described in detail, various equivalents, modifications, and improvements will be apparent to one of ordinary skill in the art from the above description. Such equivalents, modifications, and improvements are intended to be encompassed by the following claims.

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CLAIMS

What is claimed is:

1. A system for preparing a light sequence, comprising

an authoring interface displaying information representative of a plurality of lighting effects, and

a sequence authoring module to permit a user to select a lighting effect, a lighting unit to execute the lighting effect, a start time for the lighting effect, and a stop time for the lighting effect.

2. The system of claim 1, further comprising

a lighting set-up module to receive information representative of an arrangement of a plurality of lighting units, and

a set-up interface to visually display the arrangement of the plurality of lighting units.

3. The system of claim 2, wherein, upon initiation of a playback function, the set-up interface displays a selected lighting effect, as defined by a start time and a stop time associated therewith, on a portion thereof defined by a lighting unit associated with the selected lighting effect.

4. The system of claim 2, wherein each lighting unit is associated with a unique address.

5. The system of claim 2, wherein the plurality of lighting units include an LED lighting unit capable of emitting light of any of a range of different colors.

6. The system of claim 1, wherein the authoring interface includes a grid, wherein a plurality of lighting units are represented along one axis and wherein time is represented along a second axis.

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7. The system of claim 5, wherein the authoring interface visually represents the selected lighting effect on a region of the grid defined by a lighting unit, start time, and stop time associated with the selected lighting effect.

8. The system of claim 1, further comprising

a recorder to store user selections on an electronic storage medium.

9. The system of claim 1, wherein the sequence authoring module includes a coloring unit to permit a user to select a color for the selected lighting effect.

10. The system of claim 1, wherein the sequence authoring module includes a coloring unit to permit a user to select a starting color and an ending color for the selected lighting effect.

11. The system of claim 1, wherein the sequence authoring module includes a transitioning unit to permit a user to select a transition effect for a transition between a first lighting effect and a second lighting effect.

12. The system of claim 1, wherein the sequence authoring module includes a prioritizing unit to permit a user to determine a priority for a first lighting effect which shares a temporal overlap with a second lighting effect.

13. The system of claim 1, wherein the sequence authoring module includes an intensity unit to permit a user to determine a brightness for the selected lighting effect.

14. The system of claim 1, wherein the sequence authoring module includes a cue unit to permit the user to provide instructions to start the selected lighting effect upon receiving an external stimulus.

15. The system of claim 1, wherein the sequence authoring module includes a motion unit to permit the user to determine a motion of a lighting unit.

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16. The system of claim 1, further comprising a lighting effect creator to permit a user to design lighting effects using the sequence authoring module and to include the user-designed effects on the authoring interface.

17. A method for preparing a lighting sequence capable of being executed by a processor, comprising

providing a processor interface including information representative of a plurality of lighting effects,

receiving information representative of a lighting unit,

receiving information representative of a first lighting effect to be executed by the lighting unit,

receiving information representative of a start time for the first lighting effect, and

receiving information representative of a stop time for the first lighting effect.

18. The method of claim 17, further comprising

receiving information representative of an arrangement of a plurality of lighting units, and

providing a processor interface representative of the arrangement of the plurality of lighting units.

19. The method of claim 18, further comprising

visually representing the first lighting effect on the portion of the interface representative of an arrangement of a plurality of lighting units as defined by the lighting unit, the start time, and the stop time.

20. The method of claim 17, further comprising

repeating the method for a second lighting unit.

21. The method of claim 17 wherein providing a processor interface includes providing an interface which displays a grid, wherein a plurality of lighting units are represented along one axis and wherein time is represented along a second axis.

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22. The method of claim 20 further comprising

visually representing the first lighting effect on the region of the grid defined by the lighting unit, the start time, and the stop time.

23. The method of claim 23, further comprising

storing the received information on an electronic storage medium.

24. The method of claim 17, further comprising

receiving information representative of a color for the first lighting effect.

25. The method of claim 17, further comprising

receiving information representative of a second lighting effect to be executed by the lighting unit,

receiving information representative of a start time for the second lighting effect, and

receiving information representative of a stop time for the second lighting effect.

26. The method of claim 25, further comprising

receiving information representative of a transition effect between the first lighting effect and the second lighting effect.

27. The method of claim 25, further comprising

receiving information representative of a priority for the second lighting effect.

28. The method of claim 17, further comprising

receiving information representative of a brightness for the first lighting effect.

29. The method of claim 17, wherein receiving information representative of a lighting unit includes receiving information representative of a plurality of lighting units, and receiving information representative of a first lighting effect includes receiving information representative of a first lighting effect to be executed by the plurality of lighting units.

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30. The method of claim 17, wherein receiving information representative of a lighting unit includes receiving information representative of an LED lighting unit capable of emitting light of any of a range of colors.

31. The method of claim 17, wherein receiving information representative of a start time includes receiving instructions to start the first lighting effect upon receiving an external stimulus.

32. The method of claim 17, wherein receiving information representative of a lighting unit includes receiving an address of the lighting unit.

33. The method of claim 17, further comprising

receiving information representative of a first motion of the lighting unit.

34. A system for controlling a plurality of lighting units, comprising

a data interface for receiving instructions for controlling a plurality of lighting units,

a signal interface for receiving external signals,

a processor for converting said instructions to a data stream and for altering the conversion of said instructions based on the external signals received, and

a data output for transmitting the data stream to a plurality of lighting units.

35. The system of claim 34, wherein said signal interface includes a mechanical interface for receiving an input.

36. The system of claim 34, wherein said signal interface includes a port for receiving an electromagnetic signal.

37. The system of claim 34, wherein said data output includes a port for transmitting data to a mechanical device.

38. The system of claim 34, wherein said data output includes a port for transmitting data to a device for reproducing an audio signal.

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39. The system of claim 34, wherein said data output includes a port for transmitting data to a device for reproducing a video image.

40. The system of claim 34, wherein said data interface is a data connection for receiving instructions from another processor.

41. The system of claim 40, wherein said data connection comprises an infrared port, a serial port, a parallel port, an RF port, a wireless port or a USB port.

42. The system of claim 34, wherein said data interface is capable of reading instructions from a storage medium.

43. The system of claim 42, wherein said storage medium is selected from a magnetic disk, magnetic tape, smart card, volatile solid state memory, non-volatile solid state memory and compact disk.

44. The system of claim 34, further comprising

a database to store directions for converting predetermined lighting effects having parameters associated therewith into data suitable for controlling a plurality of lighting units.

45. The system of claim 34, further comprising

a memory module for storing information representative of effects being executed by a plurality of lighting units.

46. The system of claim 34, further comprising

a timing mechanism for measuring intervals of time.

47. The system of claim 34, further comprising

a first timing mechanism for measuring elapsed time, and

a second timing mechanism for determining the date and time of day.

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48. The system of claim 34, wherein the data output includes a color mechanism for setting the color of an LED lighting unit capable of emitting light of any of a range of colors.

49. A method for controlling a plurality of lighting units, comprising
receiving instructions for controlling a plurality of lighting units,
receiving external signals,
converting said instructions to a data stream based on the external signals received, and
transmitting the data stream to a plurality of lighting units.

50. The method of claim 49, wherein receiving external signals includes receiving input from a mechanical interface

51. The method of claim 49, wherein receiving external signals includes receiving an electromagnetic signal.

52. The method of claim 49, wherein transmitting the data stream includes transmitting data to a mechanical device.

53. The method of claim 49, wherein transmitting the data stream includes transmitting data to a device for reproducing an audio signal.

54. The method of claim 49, wherein transmitting the data stream includes transmitting data to a device for reproducing a video image.

55. The method of claim 49, wherein receiving instructions includes receiving instructions from another processor.

56. The method of claim 55, wherein receiving instructions from another processor includes using an infrared port, a serial port, a parallel port, or a USB port.

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57. The method of claim 40, wherein receiving instructions includes reading instructions from a storage medium.

58. The method of claim 58, wherein reading instructions from a storage medium includes reading data from a medium selected from a magnetic disk, magnetic tape, smart card, and compact disk.

59. The method of claim 49, wherein receiving instructions includes receiving a plurality of lighting effects having parameters associated therewith.

60. The method of claim 59, further comprising

utilizing directions for converting predetermined lighting effects to convert said plurality of lighting effects into data suitable for controlling a plurality of lighting units.

61. The method of claim 49, further comprising

storing information representative of effects being executed by a plurality of lighting units in a transient memory.

62. The method of claim 49, wherein receiving external signals includes receiving data from a timing mechanism.

63. The method of claim 49, wherein receiving external signals includes receiving data from a first timing mechanism for measuring elapsed time, and a second timing mechanism for determining the date and time of day.

64. The method of claim 49, wherein receiving external signals includes receiving data from a sensor.

65. The method of claim 49, wherein receiving external signals includes receiving an alarm signal.

66. The method of claim 49, wherein transmitting the data stream setting the color of an LED lighting unit capable of emitting light of any of a range of colors.

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67. The method of claim 49, wherein converting said instructions to a data stream based on the external signals received includes repeating an effect until an external signal is received.

68. The method of claim 49, wherein converting said instructions to a data stream based on the external signals received includes modifying the rate of a lighting sequence.

69. The method of claim 49, wherein converting said instructions to a data stream based on the external signals received includes switching from a high priority effect to a low priority effect.

70. The method of claim 49, wherein converting said instructions to a data stream based on the external signals received includes interrupting a lighting sequence to execute a different effect.

71. A method for controlling a plurality of lighting units, comprising

receiving instructions including a primary lighting effect and a secondary lighting effect, the secondary lighting effect designated to be executed instead of the primary lighting effect upon a predetermined condition,

sending instructions to a lighting unit to execute the primary lighting effect,

receiving a signal indicative of the predetermined condition, and

sending instructions to the lighting unit to execute the secondary lighting effect.

72. A method for controlling a plurality of lighting units, comprising

receiving instructions for executing a timed sequence of lighting effects,

executing the sequence of lighting effects utilizing a plurality of lighting units,

receiving an external signal, and

altering the execution of the sequence of lighting effects.

73. The method of claim 72, wherein altering the execution of the sequence of lighting effects includes altering the rate of the timed sequence.

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74. The method of claim 72, wherein altering the execution of the sequence of lighting effects includes executing a different sequence of lighting effects.

75. The method of claim 72, wherein altering the execution of the sequence of lighting effects includes pausing during the sequence.

76. The method of claim 72, wherein altering the execution of the sequence of lighting effects includes changing the brightness of the light emitted by the plurality of lighting units.

77. The method of claim 72, wherein altering the execution of the sequence of lighting effects includes changing the color of the light emitted by the plurality of lighting units.

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Figure 1

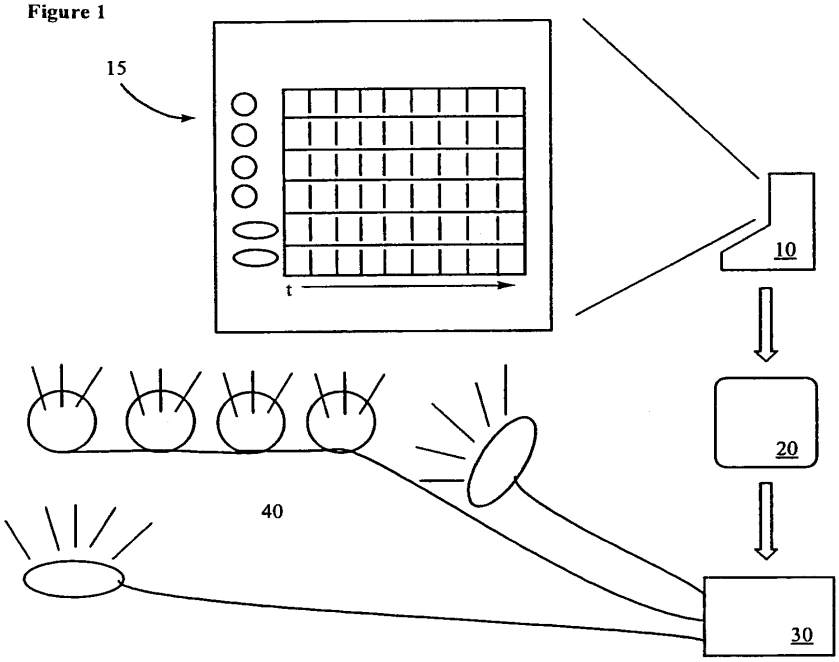
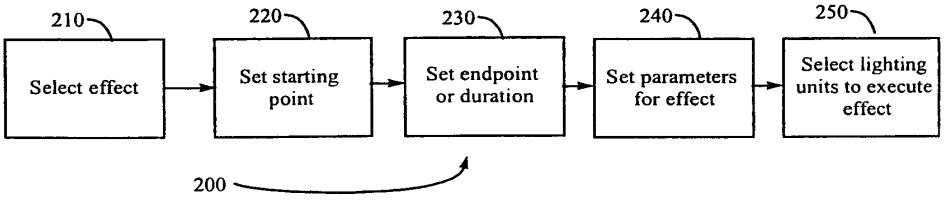


Figure 2



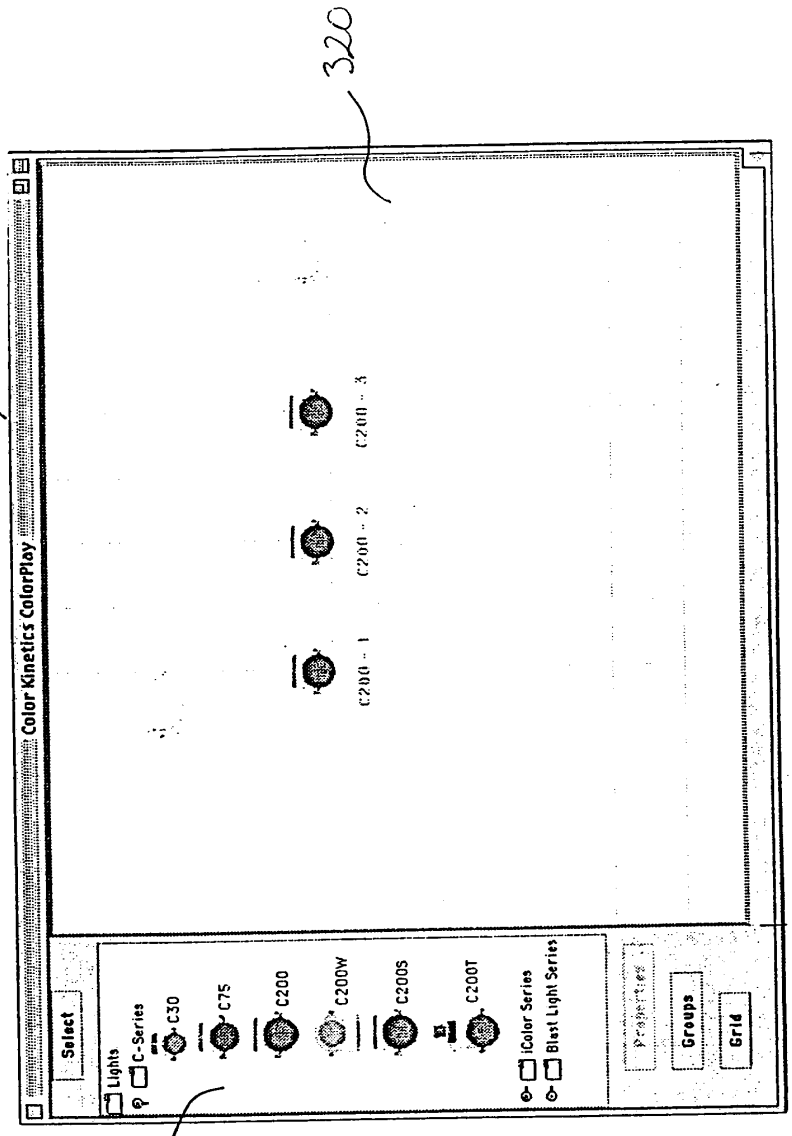

300
320
310
Color Kinetics ColorPlay
Select
Lights
C-Series
C30
C75
C200
C200W
C200S
C200T
iColor Series
Blast Light Series
Groups
Grid
C200 - 1
C200 - 2
C200 - 3

Fig. 3