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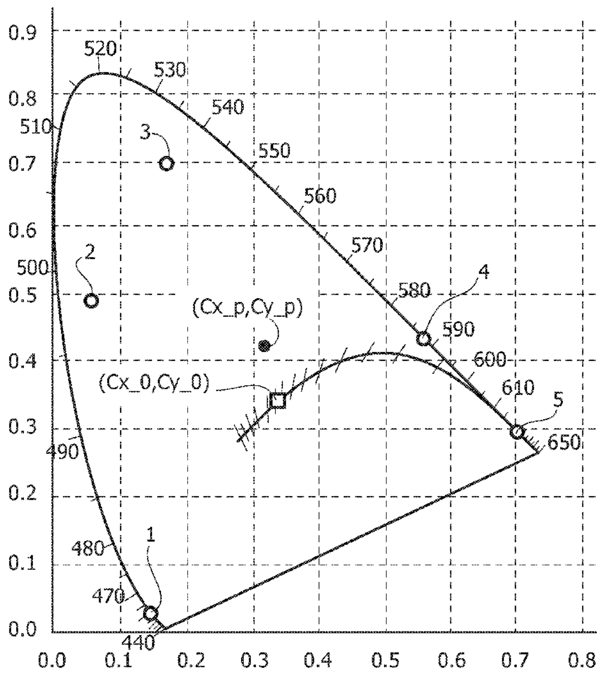
(54) Title: A METHOD OF DRIVING LIGHTING DEVICES, CORRESPONDING LIGHTING DEVICE AND COMPUTER PROGRAM PRODUCT

FIG. 2



(57) Abstract: A lighting device includes a plurality of electrically-powered light radiation sources emitting a respective light radiation flux at a respective point (Cx_k, Cy_k; 1, 2, 3, 4, 5) in the CIE 1931 chromaticity diagram, by producing a combined light radiation at a first point (Cx_p, Cy-p) in the CIE 1931 chromaticity diagram. In one embodiment, the device is driven by modulating the light radiation flux of the light radiation sources, in such a way as to produce a combined light radiation at a second point in the CIE 1931 chromaticity diagram, wherein said second point is closer than said first point (Cx_p, Cy p) to a target point (Cx_0; Cy_0) in the CIE 1931 chromaticity diagram.

WO 2017/178928 A1

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"A method of driving lighting devices, corresponding lighting device and computer program product"

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Technical Field

The present description relates to lighting techniques.

One or more embodiments may be applied to lighting devices employing electrically-powered light radiation sources, e.g. solid-state light radiation sources such as LED sources.

Technological Background

Solid-state light radiation sources may be employed in order to obtain colour points on a wide gamut area, the possibility being given e.g. to obtain tuneable white colour temperatures.

This result may be achieved by using a plurality of sources (e.g. LEDs) having different chromatic features (i.e. as regards emission wavelength). These plural sources may be embedded in one package (e.g. in multichip solutions) or may be implemented as discrete sources, e.g. discrete LEDs.

The colours thus made available may define the gamut of the related chromatic coordinate system, so that each point within the gamut may be obtained by combining lights of different sources, each having a specific flux value.

This approach involves setting the flux fraction, i.e. the contribution of each source to the output radiation, which results from the combination of the radiations of the plural sources. The colour point obtained via the combination of multiple sources (e.g. multiple LED sources) may be described by three chromatic coordinates (X, Y, Z) or, alternatively, two chromatic coordinates and a flux value (Cx, Cy, Flux), e.g. in the CIE 1931 colour space.

Assuming Cx and Cy as known for every source, setting the flux values in such a way as to obtain a certain colour point (Cx_0, Cy_0) and a flux Flux_0 considered as “target” is a mathematical problem described by three equations.

In the case of three different sources (e.g. three LEDs), three equations are therefore available for three flux variables of the sources: the mathematical problem has a unique solution (or no solution, if the target point is outside the gamut defined by the plural sources).

In various applications, more than three different sources may be resorted to, wherein all sources contribute to the definition of the gamut perimeter; in some cases a white colour source may be used, provided it falls within the gamut defined by the “coloured” sources.

In this instance, the mathematical problem has infinite solutions.

The need is therefore felt of finding a solution which best satisfies certain flux and/or colour requirements. Moreover, in various applications (e.g. for stage lighting or the like), a “fast” determination of each target colour is desirable, wherein “fast” refers to a determination adapted to take place at a rate higher than the refresh rate of the colour point of the application.

In the entertainment applications previously referred to by way of example, such a rate may amount to 50 Hz, which makes it desirable to find simple solutions having a less cumbersome determination procedure.

Object and Summary

One or more embodiments aim at meeting the needs described in the foregoing.

According to one or more embodiments, said object may be achieved by a method having the features set forth in the claims that follow.

One or more embodiments may also concern a corresponding lighting device (e.g. a light radiation source or fixture which is coupled, optionally via remote communication, to a control module adapted to implement the presently considered method) as well as a corresponding computer program product which can be loaded into the memory of at least one processing device, comprising software code portions adapted to execute the method steps when the product is run on at least one processing device.

As used herein, the reference to said computer program product includes computer-readable media containing instructions for controlling the processing system, in order to coordinate the implementation of the method according to the invention.

The reference to "at least one processing device" highlights the possibility of implementing one or more embodiments in a modular and/or distributed form.

The claims are an integral part of the technical teaching provided herein with reference to the invention.

One or more embodiments may improve known solutions by offering a method of precisely tuning e.g. the PWM values applied to plural light radiation sources, such as LED sources, in order to obtain a target point, without imposing constraints onto the performances of the lighting device (fixture) as a whole.

One or more embodiments may offer the advantage of originating a method which in all cases (so to say "by definition") is adapted to take the current colour point as close to the target point as possible.

Brief Description of the Figures

One or more embodiments will now be described, by way of non-limiting example only, with reference to the annexed Figures, wherein:

- Figure 1 exemplifies, in a functional block diagram, the structure of a lighting device adapted to include one or more embodiments;

- Figures 2 and 3 are diagrams, based on the CIE 1931 colour space diagram, which exemplify implementations of one or more embodiments, and

- Figure 4 is an exemplary flow chart of the possible operation of embodiments.

Detailed Description

In the following description, various specific details are given to provide a thorough understanding of various exemplary embodiments according to the present specification. The embodiments may be practiced without one or several specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials or operations are not shown or described in detail to avoid obscuring various aspects of the embodiments.

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the possible appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

The headings provided herein are for convenience only, and therefore do not interpret the extent of protection or scope of the embodiments.

In Figure 1, reference 10 generally denotes a lighting device (system) comprising a number of light radiation sources, e.g. LED sources, S1, S2, …, S5.

The reference to five light radiation sources is purely exemplary of a possible application scenario wherein the combined light radiation, resulting from the superposition of the light radiations output by a number of sources S1, S2, … SN (e.g. N being higher than 3) and having different emission features (colour point, flux), must correspond to a target colour point (Cx0, Cy0).

Reference 12 denotes a control system of the light radiation sources S1, S2, … adapted to control the flux output by each source (e.g. LED source).

This may be achieved by operating via a Pulse Width Modulation (PWM) and/or via the modulation of the intensity of the current supplied to sources S1, S2, …. The execution of such a control action (via PWM and/or current) is known in itself in the state of the art, and therefore does not require a detailed description herein.

This is also true for the reference throughout the present specification to the CIE 1931 colour space, and the consequent possibility of identifying, in said space, colour points corresponding both to the radiation output by a single source S1, S2 … and to the combined light radiation resulting from mixing the light radiations output by sources S1, S2, ….

The CIE 1931 (or CIE XYZ) space is one of the colour spaces mathematically defined by the International Commission on Illumination (Commission Internationale de l'Éclairage - CIE in 1931). The CIE space is a widely known scientific tool, which is used in colorimetry and lighting technology, which makes it unnecessary to provide a more detailed description herein.

In the case e.g. of PWM control, the performances of a single source Si (i= 1, …, N) as regards colour coordinates, flux, forward voltage, lifetime etc. may depend mainly from junction temperature Tj, so that the single sources may be modelled (in the following, for simplicity, the exemplary reference will always concern LED sources) by creating predefined PWM tables. Such a PWM table may be obtained via a rather time consuming optimization procedure, adapted to determine the optimum solution (in terms of PWM combinations) for maximizing flux for a given target colour point (Cx_0, Cy_0).

Said procedure may be repeated for each colour point in the gamut defined by the sources (e.g. LED sources) and for various combinations of junction temperature. In order to keep the number of said combinations within acceptable limits, while preserving a good coverage of the operating range, the values of the range of junction temperature Tj may be discretized. This causes a certain approximation of the colour point in the combined output radiation (Cx_p, Cy_p), which may approach, but not coincide with target point (Cx_0, Cy_0): this is due to the fact that a fine tuning of the PWM of sources, leading to the decrease of the discrepancy between (Cx_p, Cy_p) and (Cx_0, Cy_0), is a rather complex mathematical problem.

When a higher accuracy or a shorter computational time is required, some constraints may be imposed on the flux ratio among a number of sources in the combination; this may indeed increase the number of equations, bringing the problem to a unique solution.

The PWM values obtained via this optimization may be loaded into device 10 (e.g. in 12) for example in a

Look Up Table (LUT). In this way, once the user has set a certain target value (Cx_0, Cy_0), system 12 may (e.g. by operating via firmware and hardware):

- detect the working conditions of the sources (e.g. junction temperatures Tj), and
- select the PWM combination closest to (Cx_p, Cy_p), as an approximation of (Cx_0, Cy_0).

Optionally, a sensor 14 may be coupled to the assembly described in the foregoing, which is adapted to detect and monitor colour point (Cx_p, Cy_p).

A generally similar approach may be adopted in the case of a current control, an additional complexity being given by the need of taking into account the variations of the light radiation output by each source as a function of the current (as well as a function of junction temperature Tj).

In one or more embodiments, a system having a structure as exemplified in Figure 1 may be configured (in hardware and/or software and optionally firmware) so as to carry out the procedure exemplified in the following.

The implementation may take place according to criteria known in themselves, which therefore will not be detailed herein. Moreover, as previously stated, the possibility is given to implement one or more embodiments either in a concentrated or in a distributed arrangement.

For example, it is possible to envisage either a driving system 12 associated to a lighting device (fixture) including sources S1, S2, …, or a distributed system, optionally by having the “intelligence” of the system reside at least in part in a decentred position (e.g. in a remote server) from sources S1, S2, ….

One or more embodiment enable a fine tuning of the colour point (Cx_p, Cy_p) of the combined radiation resulting from mixing the light radiations output by the single sources S1, S2, …, so that such colour point (Cx_p, Cy_p) is brought as close to a target point as possible (and virtually coincides with it), without imposing additional limitations by resorting to a purely geometrical approach.

One or more embodiments will be exemplified herein by referring ideally to a PWM control of the single sources S1, S2, …. However, similar criteria may be applied in the case of a current control.

One or more embodiments are described herein by referring to the diagrams of Figures 2 and 3, which depict the CIE 1931 chromaticity diagram.

Specifically, according to the example shown in Figure 1, there are present five light radiation sources S1, …, S5 (by way of example only), which are assumed to emit respective radiations corresponding to points 1, 2, 3, 4, 5 shown as circles in the CIE 1931 diagrams of Figures 2 and 3.

This arrangement generally exemplifies the possible presence, within source 10 of Figure 1, of a given number N of sources S1, …, SN, each being identified with a suffix "_k", with k=1, ... N, e.g. N being higher than 3.

It will be assumed, moreover, that the k-th source emits a light radiation corresponding to the point having coordinates (Cx_k, Cy_k) in the diagram of Figures 2 and 3, and having a flux with an assumed value Flux_k at a PWM duty cycle of 1. Said value, therefore, identifies the flux output by the k-th source when the latter is supplied directly (duty cycle = 100%). Moreover, it will be assumed that the control action of the single source sets the duty cycle of the corresponding PWM to a value PWM_k (ideally ranging from 0% - source constantly off, to 100% - source constantly on).

As previously stated, said criteria may also be applied to the control of the current supplying each single source, e.g. by modulating the intensity of the current flowing through each single source to a value ranging from 0% (source off) to 100% (source constantly on, supplied with the maximum current envisaged for the operation thereof).

In one or more embodiments, it is moreover possible to assume that the presently considered control procedure operates iteratively, the i-th iteration being identified by suffix "_i" applied to the related parameters.

It may therefore be assumed to begin (see e.g. diagram of Figure 2) from a starting colour point (Cx_p, Cy_p) and to proceed towards the target point (Cx_0, Cy_0) via subsequent steps, so that at the i-th iteration a resulting starting light emission may be achieved which corresponds to point (Cx_p_i, Cy_p_i).

In one or more embodiments, the procedure to be implemented by system 12 envisages operating in geometrical form, according to the following steps.

The first step involves determining (step 100, after START in the flowchart of Figure 4) a first straight line line_R – see Figure 3 – passing through the "current" point (Cx_p_i, Cy_p_i) and through the "target" point (Cx_0, Cy_0) – see Figure 2.

Said line line_R may be defined in the plane XYZ of the CIE 1931 diagram as

a_r*Cx+b_r*Cy*+c_r=0

Said definition essentially corresponds to the problem (having a well-known solution) of determining, in a Cartesian plane x, y, the straight line passing through two points.

In a subsequent step 102, a second straight line may be determined which is named line_T, is perpendicular to straight line line_R and passes through target point (Cx_0, Cy_0).

Said operation (corresponding to imposing a condition of perpendicularity between straight lines in a cartesian plane) may be expressed as:

a_t*Cx+b_t*Cy+c_t=0, with m_t = -1*m_r

wherein m_r = -a_r/b_r, m_t = -a_t/b_t.

Then, in a subsequent step 104, LEDs S1, S2, … may be partitioned according to their location on the opposed sides of line line_T, i.e. by separating:

- on one side, the sources (S2, S3 and S4 in the example depicted in Figures 2 and 3) located “above” straight line line_T,

- on the other side, the sources (S1 and S5 in the example shown in Figures 2 and 3) located “below” straight line line_T.

This involves the solution of equations such as:

a_t*Cx_i+b_t*Cy_i+c_t≥0 (for the sources located above straight line line_T) and

a_t*Cx_i+b_t*Cy_i+c_t<0 (for the sources located below straight line line_T).

In a subsequent step 106 it is possible to calculate two colour points adapted to be obtained by mixing the output light radiations respectively emitted by:

- the set of sources (S2, S3 and S4) located above line line_T, and

- the set of sources (S1 and S5) located below line line_T.

This leads to identifying a first and a second colour point (specifically, see the diagram in Figure 3), that is (omitting the iteration indexes for simplicity):

- colour point (Cx_Up, Cy_Up), with relative flux

Flux_Up, resulting from the combination of the radiations output by the LEDs (S2, S3 and S4 in the presently considered example) located above line line_T, and

- colour point (Cx_Dw, Cy_Dw), with relative flux Flux_Dw, resulting from the combination of the radiations output by the LEDs (S1 and S5, in the presently considered example) located below line line_T.

As previously stated, one or more embodiments may assume beginning (see for example the diagram in Figure 2) from a starting colour point (Cx_p, Cy_p) and proceeding towards the "target" point (Cx_0, Cy_0) through subsequent steps, in such a way as to obtain, at the i-th iteration, a resulting starting light radiation corresponding to point (Cx_p_i, Cy_p_i).

It is therefore clear that, at each step, the colour points (Cx_Up, Cy_Up) with relative flux Flux_Up, and the colour points (Cx_Dw, Cy_Dw) with relative flux Flux_Dw, respectively deriving:

- from the combination of the radiations output by LEDs (S2, S3 and S4, in the presently considered example) located above line line_T, and

- from the radiations output by LEDs (S1 and S5, in the presently considered example) located below line line_T

are obtained without altering (yet) the tunings which produce the current point (Cx_p_i, Cy_p_i), i.e the resulting starting light radiation.

As exemplified in Figure 3, both points (Cx_Up, Cy_Up) and (Cx_Dw, Cy_Dw) may be considered as adapted to define, in turn, jointly (step 108), a further (third) straight line, denoted as line_Q, which passes through point (Cx_p_i, Cy_p_i): this is due to the above reasons, i.e. to the fact that point (Cx_Up, Cy_Up) corresponds to the combination of the radiations output by LEDs S2, S3 and S4, while point (Cx_Dw, Cy_Dw) corresponds to the combination of the radiations output by LEDs S1 and S5, with the point (Cx_p_i, Cy_p_i) corresponding to the combination of the radiations output by all LEDs S1, S2, S3, S4 and S5.

Subsequently, in a step 110 it is possible to define the approach for modulating (e.g. by acting on PWM according to criteria known in themselves) the sources respectively located above (S2, S3 and S4) and below (S1, S5) straight line line_T, so as to move the starting colour point (Cx_p_i, Cy_p_i) along straight line line_Q towards a position of a lesser (virtually minimum) distance from target point (Cx_0, Cy_0).

In one or more embodiments, said minimum distance point may be obtained by calculating the intercept of straight line line_Q with a fourth straight line line_H passing through target point (Cx_0, Cy_0), and perpendicular to the same line line_Q.

In other words, the point moves along straight line line_Q and stops when perpendicular line line_H, passing through said point, crosses the target point.

The point obtained in step 110 may be defined as (Cx_H, Cy_H).

In step 110 it is therefore possible to calculate the value of PWM_k (in practice the modulation applied to each source) again, according to the modulation leading to (Cx_H, Cy_H).

In one or more embodiments, the corresponding modulation (i.e., in the case of PWM, essentially the duty cycle thereof) may be defined by resorting (as known in itself, so as not to require a detailed description herein) to currently employed colorimetric equations.

In step 112 it is possible to check about a possible continuation of the described iterative process.

For example, in step 112 a check may be carried out concerning whether the envisaged (predefined) number of equations has been carried out.

If the iterative process must be continued (e.g. due to a negative result of step 112), the procedure returns upstream step 100, using the point (Cx_H, Cy_H) obtained from the previous iteration as a (new) input item, i.e. by repeating steps 100 to 110 using, as said first point of a given iteration, the result of the previous iteration.

It will be appreciated that, in one or more embodiments, each iteration converges towards a solution monotonically, i.e. determines a point (Cx_H, Cy_H) adapted to reduce (and virtually minimize) the distance from the target point (Cx_0, Cy_0).

As a consequence, in one or more embodiments, the check of step 112 may be performed by checking if a (lower) distance threshold from the target point (Cx0, Cy0) has been reached.

One or more embodiments are not constrained by any particular equation referring to flux, efficiency or other limitations / performance optimization criteria.

One or more embodiments may be used in a step for determining PWM (or current modulation) values, e.g. as a second step aiming at obtaining a second-order fine tuning solution in the determination of the value of the (PWM or current) modulation.

In one or more embodiments, a system such as system 10 exemplified in Figure 1 may include a sensor 14, adapted to sense (measure) the colour of the output radiation (Cx_p, Cy_p) and to provide a corresponding value (Cx_p, Cy_p) on a line 140. Said value may therefore be used as an input value for running the previously described procedure.

Without prejudice to the basic principles, the details and the embodiments may vary, even appreciably, with respect to what has been described herein by way of non-limiting example only, without departing from the extent of protection.

The extent of protection is defined by the annexed claims.

CLAIMS

1. A driving method for a lighting device (10) including a plurality of electrically-powered light radiation sources (S1, S2, S3, S4, S5) emitting a respective light radiation flux at a respective point (Cx_k, Cy_k; 1, 2, 3, 4, 5) in the CIE 1931 chromaticity diagram by producing a combined light radiation at a first point (Cx_p_i; Cy_p_i) in the CIE 1931 chromaticity diagram,

wherein the method includes modulating (12) the light radiation flux of said plurality of light radiation sources (S1, S2, S3, S4, S5) to produce a combined light radiation at a second point (Cx_H, Cy_H) in the CIE 1931 chromaticity diagram, wherein said second point (Cx_H; Cy_H) is closer than said first point (Cx_p_i; Cy_p_i) to a target point (Cx_0; Cy_0) in the CIE 1931 chromaticity diagram, wherein the method includes:

- a) calculating (100) a first straight line (line_R) passing through said first point (Cx_p_i, Cy_p_i) and said target point (Cx_0, Cy_0),

- b) calculating (102) a second straight line (line_T) perpendicular to said first straight line (line_R) and passing through said target point (Cx_0, Cy_0),

- c) partitioning (104) said plurality of light radiation sources in a first set (S2, S3, S4) and a second set (S1, S5) lying, in the CIE 1931 chromaticity diagram, on opposite sides with respect to said second straight line (line_T),

- d) calculating (106) a pair of colour points (Cx_Up, Cy_Up; Cx_Dw, Cy_Dw) representative, in the CIE 1931 chromaticity diagram, of the combined radiation of the light radiation sources of said first set (S2, S3, S4) and said second set (S1, S5),

- e) calculating (108) a third straight line (line_Q) passing through the colour points (Cx_Up, Cy_Up; Cx_Dw, Cy_Dw) of said pair,

- f) modulating (110) the respective flux of the light radiation sources of said first set (S2, S3, S4) and said second set (S1, S5) by moving the combined light radiation of said light radiation sources of said first set (S2, S3, S4) and said second set (S1, S5) from the colour points (Cx_Up, Cy_Up; Cx_Dw, Cy_Dw) of said pair towards said target point (Cx_0, Cy_0) along said third straight line (line_Q).

2. The method of claim 1, wherein said modulating (110) the respective flux of the light radiation sources of said first set (S2, S3, S4) and said second set (S1, S5) includes moving the combined light radiation of said first set of light radiation sources (S2, S3, S4) and said second set (S1, S5) of light radiation sources towards an intersection point of said third straight line (line_Q) with a fourth straight line (line_H) passing through said target point (Cx_0, Cy_0) and perpendicular to said third straight line (line_Q).

3. The method of claim 1 or claim 2, including repeating said steps a) to f) in an iterative manner (100 to 110) by using as said first point at a certain iteration the result of said step f) in the previous iteration.

4. The method of any of claims 1 to 3, including detecting (14, 140) the colour of the light radiation emitted by said plurality of light radiation sources (S1, S2, S3, S4, S5) to identify said first point (Cx_p_i, Cy_p_i).

5. The method of any of the preceding claims, wherein said modulating includes modulating with PWM modulation said plurality of light radiation sources

(S1, S2, S3, S4, S5).

6. The method of any of the preceding claims, wherein said modulating includes modulating the intensity of the current fed to said light radiation source (S1, S2, S3, S4, S5).

7. A lighting device (10) including:

- a plurality of electrically-powered light radiation sources (S1, S2, S3, S4, S5) emitting a respective light radiation flux at a respective point in the CIE 1931 chromaticity diagram by producing a combined light radiation at a first point (Cx_p_i; Cy_p_i) in the CIE 1931 chromaticity diagram, and

- a drive module (12) for modulating the light radiation flux of said plurality of light radiation sources (S1, S2, S3, S4, S5) to produce a combined light radiation at a second point (Cx_H, Cy_H) in the CIE 1931 chromaticity diagram, wherein said second point (Cx_H; Cy_H) is closer than said first point (Cx_p_i; Cy_p_i) to a target point (Cx_0; Cy_0) in the CIE 1931 chromaticity diagram, wherein said drive module (12) is configured for implementing the method according to any of claims 1 to 6.

8. A computer program product loadable into the memory of at least one processing device (12) and including software code portions for performing the method according to any of claims 1 to 6, when the product is run on at least one processing device (12).

FIG. 1

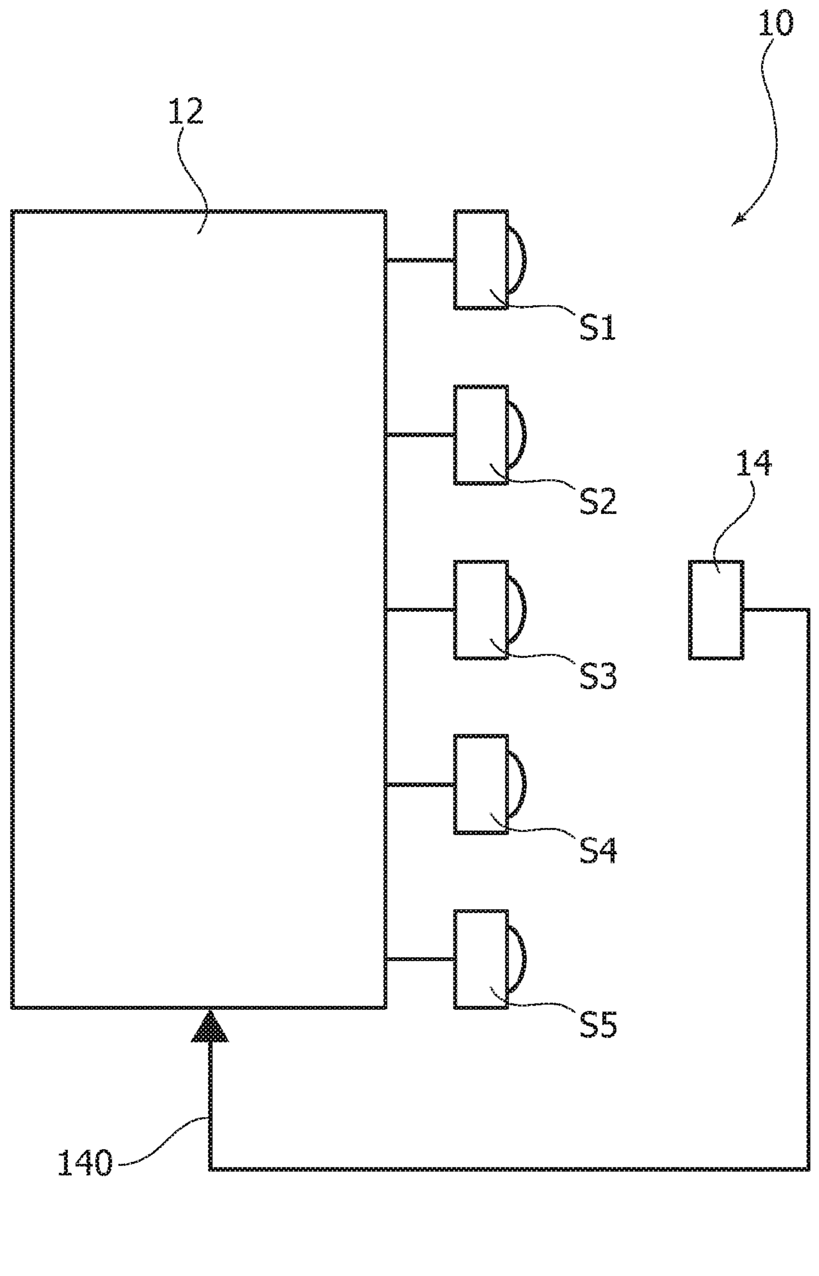

FIG. 2

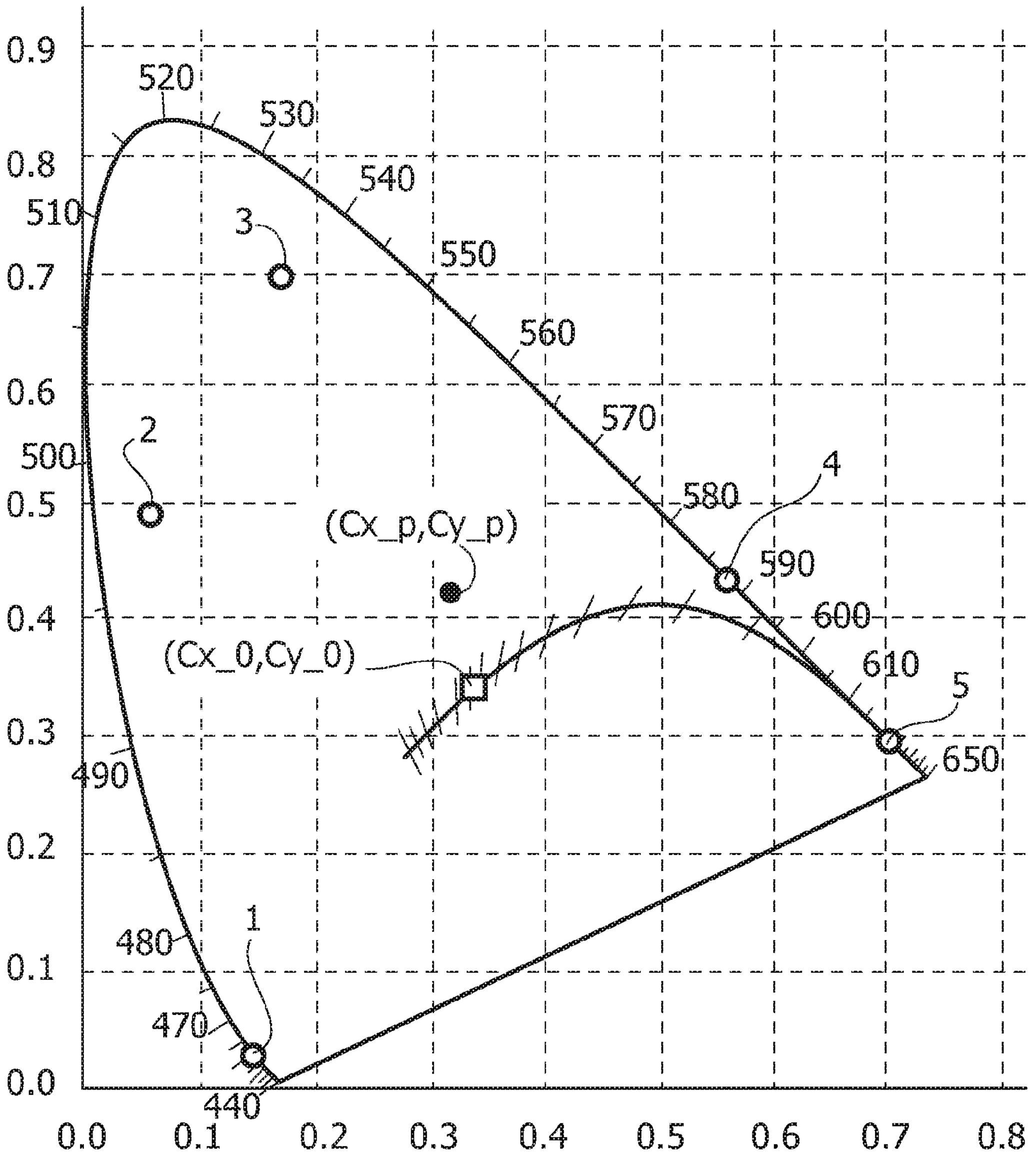
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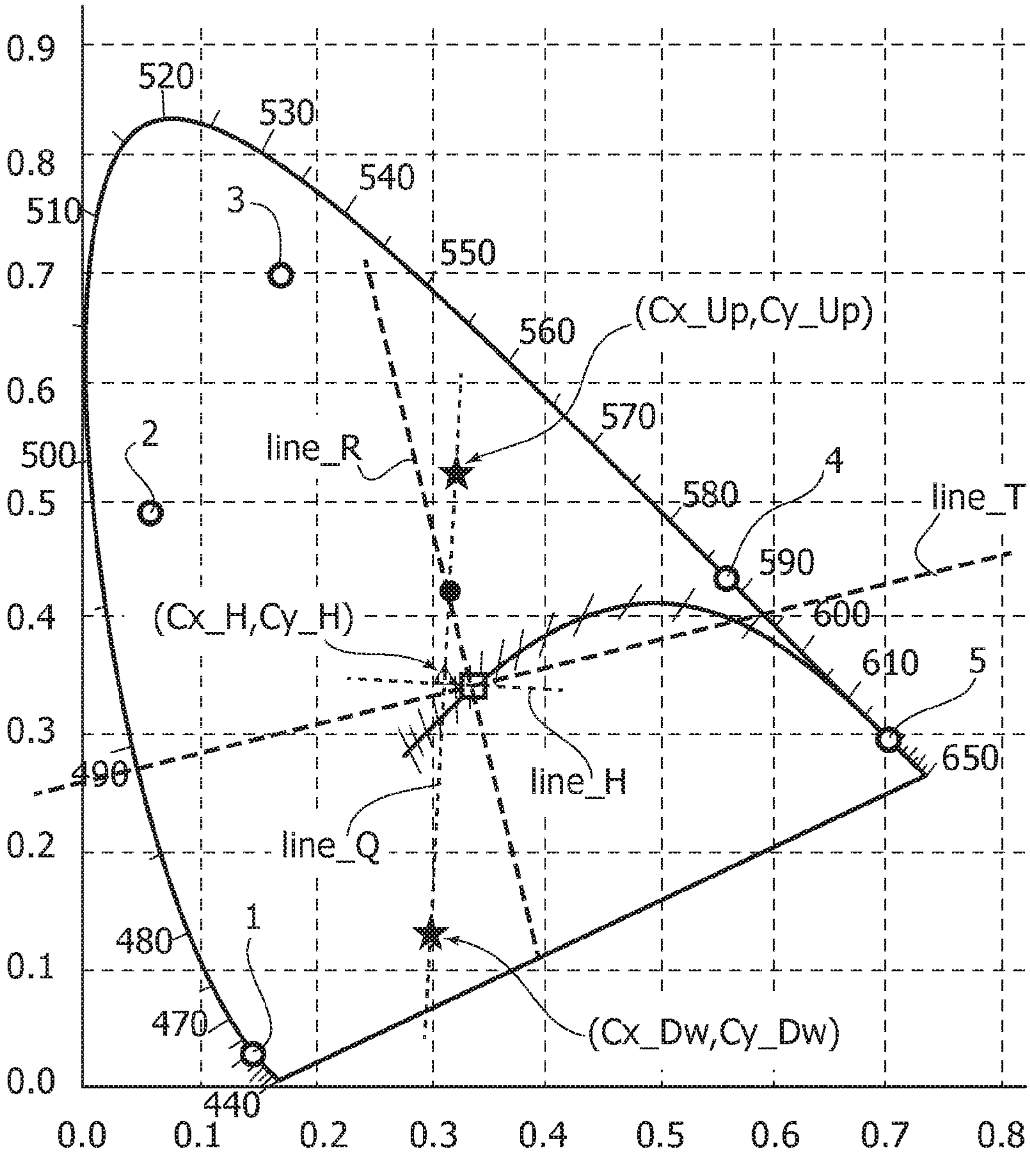
FIG. 3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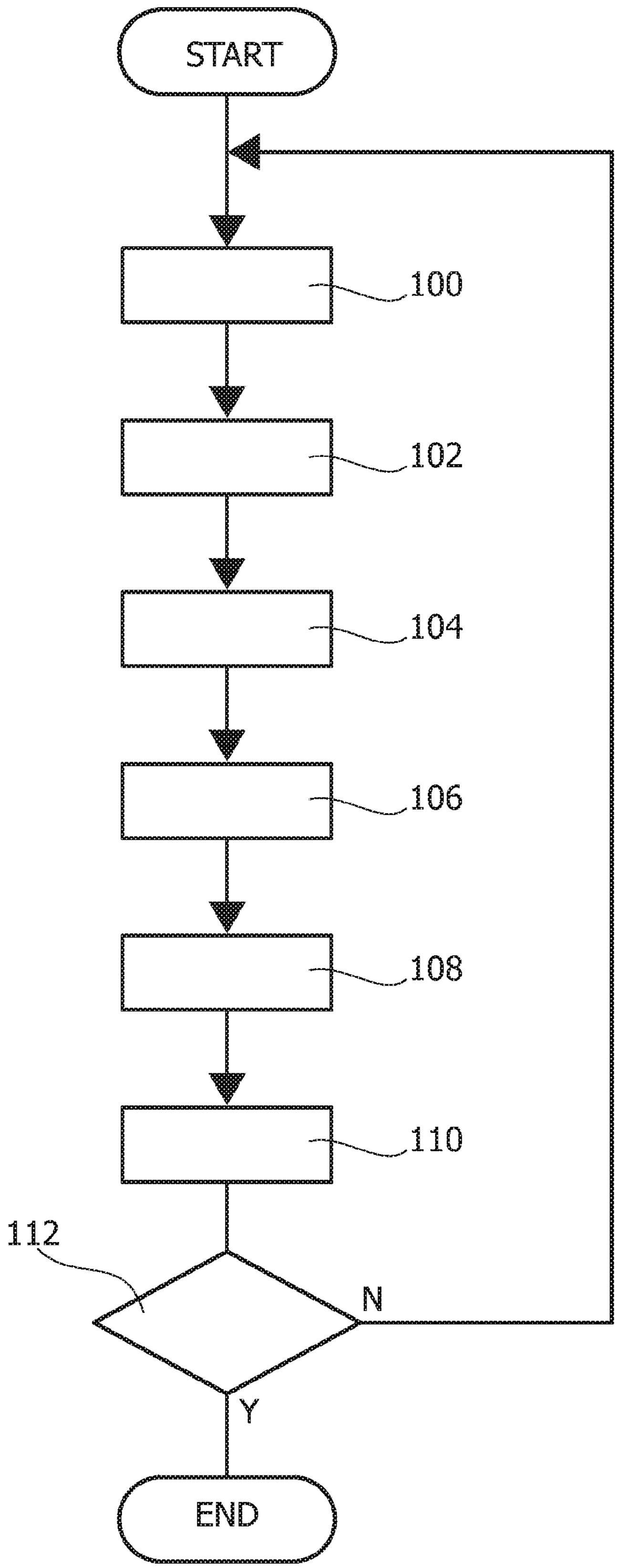
0.1
0.0
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
520
530
540
550
560
570
580
590
600
610
650
510
500
490
480
470
440
1
2
3
4
5
(Cx_Up,Cy_Up)
line_R
line_T
(Cx_H,Cy_H)
line_H
line_Q
(Cx_Dw,Cy_Dw)

FIG. 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051955

A. CLASSIFICATION OF SUBJECT MATTER
INV. 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.
A	WO 2011/036612 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; LENDERINK EGBERT [NL]) 31 March 2011 (2011-03-31) the whole document -----	1-8
A	US 2012/235600 A1 (SIMONIAN DMITRI [US] ET AL) 20 September 2012 (2012-09-20) the whole document -----	1-8

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

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 May 2017	31/05/2017

Name and mailing address of the ISA/	Authorized officer
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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2017/051955

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011036612 A1	31-03-2011	CN 102577604 A	11-07-2012
		EP 2481262 A1	01-08-2012
		JP 2013505552 A	14-02-2013
		KR 20120076359 A	09-07-2012
		TW 201127200 A	01-08-2011
		US 2012169238 A1	05-07-2012
		WO 2011036612 A1	31-03-2011
US 2012235600 A1	20-09-2012	US 2012235600 A1	20-09-2012
		US 2015108920 A1	23-04-2015