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(54) **ORGANIC LIGHT EMITTING DIODE  
DISPLAY DEVICE AND METHOD FOR  
COMPENSATING FOR LUMINANCE  
VARIATIONS THEREOF**

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CPC ..... **G09G 3/3225** (2013.01); **G09G 2320/029**  
(2013.01); **G09G 2320/0233** (2013.01); **G09G**  
**2320/0271** (2013.01); **G09G 2320/0285**  
(2013.01); **G09G 2320/0693** (2013.01)

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G09G 2330/12; G09G 2300/0819; G09G  
2320/0646  
USPC ..... 345/211  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

2011/0285763 A1\* 11/2011 Bassi ..... G06T 5/008  
345/694  
2015/0103062 A1\* 4/2015 Kwon ..... G09G 3/3291  
345/212

\* cited by examiner

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(57) **ABSTRACT**

An organic light emitting diode display device includes: a display panel including a plurality of pixels in a display region, each pixel including a switching thin film transistor, a driving thin film transistor, and a light emitting diode, the display region divided into a plurality of regions; a diode current measuring portion electrically connected to the light emitting diode of each pixel and measuring a current of each divided region; a timing control portion obtaining a gain value of each divided region based on the measured current of each divided region, and generating compensated image data using the gain value; a gate driver supplying gate voltages to the display panel; and a data driver supplying data voltages corresponding to the compensated image data to the display panel.

**6 Claims, 4 Drawing Sheets**

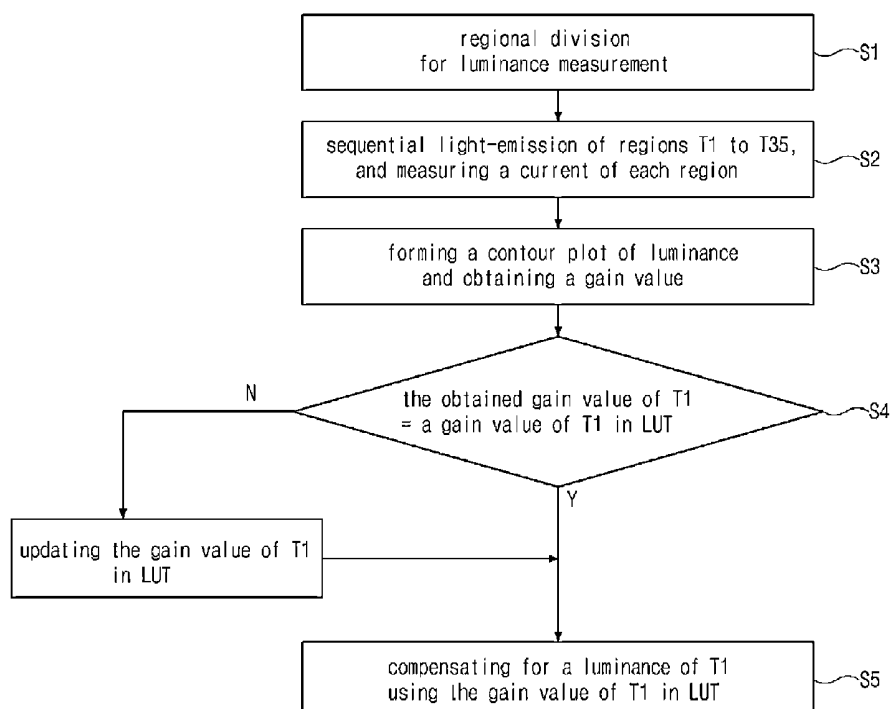


FIG. 1

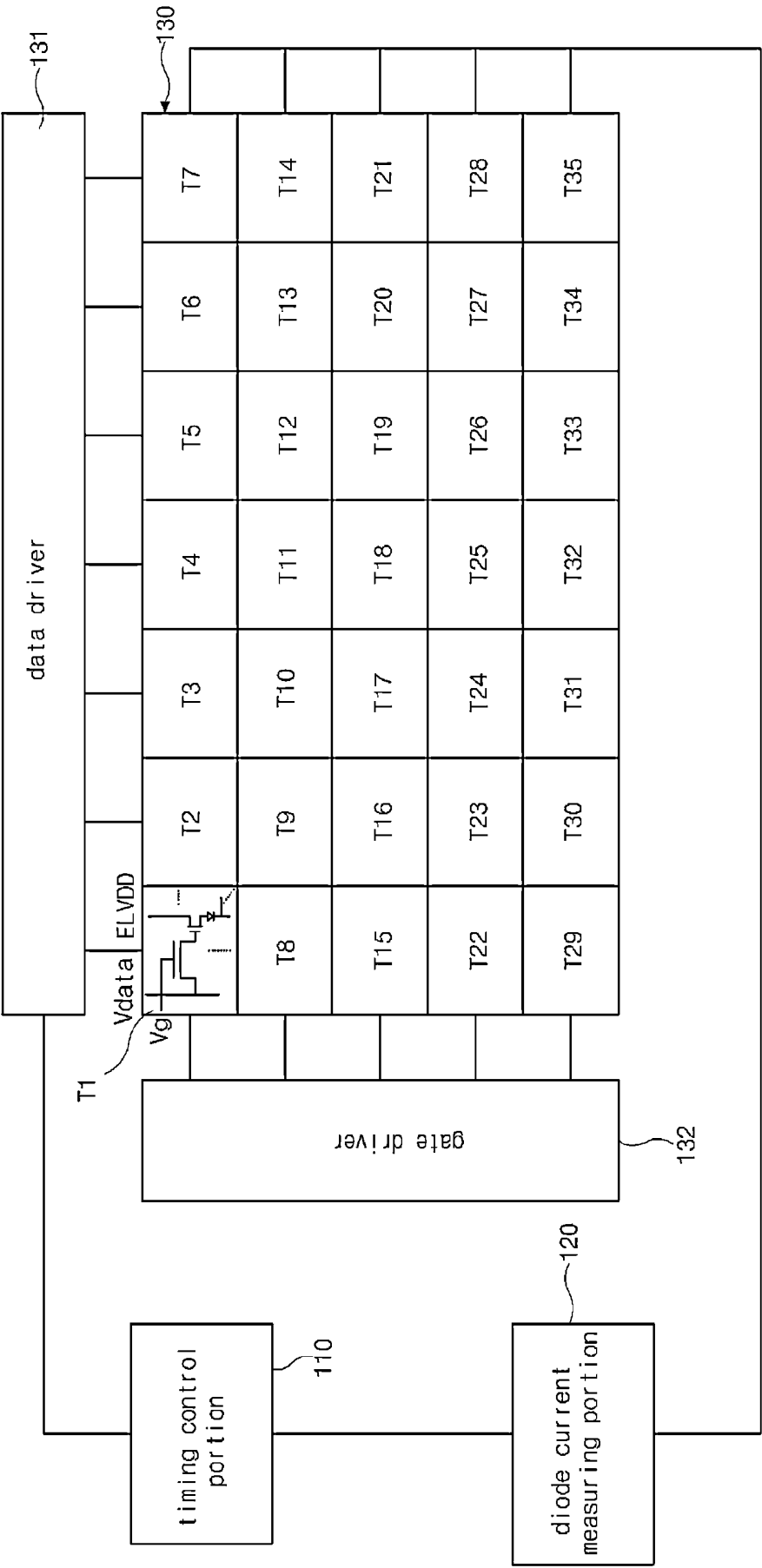


FIG. 2  
RELATED ART

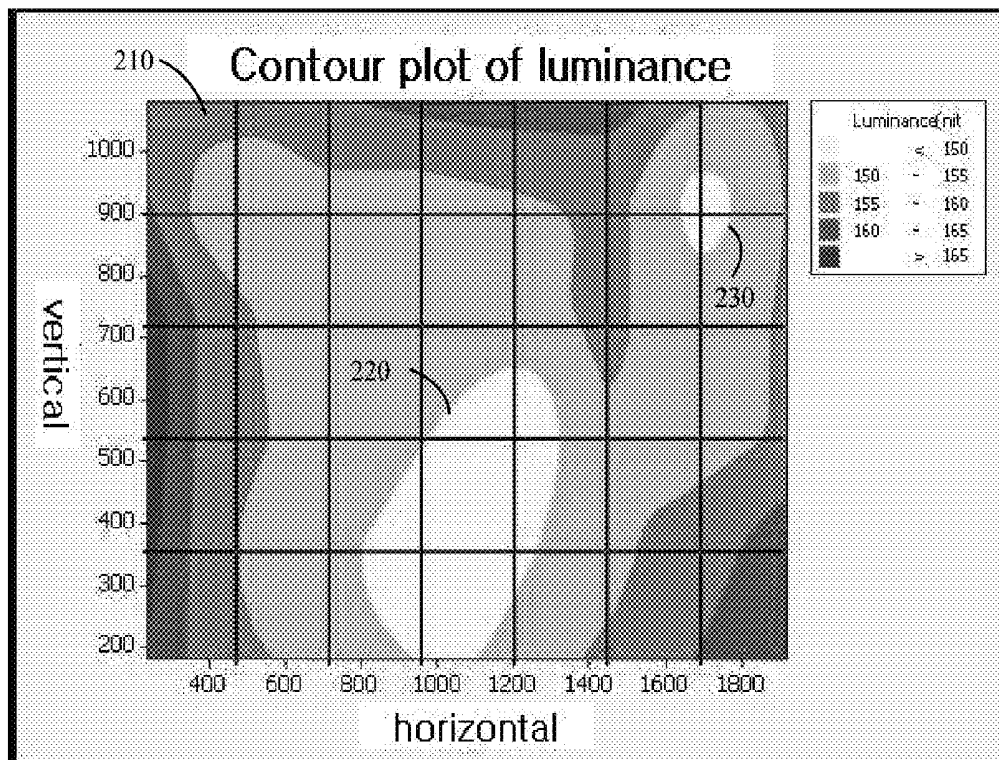


FIG. 3

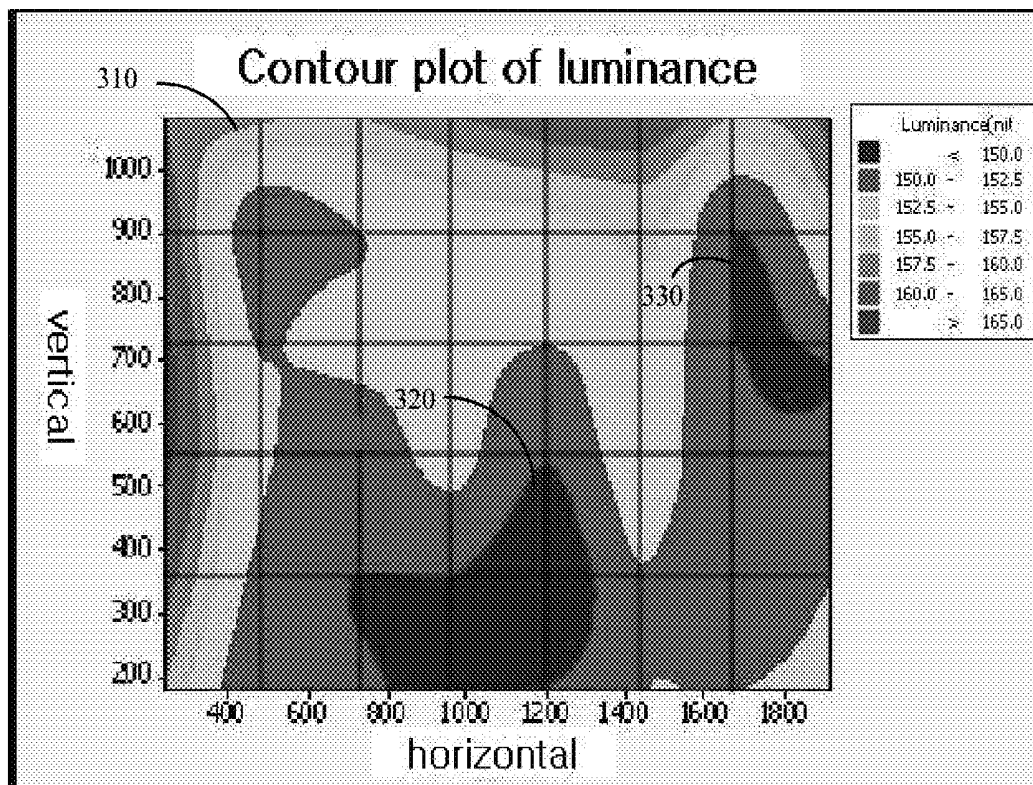
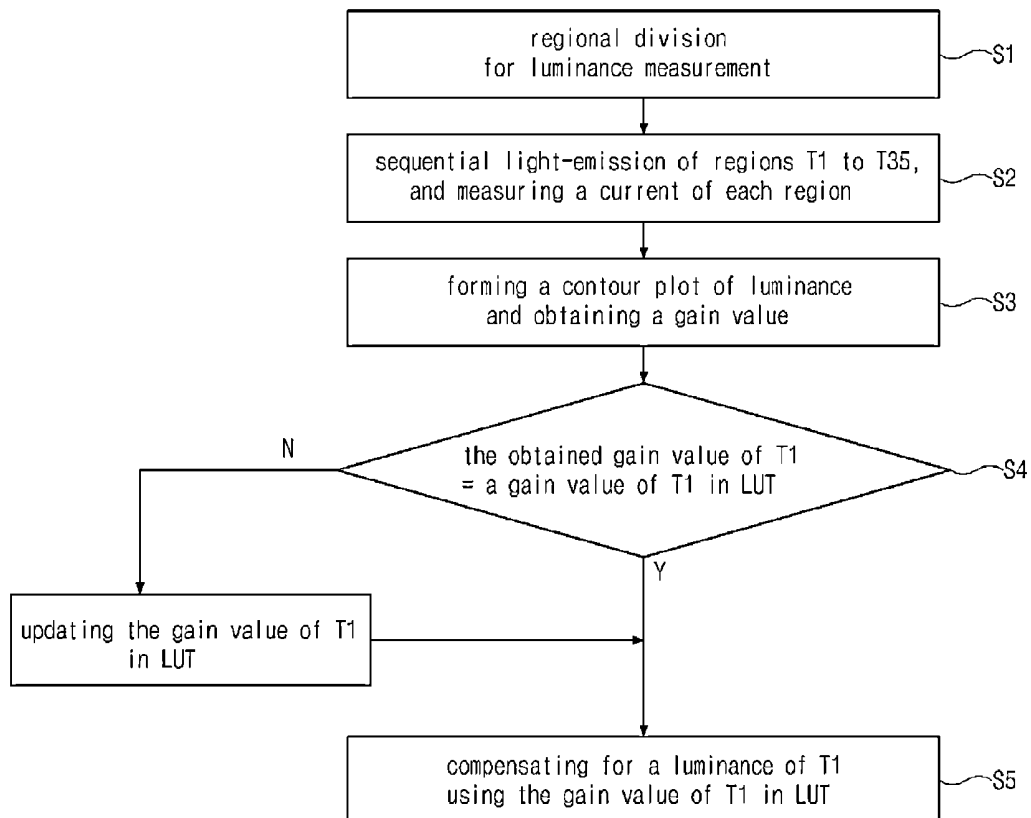


FIG. 4



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# ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE AND METHOD FOR COMPENSATING FOR LUMINANCE VARIATIONS THEREOF

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Korean Patent Application No. 10-2013-0147442, filed on Nov. 29, 2013, which is hereby incorporated by reference for all purposes as if fully set forth herein.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present disclosure relates to an organic light emitting diode display device having a structure to compensate for a luminance variation and a method of compensating for a luminance variation.

### 2. Discussion of the Related Art

An organic light emitting diode (OLED) display device emits light directly from each element formed on a substrate in a different way from a liquid crystal display device, and thus the OLED display device has advantages of high response speed and high contrast ratio.

However, an OLED display panel suffers from low luminance uniformity due to variation of elements, such as thin film transistors and organic emitting layers, forming the OLED display panel.

Accordingly, a step of measuring a luminance property of each region for the same color pattern using a luminance meter and adjusting a luminance to display uniform luminance is required for the OLED display panel. Thus, a manufacturing time may be extended.

To solve this problem, a process to raise uniformity of organic material deposition, a process to reduce sheet resistances among an anode, an organic material and a cathode, and a process to form thin film transistors having stable variation may be improved. However, even though the processes are improved, a light-emission luminance property of the organic material varies over time, and thus OLED display panels have different luminance properties. Thus, the test step for luminance adjustment may be needed.

## SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an organic light emitting diode display device having a structure to compensate for a luminance variation and a method of compensating for a luminance variation that substantially obviates limitations and disadvantages of the related art.

Advantages of the present invention includes providing an organic light emitting diode display device having a structure to compensate for a luminance variation and a method of compensating for a luminance variation that can reduce process time for luminance compensation.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. These and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages in accordance with the purpose of the present invention, as embodied and broadly described herein, an organic light emitting diode display

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device includes: a display panel including a plurality of pixels in a display region, each pixel including a switching thin film transistor, a driving thin film transistor, and a light emitting diode, the display region divided into a plurality of regions; a diode current measuring portion electrically connected to the light emitting diode of each pixel and measuring a current of each divided region; a timing control portion obtaining a gain value of each divided region based on the measured current of each divided region, and generating compensated image data using the gain value; a gate driver supplying gate voltages to the display panel; and a data driver supplying data voltages corresponding to the compensated image data to the display panel.

In another aspect, a method of compensating for a luminance variation of an organic light emitting diode display device, wherein the organic light emitting diode display device includes a display panel including a plurality of pixels in a display region, each pixel including a switching thin film transistor, a driving thin film transistor, and a light emitting diode, the display region divided into first to Nth regions, the method includes: measuring a current of a nth region among the first to Nth regions through a diode current measuring portion; obtaining a gain value based on the measured current of the nth region; and adjusting image data signals using the gain value.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

FIG. 1 is a block diagram illustrating an OLED display device according to an embodiment of the present invention;

FIG. 2 is a contour plot of luminance showing a result through a luminance measuring method using a luminance meter according to the related art;

FIG. 3 is a contour plot of luminance showing a result through a current measuring method according to the embodiment of the present invention; and

FIG. 4 is an algorithm illustrating a method of compensating for a luminance variation of the OLED display device according to the embodiment of the present invention.

## DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Reference will now be made in detail to exemplary embodiments, examples of 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.

FIG. 1 is a block diagram illustrating an OLED display device according to an embodiment of the present invention.

Referring to FIG. 1, the OLED display device includes a timing control portion 110, a diode current measuring portion 120, a data driver 131, a gate driver 132, and an OLED display panel 130.

The OLED display panel 130 is supplied with voltages from the data driver 131 and the gate driver 132, and displays images. The OLED display panel 130 includes a switching thin film transistor, a driving thin film transistor, and a light emitting diode connected to the driving thin film transistor formed on a substrate. The light emitting diode includes an

anode and a cathode. A power line is electrically connected to the driving thin film transistor.

The timing control portion **110** supplies signals to display images to the data driver **131** and the gate driver **132**. The timing control portion **110** is connected to the diode current measuring portion **120** and measures a current applied to each region of the OLED display panel **130**.

Regarding measuring the current applied, the timing control portion **110** may divide a display region of the OLED display panel **130** into a plurality of regions, where each region has a predetermined size. A number of the divided regions may increase or decrease according to an initial setting. As a number of the divided regions increases, more precise luminance compensation is possible.

In the embodiment, for the purpose of explanations, it is assumed that the OLED display panel **130** has a resolution of, for example, but is not limited to, 1920 columns and 1080 rows, and is divided into 7-column regions and 5-row regions in a matrix form i.e., 35 regions **T1** to **T35**.

The diode current measuring portion **120** functions to measure a current of the light emitting diode in the OLED display. To do this, the diode current measuring portion **120** may be connected to the cathode or a source electrode of a driving thin film transistor.

The data driver **131** and the gate driver **132** are operated by the signals from the timing control portion **110**, then the gate driver **132** outputs gate voltages  $V_g$  to gate lines corresponding to areas to be measured, and the data driver **131** outputs data voltages  $V_{data}$  to data lines corresponding to areas to be measured. Further, power voltages  $ELVDD$  are output to power lines connected to the pixel regions.

The timing control portion **110** may have a storing portion to store a value of the measured current.

The above-configured OLED display device can have a luminance, which is obtained based on the current measured by the diode current measuring portion **120**, very similar to a luminance measured actually by a luminance meter. This is explained below with reference to FIGS. **2** and **3**.

FIG. **2** is a contour plot of luminance showing a result through a luminance measuring method using a luminance meter according to the related art, and FIG. **3** is a contour plot of luminance showing a result through a current measuring method according to the embodiment of the present invention.

The contour plots of luminance of FIGS. **2** and **3** are obtained with respect to an OLED display panel having a resolution of 1920\*1080.

The contour plot of luminance of FIG. **3** is made by obtaining a luminance proportional to a measured current. Overall, luminance of FIG. **3** is quite similar to that of FIG. **2**. A luminance measuring unit of FIG. **2** is 5 nit while a luminance unit of FIG. **3** is 2.5 nit.

This shows that the difference between the result of the luminance obtained by the current measuring method of the embodiment and the result of the luminance obtained by the actual luminance measuring method is small. For example, shapes and locations of contours **210**, **220**, and **230** of FIG. **2** obtained by the luminance meter are similar to shapes and locations of contours **310**, **320**, and **330** of FIG. **3** obtained by the current measuring method, respectively.

Since the related art uses the luminance measuring method using an expensive luminance meter, production cost increases and a luminance measuring time is extended.

However, the embodiment uses the current measuring method to obtain the result very similar to the result obtained by the related art. Therefore, the embodiment has advantage

that a luminance measuring time is shortened and production cost is reduced by eschewing using the expensive luminance meter.

The contour plot of luminance of FIG. **3** can be used for luminance compensation of the OLED display panel, which is explained below with reference to FIG. **4**.

FIG. **4** is an algorithm illustrating a method of compensating for a luminance variation of the OLED display device according to the embodiment of the present invention.

Referring to FIG. **4**, the OLED display device performs a luminance compensation through first to fifth steps **S1** to **S5**.

In the first step **S1**, a regional division for luminance measurement is performed. For example, as shown in FIG. **1**, the region division divides the display region of the OLED display panel into 35 regions **T1** to **T35** on 7 columns and 5 rows.

To measure the first region **T1**, the data driver **131** applies data voltages to the first region **T1** and the gate driver **132** applies gate voltages to the first region **T1**.

In this case, the data voltages output from the data driver **131** may have a maximum grey level.

For the diode current measuring portion **120** to measure a current of a  $n$ th region  $T_n$ , the diode current measuring portion **120** is connected to the cathode of each pixel of the  $n$ th region  $T_n$ . Alternatively, the diode current measuring portion **120** may be connected to the cathode of each pixel of the  $n$ th region  $T_n$  via a separate circuit installed in the OLED display panel **130**.

In the second step **S2**, the first to thirty-fifth regions **T1** to **T35** sequentially emit light, and a current of each region is measured by the diode current measuring portion **120**.

For example, the data driver **131** and the gate driver **132** apply voltages to the first region **T1** to emit light from the first region **T1**, and then a current of the first region **T1** is measured by the diode current measuring portion **120**.

Likewise, other regions **T2** to **T35** are then sequentially operated to emit light, and each current of a corresponding region is measured by the diode current measuring portion **120**.

The measured currents of the regions **T1** to **T35** may be stored in the storing portion of the OLED display device.

In the third step **S3**, a contour plot of luminance is formed based on the measured currents, and then a gain value for each region is obtained based on the contour plot of luminance.

The contour plot of luminance is obtained based on the currents measured by the diode current measuring portion **120** electrically connected to the cathodes of the first to thirty-fifth regions **T1** to **T35**, and the measured currents of the first to thirty-fifth regions **T1** to **T35** may be converted into the gain values, respectively.

The method of converting the current value of the first region **T1** into the gain value of the first region **T1** is explained as follows:

(1) a maximum value is obtained from amongst the current values of the first to thirty-fifth regions **T1** to **T35**;

(2) the current value of the first region **T1** is divided by the maximum value to obtain an intermediate result value; and

(3) a reciprocal of the intermediate result value is generated as a gain value.

Assuming that the measured current value of the first region **T1** is 0.3165 A, and the maximum among the current values of the first to thirty-fifth regions **T1** to **T35** is 0.9357 A, the intermediate result value of the first region **T1** is 0.3382.

Accordingly, the gain value of the first region **T1** is the reciprocal of 0.3382 i.e., 2.9568. This gain value is stored.

Likewise, the gain values of the second to thirty-fifth regions **T2** to **T35** can be obtained.

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In the fourth step S4, the obtained gain value of the first region T1 is compared with a gain value stored in a look-up table (LUT).

When the obtained gain value is the same as the gain value stored in the LUT or within an error range, a luminance of the first region T1 is compensated for by using the obtained gain value. In this case, the gain value of the first region T1 stored in the LUT does not change and is maintained.

When the obtained gain value is beyond an error range, the obtained gain value is stored as the gain value of the first region T1 in the LUT and a luminance of the first region T1 is compensated for by using the obtained gain value. In this case, the gain value of the first region T1 in the LUT is updated with the obtained gain value.

The above fourth step S4 may be performed by the timing control portion 110.

In the fifth step S5, luminance of region T1 is compensated for by adjusting image data of the first region T1 using the gain value stored of the first region T1 in the LUT. This compensation is conducted by the timing control portion 110.

The gain value of the first region T1 stored in the LUT is for luminance compensation of the first region T1.

To compensate for the luminance of the first region T1 using the corresponding gain value, the image data corresponding to the first region T1 is multiplied by the gain value. Accordingly, compensated data voltages corresponding to the compensated/adjusted image data are output to the OLED display panel 130 from the data driver 131.

The above fourth and fifth steps S4 and S5 can be also conducted to compensate for luminance variation of other regions T2 to T35.

The above-described method can be applied to achieve luminance uniformity of each of red, green and blue of an OLED display panel including red, green and blue pixel units.

As described above, the embodiment can obtain and compensate for luminance variation through measuring currents of light emitting diodes of an OLED display panel. Accordingly, production cost can be reduced, and a luminance measuring time can be reduced. Thus, production efficiency can be improved.

Further, luminance compensation can be performed regardless of size and type of an OLED display panel because the compensation is based on the current measuring method.

It will be apparent to those skilled in the art that various modifications and variation can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic light emitting diode display device, comprising:

a display panel including a plurality of pixels in a display region, each pixel including a switching thin film transistor,

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a driving thin film transistor, and a light emitting diode, the display region divided into a plurality of regions;

a diode current measuring portion electrically connected to the light emitting diode of each pixel and measuring a current of each divided region to generate a contour plot of luminance based on the measured current;

a timing control portion obtaining a gain value of each divided region based on the measured current of each divided region, and generating compensated image data using the gain value to compensate for non-uniformity of luminance in the display region according to the contour plot of luminance generated based on the measured current;

a gate driver supplying gate voltages to the display panel; and

a data driver supplying data voltages corresponding to the compensated image data to the display panel.

2. The device of claim 1, wherein the timing control portion includes a storing portion that stores the measured current by the diode current measuring portion.

3. The device of claim 2, wherein the timing control portion converts the measured current into the gain value and stores the gain value in the storing portion.

4. A method of compensating for a luminance variation of an organic light emitting diode display device, wherein the organic light emitting diode display device includes a display panel including a plurality of pixels in a display region, each pixel including a switching thin film transistor, a driving thin film transistor, and a light emitting diode, the display region divided into first to Nth regions, the method comprising:

measuring currents of the first to Nth regions through a diode current measuring portion;

generating a contour plot of luminance based on the measured currents of the first to Nth regions;

obtaining gain values based on the measured currents of the first to Nth regions, each of the gain values associated with a corresponding region of the first to Nth regions; and

adjusting image data signals using the gain values to compensate for non-uniformity of luminance in the display region according to the contour plot of luminance generated based on the measured currents.

5. The method of claim 4, wherein obtaining the gain values comprises:

obtaining a maximum current among the currents of the first to Nth regions; and

dividing, for each of the first to Nth regions, a measured current of a region by the maximum current to obtain an intermediate result value associated with the region, a gain value associated with the region being a reciprocal of the intermediate result value associated with the region.

6. The method of claim 4, wherein adjusting the image data signals using the gain values includes multiplying the image data signals by the gain values.

\* \* \* \* \*

|                |                                                                                 |         |            |
|----------------|---------------------------------------------------------------------------------|---------|------------|
| 专利名称(译)        | 有机发光二极管显示装置和用于补偿其亮度变化的方法                                                        |         |            |
| 公开(公告)号        | <a href="#">US9396678</a>                                                       | 公开(公告)日 | 2016-07-19 |
| 申请号            | US14/551568                                                                     | 申请日     | 2014-11-24 |
| [标]申请(专利权)人(译) | 乐金显示有限公司                                                                        |         |            |
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| [标]发明人         | HONG MOO KYOUNG                                                                 |         |            |
| 发明人            | HONG, MOO-KYOUNG                                                                |         |            |
| IPC分类号         | G09G3/32                                                                        |         |            |
| CPC分类号         | G09G3/3225 G09G2320/029 G09G2320/0233 G09G2320/0271 G09G2320/0285 G09G2320/0693 |         |            |
| 优先权            | 1020130147442 2013-11-29 KR                                                     |         |            |
| 其他公开文献         | US20150154912A1                                                                 |         |            |
| 外部链接           | <a href="#">Espacenet</a> <a href="#">USPTO</a>                                 |         |            |

#### 摘要(译)

一种有机发光二极管显示装置，包括：显示面板，包括显示区域中的多个像素，每个像素包括开关薄膜晶体管，驱动薄膜晶体管和发光二极管，所述显示区域分为多个地区；二极管电流测量部分，电连接到每个像素的发光二极管，并测量每个划分区域的电流；定时控制部分基于每个划分区域的测量电流获得每个划分区域的增益值，并使用该增益值生成补偿图像数据；栅极驱动器向显示面板提供栅极电压；数据驱动器将与补偿后的图像数据对应的数据电压提供给显示面板。

