Structure and drive scheme for active matrix light emitting devices

DESCRIPTION

BACKGROUND OF THE INVENTION

[Para 1] 1. Field of the Invention

[Para 2] The present invention relates to a display comprising a light-emitting device (LED) array and a drive scheme to operate such. More specifically, the present invention provides a method to operate the light emitting device array in response to a stream of input image data to provide dynamic control of light emitting device array to deliver a composite image on a front panel.

[Para 3] 2. Description of the Prior Art

[Para 4] Light emitting diodes are attracting wide interests in display application in recent years. The applications include direct view screen constructed from organic or inorganic light emitting diodes and backlight for LCD. Its excellent form factor, fast response time, lighter weight, low operating voltage, make it the ideal device for a wide range of applications. These emerging applications typically involve an array of LED or OLED with active control element for each light emitting element. Despite superior performance in displaying images, these new applications still face various technical challenges associated with its commercialization. For example, the OLED displays need a longer operation lifetime. Furthermore, the processing techniques for generating small geometry OLED pixels in large number, and the complexity of pixel circuit needed for a uniform large size display panel remain to be the gating factors for a full commercialization of OLED display. On the other hand, the LED or OLED may be structured as a light source for light valve-controlled display device such as LCD. This invention provides a

condition, and combines a second active matrix of light valves, such as LCD, to produce a final fine grained image.

SUMMARY OF THE INVENTION

[Para 5] The present invention provides architectures that provide a structure that combines a matrix of LED and a matrix of light valve, such as LCD, to form a composite image display system. The matrix of LED may be an active matrix comprising individual current control circuit within each lighting unit, or connected to a peripheral driver circuit. More specifically, the system comprises a data storage device storing reference information corresponding to exiting light from the light valve matrix. Both the LED control signal and the light valve (or LCD) control signal are modulated by such reference information. The structure and operating method allow the image to be produced in high precision, both in intensity and color.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 6] FIG. 1 is the schematic diagram of a preferred embodiment of the present invention.

[Para 7] FIG. 2 is the schematic diagram of a preferred embodiment of the present invention.

[Para 8] FIG. 2A is the schematic diagram of a preferred embodiment of the present invention.

[Para 9] FIG. 3 is a preferred embodiment of the present invention.

[Para 10] FIG. 4 is an example of a preferred embodiment of a light emitting device unit in an active matrix in the present invention.

[Para 11] FIG. 5 is an illustration of a display structure of the present invention.

[Para 12] FIG. 6 is an illustration of a display structure of the present invention.

[Para 13] FIG. 7 is an illustration of the present invention.

[Para 14] FIG. 8 is an illustration of the present invention.

[Para 15] FIG. 9 is a preferred embodiment of the present invention.

[Para 16] FIG. 10 is a preferred embodiment of the present invention.

[Para 17] FIG. 11 is a preferred embodiment of the present invention.

[Para 18] FIG. 12 is a preferred embodiment of the present invention.

[Para 19] FIG. 13 is a schematics of a preferred embodiment of a method of the present invention.

[Para 20] FIG. 14 is a schematics of a preferred embodiment of a method of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[Para 21] The present invention is directed to the structure of a system comprising a light emitting device array and light valve array such as LCD, and the operation methods of such display system. Preferred embodiments are explained in applications for display apparatus. In this description, light emitting diode is used as preferred embodiment. For those skilled in the art, it is readily conceivable that any light emitting devices with sufficiently fast response time will work equally well in all embodiments presented herein.

[Para 22] In this description, transmissive liquid crystal light valve array is used as preferred illustration as a second active matrix for displaying the final image. An LCD array in this system may comprise a typical structure of a commercially available LCD array, however, the drive electronic, light source, and operating method allow an image to be displayed in a higher quality.

[Para 23] Light emitting diodes are used as the preferred embodiment in this description. It is readily conceivable that a light emitting device of similar or faster response time works equally well. For example, a bi-directional light emitting device or a fast response lamp may also be used as the light sources.

[Para 24] The present invention will hereinafter be described in detail with reference to the drawings.

[Para 25] Fig. 1 provides a schematic diagram of a preferred embodiment of a light emitting device display 100 of the present invention, wherein the display comprising an array of light emitting devices. The display 100 further comprises a current control circuit wherein each output channel of said control circuit delivers a drive current to an LED 101, an EEPROM 103 as the data storage device to store reference information, a data processor to generate current control signal according to an input data signal. An LED 101 produces light output according to the drive current. A commercially available current driver may be used as a preferred embodiment for generating an output current according to an input data signal. The input data signal represents a set of data values corresponding to the desired brightness levels (gray scales) that the LEDs to be operated to display to a viewer. As the characteristics of LEDs may vary, the drive current directly converted from an input data signal by a current control circuit will typically result in a light output distorted by such variation, i.e. an output light intensity not in proportionally representing the input data signal. Such deviation of light output may arise from both the variation of LED characteristics in electrical current at a given voltage and in light output at a given electrical current. One feature of the present invention provides reference information stored in the EEPROM 103 as part of a display system to adjust the drive current accordingly. This reference information is the measured output light intensity at a given current set by a given input data signal. In Fig 1, a sensor device 109 comprising an array of light sensing elements is illustrated. A CCD camera may be used as a preferred measurement device. The measured intensity in the CCD array corresponding to a specific LED 101 at specific time during a drive period is sent via a data signal link, such as a data cable, to the data storage EEPROM 103. The data processor use this stored reference information to re-process the input data signal. A preferred embodiment of the function of the data processor is to perform a scaling of the input data signal according to the stored reference information.

[Para 26] As a preferred scaling operation of the data processor, given an array of input data signal (S1, S2, ..., Sn) and an array of data value (R1, R2,..., Rn) as part of the reference information representing the maximum light output measured by sensor 109 when a respective LED is driven at a full scale (highest gray scale), the processor operates to produce a current driving signal (S1 x R1, S2 x R2,...,Sn x Rn)/M, where M is the maximum value of (R1 R2 ... Rn). Such scaled current drive signal is then sent to current control circuit for generating drive current.

[Para 27] As a preferred embodiment for Fig. 1, the LED array forms an active matrix wherein each unit cell comprises an LED element, a drive transistor, and a storage capacitor. An example of a unit circuit of such LED matrix is provided in Fig. 4, wherein a transistor 402 modulates the current directed to the LED 405 according to a data information stored in storage capacitor 404. The data information is written into the storage capacitor 404 from a data electrode when a data control transistor 403 is selected by the scan electrode 410.

[Para 28] Fig 2. provides a schematic diagram of further detail of a preferred embodiment of a display system of the present invention. The system 200 further comprises a programming circuit 204 as an input-output interface for writing data into and reading data from the data storage EEPROM. A timing control circuit is provided as a circuit separated from current control circuit to provide timing control to the current control circuit. The same timing control signal is provided synchronously to the programming circuit to synchronize the data writing with the drive current so that the data measured from the sensor 209 is correctly register to a proper LED at a specific time when such LED is driven at a given current level.

[Para 29] Programming or data recording operation of the data storage device may be performed before or after the assembly of the LED array with the light valve matrix of the display unit. In a preferred embodiment, a communication port is provided for accessing the storage device to program or re-program the reference information. One preferred embodiment of such data storage device is an EEPROM that may be programmed with software from a computer

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