thereby increasing the cost of the digital LED signage display 10, and reducing the reliability thereof because of the high risk that the wires in ribbon cables may get disconnected and/or damaged over time, particularly in outdoor applications.

SUMMARY

Herein, embodiments of a Light-Emitting Diode (LED) apparatus are disclosed. According one aspect of this disclosure, there is provided a LED apparatus. The LED apparatus comprises: at least one LED module, the at least one LED module comprising a plurality of LEDs and at least one communication unit; a gateway functionally coupled to the at least one communication unit; at least one digital control unit coupled to the at least one communication unit; and at least one DC-to-DC (DC/DC) converter coupled to the at least one digital control unit and the plurality of LEDs, wherein the gateway is configured for wirelessly receiving one or more commands from one or more computing devices for controlling the LED apparatus and in response to the received one or more commands, wirelessly sending one or more instructions to the at least one communication unit, and wherein the communication unit is configured for receiving the one or more instructions from the gateway, and sending the received one or more instructions to the at least one digital control unit, and wherein the at least one digital control unit is configured for receiving the one or more instructions, decoding the one or more instructions, and controlling the at least one DC/DC converter based on the decoded one or more instructions for controlling lighting of the plurality of LEDs.

According to one aspect of this disclosure, there is provided a LED module. The LED display module comprises: a plurality of LED submodules, each LED submodule comprising one or more LEDs; a communication hub configured for communication with the plurality of LED submodules for adjusting lighting of the one or more LEDs thereof; and a gateway configured for wireless communication with the communication hub and for wireless communication with one or more computing devices. wherein each LED submodule comprises a digital control unit coupled to the communication hub, and a DC/DC converter coupled to the digital control unit and the one or more LEDs, and wherein the gateway is configured for wirelessly receiving one or more commands from the one or more computing devices and in response to the received one or more commands, sending one or more instructions to the communication hub, and wherein the communication hub is configured for receiving the one or more instructions from the gateway, and selectively sending the received one or more instructions to the digital control unit of each LED submodule, and wherein the digital control unit of each LED submodule is configured for decoding the one or more instructions and controlling the DC/DC converter based on the decoded one or more instructions for controlling the lighting of the one or more LEDs.

According to one aspect of this disclosure, there is provided circuitry for controlling a LED module. The circuitry comprises: a communication hub; a gateway configured for communication with the communication hub wirelessly or via a DC power line and for wireless communication with one or more computing devices; a plurality of digital control units coupled to the communication hub; and a plurality of DC/DC converters each coupled to a respective one of the plurality of digital control units, each of the plurality of DC/DC converters being configured for powering one or more LEDs, wherein the gateway is

configured for wirelessly receiving one or more commands from the one or more computing devices and in response to the received one or more commands, sending one or more instructions to the communication hub, and wherein the communication hub is configured for receiving the one or more instructions from the gateway, and selectively sending the received one or more instructions to the plurality of digital control units, and wherein each of the plurality of digital control units is configured for decoding the one or more instructions and controlling the respective DC/DC converter based on the decoded one or more instructions for controlling lighting of the one or more LEDs.

According to one aspect of this disclosure, there is provided circuitry for controlling a LED module. The circuitry comprises: a communication unit for wireless communication with one or more computing devices; a digital control unit; and a DC/DC converter for coupling to a plurality of LEDs, wherein the digital control unit is coupled to the communication unit, and wherein the DC/DC converter is coupled to the digital control unit, and wherein the communication unit is configured for receiving one or more instructions from the one or more computing devices and sending the received one or more instructions to the digital control unit, and wherein the digital control unit is configured for receiving the one or more instructions, decoding the one or more instructions, and controlling the DC/DC converter based on the decoded one or more instructions for controlling lighting of the plurality of LEDs.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the present disclosure will now be described with reference to the following figures, in which identical reference numerals in different figures indicate identical elements and in which:

FIG. 1 is a schematic diagram of a prior-art LED signage, illustrating how data is transferred from a computer to the LED signage display;

FIG.2 is a block diagram of a central controller of the prior-art digital LED signage display shown in FIG. 1;

FIGs. 3A and 3B are simplified schematic block diagrams of a LED display system having a LED signage display, according to some embodiments of this disclosure;

CLAIMS

WHAT IS CLAIMED IS:

1. A Light-Emitting Diode (LED) apparatus comprising:

at least one LED module, each LED module comprising a plurality of LEDs and at least one communication unit;

a gateway functionally coupled to the at least one communication unit;

at least one digital control unit coupled to the at least one communication unit; and

at least one DC-to-DC (DC/DC) converter coupled to the at least one digital control unit and the plurality of LEDs,

wherein the gateway is configured for wirelessly receiving one or more commands from one or more computing devices for controlling the LED apparatus and in response to the received one or more commands, wirelessly sending one or more instructions to the at least one communication unit, and

wherein the communication unit is configured for receiving the one or more instructions from the gateway, and sending the received one or more instructions to the at least one digital control unit, and

wherein the at least one digital control unit is configured for receiving the one or more instructions, decoding the one or more instructions, and controlling the at least one DC/DC converter based on the decoded one or more instructions for controlling lighting of the plurality of LEDs.

2. The LED apparatus of claim 1, wherein each LED module comprises a plurality of communication units and a plurality of LED submodules, each LED submodule comprising a subset of the plurality of LEDs and one of the plurality of communication units.

3. The LED apparatus of claim 2, wherein each LED submodule further comprises an Integrated Circuit (IC) chip, and wherein the IC chip comprises the at least one digital control unit, the at least one DC/DC converter, and the at least one communication unit and configured for controlling the lighting of the plurality of LEDs in the LED submodule.

4. The LED apparatus of any one of claims 1 to 3, wherein the at least one LED module comprises a flexible surface configurable to a nonplanar surface.

5. The LED apparatus of any one of claims 1 to 4**Error! Reference source not found.**, wherein the at least one DC/DC converter is a multi-output DC/DC converter.

6. The LED apparatus of any one of claims 1 to 55, wherein the at least one communication unit further comprises a data acquisition component for collecting data of the LEDs and for adjusting the lighting of the LEDs.

7. The LED apparatus of claim 66, wherein the at least one communication unit further comprises a communication component functionally coupled to the data acquisition component for transmitting data to and from the data acquisition component.

8. A LED module comprising:

a plurality of LED submodules, each LED submodule comprising one or more LEDs;

a communication hub configured for communication with the plurality of LED submodules for adjusting lighting of the one or more LEDs thereof; and

a gateway configured for wireless communication with the communication hub and for wireless communication with one or more computing devices,

wherein each LED submodule comprises a digital control unit coupled to the communication hub, and a DC/DC converter coupled to the digital control unit and the one or more LEDs, and

wherein the gateway is configured for wirelessly receiving one or more commands from the one or more computing devices and in response to the received one or more commands, sending one or more instructions to the communication hub, and

wherein the communication hub is configured for receiving the one or more instructions from the gateway, and selectively sending the received one or more instructions to the digital control unit of each LED submodule, and

wherein the digital control unit of each LED submodule is configured for decoding the one or more instructions and controlling the DC/DC converter based on the decoded one or more instructions for controlling the lighting of the one or more LEDs.

9. The LED module of claim 8, wherein the communication hub further comprises a data acquisition component for collecting data of the LEDs and for adjust the lighting of the LEDs.

10. The LED module of claim 99, wherein the communication hub further comprises a communication component functionally coupled to the data acquisition component for transmitting data to and from the data acquisition component.

11. A circuitry for controlling a LED module, the circuitry comprising:

a communication hub;

a gateway configured for communication with the communication hub wirelessly or via a DC power line and for wireless communication with one or more computing devices;

a plurality of digital control units coupled to the communication hub; and

a plurality of DC/DC converters each coupled to a respective one of the plurality of digital control units, each of the plurality of DC/DC converters being configured for powering one or more LEDs,

wherein the gateway is configured for wirelessly receiving one or more commands from the one or more computing devices and in response to the received one or more commands, sending one or more instructions to the communication hub, and

wherein the communication hub is configured for receiving the one or more instructions from the gateway, and selectively sending the received one or more instructions to the plurality of digital control units, and

wherein each of the plurality of digital control units is configured for decoding the one or more instructions and controlling the respective DC/DC converter based on the decoded one or more instructions for controlling lighting of the one or more LEDs.

12. The circuitry of claim 11, wherein the communication hub comprises a low-pass filter (LPF) for filtering the electrically current of the DC power line for reducing interference and/or noises.

13. The circuitry of claim 11 or 12, wherein the communication hub further comprises a data acquisition component for collecting data of the LEDs and for adjusting the lighting of the LEDs.

14. The circuitry of claim 0, wherein the communication hub further comprises a communication component functionally coupled to the data acquisition component for transmitting data to and from the data acquisition component.

15. A circuitry for controlling a LED module, the circuitry comprising:

a communication unit for wireless communication with one or more computing devices;

a digital control unit; and

a DC/DC converter for coupling to a plurality of LEDs,

wherein the digital control unit is coupled to the communication unit, and

wherein the DC/DC converter is coupled to the digital control unit, and

wherein the communication unit is configured for receiving one or more instructions from the one or more computing devices and sending the received one or more instructions to the digital control unit, and

wherein the digital control unit is configured for receiving the one or more instructions, decoding the one or more instructions, and controlling the DC/DC converter based on the decoded one or more instructions for controlling lighting of the plurality of LEDs.

16. The circuitry of claim 15, wherein the circuitry is an Integrated Circuit (IC) chip.

17. The circuitry of claim 15 or 16 further comprising a data acquisition component for collecting data of the LEDs and for adjusting the lighting of the LEDs.

18. The circuitry of claim 17 further comprising a communication component functionally coupled to the data acquisition component for transmitting data to and from the data acquisition component.