Moreover, using fans or rotational parts for the digital LED signage display significantly reduces its reliability since the rotational parts are usually the points of failure in these products.

As each LED driver 22 is connected to the central controller 20 via the cable 16B (for example a ribbon cable), a large digital LED signage display 10 generally requires one or more ribbon cables 16B having a large number of wires therein, which makes the digital LED signage display 10 expensive and unreliable since there is a high risk that the wires in ribbon cables may get disconnected and/or damaged over time, particularly in outdoor applications. Moreover, these ribbon cables are usually points of failure for digital LED signage displays.

As all above-described components are received in the cabinet 14, a prior-art LED signage display is usually bulky and heavy, and therefore, difficult to install and handle. Lifting or crane equipment is often required for installation of a prior-art LED signage display.

SUMMARY

The embodiments of the present disclosure relate to a Light-Emitting Diode (LED) display module. The LED display module comprises a plurality of LED display submodules. Each LED display submodule comprises one or more LEDs, and the plurality of LED display submodules are flexibly coupled to each other to form a flexible display surface.

In some embodiments, each LED display submodule may comprise an enclosure in a frustum shape.

In some embodiments, each LED display submodule may comprise 9 LEDs arranged in a 3-by-3 matrix.

In some embodiments, each LED display submodule may be flexibly coupled to one or more neighboring LED display submodules via a flexible coupling structure.

In some embodiments, the LED display module further comprises a plurality of flexible electrical-connectors for interconnecting the plurality of LED display submodules.

In some embodiments, at least one of the plurality of flexible electrical-connectors is removably connectable to two of the plurality of LED display submodules.

In some embodiments, at least two of the plurality of LED display submodules may comprise a first electrically-conductive coupling structure. At least one of the plurality of flexible electrical-connectors comprises a second electrically-conductive coupling structure for electrically and mechanically engaging the first electrically-conductive coupling structure.

In some embodiments, the first electrically-conductive coupling structure may comprise a set of electrically-conductive recesses. The second electrically-conductive coupling structure may comprise at least two sets of electrically-conductive extrusions, wherein each set of extrusions is electrically and mechanically engageable with the set of electrically-conductive recesses.

In some embodiments, the set of electrically-conductive recesses and the set of electrically-conductive extrusions may comprise magnets with opposite poles.

In some embodiments, at least one of the plurality of flexible electrical-connectors may comprise a flexible Printed Circuit Board (PCB).

In some embodiments, at least one of the plurality of flexible electrical-connectors is a flexible and electrically conductive strip.

In some embodiments, the LED display module further may comprise a flexible housing structure, wherein the flexible housing structure comprises a plurality of cells for receiving the plurality of LED display submodules. The plurality of flexible electrical conductors may be embedded in the flexible housing structure.

In some embodiments, each cell may comprise a plurality of electrical terminals connected to the plurality of flexible electrical conductors and configured for electrically connection with the LED display submodule received in the cell.

In some embodiments, the plurality of electrical terminals of each cell may comprise at least a first set of electrical terminals for transmitting electrical power.

According to one aspect of this disclosure, there is disclosed a LED apparatus. The LED apparatus comprises: one or more LED display modules, each LED display module comprising at least one first coupling structure and a plurality of LEDs; and one or more set of attachment structures for attaching the one or more LED display modules to a surface, each attachment structure comprising at least one second coupling structure for engaging the first coupling structure. The first and second coupling structures comprise magnets with opposite poles.

In some embodiments, each of the one or more set of attachment structures may comprise a mounting structure for mounting the attachment structure to a surface.

In some embodiments, the at least one first coupling structure of each LED display module may comprise four first coupling structures located at four corners of the LED display module.

In some embodiments, the one or more LED display modules may comprise a plurality of LED display modules arranged in a matrix manner. The one or more set of attachment structures may comprise at least one first attachment structure configured for coupling two neighboring LED display modules and for attaching the two neighboring LED display modules to a surface.

In some embodiments, each first attachment structure may comprise two halves flexibly coupled together; wherein each half is made of a rigid material and comprises one of the second coupling structures.

In some embodiments, the second coupling structure of each half of the first attachment structure may comprise at least one magnet with a pole opposite to that of the magnets of the first coupling structure.

In some embodiments, the first attachment structure is configured for electrically connecting the two neighboring LED display modules.

In some embodiments, the first attachment structure may comprise a plurality of first electrical terminals for electrically connecting the two neighboring LED display modules.

In some embodiments, the plurality of first electrical terminals may comprise at least a first set of first electrical terminals for transmitting electrical power.

In some embodiments, the plurality of first electrical terminals of each cell may further comprise at least a second set of first electrical terminals for transmitting data or control signals.

In some embodiments, each LED display module may comprise a flexible housing structure; and the flexible housing structure comprises: a plurality of cells for receiving a plurality of LED display submodules, each LED display submodule comprising a portion of the plurality of LEDs, and a plurality of flexible electrical conductors embedded in the flexible housing structure.

In some embodiments, each cell may comprise a plurality of second electrical terminals connected to the plurality of flexible electrical conductors and configured for electrically connection with the LED display submodule received in the cell.

In some embodiments, the plurality of electrical terminals of each cell may comprise at least a first set of second electrical terminals for transmitting electrical power.

In some embodiments, the plurality of electrical terminals of each cell may further comprise at least a second set of second electrical terminals for transmitting data or control signals.

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 side view of a prior-art LED signage display;

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

WHAT IS CLAIMED IS:

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

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

a plurality of electrical conductors for electrically connecting the plurality of LED display submodules to one or more sources;

wherein each LED display submodule comprises an enclosure in a frustum shape and having a front side for emitting light therefrom and a sidewall rearwardly tapering from said front side thereof; and

wherein the plurality of LED display submodules are flexibly coupled to each other side-by-side at neighboring edges on the front side thereof to form a flexible display surface.

2. The LED display module of claim 1, wherein each LED display submodule is flexibly coupled to one or more neighboring LED display submodules via a flexible coupling structure.

3. A Light-Emitting Diode (LED) display module comprising:

a plurality of LED display submodules, each LED display submodule comprising one or more LEDs, the plurality of LED display submodules flexibly coupled to each other to form a flexible display surface; and

a plurality of flexible electrical-connectors for interconnecting the plurality of LED display submodules, at least one of the plurality of flexible electrical-connectors comprising two halves flexibly coupled together, the two halves made of a rigid material.

4. The LED display module of claim 3, wherein at least one of the plurality of flexible electrical-connectors is removably connectable to two of the plurality of LED display submodules.

5. The LED display module of claim 3, wherein at least two of the plurality of LED display submodules each comprises a first electrically-conductive coupling structure; and wherein at least one of the plurality of flexible electrical-connectors comprises a second electrically-conductive coupling structure for electrically and mechanically engaging the first electrically-conductive coupling structure.

6. The LED display module of claim 5, wherein the first electrically-conductive coupling structure comprises a set of electrically-conductive recesses; and wherein the second electrically-conductive coupling structure comprises at least two sets of electrically-conductive extrusions, each set of extrusions electrically and mechanically engageable with the set of electrically-conductive recesses.

7. The LED display module of claim 6, wherein the set of electrically-conductive recesses and the set of electrically-conductive extrusions comprise magnets with opposite poles.

8. The LED display module of any one of claims 3 to 7, wherein at least one of the plurality of flexible electrical-connectors comprises a flexible Printed Circuit Board (PCB) or a flexible and electrically conductive strip.

9. A Light-Emitting Diode (LED) display module comprising:

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

a flexible housing structure, the flexible housing structure comprising a plurality of cells for receiving the plurality of LED display submodules such that the plurality of LED display submodules are flexibly coupled to each other to form a flexible display surface; and

a plurality of flexible electrical conductors embedded in the flexible housing structure.

10. The LED display module of claim 9, wherein each cell comprises a plurality of electrical terminals connected to the plurality of flexible electrical conductors and configured for electrically connection with the LED display submodule received in the cell; wherein the plurality of electrical terminals of each cell comprises at least one of a first set of electrical terminals for transmitting electrical power and a second set of electrical terminals for transmitting data or control signals.

11. A LED apparatus comprising:

one or more LED display modules, each LED display module comprising at least one first coupling structure and a plurality of LEDs; and

one or more sets of attachment structures for attaching the one or more LED display modules to a surface, each attachment structure comprising at least one second coupling structure for engaging the first coupling structure via magnetic force;

wherein the one or more sets of attachment structures comprises at least one first attachment structure configured for coupling two neighboring LED display modules and for attaching the two neighboring LED display modules to the surface;

wherein each first attachment structure comprises two halves flexibly coupled together; wherein each half is made of a rigid material and comprises one of the second coupling structures.

12. The LED apparatus of claim 11, wherein each of the one or more sets of attachment structures comprises a mounting structure for mounting the attachment structure to a surface.

13. The LED apparatus of any one of claims 11 or 12, wherein the at least one first coupling structure of each LED display module comprises four first coupling structures located at four corners of the LED display module.

14. The LED apparatus of any one of claims 11 to 13, wherein the second coupling structure of each half of the first attachment structure comprises at least one magnet with a pole opposite to that of the magnets of the first coupling structure.

15. The LED apparatus of any one of claims 11 to 14, wherein the first attachment structure is configured for electrically connecting the two neighboring LED display modules.

16. The LED apparatus of any one of claims 11 to 15, wherein the first attachment structure comprises a plurality of first electrical terminals for electrically connecting the two neighboring LED display modules; and wherein the plurality of first electrical terminals comprises at least one of a first set of first electrical terminals for transmitting electrical power and a second set of first electrical terminals for transmitting data or control signals.

17. The LED apparatus of any one of claims 11 to 16, wherein each LED display module comprises a flexible housing structure; and

wherein the flexible housing structure comprises:

a plurality of cells for receiving a plurality of LED display submodules, each LED display submodule comprising a portion of the plurality of LEDs, and

a plurality of flexible electrical conductors embedded in the flexible housing structure.

18. The LED apparatus of claim 17, wherein each cell comprises a plurality of electrical terminals connected to the plurality of flexible electrical conductors and configured for electrically connection with the LED display submodule received in the cell.

19. The LED apparatus of claim 18, wherein the plurality of electrical terminals of each cell comprises at least one of a first set of second electrical terminals for transmitting electrical power and a second set of second electrical terminals for transmitting data or control signals.

20. A Light-Emitting Diode (LED) display module comprising:

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

a flexible housing structure, the flexible housing structure comprising a plurality of pockets for receiving the plurality of LED display submodules, each pocket comprising a sidewall and a rear wall; and

a plurality of electrical conductors for electrically connecting the plurality of LED display submodules to one or more sources.

21. The LED display module of claim 20, wherein said plurality of electrical conductors comprise a plurality of flexible electrical conductors.

22. The LED display module of claim 21, wherein the plurality of flexible electrical conductors are embedded in the flexible housing structure.

23. The LED display module of any one of claims 20 to 22, wherein the flexible housing structure is made of a flexible rubber.

24. A LED apparatus comprising one or more LED display modules of any one of claims 1 to 10 and 20 to 23.