ABSTRACT
Provided herein are display systems and units, including those configured for dynamic communication, inventorying, and monitoring environmental conditions in a physical location, such as in retail settings. Also included herein are methods for dynamically displaying product information in a physical location, such as a retail setting.
FIG. 10

RECEIVE SENSOR OUTPUT SIGNAL(S)

SENSOR STATE 1 SATISFIED?

YES

DISPLAY INFO 1

NO

SENSOR STATE 2 SATISFIED?

YES

DISPLAY INFO 3

NO

SENSOR STATE 3 SATISFIED?

YES

DISPLAY INFO 5

NO

DISPLAY INFO 9

STITCH IDENTIFIED DISPLAY INFORMATION

TRANSMIT DISPLAY INFORMATION TO DISPLAY UNIT(S)
MERCHANDISING COMMUNICATION AND INVENTORYING SYSTEM

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application Nos. 62/031,258, filed 31 Jul. 2014, and 62/190,580, filed 9 Jul. 2015, both of which are incorporated herein in their entireties.

FIELD

[0002] The disclosure relates to a systems and methods for conveying content to and displaying content on merchandising communication systems and systems and methods for monitoring various environments, particularly retail environments.

BACKGROUND OF THE INVENTION

[0003] There are a variety of retail options for displaying a variety of information in retail environments, including, pricing, labeling, promotions, etc. Traditionally, this information has been provided using print systems, including slide-in paper system, plastic label systems, adhesive label systems, etc. More recently, there has been increased interest in utilizing digital or electronic systems to display such information.

[0004] The utilization of high definition display technology, including plasma displays, LCD displays (including those backlit by light emitting diodes (LEDs)), etc., in such applications was considered, but such systems are expensive, limiting their scope of commercial adoption. For example, many retail outlets have large numbers of shelves that require the display of information. Systems described in US 2014/0139548 utilize only a single display strip per aisle for displaying the prices of products on a multiple shelves. This approach may alleviate some of the cost-prohibitive nature of such devices, but leaves a great deal to be desired as the prices are no longer located adjacent the product, resulting in frustrated customers having to search for prices. In addition, such systems utilize displays that are not only expensive to install, but to replace. US 2010/0012600 suggests the use of such displays protrude into the aisles where customers can knock the displays off and/or otherwise damage the displays. The solution there was to provide a large housing below the shelf to secure the electronics and protect them from being damaged. However, these large systems are even more difficult and expensive to transport and install, and do not provide optimal display surface areas.

[0005] The utilization of less complex and cheaper displays have also been considered, including e-paper displays (EPD), and thin-film-transistor liquid crystal displays (TFT LCD). However, such solutions are not one continuous strip. Therefore, a retailer cannot manage and communicate with an entire shelf display or multiple shelf displays in a single action. Instead, such digital and print displays, while possibly being adequate for displaying pricing information, product information, etc., they must be managed individually and do not have the ability to display complete aisle cross-branding, customer communication, display true or full-spectrum color, or full motion video and/or animation. Typical TFT displays for such applications are limited to displays that are 480 pixels wide by 272 pixels high, limiting the viability of such solutions. With graphics cards having a 2048 pixel wide by 1152 pixel high capability, such displays would need to be linked together with multiple displays and multiple graphics cards, requiring sophisticated and expensive synchronization software. Further, such systems would be limited to a maximum of twelve displays, equivalent to a five-foot section of tethered displays, through a single display server. In addition, such displays have relatively poor brightness—e.g., generally only up to about 25 NITS—and angle and distance legibility parameters—e.g., generally up to a maximum of about 2-3 feet at a 90 degree viewing angle and about 1-2 feet at a 25 degree viewing angle.

SUMMARY OF THE INVENTION

[0006] Provided herein are displays, components thereof, and systems thereof. In specific embodiments, such displays, components and systems are used or useful in retail applications. In some embodiments, such displays are cost effective, while having a low profile, being impact resistant, having continuous display capabilities, having full color capabilities, having excellent brightness parameters, and/or having excellent visibility parameters, as well as other advantageous features. Further, by including sensor capabilities, systems and display units provided herein are able to provide dynamic merchandising and experiences, as well reduce labor and capital investment costs associated with inventoring, controlling product environments (e.g., to reduce product spoilage and waste), and the like.

[0007] In some embodiments, provided herein is a display system (e.g., dynamic retail display system) comprising a sensor (e.g., an inventorying sensor (e.g., camera, RFID sensor, a sensor film (e.g., a pressure sensor film, a resistive sensor film, a capacitive sensor film, or the like), etc.) (e.g., the system being configured to use sensor signals to identify product location and/or product inventory), environmental sensor(s) (e.g., humidity sensor, temperature sensor, etc.—and combinations thereof) and one or more display unit (e.g., a display unit or strip described herein). In specific instances, the system or display unit comprises a sensor (e.g., a display unit of the system comprising the camera integrated therein) and a display surface (e.g., both of which are, in exemplary embodiments, combined into a display unit). In some embodiments, the display surface (e.g., LED array) is configured to face in a first direction and a camera (e.g., lens thereof) is configured to face in a second direction (e.g., a direction of about 90 degrees to 180 degrees or about 135 degrees to about 180 degrees opposed to the first direction). In certain embodiments, the sensor is configured to provide output signals to a controller, the sensor output signals conveying information regarding objects (e.g., retail products) configured in proximity to (e.g., within about 10 feet, within about 5 feet, or within about 3 feet, such as behind, below, and/or behind) the display unit (e.g., on a shelf behind, or behind and below, the display unit). In more specific instances, the system comprises a first display unit comprising a first display surface (e.g., an LED array described herein) and a first camera, the first display surface configured to face a first direction and the first camera configured to face in a second (e.g., opposed) direction; and a second display surface (e.g., an LED array described herein) and a second camera, the second display surface configured to face a third direction and the second camera configured to face in a fourth (e.g., opposed) direction. In some instances, the first and third directions are the same or different, and the second and fourth directions are the same or different. As used herein, a camera refers to any device suitable for capturing images and/or video.
[0008] In certain embodiments, the controller comprises a module configured to identify objects in proximity to a sensor (e.g., camera, RFID sensor, a sensor film (e.g., a pressure sensor film, a resistive sensor film, a capacitive sensor film, or the like), or the like) or display unit of the system (e.g., products or merchandise located on the shelf to which the display unit is attached and/or the products located on a shelf below the shelf to which the display unit is attached). In specific embodiments, the controller comprises a module configured to identify whether or not an object is in proximity to a sensor or display unit of the system. In certain embodiments, the controller comprises a module configured to access a data store comprising information regarding an object assigned to be in proximity to the sensor (e.g., camera) or display unit and a module configured to determine whether or not an object in proximity to the sensor (e.g., camera) or display unit corresponds to the object assigned to be in proximity to the sensor (e.g., camera) or display unit, based on the information conveyed to the controller by the sensor (e.g., camera) output signal (e.g., by comparing an image of an object captured by the camera and conveyed via the output signal to the controller to an image of an object assigned to be in proximity to the camera—such image being stored, e.g., in a data store, and accessed by a controller module). In specific embodiments, the controller comprises a sensor identification module configured to identify the sensor from which the sensor information is conveyed, a module configured to access a data store comprising information associating an object (e.g., product) with the identified sensor (e.g., camera), and a module configured to determine whether or not an object in proximity to the sensor (e.g., camera) corresponds to the object assigned to be in proximity to the camera. In some embodiments, the controller further comprises a module configured to send an alert output signal to display or otherwise trigger an alert if an unassigned object is identified as being in proximity to the sensor (e.g., camera).

In some embodiments, the system or display unit provides herein comprises an environmental sensor (e.g., a temperature sensor, a humidity sensor, or a combination thereof). In specific embodiments, a system provided herein comprises a controller comprising a module configured to determine an environmental state in proximity to the sensor (e.g., in proximity to a display unit of the system). In certain embodiments, the environmental sensor is configured to provide output signals to a controller, the output signals conveying information regarding an environmental state (e.g., temperature and/or humidity) in proximity to (e.g., behind, below, and/or behind) the sensor (e.g., in proximity to the display unit, particularly wherein the sensor(s) are housed within the display unit). In some embodiments, the controller comprises a module configured to determine the status of an environmental state (e.g., temperature or humidity) in proximity to the sensor based on the information conveyed to the controller by the environmental sensor signals (e.g., from the environmental sensor(s)). In some embodiments, the controller comprises a module configured to compare the status of the environmental state (e.g., temperature and/or humidity) in proximity to the environmental sensor to a predetermined parameter (e.g., a minimum temperature, a maximum temperature, a minimum humidity, a maximum humidity, or the like). In specific embodiments, the controller comprises a sensor identification module configured to identify the sensor from which the sensor information is conveyed, a module configured to access a data store comprising information associating an object (e.g., product) with the identified sensor, and a module configured to compare the status of the environmental state in proximity to the sensor to a predetermined parameter. In some embodiments, the controller further comprises a module configured to send an alert output signal (e.g., to a display, light, an audio receiver, a personal computer, a database, or the like) if the status of the environmental state satisfies (or fails to satisfy) a predetermined parameter (e.g., to facilitate environmental control of the retail environment). In some embodiments, the controller further comprises a module configured to send an alert output signal (e.g., to a display, light, an audio receiver, a personal computer, a database, or the like) if the amount of the object meets or fails to meet a predetermined parameter (e.g., falls below a minimum value, such as to facilitate re-ordering and/or re-stocking). In some embodiments, the alert is optionally displayed or otherwise signaled on a display unit described herein, on a separate user interface, such as a person computer, tablet, or the like, an alert light (e.g., an LED), a speaker (e.g., for audio alerts), or the like. In certain embodiments, the controller comprises a module configured to record the amount of object in proximity to the sensor (e.g., periodically, such as daily) to a data store (e.g., so as to allow inventory tracking of a product—in some instances, the controller further comprises a module configured to track inventory of a product).
ments, the alert is optionally displayed or otherwise signaled on a display unit described herein, on a separate user interface, such as a person computer (e.g., a monitor thereof), tablet, or the like, an alert light (e.g., an LED), a speaker (e.g., for audio alerts), or the like. In certain embodiments, the controller comprises a module configured to record the status of the environmental state in proximity to the sensor (e.g., periodically, such as weekly, daily, nightly, or the like) to a data store, such as the hard drive of a personal computer, a cloud, or the like (e.g., so as to allow tracking of an environmental state, such as temperature and/or humidity). In specific embodiments, environmental units are particularly useful in refrigerated units.

[0011] In certain embodiments, the sensor (e.g., rear facing camera) is configured to provide output signals, the output signals conveying information regarding a state of an operating parameter (e.g., an inventory level and/or product or merchandise placement). In certain embodiments, the sensor (e.g., camera) conveys information suitable for determining inventory levels using, e.g., spatial recognition software, and/or product identification using, e.g., label and/or barcode recognition software, or other desired information. In specific embodiments, the sensor (e.g., camera) is configured to detect (or convey information about) product or merchandise in proximity to the sensor (e.g., camera) (e.g., on a shelf below and behind a unit housing the camera, on a shelf to which a unit housing a camera is affixed or otherwise attached, or the like). Further, in some embodiments, the display unit, e.g., sensor (e.g., camera) thereof, comprises a module configured to store and/or determine a sensor (e.g., camera) identifier associated with (e.g., the location of) the sensor (e.g., camera) (e.g., in and/or near which display units the sensor is located). In specific instances, the sensor identifier is a dynamic identifier, such as an identifier assigned based on the order in which multiple sensors (e.g., cameras) of the system are manually connected to the system.

[0012] In certain embodiments, a system or display unit (e.g., strip) provided herein further comprises an additional sensor, the additional sensor configured to provide sensor output signals, the sensor output signals conveying information regarding a state of an operating parameter (e.g., of the display unit or sensor). In certain embodiments, the sensor is a motion detector, a camera (e.g., configured to detect motion and/or facial features—i.e., facial recognition), or any suitable sensor for detecting an object or person in proximity to the display, and/or detecting a state of an object or person in proximity to the display. In specific embodiments, the sensor is configured to detect a person located in front of the display and/or in front of closely adjacent displays (e.g., wherein a system comprising multiple display units is provided). In some embodiments, the sensor is configured to detect a predetermined state of a person located in front of the display and/or in front of closely adjacent displays (e.g., wherein a system comprising multiple display units is provided). In specific embodiments, provided herein is a system comprising multiple display units, at least one display unit comprising a sensor. Further, in some embodiments, the display unit, e.g., sensor thereof, comprises a module configured to store and/or determine a sensor identifier associated with (e.g., the location of) the sensor (e.g., in and/or near which display units the sensor is located). In specific instances, the sensor identifier is a dynamic identifier, such as an identifier assigned based on the order in which multiple sensors of the system are manually connected to the system.

[0013] In specific instances, the additional sensor is a camera (e.g., wherein a display unit of the system comprising the camera integrated therein) configured to detect the presence of persons and/or objects in proximity to a display surface (e.g., the camera and the display surface both being, in exemplary embodiments, combined into a display unit). In some embodiments, the display surface (e.g., LED array) is configured to face in a first direction and the camera (e.g., lens thereof) is configured to face in a second direction (e.g., the first and second direction being the same, or being within 0 degrees to about 75 degrees of one another). In certain embodiments, the camera is configured to provide output signals to a controller, the output signals conveying information regarding objects and/or persons configured in proximity to (e.g., in front of) the display unit (e.g., in an aisle in front of—including, e.g., directly in front of and adjacent to in front of, and the like). In more specific instances, the system comprises a first display unit comprising a first display surface (e.g., an LED array described herein) and a first camera, the first display surface configured to face a first direction and the first camera configured to face in a second (e.g., similar) direction; and a second display surface (e.g., an LED array described herein) and a second camera, the second display surface configured to face a third direction and the second camera configured to face in a fourth (e.g., similar) direction. In some instances, the first and third directions are the same or different, and the second and fourth directions are the same or different. In specific instances, the system comprises a sensor configured to provide output signals to a controller, the output signals conveying information regarding the state of an operating parameter, the controller configured to identify the state of an operating parameter (e.g., identify the status of a predetermined sensor state, such as motion, no motion, and capture (e.g., as determined by identification of a face using facial recognition software)) and to provide predetermined display information (content) to the one or more display unit of the system based on the identified sensor state.

[0014] In some embodiments, provided herein is a system (e.g., a retail display system) comprising any display described herein, camera (e.g., rear facing camera), an optional additional sensor (e.g., forward facing camera), and a controller. In various embodiments, the controller comprises one or more controller units that when taken together comprise the features and/or perform the functions described herein. In some embodiments, the controller comprises an output configured to provide global system display information to one or more display unit (e.g., multiple display units). In certain embodiments, the controller comprises an input configured to receive a sensor output signal (e.g., from one or more sensor (e.g., a forward facing and/or rear facing camera) of one or more display unit described herein).

[0015] In some embodiments, the system, e.g., controller thereof, comprises a sensor state identification module configured to identify or monitor a sensor state (e.g., of an operating parameter) of a sensor thereof (e.g., configured to detect sensor states and/or interactions). For example, in certain embodiments, the sensor state identification module is configured to detect whether or not a person is in proximity to a display unit of the system (e.g., the display unit in which the sensor is located, or an adjacent or otherwise nearby display unit) (e.g., wherein the sensor state operating parameter is near or not near one or more display unit of a system described herein). In further or additional embodiments, the sensor state identification module is configured to detect
whether or not inventory level of a product are low (e.g., below a predetermined level) or high (e.g., above a predetermined level) and/or whether or not a product is misplaced. In some embodiments, a system provided herein further comprises a sensor state information module configured to identify predetermined information to be provided to (or displayed on) a display unit based on whether or not a predetermined sensor state (e.g., of an operating parameter) of a sensor has been satisfied.

[0016] In specific embodiments, provided herein is a display system comprising a first camera, a second camera and one or more display unit. In specific embodiments, the display system comprises the first camera, the second camera (or other sensor configured to detect persons or evidence of persons (e.g., motion, heat, or the like), such as customers, in front of or in viewable proximity of the display surface), and a display surface (e.g., the display surface comprising an LED array described herein). In some embodiments, the display surface (e.g., LED array) is configured to face a first direction, the first camera (e.g., lens thereof) is configured to face a second direction (e.g., a direction about 90 degrees to 180 degrees or about 135 degrees to about 180 degrees opposed to the first direction—a rear facing direction), and the second camera (e.g., lens thereof) is configured to face a third direction (e.g., a direction 0 degrees to about 90 degrees or 0 degrees to about 75 degrees or about 0 to about 45 degrees of the first direction—a forward facing direction). In certain embodiments, the first camera is configured to provide first output signals to a first controller, the first output signals conveying information regarding objects (e.g., retail products) configured in proximity to (e.g., behind, below, and/or behind) the display unit (e.g., on a shelf behind, or behind and below, the display unit), and the second camera is configured to provide second output signals to a second controller (e.g., a sub-controller unit of the system controller), the second output signals conveying information regarding the state of an operating parameter. Further, in specific embodiments, the second controller is configured to identify the state of an operating parameter (e.g., identify the status of a predetermined sensor state, such as motion, no motion, and captive (e.g., as determined by identification of a face using facial recognition software)) and to provide predetermined display information (content) to the display unit based on the identified state of the operating parameter. In further embodiments, the system further comprises an environmental sensor (e.g., a temperature sensor, a humidity sensor, or both). In specific embodiments, the environmental sensor is configured to provide environmental sensor output signals to a third controller (e.g., a sub-controller unit of the system controller). In some embodiments, the third controller comprising a module configured to determine an environmental state in proximity to the sensor (e.g., in proximity to a display unit of the system). In various embodiments, the first, second, and third controllers are optionally taken together in a single device (e.g., a single computer or control unit), or in any combination of devices.

[0017] In some embodiments, provided herein is a display system (e.g., a retail display system) comprising a first display unit and a second display unit, the first display unit comprising a display surface (e.g., an LED display surface described herein), a forward facing camera (e.g., facing in a direction within 0 to about 75 degrees of the direction in which the display surface is facing), and a rear facing camera (e.g., facing in a direction of about 90 to about 180 degrees opposed to the direction in which the display surface is facing); and the second display unit comprising a display surface (e.g., an LED display surface described herein), and a rear facing camera (e.g., facing in a direction of about 90 to about 180 degrees opposed to the direction in which the display surface is facing). In specific embodiments, the system comprises at least one first display unit and multiple second display units. In some instances, given the open configuration in front of a display unit, a single forward facing or forward detecting sensor (e.g., camera) is able to be configured to detect the state of an operating parameter (e.g., for determining target—customer—proximity) for several display units, whereas the rear facing sensors (e.g., cameras) are situated closely to the objects (e.g., shelved merchandise behind the display units), affording them less field of view. Therefore, in some instances, it is desirable to reduce the number of forward detecting sensors in a system provided herein in order to further enhance affordability of the system. In some embodiments, a system provided herein comprises at least 2 rear facing sensors to every 1 forward detecting sensor. In more specific embodiments, the ratio is at least 4:1 or at least 8:1.

[0018] In specific embodiments, display units and display surfaces described herein comprise light emitting diode (LED) displays. In specific embodiments, the light emitting diode display comprises a viewable surface comprising light emitting diode pixels. Generally, it is to be understood that such displays are not to be confused with liquid crystalline displays (LCDs) that are backlit with light emitting diodes (LEDs), but are often referred to in the art as LED displays. Thus, in certain embodiments, LED displays provided herein are non-LCD LED displays, or displays that do not comprise an LCD viewable surface.

[0019] Provided in certain embodiments herein is a display unit, such as a high aspect ratio display strip. In specific embodiments, such display units are configured for use in a retail environment, such as being configured to be affixed to or integrated with a retail shelving system. In other embodiments, high aspect ratio display strips provided herein are optionally configured to be utilized in other applications, including being configured to be affixed to or integrated with non-retail shelving systems.

[0020] In some embodiments, provided herein is an LED display unit (e.g., LED display strip). Generally, the LED display unit comprises an array of viewable LED pixels and an input configured to receive (or be connected to receive) display information. In some instances, the input is configured to receive display information from a controller, e.g., directly from the controller, via another LED display unit (e.g., by daisy chaining therefrom), or the like. In some embodiments, the display information is global system display information, such as display information for multiple display units—e.g., multiple display units connected to a common controller. In some embodiments, the display unit further comprises a display component output configured to provide display information to the array of viewable LED pixels (e.g., an LED display component body, the LED display component being the component body, such as a circuit board, of the unit comprising the array of LED pixels mounted or embedded therein/thereon). In specific embodiments, the display information provided to the LED pixel array is the display information received by the display unit, or a subset thereof. In specific embodiments, such as wherein multiple display units are controlled by a controller, the LED display unit is configured to receive global system display
information and provide local display information (a subset of the global system display information) to the LED pixel array. In further embodiments, a display unit provided herein comprises one or more processor (e.g., a FPGA) configured to execute one or more program modules. An exemplary program module comprises, by way of non-limiting example, a content identification module configured to identify the local display information (e.g., identify the subset of global system display information that is to be displayed on the specific display unit). Additional non-limiting, exemplary display unit program modules that are optionally included in the display units provided herein are found throughout this disclosure.

In specific embodiments, provided herein is a (e.g., high aspect ratio) light emitting diode (LED) display unit (e.g., a retail display unit) comprising a receiving card and an array of LED pixels. In some embodiments, the receiving card comprises a circuit board, the circuit board comprising an input and an output (e.g., mounted thereon). In specific embodiments, the first input of the receiving card is configured to receive or to be connected to receive display information (e.g., global display information, a subset thereof to be locally displayed on the display unit). In certain embodiments, the array of LED pixels is in the form of a circuit board comprising the array of LED pixels mounted thereon or embedded therein. In further embodiments, the circuit board comprising the LED array further comprises one or more (e.g., multiple) LED drivers. In some embodiments, the output of the receiving card is configured to convey display information (e.g., local display information, such as a subset of the global display information received at the receiving card) to the LED array (e.g., circuit board comprising the same). In further or additional embodiments, the unit further comprises a second output (e.g., mounted thereon), the second output of the receiving card being configured to convey display information (e.g., local display information, such as a subset of the global display information received at the receiving card) to the second LED array (e.g., circuit board comprising the same). In further or additional embodiments, the display unit further comprises a sensor (e.g., a forward facing camera and a rear facing camera). In specific embodiments, the sensor(s) comprises an output configured to convey or to be connected to convey an output signal (e.g., to a controller or a sensor control unit thereof). In further or additional embodiments, the display unit further comprises a housing defined with one or more opening. In specific embodiments, the housing is defined with one or more opening by which the LED array(s) are exposed (e.g., externally exposed, such as to be viewable external to the display unit). In specific embodiments, a single opening exposes all LED arrays of the display unit. In some embodiments, the housing further defines a camera opening (e.g., on the opposite surface as the LED opening(s)) through which a camera (e.g., lens thereof) is exposed (e.g., externally exposed, such as to allow the camera to detect and/or identify objects (e.g., products or merchandise) behind the display unit, or the LED array thereof). Specific optional details of the display unit are described throughout this disclosure. In specific embodiments, however, the arrays have a pixel pitch of about 2.5 mm or less (e.g., about 2 mm or less, or about 1.8 mm to about 1.9 mm, or about 1.875 mm). In further or additional specific embodiments, the display unit having an aspect ratio (length/height) of about 2 or more (e.g., about 2.5 or more, or about 3 or more).
nique, such as by affixing the chip with an electrically con-
ductive adhesive (e.g., an epoxy, an acrylic, a cyanacrylate, a
silicone, a urethane acrylate, or the like comprising a con-
ductive filler, such as silver, nickel, carbon, or the like) or
using any other suitable technique, such as soldering. In some
embodiments, it is possible to reduce the pixel pitch (i.e., the
distance between the center of one pixel to the center of
adjacent pixel(s)). In some embodiments, any suitable LED
technology is optionally utilized, e.g., multiple cups on chip
board (MCOB), chip on board (COB) LED, surface mounted
device (SMD) LED, wired LED, or the like. In preferred
embodiments, the pixel pitch of any LED display or display
unit provided herein is about 3.0 mm or less. In more pre-
ferred embodiments, the pixel pitch is about 2.5 mm or less.
In still more preferred embodiments, the pixel pitch is about
2.0 mm or less. In yet more preferred embodiments, the pixel
pitch is about 1.9 mm or less (e.g., about 1.875 mm).

In certain embodiments, the array of viewable LED
pixels has a first number of pixels in the first dimension and a
second number of pixels in a second dimension. In some
embodiments, the first (height) dimension comprises about
24 pixels or more. In preferred embodiments, the first (height)
dimension comprises about 30 pixels or more (e.g., about 32
pixels). In more preferred embodiments, the first (height
dimension comprises about 30 to about 60 pixels. Generally,
about 30 or more pixels are preferred to provide minimum
desired display requirements, providing for at least three lines
of text with minimal visible text defect. Any suitable number
of pixels is present in the second (length) direction. Pixel
pitch in the second (length) dimension is preferably about the
same as the pixel pitch in the dimension, the number of pixels
being determined thereby and by the length of the display
unit. In certain embodiments, the number of LED pixels in
the second dimension is about 100 or more. In preferred embodi-
ments, the number of LED pixels in the second dimension is
about 100 to about 500, e.g., about 120 to about 200 or about
160.

In some embodiments, the legibility of displays pro-
vided herein are superior over EPD and LCD TFT type dis-
plays, while remaining cost effective and having full color
capabilities. In certain embodiments, the maximum legality
distance of a display provided herein at a viewing angle of 90
degrees is about 5 feet or more. In more preferred embodi-
ments, the maximum legality distance of a display provided
herein at a viewing angle of 10 degrees is about 10 feet or
more. In more specific embodiments, the maximum legality
distance of a display provided herein at a viewing angle of 90
degrees is about 20 feet or more. In certain embodiments, the
maximum legality distance of a display provided herein at a
viewing angle of 25 degrees is about 2 feet more. In more pre-
ferred embodiments, the maximum legality distance of a
display provided herein at a viewing angle of 90 degrees is
about 5 feet or more. In more specific embodiments, the
maximum legality distance of a display provided herein at a
viewing angle of 90 degrees is about 8 feet or more.

In some embodiments, the brightness of the LED
displays provided herein can be configured to provide
improved viewability and an improved viewing experience,
relative to other systems, such as EPD, TFT, and similar
systems. In some embodiments, the display units (e.g., LED
display units thereof) provided herein are configured to have a
brightness of about 500 NITs or more, such as about 800
NITs or about 1000 NITs. In certain instances, while display
units described herein have high brightness capabilities (e.g.,
about 500 NITs or more, such as about 800 NITs or about
1000 NITs), the display is configured to run at lower bright-
ess levels (e.g., to save energy) (e.g., about 25% to about
100% brightness capability), such as about 200 NITs or
more, e.g., about 300 NITs to about 400 NITs.

In some embodiments, the viewable surface of the
LED display component comprises an array of viewable LED
pixels and a coating (e.g., a conformal coating in which the
LED pixels or components thereof are embedded in the coat-
ing). In certain embodiments, the coating comprising any
suitable material, such as an epoxy, a polyurethane, an
acrylic, a silicone, or a combination thereof. In some embodi-
ments, such coatings serve to protect the LED components
from impact damage or environmental damage (e.g., from
humidity, mildew, thermal variation, liquid spills, etc.).

In preferred embodiments, the display unit(s) (e.g.,
strips) comprise at least a first and a second light emitting
diode (LED) display component. In certain instances, the use
of a first and a second light emitting diode (LED) display
component further facilitates cost effective display replace-
ment options, such as when a display component become
damaged or otherwise has less than optimal or desired func-
tionality. In such instances, replacement of a display compo-
nent is optionally effected without replacing the entire dis-
play unit or even the entire display portion of the display unit.

In certain embodiments, a display unit (e.g., strip)
provided herein comprises an input configured to receive
display information (e.g., display information to be displayed
on the display unit and, optionally, to be displayed on one or
more additional display unit(s)). In some embodiments (e.g.,
in a system comprising multiple display units), the input is
configured to receive global system display information.
Generally, global system display information comprises the
display information to be displayed on one or more LED
display units (and, optionally, additional display types).
In some embodiments, the global system display information
comprises the display information to be displayed on multiple
display units. In certain embodiments, the global system
display information is provided to multiple display units in any
suitable manner. For example, in some embodiments, the
global system display information is directly provided to the
inputs of the multiple LED display units. In other embodi-
ments, the information is provided to the multiple LED
display units by daisy chaining the information through one or
more of the multiple display units.

In some embodiments, a display unit (e.g., strip)
provided herein further comprises an output configured to
provide display information (e.g., global system display
information) to an additional display (e.g., an LED display
unit described herein)—such as in a daisy-chaining manner.
In certain embodiments wherein the LED display unit is
present in a multiple display unit system, the output is con-
figured to provide display information (e.g., global system
display information) to an input configured to receive display
information of a second LED display unit.

In certain embodiments, a display unit (e.g., strip)
comprises an output configured to provide local display infor-
mation. In certain embodiments, local display information is
specific to the display unit. In some embodiments, local dis-
play information is a subset of the global system display
information. In other embodiments, local display information
is specific to an LED display component. In some embodi-
ments, the output is configured to provide local display infor-
mation to an LED display component of the display unit. In
specific embodiments, the display unit comprises a first output configured to provide local display information (e.g., first local display information) to a first LED display component and a second output configured to provide local display information (e.g., second local display information) to a second LED display component.

[0033] In some embodiments, the display unit comprises an identification module (e.g., hardware, software, firmware, or the like) configured to store and/or determine an identifier associated with the display unit, or of display components thereof (e.g., in certain instances wherein a display unit comprises multiple display components). In specific embodiments, the identifier is associated with the location of the display unit within a system comprising the display unit and at least one additional display (e.g., additional display units or strips of the type described herein). In certain embodiments, the identification module identifies the location of the display unit, such as the location in a system comprising multiple display units, including one or more of the LED display units described herein and, optionally, additional display unit types.

[0034] In some embodiments, the display unit(s) comprises a content identification module configured to identify the information (e.g., video, images, text, and/or the like) to be displayed at the identified location. In specific embodiments, the content identification module identifies a subset of information to be decompressed by the decompression module and displayed at the identified location. In some such embodiments, the decompression module de-compresses (e.g., only) the subset of information received that is to be displayed at the identified location.

[0035] In some embodiments, the display unit (e.g., strip) comprises a content identification module that is configured to identify the local display information (e.g., as-received or decompressed information) to be displayed on the display unit. In specific embodiments, one or more content identification modules is configured to identify local display information to be displayed on a first LED display component and a second LED display component. In more specific embodiments, a single content identification module is configured to identify local display information for both a first and a second LED display component. In other specific embodiments, a content identification module is configured to identify first local display information (e.g., to be displayed on) a first LED display component and a second content identification module is configured to identify second local display information (e.g., to be displayed on) a second LED display component.

[0036] In some embodiments, the display unit (e.g., strip) comprises an information decompression module that is configured to decompress compressed display information. In specific embodiments, the information decompression module is configured to decompress compressed global system display information, or a subset thereof, received by the display. In specific embodiments, the information decompression module is configured to decompress local display information (e.g., decompression information identified by the content identification module as being local display information for the identified display).

[0037] In certain embodiments, modules described herein are program modules, one or more processors configured to execute such program modules. In various embodiments, processors provided herein are units capable of executing and/or configured to execute program modules and include, by way of non-limiting example, computer processing units (CPUs), graphics processing units (GPUs), field-programmable gate arrays (FPGAs), and combinations thereof. In other embodiments, modules are, optionally, hardware modules, firmware modules, or other suitable modules. In various embodiments, modules comprise a combination of program and hardware modules.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] FIG. 1 illustrates a front perspective view of an exemplary high aspect ratio LED display unit comprising an array of viewable LED pixels.

[0039] FIG. 2 illustrates various components of an exemplary display unit provided herein.

[0040] FIG. 3 illustrates various components of an exemplary display unit provided herein.

[0041] FIG. 4 illustrates an exemplary retail shelving system comprising multiple display units provided herein.

[0042] FIG. 5 illustrates an exemplary segmentation scheme of graphic card display configurations into smaller height segments used in the display units and systems provided herein.

[0043] FIG. 6 illustrates an exemplary logical layout on one or more shelf face using a segmented graphics card configuration.

[0044] FIG. 7 illustrates an exemplary segmented content configuration of an exemplary system provided herein.

[0045] FIG. 8 illustrates components and modules of an exemplary system provided herein.

[0046] FIG. 9 illustrates components and modules of an exemplary system provided herein.

[0047] FIG. 10 illustrates modules of an exemplary controller or system provided herein, or steps of an exemplary method provided herein.

[0048] FIG. 11 illustrates modules of an exemplary controller or system provided herein, or steps of an exemplary method provided herein.

[0049] FIG. 12 illustrates an exemplary configuration of single sensors detecting multiple sensor states, e.g., in multiple sensor zones.

[0050] FIG. 13 illustrates an exemplary depiction of a retail store aisle comprising one or more retail display system provided herein.

[0051] FIG. 14 illustrates a rear view of an exemplary display unit provided herein.

[0052] FIG. 15 illustrates an exemplary LED array of a display unit provided herein, with exemplary text configurations for display thereon.

[0053] FIG. 16 illustrates an exemplary system comprising a controller and one or more display unit.

[0054] FIG. 17 illustrates a system or process configured to provide an output signal to a sensor controller, and the optional output results thereof.

[0055] FIG. 18 illustrates a cross sectional view of an exemplary display unit provided herein.

[0056] FIG. 19 illustrates a cross sectional view of an exemplary shelving system comprising a display unit provided herein.

DETAILED DESCRIPTION OF THE INVENTION

[0057] In certain embodiments, the light emitting diode displays provided herein is a high aspect ratio light emitting diode display strip, systems comprising the same and com-
ponents thereof. In specific embodiments, the display strips are useful for and/or configured for retail applications, such as to be integrated with or attached to retail scaffold, such as (e.g., the front surface of) a shelf. In specific applications, the shell is a retail shelf.

[0058] FIG. 1 illustrates an exemplary high aspect ratio LED display unit 100 provided herein. The exemplary display unit comprises a first LED display component 101 and a second LED display component 102. Each exemplary display unit comprises an array of LED pixels 103, the array comprising 32 LED pixels in a first dimension 104 and 80 LED pixels in a second dimension 105, the display unit as a whole comprising an array of 160 LED pixels by 32 LED pixels. In addition, the exemplary display unit comprises a housing body 106, comprising a front surface 107 and rear surface 108 and having a length 109, a height 110, and a depth 111. The front and rear surfaces are optionally flat or contoured, depending on the specific application. The exemplary display unit further comprises a forward facing (e.g., positioned to face outward from the front surface of the) sensor (e.g., motion detector or camera) 112 situated in an approximately central position along the length of the display unit. In some embodiments, the sensor (e.g., camera) is located in a forward facing position on an upper portion of the display unit (e.g., as displayed in FIG. 1), on a lower portion of the display unit (e.g., if the display unit of FIG. 1 were flipped over), or any other suitable position. In exemplary embodiments, the display unit 100 comprises one or more chaining (e.g., daisy chaining) connectors 113, e.g., configured to receive and/or convey, provide or transmit display information (e.g., to additional display units—not illustrated). FIG. 14 illustrates the rear surface of an exemplary display unit 1400 provided herein. In some instances, the display unit comprises a power input 1401 and a power output 1402 (e.g., a simple two pin power connector, such as a molex), e.g., configured to daisy chain power to one or more additional display unit. In certain instances, the display unit comprises a display information input 1403 and a display information output, e.g., configured to daisy chain data to one or more additional display unit. In some instances, the display unit further comprises one or more data input and/or output 1404 and 1405 (e.g., a USB type output, such as USB 3.0, USB 2.0, mini USB, micro USB, or the like), such as a sensor information output and/or a sensor information input (e.g., configured to receive and/or convey sensor information from one or more sensor). In specific instances, the two data outputs 1404 and 1405 are data outputs for conveying output signals away from the display unit 1400 from the forward sensor 112 and the rear sensor 1408. In some instances, display units provided herein are integrated with a shelving system, or the like, and in other instances, the display units are configured to be capable of being attached to retail scaffold, such as a shelf (e.g., the front edge thereof), e.g., using one or more bracket or magnet 1407.

[0059] As illustrated in the cross-sectional view of FIG. 18, in some embodiments, a display unit 1800 provided herein comprises a display surface 1801 (e.g., comprising an LED array, which is optionally coated 1803, such as with a resin to protect the LED pixels 1804) is configured to face in a first direction 1805 and the camera 1806 (e.g., lens thereof) is configured to face in a second direction 1807 (e.g., a direction about 90 degrees to 180 degrees or about 135 degrees to about 180 degrees opposed to the first direction). In specific embodiments, the first and second directions are parallel and opposed (i.e., 180 degrees opposed), such as illustrated in FIG. 18. In some instances, the camera 1806 has an angle of view 1808 (e.g., any suitable angle 180 degrees or less, such as about 120 degrees), the second direction 1807 bisecting the angle of view 1808. In some embodiments, the display unit further comprises a second camera 1809, configured to face in a third direction 1810 (e.g., a direction 0 degrees to about 90 degrees aligned with the first direction). In some instances, the second camera 1809 has an angle of view 1811 (e.g., any suitable angle 180 degrees or less, such as about 60 degrees), the third direction 1810 bisecting the angle of view 1811. In some embodiments, the first direction and third direction are aligned within 0 degrees of each other (i.e., parallel as illustrated in FIG. 18). In other embodiments, the first and third directions are aligned within 90 degrees of one another (e.g., within 60 degrees, within 45 degrees, within 30 degrees, or the like of one another).

[0060] In specific embodiments, such as illustratively displayed by way of non-limiting example in FIG. 19, the display unit 1901 comprising a viewable display 1902 (e.g., comprising an array of coated 1903 and viewable LED pixels 1904) is attached to or integrated with a shelf 1911 and is configured to face in a first direction 1905. In some embodiments, provided herein is a shelving system (e.g., retail shelving system) comprising a plurality of shelves comprising one or more display unit attached to or integrated therewith. In some embodiments, the display unit comprises a first sensor configured to detect product in proximity to the display unit. In specific embodiments, the first sensor is a camera 1906 configured to face a second direction 1907, e.g., in a rear facing direction, as discussed herein. In some embodiments, provided herein is a system (e.g., inventorying system) wherein a camera is affixed to or integrated with a shelving unit and is configured to capture and/or convey information about objects (e.g., product or merchandise) situated in proximity to (e.g., on a shelf below) the camera. In specific embodiments, the camera is integrated with a display unit provided herein, the camera being configured to be accepted into the display unit housing on the lower half, e.g., lower third or lower quarter, of the housing. In some embodiments, this configuration allows the camera to hang below the bottom face of a shelf and/or be in a better position to view objects in proximity to the camera. In certain embodiments, the first sensor is configured to detect objects 1912 (e.g., product or merchandise) in proximity to the display unit or first sensor and to send output signals (e.g., to a system controller) conveying information about the objects in proximity to the first sensor. In some embodiments, a system controller (not illustrated in FIG. 19) comprises a module configured to compare sensor information received from the first sensor (e.g., an image of an object captured by a camera) to information (e.g., retrieved from a data store) about an object assigned to be in proximity to the first sensor (e.g., and a module configured to access a data store configured to store accessible information regarding objects assigned to be in proximity to the sensor). In some embodiments, the module is configured to compare images of the objects in proximity to the sensor to images of objects assigned to be in proximity to the sensor. In other specific embodiments, (e.g., wherein the sensor is an RFID sensor) the module is configured to compare RFIDs of objects in proximity to the sensor or display unit to RFIDs of objects assigned to be in proximity to the sensor or display unit. In yet other specific embodiments, (e.g., wherein a sensor film is placed on the shelf to which the display unit is attached or integrated) the module is config-
ured to compare a sensor state (e.g., weight) of the objects present on the shelf to information about the state (e.g., weight of) an object assigned to be on the shelf (and, e.g., a module configured to divide the total weight on the shelf by the weight of an object assigned to be on the shelf to arrive at the number of objects assigned to be on the shelf that are on the shelf). In still other specific embodiments, the module is configured compare the amount of space taken up proximity to the sensor (e.g., on a shelf) compared to the amount of space taken up by each object assigned to be in proximity to the sensor. For example, a module is configured to look for a pattern on the shelf (e.g., markers on a shelf). As an example, when the shelf is empty, each foot of shelving has x (10–1000, such as 216—one by one inch for an 18" deep shelf per 1' of shelf) number of markers (e.g., actual markers—such as dots, or a program construct thereof), and none of the markers are obstructed by product. In some instances, the module is configured to compare the number of markers obstructed to the number of markers each object assigned to be at the location would obstruct if located on the shelving. As such, in some embodiments, a controller module herein is configured to count visible markers on a shelf, compare the number of markers assigned to be in proximity to the sensor to the number of markers visible, and further compare the number of non-visible markers to the number of markers obstructed by an object in proximity to the sensor (e.g., in order to make a determination of the number of assigned objects—product or merchandise—in proximity to the sensor). In addition, in some embodiments, the display unit comprises a sensor configured to detect the sensor state of an operable parameter of the content displayed on the display unit, such as, e.g., a motion detector, forward facing camera (e.g., the configuration of which is described herein, particularly facing in a third direction 1910, such as that is within 90 degrees of the first direction), or other sensor suitable for detecting the presence of a person (e.g., customer in a retail environment) in proximity to the display unit.

[0061] In some embodiments, provided herein is a display unit comprising a power supply (e.g., a DC/DC converter or an AC/DC converter). In certain embodiments, a display unit provided herein is configured to receive power and display information via a single source, such as over Ethernet. In other embodiments, a display unit provided herein is configured to receive power and display information via different sources. In some embodiments, display units provided herein further comprise power regulators, e.g., to ensure a stable voltage provided to the display unit components. In some embodiments, display units provided herein additionally comprise one or more LED driver, e.g., configured to control the current provided to the LED array, which in some instances reduces the risk of LED failure.

[0062] Display units provided herein are configured to receive display information from wired and/or wireless sources. In certain embodiments, the display unit(s) (e.g., strip) comprises a receiver for receiving information (e.g., digital information). In various embodiments, the receiver comprises an input, such as a wired information input (e.g., a port) (e.g., a USB (e.g., USB 1.0, USB 2.0, USB 3.0) input, a modular connector input (e.g., a 4 position 4 contact (4P4C), 6P6C, 6P2C, 6P4C, 6P6C, 8P8C, 10P10C, or similar modular connector)), an Ethernet input, a cat5 input, a cat5e input, a cat6 input, a micro USB input, a mini USB input, a registered jack (e.g., RJ11) input, a component input, a RCA input, a coaxial input, a digital visual interface (DVI) input, a video graphics array (VGA) input, a wireless information (e.g., WiFi, 4G, 3G) input, or the like. In certain embodiments, the receiving module is configured to receive compressed information.

[0063] Further, display units provided herein generally comprise one or more processor configured to execute one or more program module. In specific embodiments, the processor is a field programmable gate array or suitable microprocessor. In some embodiments, the one or more processor is configured to execute an identification module configured to store and/or access a stored identifier associated with the display strip in which the processor is located. In specific embodiments, the identifier is associated with the location of the display strip. In further embodiments, the one or more processor is configured to execute an identification module configured to determine an identifier associated with the display strip in which the processor is located. In certain embodiments, the one or more processor is configured to decompress global system display information or a subset thereof—such as the identified local display information.

[0064] FIG. 2 illustrates an exemplary display unit 200 provided herein, wherein the display unit is configured to receive power and display information over Ethernet (using Ethernet protocols, or using a cat5, cat5e, cat6 or similar Ethernet type cable using other suitable protocols). The display unit comprises an optional power supply or power converter 201 configured to receive integrated display information and power 204, and an optional power regulator 202 configured to provide a suitable power source to the display unit (e.g., various components thereof). In some embodiments, the power supply or power converter is configured to convert received DC voltage to a suitable DC voltage (e.g., about 3 Vdc to about 5 Vdc) and the power regulator is configured to regulate the voltage (e.g., at about 3 Vdc to about 5 Vdc). The exemplary display unit 200 further comprises a display information receiver 203, such as the Ethernet receiver illustrated, and a processor 205, such as the FPGA illustrated. In certain embodiments, the processor 205 is configured to determine the display information to be displayed on the display array 206. Optional LED drivers 207 are also included. Display information and power are optionally provided to additional display units via any suitable technique, such as daisy chaining 208 (e.g., using a T568B Ethernet cable, or any other suitable cable).

[0065] FIG. 3 illustrates another exemplary display unit 300, wherein the display unit is configured to receive power in a first (power) input 301 (e.g., receive AC power) and display information in a second (information) input 302 (e.g., receiving compressed display information). The display unit comprises an optional power supply 303 (e.g., converting AC power to DC power, such as about 3 Vdc to about 5 Vdc) connected to the power input 301, and an optional power regulator 304 connected to the power supply 303 and configured to provide a suitable power source to the display unit (e.g., various components thereof). The input information 302 is connected to a receiver (information receiver) 305. The display unit comprises one or more processor (e.g., FPGA) 306 configured to execute one or more program modules
configured to identify local display content to be displayed on the display unit (i.e., the LED array thereof 312). In some embodiments, the program modules comprise a display identification module 307, a content identification module 308, and a decompression module 309. Optional LED drivers 310 are also included. Display information and power are optionally provided to additional display units via one or more output 311 using any suitable technique, such as daisy chaining.

[0066] FIG. 4 illustrates a retail system 400 comprising multiple display units 401 provided herein. The display units are optionally affixed to and/or integrated with retail shelving 402. As illustrated, given the cost effective nature of the display units, it is possible to utilize the display units 401 provided herein to provide specific display content for each product 403 on the shelves, even when the shelves are in complex configurations. In some embodiments, the system comprises one or more display unit comprising a sensor 404 (e.g., camera) configured to detect a sensor state, such as proximity to the sensor or a display unit comprising the sensor, and/or near a display unit comprising the sensor. In some instances, only a single sensor comprising display unit is needed to detect, for example, proximity to several (e.g., nearby) display units. For example, while each or multiple display units of a system optionally comprise a sensor, FIG. 4 illustrates a single display unit comprising a sensor 404. In some embodiments, by reducing the number of display units comprising a sensor, an even more cost effective system is achieved.

[0067] FIG. 5 illustrates an exemplary segmentation scheme of graphic or sending card display configurations into smaller height segments used in the display units and systems provided herein. As illustrated, an exemplary graphics (or sending) card 501 (e.g., QWXGA graphics card) provides image content to a pixel array 502 (e.g., 2048x1152). In specific instances, a single QWXGA graphics card of 2048x1152 supports 2,359,296 pixels in a system provided herein. Optionally, other graphics (or sending) cards are alternatively utilized to prepare other segmentation schemes. Other graphics cards or sending cards supporting various graphics arrays, such as XGA (1024x768), WXGA (1366x768), XGA+ (1152x864), WXGA+ (1440x900), SXGAXA (1280x1024), SXGAXA+ (1400x1050), WSXGAXA+ (1680x1050), UXGA (1600x1200), WUXGA (1920x1200), and many other types are optionally utilized. In specific embodiments, graphics or sending cards provided herein support a system comprising more pixels. For example, in some embodiments, dual sending cards provided herein support twice as many pixels. Further, in some embodiments, the system is configured to provide failover (e.g., by being configured to provide display information to a first and a last display unit of the system), thereby support half as many pixels. Segmentation of such a 2048x1152 array provides, for example, forty eight (48) segments 503 for display units having a height of 24 pixels. In other examples, using such a segmentation scheme is used to provide content to 36 segments for display units having a height of 32 pixels. In some embodiments, systems provided herein are configured as continuous displays (e.g., limited only by the display size desired), e.g., utilizing such techniques. FIG. 6 illustrates the logical layout on a shelf face of such a segmentation configuration (e.g., to create a width of greater than the pixel array width generally supported by a specific graphics card, such as a width greater than 2048 for QWXGA graphics cards). In some embodiments, provided in a system, e.g., a controller thereof, is a segmentation module configured to segment a graphics array to provide display content for a high aspect ratio system display array (e.g., a system display array of greater than that typically supported by the graphics card). In such embodiments, segmentation allows for a single graphics card to provide display content to a very high aspect ratio system display array of 98,304x24 for displays having a height of 24 pixels (e.g., up to over 900 display units having an LED array of 160x24) or 73,728x32 for displays having a height of 32 pixels (e.g., up to over 450 display units having an LED array of 160x32). Further, as illustrated in FIG. 5, with additional (n) graphics cards 504, additional display content is optionally provided to additional (n) arrays 505 that are similarly segmented. As illustrated in FIG. 7, however, global and local display content is not limited by the segment or display sizes. In some instances, content segments optionally span two or more adjacent configurations display units. Depending on how the products are arranged, for example, segmented content (701-708) is optionally stitched together (e.g., by a stitching module discussed herein) in any suitable manner.

[0068] In some embodiments, provided herein is a display system comprising one or more display unit and a controller. FIG. 16 illustrates an exemplary system 1600 comprising a controller 1601 and one or more display unit 1602. A single controller is illustrated comprising a plurality of controller subunits combined to serve the function of the system controller. In some instances, a controller comprises one or more processor configured to execute one or more controller program module. Exemplary program modules comprise, by way of non-limiting example, a sensor state identification (e.g., configured to monitor or detect sensor states, including operating parameters thereof), content identification module (e.g., configured to identify predetermined information to be provided to the one or more system display units based on the status of a sensor state), a content stitching module (e.g., configured to stitch the predetermined information (e.g., corresponding to local display information to ultimately be displayed at the display unit(s)) together, such as to form a global system display information, a content compression module (e.g., configured to compress display information), or combinations thereof. In some instances, a controller provided herein further comprises a transmitter configured to provide global system display information (e.g., compressed or not), to one or more system display unit 1602. As illustrated, in some embodiments, a display unit (e.g., display strip) comprises a receiver configured to receive display information (e.g., global system display information or local display information). As further illustrated, in certain embodiments, a display unit (e.g., display strip) comprises one or more output (e.g., an output hub as illustrated) configured to provide display information (e.g., local display information) to one or more display component (two display components are illustrated, but units comprising a single or more than two display components are contemplated). In certain embodiments, a display unit provided herein further comprises a receiver and an output (e.g., configured to provide display information to the display components). In some instances, the output is an output hub, as illustrated in FIG. 16, configured to provide display information to more than one display component of the display unit. In certain embodiments, a display unit provided herein further comprises one or more processor (e.g., FPGA) configured to execute program modules, such as any one or more of the various display unit program modules discussed herein. In certain embodiments,
a display unit provided herein comprises an output configured to convey or transmit display information 1604 (e.g., global system display information) to another system display unit (e.g., by daisy-chaining). In other embodiments, a controller 1601 provided herein optionally provides display information (e.g., global system or local display information) directly to individual display units. In some embodiments, a system provided herein comprises one or more power supply. In certain embodiments, the system comprises at least one power supply (e.g., a switching power supply configured to convert AC to DC, such as about 5 Vdc) configured to provide power to one or more display unit and at least one power supply configured to provide power to the controller. In some instances, the system comprises one or more power supply that is configured to provide power directly 1608 to one or more display units, configured to provide power directly to a first display unit and chained 1609 to a second display unit, or a combination thereof. In certain embodiments, the system 1600 further comprises one or more sensor, e.g., configured to provide sensor output signals (e.g., the sensor output signals conveying information regarding a sensor state—e.g., a state of an operating parameter) to a controller 1601. In specific instances, the controller 1601 comprises a display controller subunit configured to provide predetermined display information to one or more display unit of the system. In some instances, the display controller provides display information to one or more display units based on the sensor state of the system. In certain embodiments, the system comprises a forward and/or rear sensor configured to convey information to one or more sensor controller, such as a rear sensor controller and/or forward sensor controller as illustrated in FIG. 16. In some instances, the sensor controller(s) comprise a module configured to determine the sensor state(s) which is then optionally used by the display controller to determine the display information to convey to the one or more display units). In specific embodiments, the display controller is configured to retrieve display information from a data store based on the sensor state(s) identified by the sensor controller(s). In some embodiments, the display controller is configured to retrieve display information from a data store based on the sensor state(s) identified by a forward sensor controller (e.g., based on sensor information conveyed from one or more forward facing sensor). In certain embodiments, the rear sensor controller is configured to receive rear sensor signals from one or more rear facing sensor (e.g., a sensor facing in a direction about 90 degrees to 180 degrees opposed to the viewable surface of the display unit/component), and comprises a module configured to identify the number of product or merchandise in proximity to the sensor and/or identify any misplaced products or merchandise. In some embodiments, identification of such information (e.g., sensor states) is utilized by system modules configured to determine display information provided to the displays, and/or to record a record of such information to a data store, which information is accessible by a personal computer, a tablet, or the like (e.g., used to keep inventory records). Similar systems and methods are optionally utilized for if environmental sensors are used in addition to or instead of a rear-facing sensor (e.g., camera). In some instances, power is provided to the sensor via a controller power supply (as illustrated, such as through a USB connection) or a display unit power supply. In other instances, a sensor comprises it own power supply. In certain embodiments, one or more display unit of the system comprises the sensor mounted therein or thereon. [0069] As more generally illustrated in FIG. 17, in some embodiments, provided herein is a system comprising a sensor configured to provide an output signal to a sensor controller, the output signal conveying information regarding a state in proximity to sensor (or a display unit comprising the sensor). In specific embodiments, the sensor is a camera (e.g., a rear facing camera), or an environmental sensor (e.g., a humidity or temperature sensor). In certain embodiments, the sensor controller comprises one or more processor configured to execute one or more sensor controller program module. In specific embodiments, the sensor is a rear facing camera (e.g., the camera is configured to face in a direction about 90 degrees to 180 degrees opposed to the viewable display surface of one or more display unit of the system, such as the viewable display surface of a display unit in which the sensor is housed) and the one or more sensor controller program module comprises a module configured to determine whether any objects (e.g., products or merchandise) in proximity (e.g., within about 10 feet, about 5 feet, or about 3 feet) of the sensor are out of place (e.g., a first module configured to access a data store comprising information about what objects are assigned to be in proximity to the sensor and a second module configured to compare the objects in proximity to the sensor to the objects assigned to be in proximity to the sensor); a module configured to determine the amount of objects there are in proximity to the sensor (e.g., a first module configured to access a data store comprising information about what objects are assigned to be in proximity to the sensor and a second module configured to count or approximate the number of object assigned to be in proximity to the sensor are actually in proximity to the sensor); or a combination thereof. In other specific embodiments, the sensor is an environmental sensor (e.g., a temperature and/or humidity sensor) and the one or more sensor controller program module comprises a module configured to determine the status of an environmental state (e.g., temperature and/or humidity) in proximity to the sensor; a module configured to determine whether the environmental state is outside an acceptable level (e.g., temperature above a predetermined value, temperature below a predetermined value, humidity above a predetermined value, humidity below a predetermined value, or any combination thereof) in proximity (e.g., within about 10 feet, about 5 feet, or about 3 feet) of the sensor (e.g., a first module configured to access a data store comprising information about predetermined acceptable environmental conditions (e.g., temperature and/or humidity) in proximity to the sensor and a second module configured to compare the environmental conditions in proximity to the sensor to the acceptable environmental conditions assigned to be in proximity to the sensor); or a combination thereof. In some embodiments, the sensors comprise both a rear facing camera and an environmental sensor. In some embodiments, the sensor controller further comprises one or more module configured to record or write the determined condition (e.g., amount of an object, and/or temperature and/or humidity) to a data store (e.g., a hard drive, cloud storage, or the like); to send an alert output signal (e.g., to a display, a light, a speaker, or the like); or to send a predetermined condition (e.g., amount of an object, temperature, and/or humidity) fails to satisfy a predetermined (acceptable) condition; or a combination thereof. In some specific embodiments, the sensor controller further comprises a module configured to send an output signal to an environmental control unit (e.g., temperature control unit (e.g., a refrigeration unit) or humidity control.
unit) in proximity to the sensor. In further specific embodiments, the system further comprises an environmental control unit (e.g., temperature control unit or humidity control unit) configured to receive the output signal and adjust the environmental conditions (e.g., temperature and/or humidity) in proximity to the sensor.

**[0070]** FIG. 8 illustrates an exemplary system 800 comprising a controller 801 and one or more display unit 802. A single controller is illustrated comprising a plurality of components, however, several controller subunits are optionally combined to serve the function of the controller. In some instances, a controller comprises one or more processor 805 configured to execute one or more controller program module. Exemplary program modules comprise, by way of non-limiting example, a sensor state identification module (e.g., configured to monitor or detect sensor states, particularly operating parameters thereof), content identification module (e.g., configured to identify predetermined information to be provided to the one or more system display units based on the status of the sensor state(s)), a content stitching module (e.g., configured to stitch the predetermined information (e.g., corresponding to local display information to ultimately be displayed at the display unit(s)) together, such as to form a global system display information, a content compression module (e.g., configured to compress display information), and combinations thereof. In some instances, a controller provided herein further comprises a transmitter configured to provide global system display information (e.g., compressed or not), to one or more system display unit 802. In certain embodiments, a system (e.g., controller thereof) provided herein comprises a sending card 806 configured to receive global system display information (e.g., in video format via AVI), a content compression module configured to compress the global system display information, and a transmitter configured to provide the global system display information to a system display unit 802. As illustrated, in some embodiments, a display unit (e.g., display strip) comprises a receiver configured to receive display information (e.g., global system display information or local display information). As further illustrated, in certain embodiments, a display unit (e.g., display strip) comprises one or more output (e.g., an output hub as illustrated) configured to provide display information (e.g., local display information) to one or more display component. In certain embodiments, a display unit provided herein comprises an integrated receiver/hub card, wherein the receiver input and the hub outputs are configured into a single card 803. In some embodiments, integrating the receiver and display output hub allows further compacting of the display unit, which, in some instances, reduces the chances of the display unit being impacted and/or damaged, requiring replacement. In certain embodiments, a display unit provided herein further comprises one or more processor (e.g., FPGA) configured to execute program modules, such as any one or more of the various display unit program modules discussed herein. In certain embodiments, a display unit provided herein comprises an output configured to convey or transmit display information 804 (e.g., global system display information) to another system display unit (e.g., by daisy-chaining). In other embodiments, a controller 801 provided herein optionally provides display information (e.g., global system or local display information) directly 807 to individual display units. In some embodiments, a system provided herein comprises one or more power supply. In certain embodiments, the system comprises at least one power supply (e.g., a switching power supply configured to convert AC to DC, such as about 5 Vdc) configured to provide power to one or more display unit and at least one power supply configured to provide power to the controller. In some instances, the system comprises one or more power supply that is configured to provide power directly 809 to one or more display units, configured to provide power directly to a first display unit and chained 809 to a second display unit, or a combination thereof. In certain embodiments, the system 800 further comprises one or more sensor, e.g., configured to provide sensor output signals (e.g., the sensor output signals conveying information regarding a sensor state—i.e., a state of an operating parameter) to a controller 801. In some instances, power is provided to the sensor via a controller power supply (as illustrated) or a display unit power supply. In other instances, a sensor comprises its own power supply. In certain embodiments, one or more display unit of the system comprises the sensor mounted therein or thereon.

**[0071]** FIG. 9 illustrates an exemplary controller 900 configured to provide power and display information to one or more display unit 901 provided herein. In some instances, a controller provided herein comprises one or more processor (e.g., a CPU) 902 and one or more power supply 911 therefor. In some embodiments, a computer 903, such as a personal computer (PC), comprises the one or more processors and power supply therefor. In certain instances, program modules, such as modules configured to detect or monitor operating parameters (such as sensor states) of the system or display units thereof, identify predetermined information to be displayed on the various display units of the system based on the status of the operating parameters, stitch the predetermined information together to generate global system display information, and/or the like, are executed by the one or more processors 902 of the computer 903. In some instances, the computer 903 is configured to transmit or convey a video signal conveying global system display information to a video receiver 904 (e.g., of a sending card 905). In some embodiments, the system (e.g., sending card thereof 905) comprises one or more processor 906 (e.g., FPGA) configured to compress the global system display information (e.g., to allow for transmission of large quantities of content over various cable types, such as Ethernet cables, which also allows integrated transmission of display information and power to the display units). In some instances, the system (e.g., sending card thereof) further comprises a transmitter 907 (e.g., Ethernet transmitter) configured to provide global system display information to one or more display unit. Further, in some embodiments, such as wherein Ethernet cables (or other cables capable of transmitting power, such as USB) are utilized, a power supply 908 and injector 909 are configured to inject power into a cable 910 (e.g., a T568B Ethernet cable, or any other cable suitable for transmitting display information and power) configured to transmit display information to a display unit. In various embodiments, the power supply and injector are optionally included together with, or separate from, a sending card comprising the video receiver, processor(s), and transmitter.

**[0072]** FIG. 10 illustrates a schematic of modules described herein configured to receive sensor output signal (e.g., from one or more sensor), identify the status of one or more sensor state (e.g., proximity) associated with one or more display units (e.g., proximity to one or more display units), identify display information corresponding to the identified sensor state(s), and stitch together display information correspond-
ing with the sensor states (e.g., wherein more than one predetermined display information is identified as corresponding to one or more sensor state). In some instances, a single sensor provides output signal that conveys information regarding the sensor state of one or more display unit. For example, in some embodiments, Sensor State 1 corresponds to proximity to a first display unit, Sensor State 2 corresponds to proximity to a second display unit, and Sensor State 3 corresponds to proximity to a third display unit. In certain embodiments, once global system display information has been stitched together, it is transmitted to the one or more display units.  

In some embodiments, provided herein is a method for displaying (e.g., interactively displaying) product information in a physical location, such as a retail store (i.e., at a brick-and-mortar merchant). In specific embodiments, the product information is displayed at the front edge of one or more shelf of the location. For example, in some embodiments, it is possible to display such product information in such a manner by affixing or integrating one or more display unit provided herein with one or more shelf at the location. Display units and systems provided herein make it possible to display such information in a cost effective manner. In some embodiments, once one or more display unit, such as an LED display unit provided herein, is mounted at the location (e.g., affixed to or integrated with a shelf of the location); it is possible to display (e.g., interactively display) product information at the location.  

In some embodiments, provided herein is a method for dynamically displaying product information in a physical location to a person or customer physically located at the location. In some embodiments, the method comprises providing one or more display unit and one or more sensor at the location (e.g., affixed to and/or integrated with shelving units thereof). In certain embodiments, the method comprises:  

1. receiving a sensor output signal from a sensor, the sensor output signal conveying information regarding a sensor state (e.g., location of and/or proximity of a person or customer, such as in relation to the sensor) of the sensor;  
2. determining a sensor state based on the received output signals from the sensor;  
3. identifying predetermined display information associated with the identified sensor state from a display information store (e.g., database); and  
4. providing the predetermined display information to the one or more display units.  

In certain embodiments, a controller (e.g., comprising one or more controller units), such as described herein, receives the sensor output signal, determines the sensor state, and identifies the display information. In some embodiments, the process further comprises displaying video, images, and/or text associated with the display information on the one or more display units.  

In specific embodiments, the sensor output signal further comprises information that identifies the sensor from which the output signal originated. In some instances, this is useful in system comprising multiple display units and multiple sensors. In certain embodiments, the method further comprises determining the identity of the sensor based on the information that identifies the sensor (a sensor identifier) from which the output signal originated. In some embodiments, the process further comprises determining the display unit(s) associated with the sensor (e.g., a display unit or display units in which the sensor is located and/or nearby the sensor or display unit in which the sensor is located). In certain embodiments, the display unit(s) associated with the sensor are determined by accessing a display registry or map, and correlating the sensor identified or sensor identifier with display unit(s) associated with the sensor identified or sensor identifier.  

In certain embodiments, a method provided herein comprises identifying predetermined display information associated not only with the identified sensor state, but also with the identified display unit(s), from a display information store (e.g., database). In some embodiments, multiple display units and multiple sensors are present in the system, e.g., being operated by a controller. In certain embodiments, a process or system provided herein comprises receiving or one or more module configured to receive multiple sensor output signals, each sensor output signal conveying information regarding one or more sensor state. In some embodiments, a process or system provided herein comprises determining or a module configured to determine multiple sensor states based on the received output signals from the sensors. In some embodiments, a process or system provided herein comprises identifying or a module configured to identify predetermined display information associated with the identified sensor states from a display information store (database). In certain embodiments, a process or system provided herein comprises providing or one or more transmitter or output configured to provide the predetermined display information to the one or more display units.  

In specific embodiments, the sensor output signals further comprise information that uniquely identifies the sensors from which the unique output signals originated. In certain embodiments, the method or a system provided herein further comprises determining or a module configured to determine the identity of the sensors based on the information that identifies the sensors (or a sensor identifier) from which the output signal originated. In some embodiments, the method or a system further comprises determining or a module configured to determine the display unit(s) associated with each sensor (e.g., a display unit or display units in which each sensor is located and/or nearby the sensors or display unit in which the sensors are located). In certain embodiments, the display unit(s) associated with the sensors are determined by accessing a display registry or map, and correlating the sensors identified or sensor identifiers with display unit(s) associated with the sensors identified or sensor identifiers.  

As illustrated in FIG. 11, in certain embodiments, predetermined display information is identified and retrieved based on the sensor states identified from multiple sensors. In some instances, once the multiple iterations of predetermined multiple display information is retrieved it is stitched in global system display information and optionally compressed for dissemination to the display units. In certain embodiments, the global system display unit is stitched in a logical order (e.g., as illustrated in FIG. 5 and FIG. 6) to allow for correlation with the correct display information with the correct display units, e.g., based on which display unit(s) are associated with which sensors, as well as how (e.g., order, location, etc.) the display units are associated with the sensors (which can be determined, e.g., by accessing a display unit registry and/or map).  

FIG. 12 illustrates an exemplary retail system 1200 provided herein comprising a first display unit 1211 compris-
In various embodiments, display units and systems described herein are configured to alter display content (e.g., alter display information provided to the display units) based on a sensor state of the display unit or system. In some instances, as discussed herein, such sensor states include identifying “motion” or “no motion.” In further embodiments, sensor states include (and/or a sensor, e.g., camera, provided herein is configured to be able to detect), by way of non-limiting embodiments, “motion,” “no motion,” and “captive” (e.g., as determined by identifying a face—i.e., facial recognition). Other exemplary sensor states include, by way of non-limiting example, “in proximity” or “not in proximity.” In some embodiments, exemplary sensor states (e.g., based on information received from a rear facing camera) include “item out of place,” “no item out of place,” “inventory low,” “inventory high,” and/or “inventory acceptable.” In certain embodiments, exemplary sensor states (e.g., based on information received from environmental sensors, such as temperature and/or humidity sensors) include, by way of non-limiting example, “temperature acceptable,” “temperature high,” “temperature low,” “humidity acceptable,” “humidity high,” and/or “humidity low.” Generally, based on such determinations, systems provided herein comprise program modules configured to identify and provide specific display information (content) to the display unit(s) thereof. For example, in some instances, when a sensor state is identified as “no motion” for one or more display unit, the system is configured to provide specific (and predetermined) display information, such as logos or decals of the products located at (e.g., on a shelf at, above, or below) the display units identified as having a sensor state of “no motion,” but when the sensor state is identified as “motion” for the one or more display unit, the system is configured to provide different, specific (and predetermined) display information, such as text describing the product(s), the price of the product(s), and optionally a QR code for the product(s) located at (e.g., on a shelf at, above, or below) the display unit(s) identified as having a sensor state of “motion.” In other exemplary embodiments, when a sensor state is identified as an environmental state being below or above acceptable levels, an inventory state being below an acceptable level, or an item is out of place, the system is configured to provide specific (and predetermined) display information, such as a type of alert—e.g., a generic alert—e.g., that there is an “unacceptable” sensor state, or a specific alert depending on the “unacceptable” state identified.

What is claimed is:

1. A retail display system comprising:
   a. a display unit, the display unit comprising a viewable display surface configured to face in a first direction;
   b. a camera, the camera configured to face a second direction, the second direction being about 90 degrees to about 180 degrees opposed to the first direction; and
   c. a sensor controller, the camera being configured to provide an output signal to the sensor controller, the output signal conveying information regarding objects in proximity to the camera, and the sensor controller comprising:
      an input configured to receive the output signal; and
      one or more processors configured to execute sensor controller program modules, the sensor controller program modules comprising:
one or more module configured to determine whether an object in proximity to the camera is out of place, based on the information conveyed by the output signal; and/or
one or more module configured to determine the amount of an object in proximity to the camera, based on the information conveyed by the output signal.

2. The system of claim 1, the display unit having an aspect ratio of at least 2:1.

3. The system of claim 1, the display surface comprising an array of viewable LED pixels.

4. The system of claim 3, the LED pixels having a pixel pitch of less than 2.5 mm and the array has a height of at least 30 pixels.

5. The system of claim 1, the second direction being about 160 degrees to about 180 degrees opposed to the first direction.

6. The system of claim 1, the display unit being attached to or integrated along a front edge of a retail shelf and the output signal of the camera conveying information regarding objects located on the retail shelf.

7. The system of claim 1, the display unit being attached to or integrated along a front edge of a first retail shelf and the output signal of the camera conveying information regarding objects located on a second retail shelf configured below the first retail shelf.

8. The system of claim 1, wherein the system comprises one or more module configured to determine whether an object in proximity to the camera is out of place comprising:
a. a module configured to identify objects in proximity to the camera;
b. a module configured to access a data store comprising information regarding an object assigned to be in proximity to the camera; and
c. a module configured to determine whether an object in proximity to the camera corresponds to the object assigned to be in proximity to the camera.

9. The system of claim 1, wherein the system comprises one or more module configured to determine the amount of an object in proximity to the camera.

10. The system of claim 1, the display unit comprising a housing defined with at least one opening; the display surface and the camera received in the housing; and the display surface and a lens of the camera being exposed by the at least one opening.

11. The system of claim 1, further comprising an environmental sensor, the environmental sensor configured to provide environmental output signals conveying information regarding the environment in proximity to the environmental sensor to the sensor controller.

12. The system of claim 11, wherein the environmental sensor comprises a humidity sensor and a temperature sensor.

13. The system of claim 1, further comprising a second camera, the second camera configured to face a third direction, the third direction being aligned within 0 degrees to about 30 degrees of the first direction; and/or

14. The system of claim 13, wherein the third direction is aligned within 0 degrees to about 30 degrees of the first direction.

15. The system of claim 1, further comprising

a. a second camera, the second camera configured to face a third direction, the third direction being aligned within 0 degrees to about 45 degrees of the first direction;
b. a first housing defined with at least one opening; the display surface, the camera, and the second camera being received in the first housing; and the at least one opening exposing the display surface, a lens of the camera, and a lens of the second camera;
c. a second display unit, the second display unit comprising a second housing, the second housing receiving a second viewable display surface configured to face in a fourth direction, a third camera being configured to face in a fifth direction, the fifth direction being about 90 degrees to 180 degrees opposed to the fourth direction, and a fourth camera being configured in a sixth direction, the sixth direction being aligned within 0 degrees to about 45 degrees of the fifth direction, the third camera being configured to convey third output signals to the sensor controller;
d. a display controller, the second camera being configured to convey second output signals to the display controller, the fourth camera being configured to convey fourth output signals to the display controller, the second and fourth output signals conveying information regarding a state of one or more operating parameter, and the display controller comprising one or more processors configured to execute display controller program modules, the display controller program modules comprising:
a module configured to determine the state of the operating parameter(s) based on the information regarding the state of the operating parameter(s) in the second and/or fourth output signals; and
a module configured to identify display information to be provided to the display unit and the second display unit, based on the status of the one or more operating parameter(s).

16. The system of claim 15, wherein the state of the one or more operating parameter is whether or not a face is detected and/or whether or not motion is detected.

17. A high aspect ratio light emitting diode (LED) retail display unit comprising:
a receiving card comprising a first circuit board, the first circuit board comprising a first input, and a first output mounted thereon, the first input configured to receive or to be connected to receive first display information;
an LED display component comprising a second circuit board comprising a first and a second surface, an array of first LED pixels mounted on or in the first surface, and a second input configured to receive display information and mounted on the second surface, the first output configured to convey second display information to the second input, and the first surface being configured to face a first direction;
a sensor configured to provide or to be connected to provide a sensor output signal, the sensor output signal conveying information regarding motion and/or a person in proximity to the display unit;
a camera configured to provide or to be connected to provide a camera output signal, the camera output signal conveying information regarding the identity and/or quantity of objects in proximity to the display unit, the camera being configured to face a second direction, the second direction being about 90 degrees to 180 degrees opposed to the first direction; and
a housing defined with at least one opening, the receiving card, the display component, and the sensor received in the housing, and the first surface and a lens of the camera being exposed by the at least one opening.
The array of LED pixels having a pixel pitch of about 2.5 mm or less the display unit having an aspect ratio (length/height) of about 2 or more; and the first and second display information being the same or different.

18. The display unit of claim 17, wherein the receiving card further comprises a second output mounted thereon; the display unit further comprises a second LED display component comprising a third circuit board comprising a third and a fourth surface, a second array of second LED pixels mounted on or in the third surface, and a third input configured to receive display information and mounted on the fourth surface, the second output configured to convey third display information to the third input, the second array of second LED pixels having a pixel pitch of about 2.5 mm or less, and the first and second, and third display information being the same or different.

19. The display unit of claim 17, further comprising a third output configured to be connected to and convey first display information to an additional display, the additional display being the same as or different from the display unit.

20. The display unit of claim 17, further comprising an environmental sensor, the environmental sensor configured to provide or to be connected to provide an environmental sensor output signal, the environmental sensor output signal conveying information regarding the environment in proximity to the display unit.  

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