US012387070B2

(12) **United States Patent**
Ahten et al.

(10) **Patent No.: US 12,387,070 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **FIXED RETAIL SCANNERS WITH ILLUMINATION ASSEMBLIES HAVING DIFFERENT SUB-GROUPS OF LEDS AND RELATED METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/071,588**

(22) Filed: **Nov. 29, 2022**

(65) **Prior Publication Data**

US 2023/0206015 A1 Jun. 29, 2023

Related U.S. Application Data

(60) Provisional application No. 63/311,789, filed on Feb. 18, 2022, provisional application No. 63/293,563, filed on Dec. 23, 2021.

(51) **Int. Cl.**
G06K 7/10 (2006.01)
G06Q 20/20 (2012.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06K 7/10831*** (2013.01); ***G06Q 20/208*** (2013.01); ***H04N 1/00931*** (2013.01); ***H04N 1/02865*** (2013.01)

(58) **Field of Classification Search**
CPC G06K 7/10722; G06K 7/10693; G06K 7/10831; G06K 7/10801; G06K 19/06037;
(Continued)

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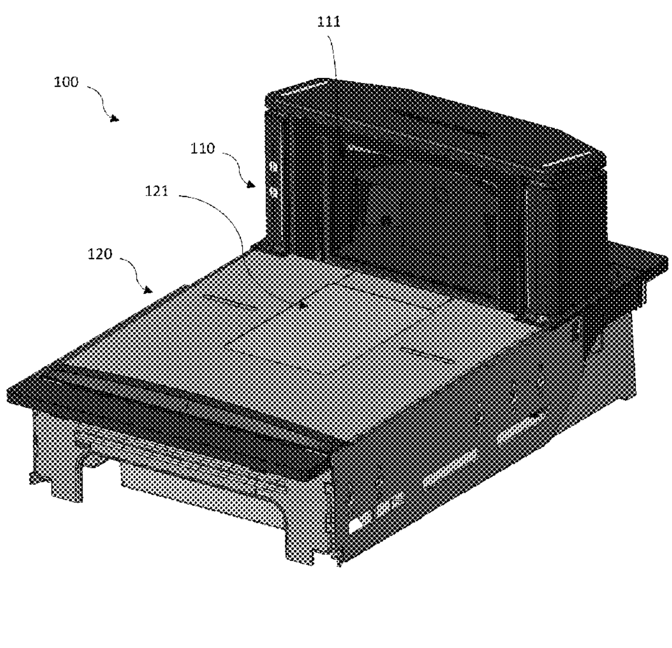
(57) **ABSTRACT**

The disclosure includes a fixed retail scanner including a data reader. The data reader includes illumination assemblies that include different LED sub-groups that are co-located within its respective assembly. These illumination assemblies may be identically constructed and installed at various positions within the data reader to provide active illumination for the camera modules. Illumination assemblies are activated together, but only with the first sub-groups from each of the illumination assemblies being activated together at a first time, and only with the second sub-groups from each of the illumination assemblies being activated together at a second time.

20 Claims, 11 Drawing Sheets



(51) **Int. Cl.**
H04N 1/00 (2006.01)
H04N 1/028 (2006.01)

(58) **Field of Classification Search**
CPC G06K 7/10623; G06K 7/1426; G06K 7/1096; G06K 2207/1011; G06K 2207/1013; G06K 7/10594; G06K 7/10732; G06K 2207/1012; G06K 7/10564; G06Q 20/208; H04N 1/00931; H04N 1/02865; H04N 9/3152; H04N 9/3129; H04N 13/243; H04N 13/324; H04N 3/1562
See application file for complete search history.

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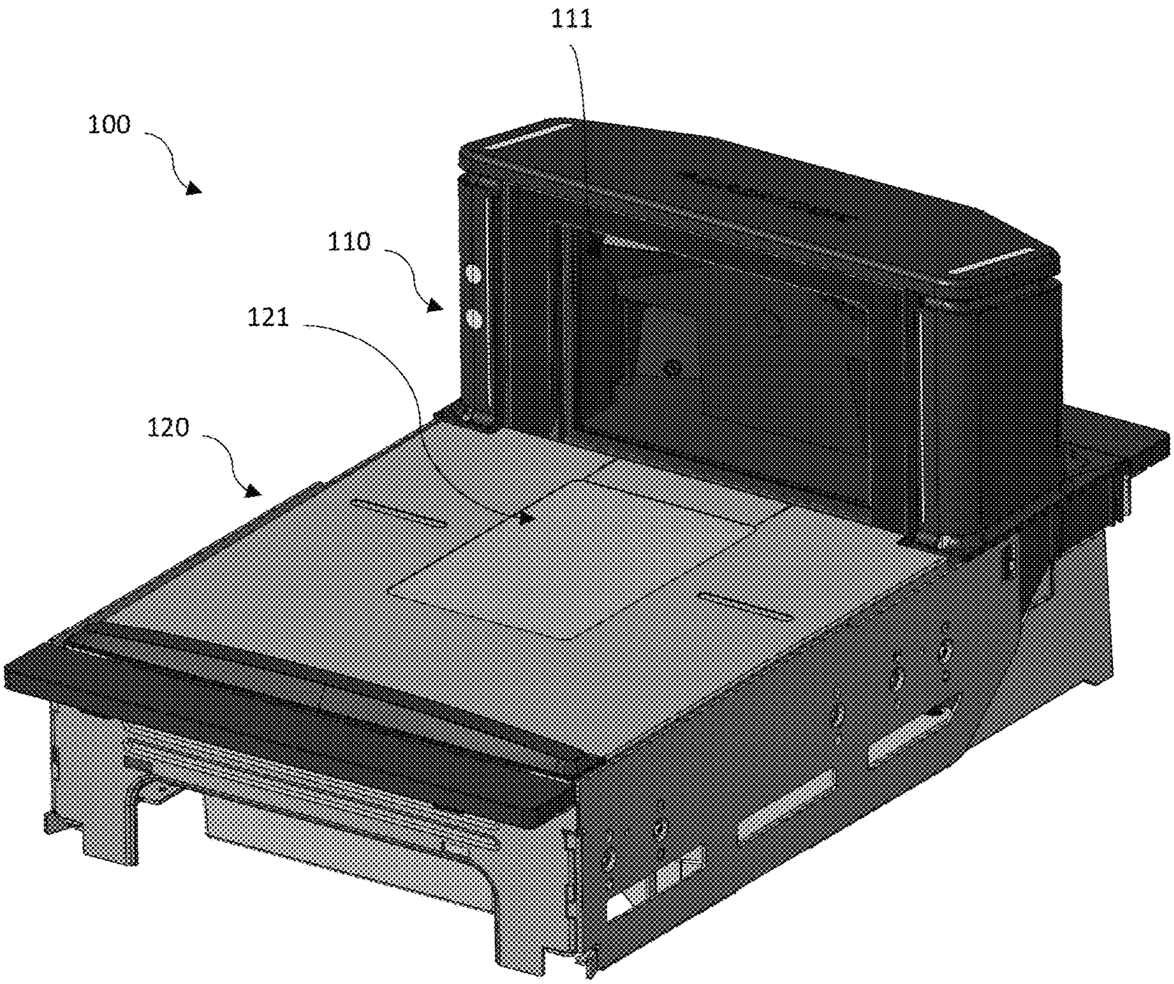

FIG. 1

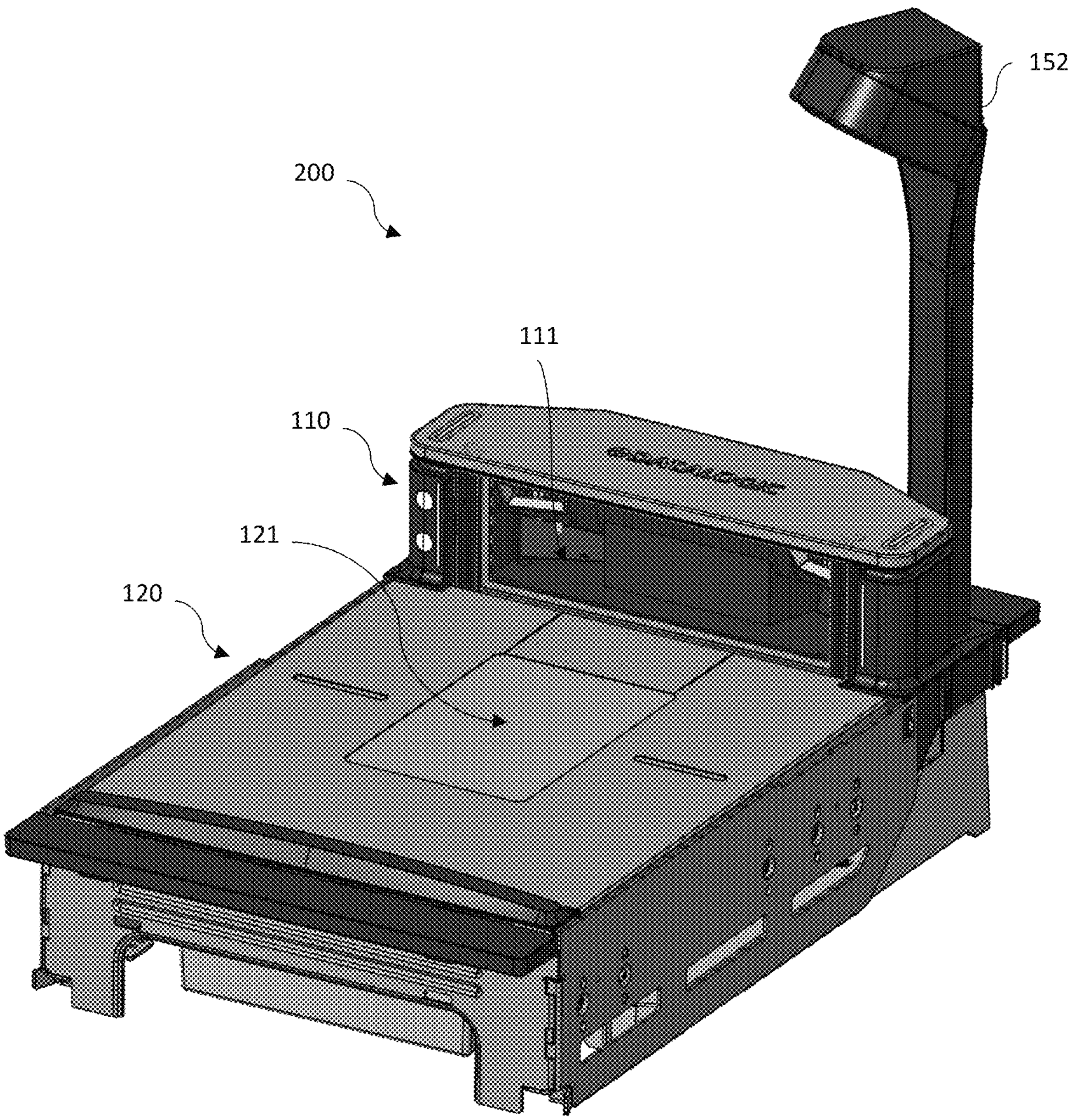

FIG. 2

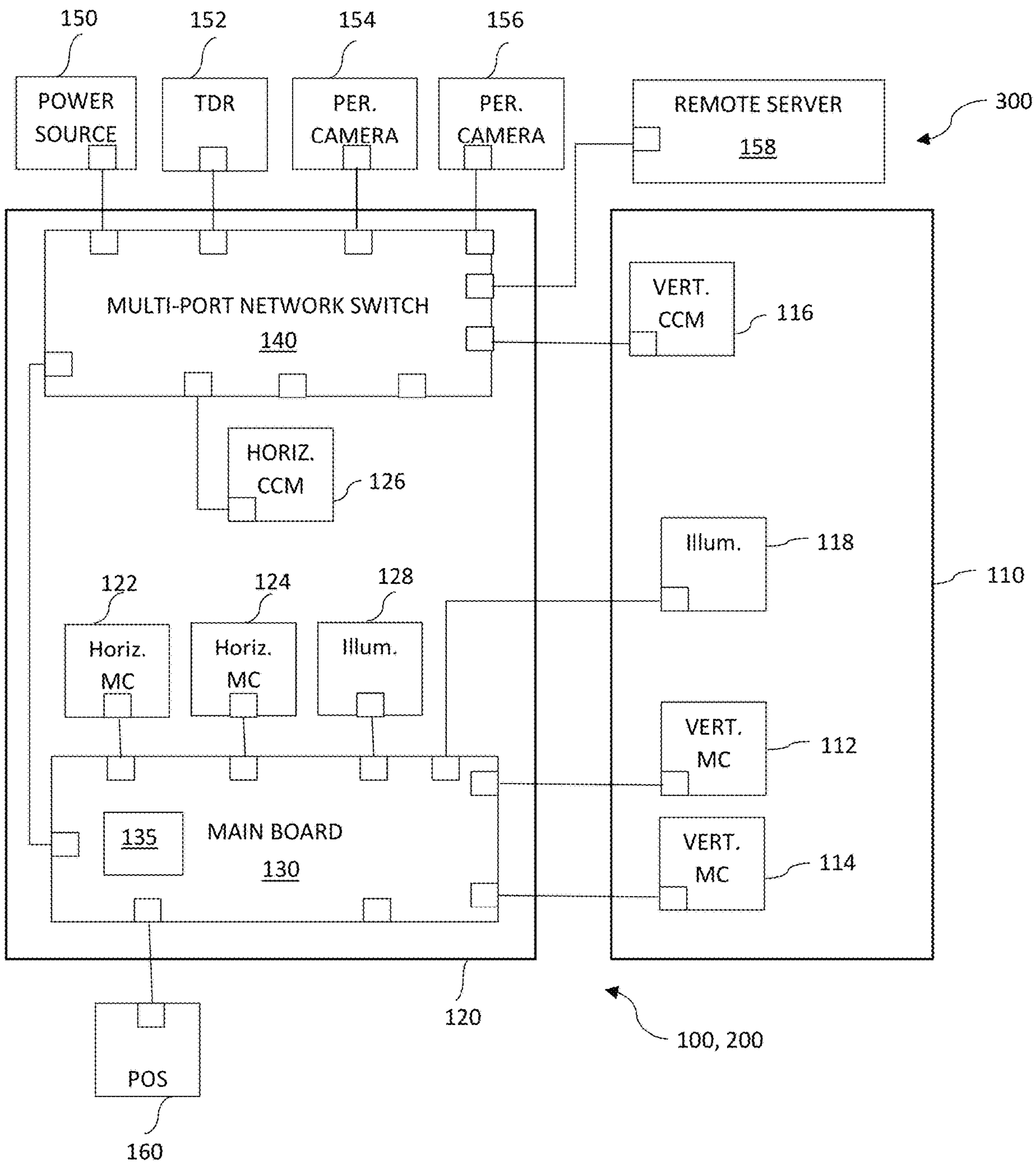
150
152
154
156
POWER SOURCE
TDR
PER. CAMERA
PER. CAMERA
REMOTE SERVER
158
300
MULTI-PORT NETWORK SWITCH
140
VERT. CCM
116
HORIZ. CCM
126
Illum.
118
110
122
124
128
Horiz. MC
Horiz. MC
Illum.
VERT. MC
112
135
MAIN BOARD
130
VERT. MC
114
120
100, 200
POS
160

FIG. 3

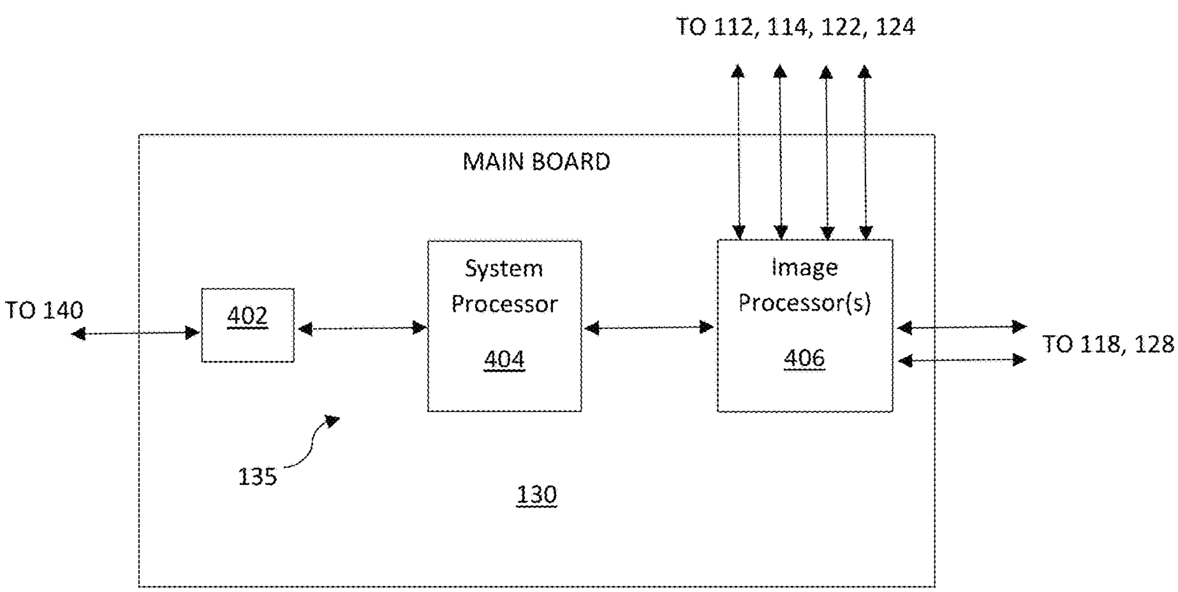
TO 112, 114, 122, 124
MAIN BOARD
TO 140
402
System
Processor
404
Image
Processor(s)
406
TO 118, 128
135
130

FIG. 4

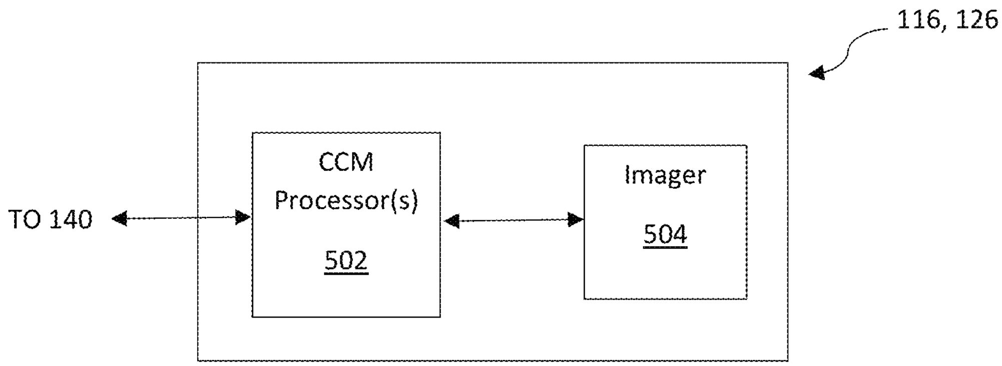

FIG. 5

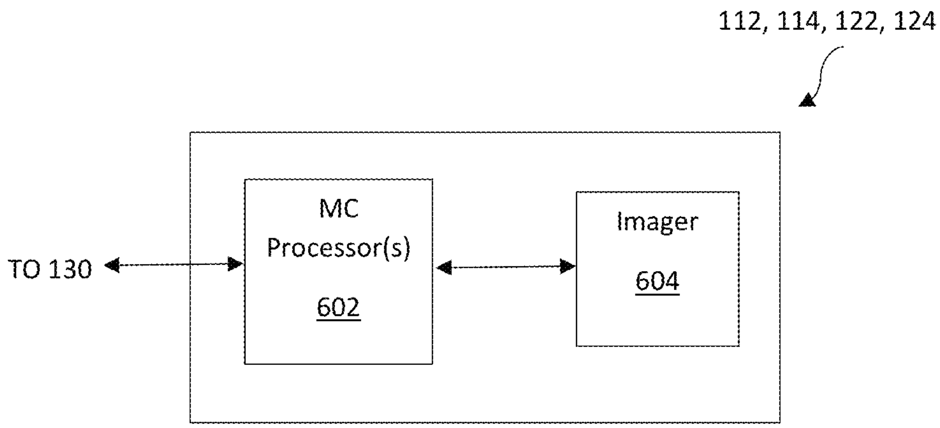

FIG. 6

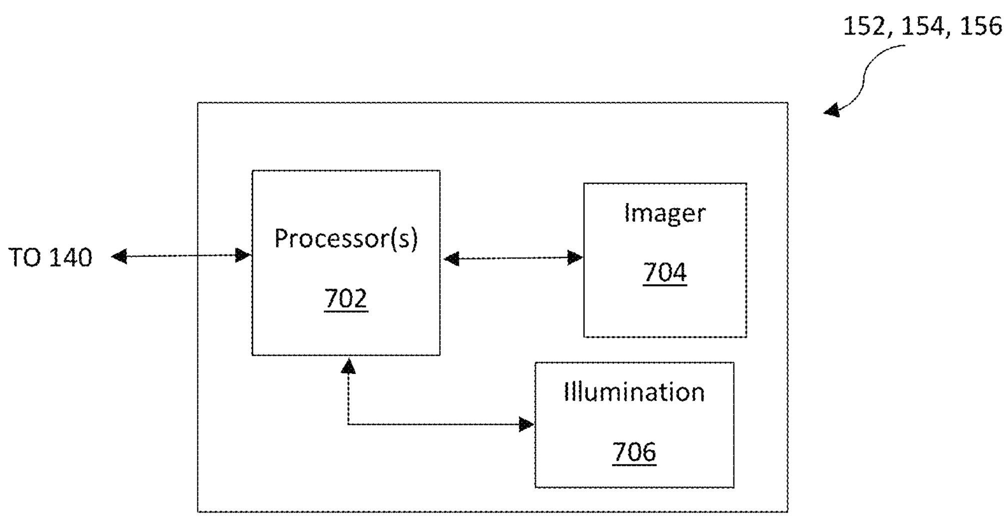

FIG. 7

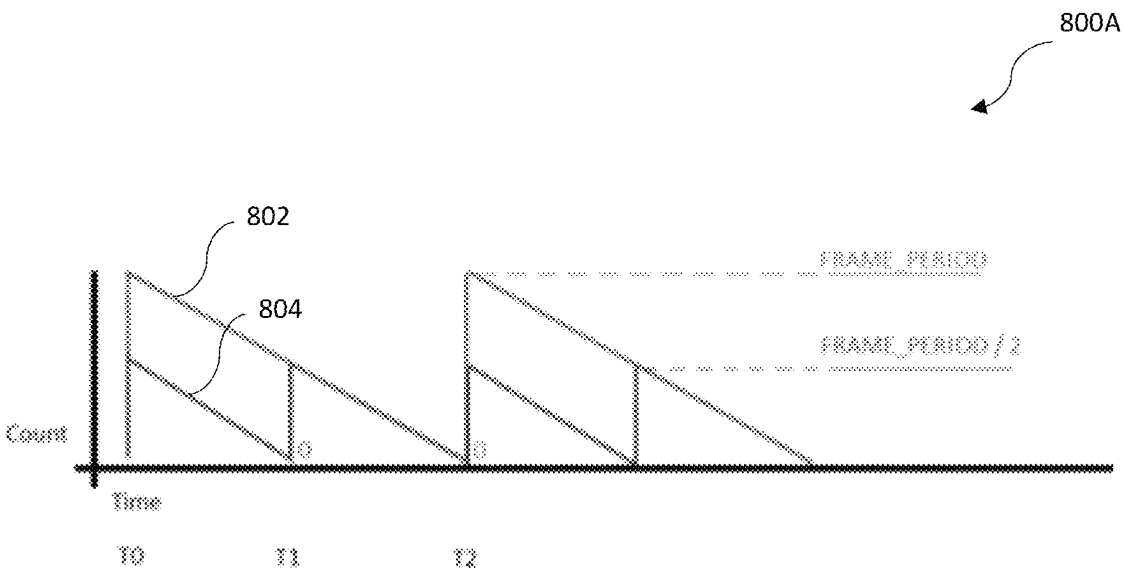
800A
802
804
FRAME_PERIOD
FRAME_PERIOD / 2
Count
0
0
Time
T0
T1
T2

FIG. 8A

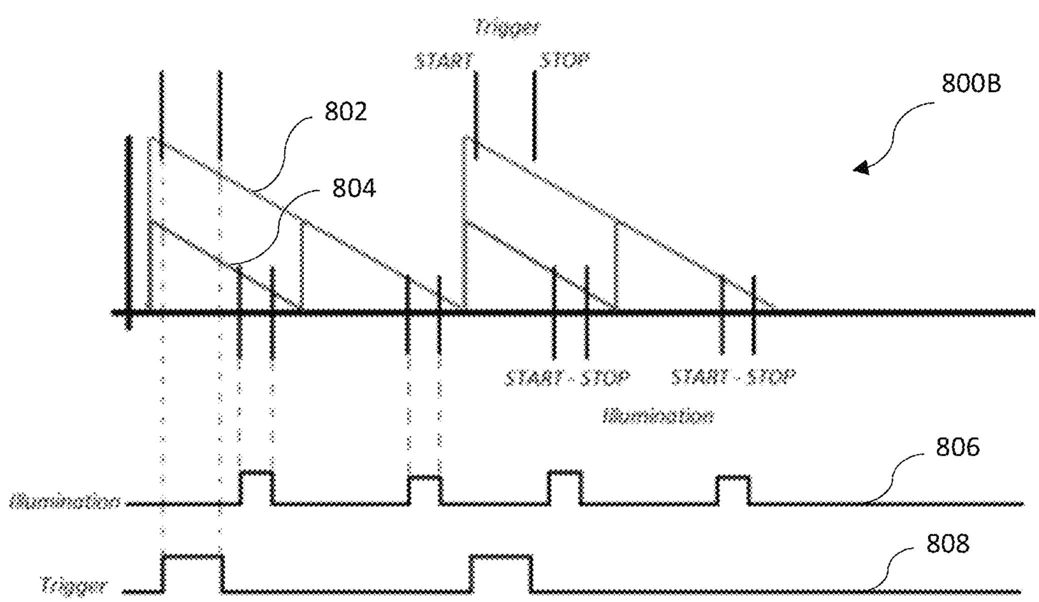
Trigger
START
STOP
800B
802
804
START - STOP
START - STOP
Illumination
806
Illumination
808
Trigger

FIG. 8B

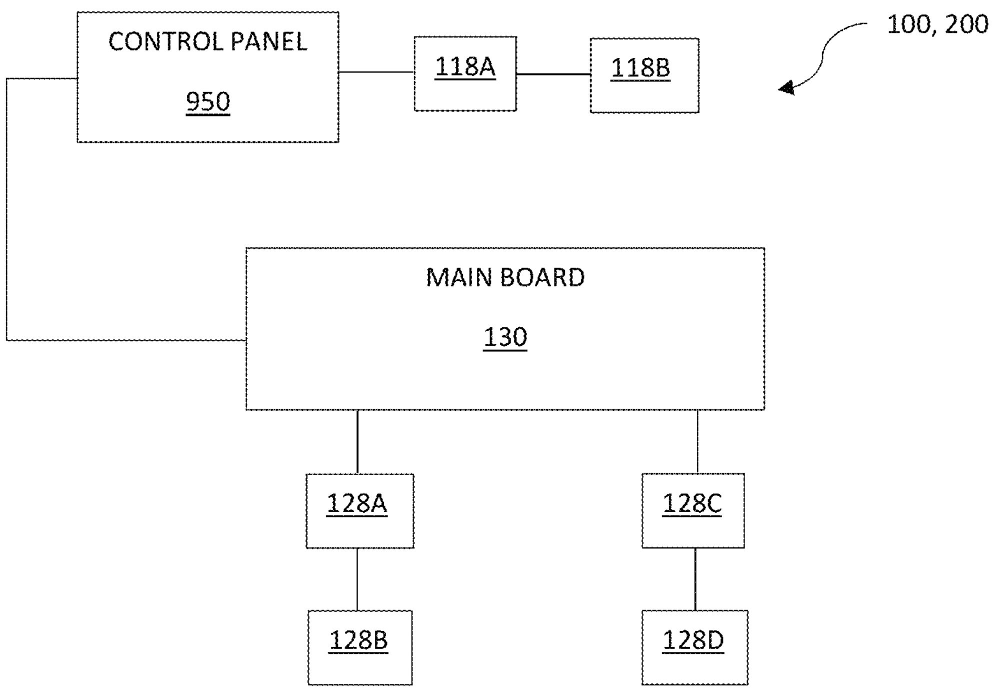
CONTROL PANEL
950
118A
118B
100, 200
MAIN BOARD
130
128A
128C
128B
128D

FIG. 9

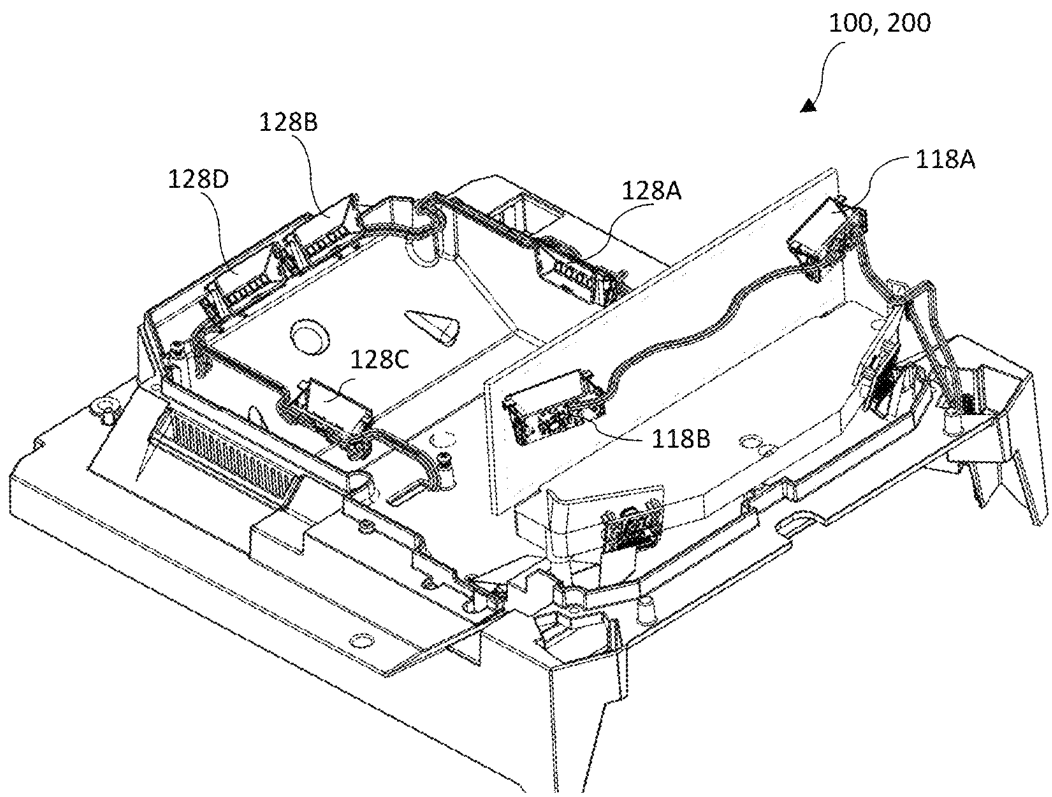

FIG. 10

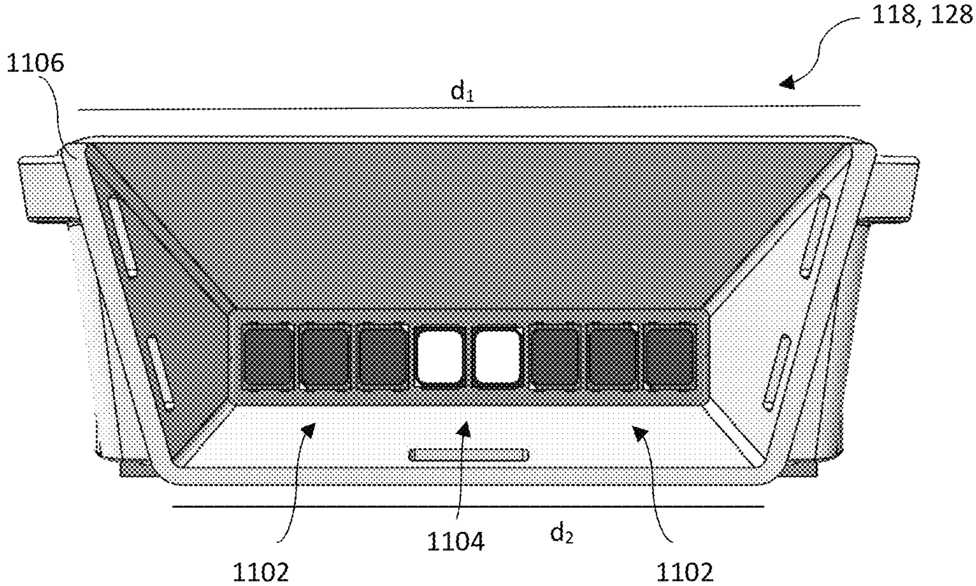

FIG. 11A

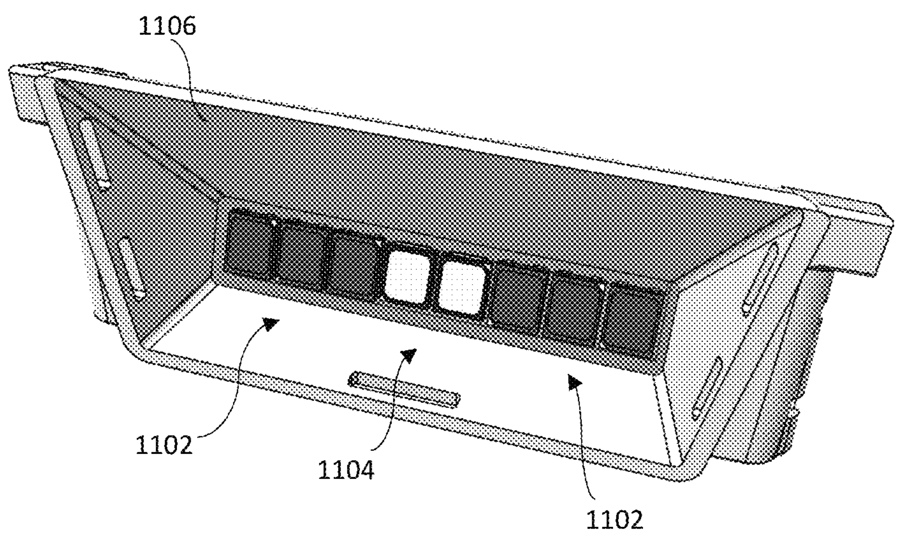

FIG. 11B

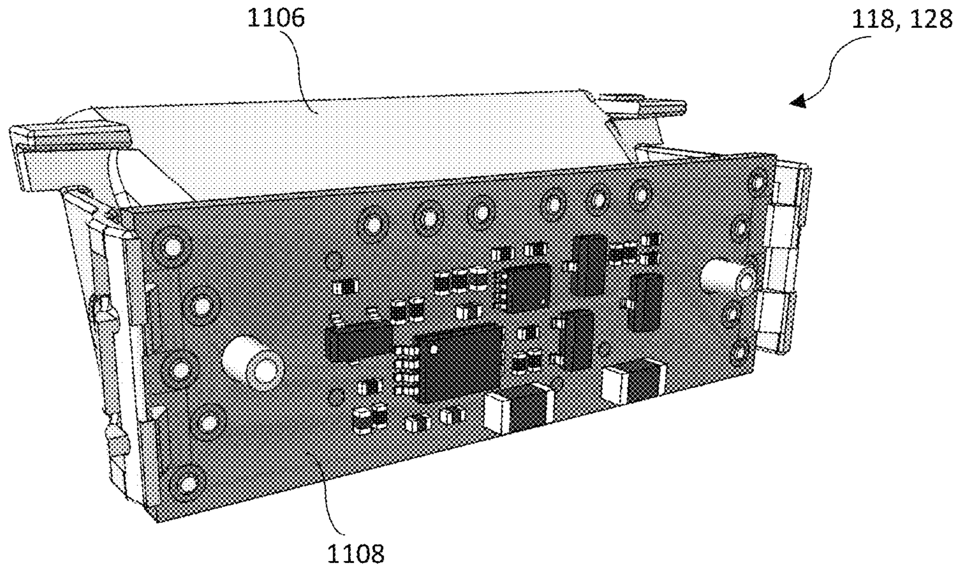

FIG. 11C

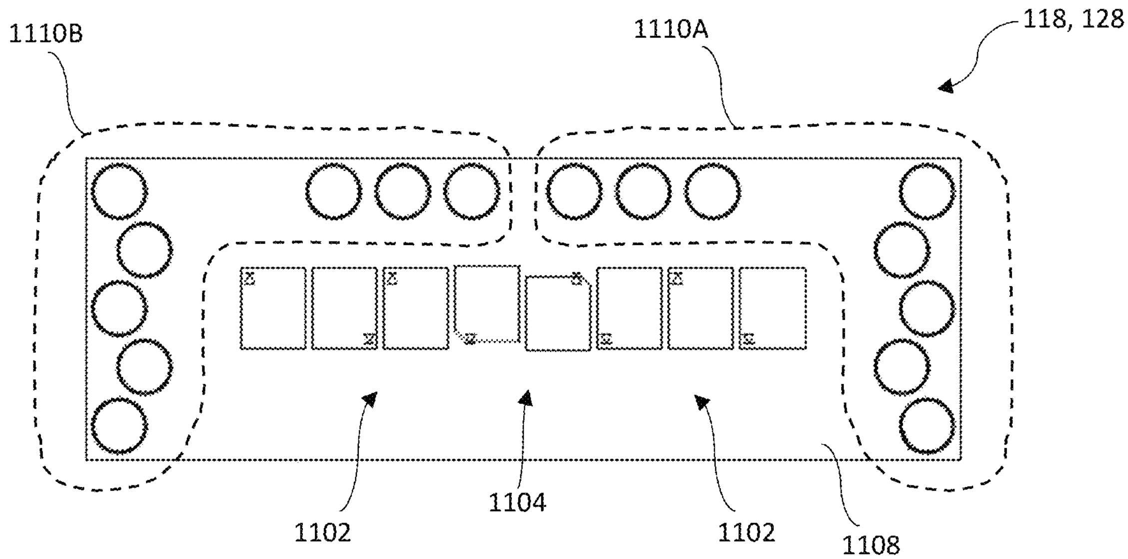

FIG. 11D

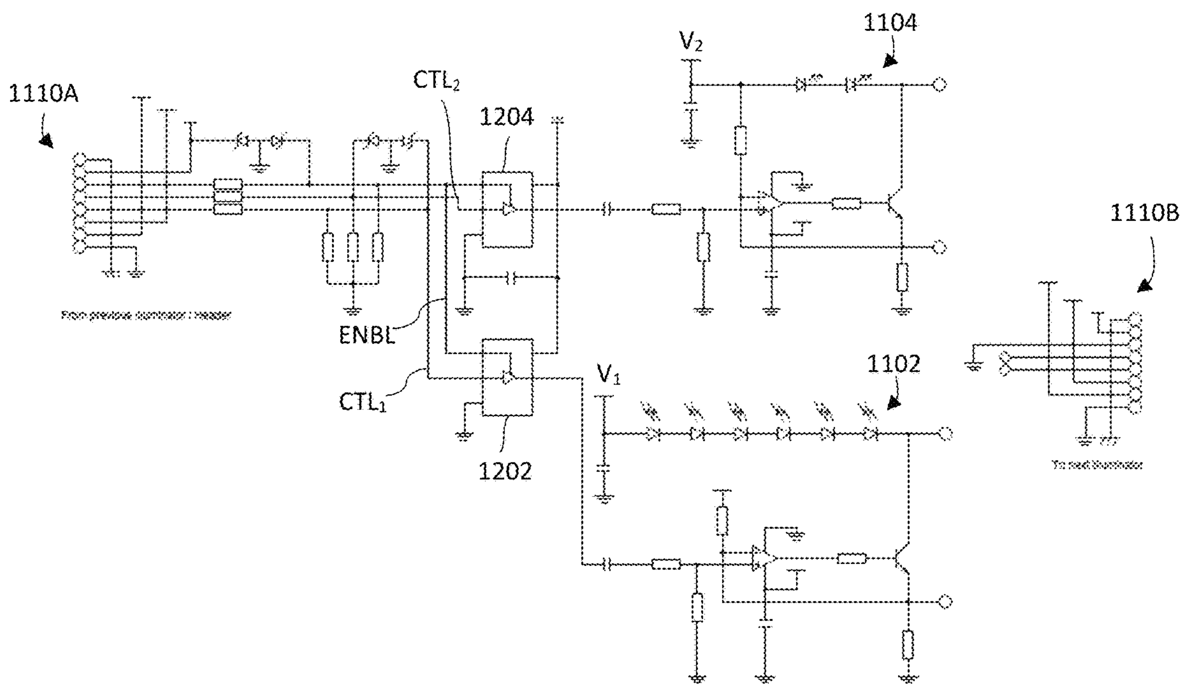

FIG. 12

FIXED RETAIL SCANNERS WITH ILLUMINATION ASSEMBLIES HAVING DIFFERENT SUB-GROUPS OF LEDS AND RELATED METHOD

PRIOR APPLICATION

This application claims the benefit of U.S. Provisional Application No. 63/293,563, filed Dec. 23, 2021, and entitles "FIXED RETAIL SCANNER WITH MULTI-PORT NETWORK SWITCH AND RELATED METHODS, the disclosure of which is incorporated by reference herein in its entirety. This application also claims the benefit of U.S. Provisional Application No. 63/311,789, filed Feb. 18, 2022, and entitled "FIXED RETAIL SCANNERS WITH ILLUMINATION ASSEMBLIES HAVING DIFFERENT SUB-GROUPS OF LEDS AND RELATED METHOD," the disclosure of which is incorporated by reference herein in its entirety.

RELATED APPLICATIONS

This application is also related to U.S. patent application Ser. No. 18/071,594, now U.S. Pat. No. 12,045,686 and Ser. No. 18/660,172, filed May , 2024, both of which also claim priority to U.S. Provisional Application Nos. 63/293,563 and 63/311,789), the disclosure of each of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present disclosure relates generally to scanners or code readers, and more particularly, to fixed retail scanners having a multiple illumination assemblies with different sub-groups of light-emitting diodes.

BACKGROUND

Data reading devices are used to read optical codes, acquire data, and capture a variety of images. Optical codes typically comprise a pattern of dark elements and light spaces. There are various types of optical codes, including one-dimensional codes, such as a Universal Product Code ("UPC") and EAN/JAN codes, and stacked and two-dimensional codes, such as PDF417 and Maxicode codes. Data reading devices are well known for reading UPC and other types of optical codes on packages, particularly in retail stores. One common data reader in such systems is an imaging reader that employs an imaging device or sensor array, such as a CCD (charge coupled device) or CMOS (complementary metal oxide semiconductor) device. Imaging readers can be configured to read both 1-D and 2-D optical codes, as well as other types of optical codes or symbols and images of other items.

BRIEF SUMMARY

A fixed retail scanner including a data reader may include multiple camera modules disposed within the data reader, multiple illumination assemblies, and a system controller. Each illumination assembly of the plurality may include a first sub-group of light emitting diodes (LEDs) emitting at a first wavelength, and a second sub-group of LEDs emitting at a second wavelength and co-located with the first sub-group of LEDs within its respective illumination assembly. The system controller is operably coupled with the camera modules and the illumination assemblies, and configured to activate each illumination assembly together to provide active illumination for the camera modules such that the first sub-group of LEDs of each illumination assembly is activated together across the different illumination assemblies to be synchronized with a first camera module, and the second sub-group of LEDs of each illumination assembly of the plurality is activated together across the different illumination assemblies to be synchronized with a second camera module at times different from the first sub-group of LEDs.

A fixed retail scanner including a data reader may include a first grouping of illumination assemblies disposed in a first housing plane of the data reader, and a system controller operably coupled with the first grouping of illumination assemblies. The first grouping of illumination assemblies may include a first illumination assembly including a first LED sub-group and a second LED sub-group co-located within a common assembly, and a second illumination assembly may include a first LED sub-group and a second LED sub-group co-located within a common assembly, where the first illumination assembly and the second illumination assembly of the first grouping are disposed at different locations. The system controller may be configured to simultaneously activate each of the first illumination assembly and the second illumination assembly with the first LED sub-groups of the first illumination assembly and the second illumination assembly of the first grouping being activated at a first time, and with the second LED sub-groups of the first illumination assembly and the second illumination assembly of the first grouping being activated at a second time different than the first time.

A method of illuminating a read zone of a fixed retail scanner may include activating a first set of LED sub-groups across multiple LED assemblies located within a data reader to be synchronized with exposure of a first camera, and activating a second set of LED sub-groups across the LED assemblies located within the data reader. Each LED assembly may include a first LED subgroup co-located with a second LED sub-group within a common assembly. In an embodiment, all LED assemblies are activated together but with only the first sub-groups from each corresponding LED assembly being synchronized with exposure of a first camera, and with only the second sub-groups from each corresponding LED assembly being synchronized with exposure of a second camera.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a data reader according to an embodiment of the disclosure.

FIG. **2** is a perspective view of a data reader according to an embodiment of the disclosure.

FIG. **3** is a simplified block diagram of an illustrative data reading system according to an embodiment of the disclosure.

FIG. **4** is a simplified block diagram of certain components mounted on the main board according to an embodiment of the disclosure.

FIGS. **5**-**7** are different simplified block diagrams of the various imager modules according to an embodiment of the disclosure.

FIGS. **8**A and **8**B are examples of waveforms showing illumination and exposure counters for an illumination source and a corresponding imager according to embodiments of the disclosure.

FIG. **9** is a simplified block diagram of the data reader focusing on the illumination assemblies according to another embodiment of the disclosure.

FIG. **10** shows a simplified perspective view of the data reader according to an embodiment of the disclosure.

FIGS. **11**A-**11**D are different views of one of the illumination assemblies according to an embodiment of the disclosure.

FIG. **12** is a simplified electrical schematic diagram of an illumination assembly according to an embodiment of the disclosure.

DETAILED DESCRIPTION

The illustrations included herewith are not meant to be actual views of any particular systems, memory device, architecture, or process, but are merely idealized representations that are employed to describe embodiments herein. Elements and features common between figures may retain the same numerical designation except that, for ease of following the description, for the most part, reference numerals begin with the number of the drawing on which the elements are introduced or most fully described. In addition, the elements illustrated in the figures are schematic in nature, and many details regarding the physical layout and construction of a memory array and/or all steps necessary to access data may not be described as they would be understood by those of ordinary skill in the art.

As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

As used herein, "or" includes any and all combinations of one or more of the associated listed items in both, the conjunctive and disjunctive senses. Any intended descriptions of the "exclusive-or" relationship will be specifically called out.

As used herein, the term "configured" refers to a structural arrangement such as size, shape, material composition, physical construction, logical construction (e.g., programming, operational parameter setting) or other operative arrangement of at least one structure and at least one apparatus facilitating the operation thereof in a defined way (e.g., to carry out a specific function or set of functions).

As used herein, the phrases "coupled to" or "coupled with" refer to structures operably connected with each other, such as connected through a direct connection or through an indirect connection (e.g., via another structure or component).

"Image data" as used herein includes both individual frames as well as multiple frames (e.g., streaming video). Image data may be captured by one or more imagers positioned at various within the housing of the fixed retail scanner, such as in a horizontal base unit or a vertical bonnet of a bi-optic scanner having imagers positioned in two different planes. Single plane scanners (e.g., horizontal or vertical only housings) are also contemplated and within the scope of the disclosure. Image data may also be captured by one or more imagers positioned external to the primary scanning unit, such as peripheral devices (e.g., top-down reader imagers, security imagers, bottom of basket readers, etc.) that may also provide image data to the fixed retail scanner and/or remote systems.

It should be understood that any reference to an element herein using a designation such as "first," "second," and so forth does not limit the quantity or order of those elements, unless such limitation is explicitly stated. Rather, these designations may be used herein as a convenient method of distinguishing between two or more elements or instances of an element. Thus, a reference to first and second elements does not mean that only two elements may be employed there or that the first element must precede the second element in some manner. Also, unless stated otherwise a set of elements may comprise one or more elements.

FIG. **1** is a perspective view of a data reader **100** according to an embodiment of the disclosure. The data reader **100** may be a bi-optic fixed retail scanner having a vertical housing **110** and a horizontal housing **120**. The vertical housing **110** may include a structure that provides for one or more camera fields-of-view (through a vertical window **111**) within a generally vertical plane across the read zone of the data reader **100**. The vertical structure provides an enclosure for one or more cameras and other optical elements (e.g., lenses, mirrors, etc.) and electrical elements (e.g., cables, circuit boards, etc.) therein. The horizontal housing **120** may include a structure that provides for one or more camera fields-of-view (through a horizontal window **121**) within a generally vertical plane across the read zone of the data reader **100**. The horizontal structure provides an enclosure for one or more cameras and other optical elements (e.g., lenses, mirrors, etc.) and electrical elements (e.g., cables, circuit boards, etc.) therein. Thus, the vertical housing **110** and the horizontal housing **120** may be generally orthogonal to each other (including slightly angled orientations, such as being in the range of ±10° from orthogonal). Depending on the arrangement and orientation of the different opto-electrical elements, certain elements related to providing a horizontal field-of-view may be physically located within the vertical structure and vice versa.

FIG. **2** is a perspective view of an illustrative data reader **200** according to an embodiment of the disclosure. As with the data reader of FIG. **1**, the data reader of FIG. **2** may also be a bi-optic fixed retail scanner having a vertical housing **110** and a horizontal housing **120**. The data reader **200** may also include a top-down reader (TDR) **152** that includes a stand connected to the data reader **100** with a head that includes one or more imagers therein. Such imager(s) typically provide a generally close overhead (angled) view of the read zone to provide a top view of a product whereas internal cameras may be better suited for capturing images of the bottom and/or sides of the object within the read zone.

The vertical housing **110** of FIG. **2** may have a lower profile bonnet compared to that of FIG. **1**, which may result in internal cameras having a lower incidence angle. Thus, such a form factor may be particularly well suited to include the TDR **152** (FIG. **3**) as an optional add-on to the data reader **200**. However, a TDR **152** may also be coupled to the data reader **100** of FIG. **1** having the taller bonnet. Such a TDR may need to be taller to accommodate the taller bonnet. In addition, some embodiments may include additional TDRs, such as on the other side of the bonnet, to provide another top view of the read zone. Thus, some embodiments may include one or more TDRs for data readers having different sized bonnets. It is also recognized that some embodiments may include single plane data readers such that certain features described herein are wholly located within a single plane housing (e.g., horizontal), which may further be coupled to other external devices or peripherals.

Different configurations and details regarding the construction and components of a fixed retail scanner are contemplated. For example, additional features and configurations of devices are described in the following patents and patent applications: U.S. Pat. No. 8,430,318, issued Apr. 30, 2013, and entitled "SYSTEM AND METHOD FOR DATA READING WITH LOW PROFILE ARRANGEMENT," U.S. Pat. No. 9,004,359, issued Apr. 14, 2015, entitled "OPTICAL SCANNER WITH TOP DOWN READER," U.S. Pat. No. 9,305,198, issued Apr. 5, 2016, entitled

"IMAGING READER WITH IMPROVED ILLUMINATION," U.S. Pat. No. 10,049,247, issued Aug. 14, 2018, entitled "OPTIMIZATION OF IMAGE FRAME MANAGEMENT IN A SWEEP-STYLE OPTICAL CODE DATA READE," U.S. Pat. No. 10,248,896, issued Apr. 2, 2019, and entitled "DISTRIBUTED CAMERA MODULES SERIALLY COUPLED TO COMMON PREPROCESSING RESOURCES FACILITATING CONFIGURABLE OPTICAL CODE READER PLATFORM FOR APPLICATION-SPECIFIC SCALABILITY," and U.S. Patent Application Publication No. 2020/0125812, filed Dec. 2, 2019, and entitled "DATA COLLECTION SYSTEMS AND METHODS TO CAPTURE IMAGERS OF AND DECODE INFORMATION FROM MACHINE-READABLE SYMBOLS," the disclosure of each of which is incorporated by reference in their entirety. Such fixed retail scanners may be incorporated within assisted checkout stations having a clerk assisting a customer, while some embodiments include self-checkout stations in which the customer is the primary operator of the device. Such components and features may be employed in combination with those described herein.

FIG. **3** is a simplified block diagram of an illustrative data reading system **300** according to an embodiment of the disclosure. The data reading system **300** may include a data reader **100**, **200** that may be operably coupled with one or more of a power source **150**, the top-down reader (TDR) **152**, peripheral cameras **154**, **156**, a remote service **158**, or a point-of-sale (POS) system **160**.

The data reader **100**, **200** may be a bi-optic fixed retail scanner having a vertical housing **110** and a horizontal housing **120**. The data reader **100**, **200** may be installed in a retail environment (e.g., grocery store), which typically is disposed within a counter or other support structure of an assisted checkout lane or a self-checkout lane. The vertical housing **110** may include a structure that provides for one or more camera fields-of-view (through a vertical window) within a generally vertical plane across the read zone of the data reader **100**, **200**. The vertical structure provides an enclosure for one or more cameras **112**, **114**, **116**, active illumination assemblies **118** (e.g., LED assemblies), and other optical elements (e.g., lenses, mirrors, etc.) and electrical elements (e.g., cables, circuit boards, etc.) therein. The horizontal housing **120** may include a structure that provides for one or more camera fields-of-view (through a horizontal window) within a generally vertical plane across the read zone of the data reader **100**, **200**. The horizontal structure provides an enclosure for one or more cameras **122**, **124**, **126**, active illumination elements **128** (e.g., LED assemblies), and other optical elements (e.g., lenses, mirrors, etc.) and electrical elements (e.g., cables, circuit boards, etc.) therein. Thus, the vertical housing **110** and the horizontal housing **120** may be generally orthogonal to each other (including slightly angled orientations, such as being in the range of ±10° from orthogonal). Depending on the arrangement and orientation of the different opto-electrical elements, certain elements related to providing a horizontal field-of-view may be physically located within the vertical structure and vice versa.

The data reader **100**, **200** may include one or more different types of imagers, such as monochrome imagers and/or color imagers. For example, vertical monochrome cameras **112**, **114** may be configured to capture monochrome images through the vertical window of the data reader **100**, **200**. Likewise, horizontal monochrome cameras **122**, **124** may be configured to capture monochrome images through the horizontal window of the data reader **100**, **200**. Vertical color camera module (CCM) **116** may be configured to capture color images through the vertical window of the data reader **100**, **200**. Likewise, horizontal color camera module (CCM) **126** may be configured to capture color images through the horizontal window of the data reader **100**, **200**. Monochrome images may be analyzed (e.g., by a decoder) to decode one or more indicia (e.g., 1D barcodes, 2D barcodes, optical character recognition, digital watermarks, etc.). Color images may be analyzed (e.g., by an image processor) to perform analysis on the images where color information may be particularly useful in performing certain functions, such as produce recognition, item recognition or verification, and/or security analysis. Such analysis may be performed by local and/or remote processors that may contain an artificial intelligence (AI) engine or otherwise configured to perform other machine learning techniques.

The data reader may further include a main board **130** and a multi-port network switch **140**. As shown herein, the main board **130** and the multi-port network switch **140** may be physically housed within the horizontal housing **120**. Bi-optic readers tend to have larger horizontal housings in order to provide support for the device within a cavity in a counter, which also provides space for a scale (not shown) used to weigh produce or other items sold by weight or otherwise perform weighing of items when placed on the horizontal surface (often called a "weigh platter"). It is contemplated that some embodiments may include the main board **130** and/or the multi-port network switch **140** to be physically located within the vertical housing **110**. In such an embodiment where one of the multi-port network switch **140** or the main board **130** is physically located within the vertical housing **110** and the other is physically located within the horizontal housing **120**, the two boards may be generally oriented orthogonal to each other similar to the orientation of the windows or other angled arrangements (e.g., slightly angled orientations such as being in the range of ±10° from orthogonal). The ports may be at least somewhat aligned in the orthogonal direction or other arrangement to accommodate easy connection of network cables therebetween.

The main board **130** may be operably coupled with the vertical monochrome imagers **112**, **114** and the horizontal monochrome imagers **122**, **124**. These connections may be via a communication interface (e.g., a MIPI interface). The main board **130** may have decoding software embedded therein such that one or more on-board processors **135** may receive monochrome images to perform decoding on the optical indicia and provide the decoding result to a point-of-sale (POS) system **160** operably coupled thereto to complete a transaction. The one or more on-board processors **135** may also be configured to provide control (e.g., coordination or synchronization) of the various components of the system including camera exposure and timing of active illumination assemblies **118**, **128** of the system. Although a single block is shown representing one or more on-board processors **135**, it is contemplated that some embodiments may include multiple processing components (e.g., microprocessors, microcontrollers, FPGAs, etc.) configured to perform different tasks, alone or in combination, including object detection, system control, barcode decoding, optical character recognition, artificial intelligence, machine learning analysis, or other similar processing techniques for analyzing the images for product identification or verification or other desired events.

The multi-port network switch **140** may be operably coupled to vertical CCM **116** and horizontal CCM **126** located within the data reader **100**, **200**. The multi-port network switch **140** may also be operably coupled with main board **130** located within the data reader **100**, **200**. Multi-port network switch **140** may also be operably coupled to the power source **150** as well as peripheral devices, such as the TDR **152**, peripheral cameras **154**, **156**, and/or the remote server **158**. The number, and types of peripheral devices, may depend on a desired application within a retail environment. The TDR **152** may be configured as a stand connected to the data reader **100**, **200** that typically provides a generally close overhead (angled) view of the read zone to provide a top view of a product whereas internal cameras **112**, **114**, **116**, **122**, **124**, **126** may be better suited for capturing images of the bottom and/or sides of the object within the read zone. Peripheral cameras **154**, **156** may be located remotely from the data reader **100**, **200**, such as being mounted on a ceiling or wall of the retail environment to provide additional views of the read zone or checkout area. Such views may be useful for security analysis of the checkout area, such as product verification, object flow, human movements, etc. Such analysis may be performed by a remote service or other local devices (e.g., located on or otherwise coupled to the main board **130** or multi-port network switch **140**). Other peripheral devices may be located near the data reader **100**, **200**, such as a peripheral presentation scanner resting or mounted to a nearby surface, and/or a handheld scanner that also may be used for manual capturing by the user (e.g., checkout assistant or self-checkout customer). Such devices may be coupled directly to the main board **130** in some embodiments or to the multi-port network switch **140** if so enabled. As shown, the POS **160** may be coupled directly to the main board **130**. Such a connection may be via communication interfaces, such as USB, RS-232, or other such interfaces. In some embodiments, the POS **160** may be coupled directly to the multi-port network switch **140** if so enabled (e.g., as an Ethernet connected device).

The multi-port network switch **140** may be implemented on a separate board from the main board **130**. In some embodiments, the multi-port network switch **140** may be implemented on the main board **130** that also supports the one or more processors **135** also described herein. The multi-port network switch may include multiple ports to provide advanced network connectivity (e.g., Ethernet) between internal devices (e.g., CCMs **116**, **126**) within the data reader **100**, **200** and external devices (e.g., TDR **152**, peripheral camera(s) **154**, **156**, remote server **158**, etc.) from the data reader **100**, **200**. Thus, the multi-port network switch **140** may provide an Ethernet backbone for the elements within the data reader **100**, **200** as well as for external devices coupled to the data reader **100**, **200** for control and/or managing data flow or analysis. As an example, multi-port network switch **140** may be implemented with a KSZ9567 Ethernet switch or other EtherSynch® product family member available from Microchip Technology Inc of Chandler, Arizona or other similar products and/or devices configured to provide network synchronization and communication with multiple network-enabled devices. Embodiments of the disclosure may include any number of ports supported by the multi-port network switch to couple to both internal devices (e.g., main board, cameras, etc.) and external devices (e.g., peripheral cameras, TDR, illumination sources, remote servers, etc.) to provide a flexible platform to add additional features for connecting with the data reader **100**, **200**.

Although FIG. **3** shows one block for active illumination assemblies **118**, **128** in each of the vertical and horizontal housings **110**, **120**, some embodiments may include multiple such assemblies in each of the horizontal and vertical housings **110**, **120** (as will be described further below) in order to provide for different lighting options at different angles across the read zone. For example, the vertical housing **110** may include two (or more) illumination assemblies therein at different locations and/or different colors for a desired illumination field from the vertical view. Likewise, the horizontal housing **120** may include two (or more) illumination assemblies therein at different locations and/or different colors for a desired illumination field from the horizontal view. As shown herein, the illumination assemblies **118**, **128** may be coupled directly to the main board **130**. However, in some embodiments, additional components may be coupled within the path from the main board **130**, such as a control panel or other such device (e.g., within the vertical section). In yet other embodiments, the illumination assemblies **118**, **128** may be coupled to the multi-port network switch **140** which may route triggering controls from the main board **130**. TDR **152** and one or more of the peripheral cameras **154**, **156** may also include associated illumination assemblies. Synchronization of such illumination sources may be managed by the multi-port network switch **140** as controlled by the main board **130**. In some embodiments, the multi-port network switch may employ or leverage IEEE1588 Precision Time Protocol to synchronize the illumination system with remote cameras, which may enable clock accuracy in sub-microsecond range.

In operation, images may be captured by the cameras **112**, **114**, **116**, **122**, **124**, **126**. Monochrome images may be captured by monochrome cameras **112**, **114**, **122**, **124** and color images may be captured by color cameras **116**, **126**. The multi-port network switch **140** may be configured to coordinate (e.g., synchronize) timing of camera exposure and active illumination (e.g., white illumination) with the color cameras **116**, **126** (as controlled by the controller on the main board **130**) to occur in an offset manner with the timing of the camera exposure and active illumination (e.g., red illumination) with the monochrome cameras **112**, **114**, **122**, **124**.

Image data (e.g., streaming video, image frames, etc.) from the color cameras **116**, **126** may be routed through the multi-port network switch **140** to the processing/analysis modules located internal to the data reader **100**, **200**, such as the one or more processors **135** supported by the main board **130**. As such, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on the color images internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. In some embodiments, barcode decoding may also be performed on the color images internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. Image data from the color cameras **116**, **126** may also be routed through the multi-port network switch **140** to external devices, such as remote server **158** or other similar devices including any network enabled POS systems. As such, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on the color images externally to the data reader **100**, **200** by external devices coupled through the multi-port network switch **140**. Such color images or other data stream may be routed directly to the network connected external devices through the multi-port network switch **140** without first being received by the main board **130** (if at all). In other words, image data may be passed from at least one imager internal to the data reader through the at least one multi-port network device **140** and on to at least one external device bypassing the main board **130**. Having a connection to both the main board **130** as well as to external devices via the multi-port network switch enables image data to be provided to internal as well as external processing resources.

Image data from the monochrome cameras **112**, **114**, **122**, **124** may be provided to the main board **130** to the processing/analysis modules located internal to the data reader **100**, **200** such as the one or more processors **135** supported by the main board **130**. As such, barcode decoding may also be performed on the color images internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. In some embodiments, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on the monochrome images internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. Image data from the monochrome cameras **112**, **114**, **122**, **124** may also be routed through the multi-port network switch **140** to external devices, such as remote server **158** or other similar devices including any network enabled POS systems. As such, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on the monochrome images externally to the data reader **100**, **200** by external devices coupled through the multi-port network switch **140**. Such monochrome images or other data stream may be routed directly to the network connected external devices to the multi-port network switch **140** after first being received by the main board **130**.

Image data (e.g., streaming video, image frames, etc.) from the TDR **152** or other external peripheral cameras **154**, **156** may be routed through the multi-port network switch **140** to the processing/analysis modules located internal to the data reader **100**, **200**, such as the one or more processors **135** supported by the main board **130**. As such, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on the images (e.g., color and/or monochrome) internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. In some embodiments, barcode decoding may also be performed on such images internally within the data reader **100**, **200** by the one or more processors **135** supported by the main board **130**. Image data from the TDR **152** or other external peripheral cameras **154**, **156** may also be routed through the multi-port network switch **140** to external devices, such as remote server **158** or other similar devices including any network enabled POS systems. As such, image analysis (e.g., AI, machine learning, OCR, object recognition, item validation, produce recognition, analytics, etc.) may be performed on these images externally to the data reader **100**, **200** by external devices coupled through the multi-port network switch **140**. Such images or other data stream may be routed directly to the network connected external devices through the multi-port network switch **140** without first being received by the main board **130** (if at all).

The multi-port network switch **140** may be coupled to the main board **130** via a single cable configured to provide power and communication to the main board **130**. Power may be provided to the system via power source **150** via the multi-port network switch **140**, which in turn provides power (e.g., power over Ethernet (PoE)) to the main board **130** and the color cameras **116**, **126**. Monochrome cameras **112**, **114**, **122**, **124** and illumination assemblies **118**, **128** may be powered via the main board **130**.

Features of employing the multi-port network switch **140** as a primary backbone for communication and power to interface between both internal and external components of the system include enabling power, communications, and camera/illumination synchronization to occur over a single cable between such connected components. In addition, precision time protocol (PTP), generic precision time protocol (GPTP), time sensitive networking (TSN) may provide an improved synchronization (e.g., within 1 microsecond error) for an open standard, widely supported, single cable solution. In addition, scanner maintenance tools may be simplified via improved network connectivity.

In some embodiments, the multi-port network switch **140** may be disposed within an external module having its own housing separate from the data reader **100**. The multi-port network switch **140** may, thus, be located outside of the bioptic housing of the data reader **100** but may operably couple to the main board **130** and internal devices (e.g., vertical CCM **116**, horizontal CCM **126**) as well other external devices (e.g., TDR **152**, cameras **154**, **156**, server **158**, etc.) for providing the network backbone for communication and/or power as described above.

FIG. **4** is a simplified block diagram of certain components mounted on the main board **130** according to an embodiment of the disclosure. In particular, further details are provided regarding the one or more processors **135** that may include an Ethernet physical layer **402**, a system processor **404**, and an image processor **406**. Additional processing elements are also contemplated among the one or more processors **135**, such as, for example, an artificial intelligence (AI) accelerator disposed on the main board **130** and coupled to the system processor **404** (e.g., via insertion into a PCIe slot on the main board **130**).

The system processor **404** may be coupled to each of the Ethernet physical layer **402** and the image processor **406**. The Ethernet physical layer **402** may be coupled with the multi-port network switch **140** to provide an interface between the main board **130** and the multi-port network switch **140**. The image processor **406** may be coupled to the monochrome imagers **112**, **114**, **122**, **124** to provide control (e.g., sync signal) and to receive monochrome images therefrom. The image processor **406** may be configured to receive and format image data from the cameras **112**, **114**, **122**, **124** before being received by the system processor **404**. In some embodiments, multiple image processors may be present such that each camera **112**, **114**, **122**, **124** may have its own image processor associated therewith. In some embodiments, cameras may share an image processor for transmission to the system processor **404**. For example, a single image processor (e.g., FPGA) may be configured to combine (e.g., concatenate) the image data from each of the monochrome cameras **112**, **114**, **122**, **124** for the system processor to receive multiple views at a single point in time through one input. An example of such a process is described in U.S. Patent Publication No. 2022/0207969, filed Dec. 31, 2020, and entitled “FIXED RETAIL SCANNER WITH ANNOTATED VIDEO AND RELATED METHODS,” the disclosure of which is incorporated by reference in its entirety. Image processor **406** may also be coupled to the illumination assemblies **118**, **128** to provide control thereto (e.g., sync signal). In some embodiments, the sync signal may be generated by one of the Ethernet physical layer **402** or the system processor **404**, and which may be based on a system clock signal.

FIGS. **5-7** are different simplified block diagrams of the various imager modules according to an embodiment of the disclosure. For example, FIG. **5** may refer to one of the color camera modules **116**, **126**, FIG. **6** may refer to one of the monochrome camera (MC) modules **112**, **114**, **122**, **124**, and

FIG. **7** may refer to one of the TDR **152** or peripheral cameras **154**, **156** as examples.

Referring to FIG. **5**, the color camera module (CCM) **116**, **126** may include a CCM processor **502** that couples to a color imager **504** and to the multi-port network switch **140**. The CCM processor **502** may include one or more processors that perform different functions, such as control, formatting, and/or certain analysis functionality, etc. Active illumination for the color camera module **116**, **126** may occur off-board via separate illumination assemblies **118**, **128**. In some embodiments, separate on-board processors may not be present for one or more of the CCM modules **116**, **126** such that the control for such may be directly from the main board (e.g., system processor **404**) and/or via the multi-port network switch **140** rather than with its own CCM processor **502**.

Referring to FIG. **6**, the monochrome camera module **112**, **114**, **122**, **124** may include a MC processor **602** that couples to a monochrome imager **504** and to the main board **130** directly. However, it is also contemplated that the monochrome imagers **504** may be connected to the multi-port network switch **140**. The MC processor **602** may include one or more processors that perform different functions, such as control, formatting, and/or certain analysis functionality, etc. Active illumination for the MC camera module **112**, **114**, **122**, **124** may occur off-board via separate illumination assemblies **118**, **128**. In some embodiments, separate on-board processors may not be present for one or more of the MC camera modules **112**, **114**, **122**, **124** such that the control for such may be directly from the main board (e.g., system processor **404** and/or image processor **406**) rather than its own MC processor **602**.

Referring to FIG. **7**, the TDR **152** or other peripheral cameras **154**, **156** may include a processor **702** that couples to an imager **704** (e.g., color and/or monochrome depending on application) and to the multi-port network switch **140**. The processor **702** may include one or more processors that perform different functions, such as control, formatting, and/or certain analysis functionality, etc. In some embodiments, certain camera modules (e.g., TDR **152** or other peripheral cameras **154**, **156**) may have their own active illumination assembly **706** associated therewith that may different than the illumination assemblies **118**, **128** within the bi-optic housing. The illumination assembly **706** may be located on-board as shown or may be provided at a separate location that may still be within the camera module housing. In some embodiments, separate on-board processors may not be present for the TDR **152** such that the control for such may be directly from the main board (e.g., system processor **404**) and/or via multi-port network switch **140** rather than with its own TDR processor **702**.

Synchronization of at least some of the active illumination source (e.g., assemblies **118**, **128**, **706**, etc.) with each other and with the exposures of the corresponding camera modules (e.g., modules **112**, **114**, **122**, **124**, **116**, **126**, **152**, **154**, **156**, etc.) may be based on time stamps corresponding to packets being generated and received over the network (e.g., IEEE 1588 Precision Time Protocol) when generating and transmitting the sync signal to each device. Each device may determine the elapsed time between packet generation and reception based on the time stamps in order to synchronize with each other and adjust the illumination/exposure scheme designated for each device.

As an example, each device (e.g., system processor **404**, horizontal CCM **126**, vertical CCM **116**, TDR **152**, and other peripheral cameras) connected to the multi-port network switch **140** may generate a sync signal (e.g., 1 PPS sync signal) that align with each other based on a common time base. Within each device, one or more separate counters may control the generation of trigger signals for the imager and illumination control signals for the active illumination. The counter(s) may cycle through a sequence of imager triggers and illumination control signals (that may be spaced a predetermined time to account for actual activation times). These internal counters may be overlayed with the internally managed sync signal such that the sync event marks the beginning of the counter time period. Within each device, the respective internal counter may be used to define when the actual trigger signals for imagers and/or illuminations are to be activated relative to the start of the counter (and the 1 PPS sync signal). As an example, the sync signal may initiate the internal counters within a respective device and/or adjust the count values loaded into the counters in order to synchronize across the system. A frame counter may have a duration that defines how often the frame sequence occurs for the cameras controlled by the respective device. An illumination counter may have a duration that defines how often the illumination sequence occurs for different illumination groups controlled by the respective device. In some embodiments, the illumination counter is loaded with half the frame period. As a result, the illumination may be activated at a higher rate than the imagers which may reduce flicker perceived by the user. The actual trigger/activation signal for the camera or imager may be at a predefined time within the duration of the respective counter. If a different illumination scheme is desired, the system processor may load different trigger values and/or count values to the respective registers throughout the different devices. Each counter may expire (e.g., decrement or increment) and reload (e.g., when it reaches zero or some other value) based on its own frequency (e.g., 1 MHz) that may be different than the sync signal.

As sync signals are adjusted depending on packet time stamps during regular communication over the network (e.g., IEEE 1588), the sync signals generated on each device may separately be adjusted to the common time base, which in turn causes the overlayed counters on each device to align as the overlayed counters are dependent on the 1 PPS sync signal. Because each device maintains its own 1 PPS sync signal and internal counter that is overlayed thereto, synchronization may be maintained without needing to send separate synchronization signals to each other, but rather adjusted based on network communications. Thus, for every network sync signal, these counters may operate through the different stages with the adjusted network sync signal operating to periodically realign the internal counters of each device. Although the sync signal is sometimes referred herein to as 1 pulse per second (PPS), other frequencies for generation of this synchronization clock are also contemplated, which could result in more frequent or less frequent synchronization of the system time base as desired.

FIGS. **8**A and **8**B are examples of waveforms showing illumination and exposure counters (e.g., frame counter **802**, illumination counter **804**) for an illumination source and a corresponding imager according to embodiments of the disclosure. At the beginning of each frame, the frame counter **802** for the corresponding imager may be loaded with a frame period from a register file. At the same time, the illumination counter **804** for the corresponding illumination source may be loaded with an illumination period from a register file. The counters **802**, **804** may change (e.g., decrement in some embodiments, or increment in some embodiments) until its limit (e.g., zero for decrementing) is reached after which the counter is reloaded. In some embodiments, illumination period may be set to be one half of the frame period (e.g., illumination period=frame period/2). In some embodiments, the illumination frequency (e.g., 60 Hz) may be double the frame rate (e.g., 30 Hz) for the imagers.

Certain events may be controlled using these counters **802**, **804** as shown in FIG. **8**B. Predetermined (e.g., configurable) start and stop registers associated with the counters **802**, **804** may implement a respective illumination waveform **806** (for controlling a corresponding illumination source) or a trigger waveform **808** (for controlling a corresponding imager). Different illumination sources may have different start/stop registers depending on when the illumination source is desired to occur. For example, start/stop registers associated with red LEDs of the illumination assemblies **118**, **128** may set for a time near the beginning of the illumination cycle, start/stop registers associated with white LEDs of the illumination assemblies **118**, **128** may be set for a time near the end of the illumination cycle. Start/stop registers associated with the illumination assembly **706** (e.g., FIG. **7**) of an external device, such as a TDR, may be set for another time (e.g., immediately after the red LEDs). Start/stop registers for the trigger waveform **808** of a corresponding imager may be similarly positioned depending on the time when the respective imager is to capture an image (e.g., during red, white, and/or ambient illumination). Other illumination schemes (e.g., including relative timing and specific wavelengths) are contemplated and such examples described herein are non-limiting.

The counters **802**, **804** and the related start/stop registers may be implemented by the controller for a particular imager and/or illumination source. For example, in some embodiments, the one or more processors **135** of the main board (e.g., image processor **406** of FIG. **4**) may execute the counter **802** associated with the illumination sources **118**, **128** (along with separate start/stop registers for the red/white illumination sources across the system), and the counter **804** associated with the MCs **112**, **114**, **122**, **124**. In some embodiments, the CCMs **116**, **126** may execute their own imager counter **804** such as via CCM processor **502** (FIG. **5**). In some embodiments, one or more peripheral cameras **152**, **154**, **156** (e.g., TDR) may execute their own illumination counter **802** and/or imager counter **804** such as via processor **702** (FIG. **7**). These various counters may be synchronized via network communications via the multi-port network switch **140** such as a 1 pulse-per-second (1 PPS) signal or other time period determined by the network traffic of the multi-port network switch **140**. As discrepancies in the synchronization are identified from the network communications, adjustments may be made to the start count values that are loaded for the respective counter during the next period before the next adjustment is made (e.g., the next 1 PPS signal). As a result, different devices may remain synchronized without a discrete synchronization signal being transmitted to each respective device.

Referring again briefly to FIG. **4**, the system processor **404** and/or the image processor **406** may generate a 1 PPS sync signal and overlay an internal counter to that sync signal to control the triggering of the monochrome imagers **112**, **114**, **122**, **124** and activate the different sub-groups of the illumination assemblies **118**, **128** described in more detail hereinbelow. As an example, the system processor **404** may generate the 1 PPS sync signal that is sent to the image processor **406** which maintains the internal counters that are tied to the 1 PPS sync signal. The internal counters define the relative timing for sending the image trigger signal to the monochrome imagers **112**, **114**, **122**, **124** and the corresponding illumination control signals to the sub-groups of the illumination assemblies **118**, **128**.

Referring again briefly to FIG. **5**, the CCM processor **502** for each CCM **116**, **126** may generate a 1 PPS sync signal and overlay an internal counter to that sync signal to control the triggering of its imager **504**. For example, the vertical CCM **116** may maintain its own 1 PPS sync signal and overlay its own internal counter to that sync signal to control the triggering of its imager. Likewise, the horizontal CCM **126** may maintain its own 1 PPS sync signal and overlay its own internal counter to that sync signal to control the triggering of its imager. If these devices control their own active illumination, separate illumination trigger signals may be generated as well. Otherwise, the synchronization of the imagers of the CCMs **116**, **126** may be aligned with the appropriate sub-group of the illumination assemblies **118**, **128** (that are controlled by the system processor **404** and/or image processor **406**).

Referring again briefly to FIG. **6**, the MC processor **602** for each MC **112**, **114**, **122**, **124**, may receive the trigger signal from the main board (e.g., image processor **406**) to determine the triggering of the imager **604**. In this embodiment, the main board maintains the 1 PPS sync signal (e.g., maintained by the system processor **404**) and/or internal counter (e.g., maintained by the image processor **406**) and the imager **604** is responsive to the trigger signals received from devices on the main board **130**. In such an embodiment, the MC processor **602** may not be necessary or included. In some embodiments, the MCs **112**, **114**, **122 124** may be operably coupled to the multi-port network switch **140** in which case it may be beneficial for the MCs **112**, **114**, **122 124** (e.g., via MC processor **602**) to maintain its own 1 PPS sync signal and/or internal controllers that are synchronized with the others connected through the network switch **140**.

Referring again to FIG. **7**, the processor **702** for the TDR **152** (or other peripheral camera **154**, **156**) may generate a 1 PPS sync signal and overlay one or more internal counters to that sync signal to control the triggering of its imager **704** and any corresponding illumination control signals of any active illumination **706** controlled thereby.

Depending on the timing of the desired trigger, different illumination may be aligned with different imager activation throughout the system. For example, if it is desirable for the vertical CCM **116** and the horizontal CCM **126** to trigger at the same time, each of their respective internal counters may define the corresponding trigger signal to be at the same duration from the beginning of the counter (and also, therefore, the 1 PPS sync signal to which the horizontal and vertical CCMS **116** and **126** are tied). If the TDR **152** is desired to be triggered at a different time, an internal counter of the TDR **152** may define a trigger therefor and/or illumination at different times such that the trigger and/or illumination are offset from the others. If that misalignment is desired to be changed, then the internal counters definitions may be changed such that the definition of the activation of the triggering pulse may be changed.

During operation and communication of packets of each of these devices with the multi-port network switch **140**, each device may determine the elapsed time between packet generation and reception based on the time stamps in order to synchronize (e.g., align 1 PPS sync signal via IEEE 1588) to the common time base. As a result, the illumination/exposure scheme designated for each device across the whole system may be maintained. Additional detail regarding control and synchronization of LEDs relative to each other, including examples of various illumination sequences, is described in U.S. patent application Ser. No. 17/154,512, filed Jan. 21, 2021, and entitled "IMAGE-READING DEVICE HAVING CONFIGURABLE MULTI-MODE ILLUMINATION AND MONOCHROME COLOR IMAGE CAPTURE AND RELATED METHODS," the disclosure of which is incorporated by reference in its entirety.

In some embodiments, the housings of the TDR **152** and/or peripheral cameras **154**, **156** may include multiple imagers disposed therein. In some embodiments, imagers may have separate connections to the multi-port network switch **140** (e.g., directly or via their own separate processor) or main board **130** to communicate (e.g., data flow, synchronization, etc.) with the base scanner as with the other imagers (e.g., **704**) inside the housing as described above. In some embodiments, such additional imagers may have a separate connection to a remote device (e.g., server) directly that bypasses the base scanner. In such embodiments, synchronization may occur via internal controls, from another remote device, and/or via communication with the processor (e.g., **702**) or main imager **704** that maintain the counters within the respective housing.

Similarly, one or more additional CCMs may be disposed within the housing of the base scanner (e.g., within the vertical portion **110** or within the horizontal portion **120**). Such additional CCMs may have separate connections to the multi-port network switch **140** (e.g., directly or via their own separate processor) to communicate (e.g., data flow, synchronization, etc.) with the base scanner as with the other CCMs (e.g., **116**, **126**) inside the housing as described above. In some embodiments, such additional CCMs may have a separate connection to a remote device (e.g., server) directly that bypasses the multi-port network switch **140**. In such embodiments, synchronization may occur via internal controls, from another remote device, and/or via communication with the main board **140** that maintains counters (e.g., for the MCs) within the base scanner housing.

FIG. **9** is a simplified block diagram of the data reader **100**, **200** focusing on the illumination assemblies **118**, **128** according to another embodiment of the disclosure. As previously described, each of the horizontal and vertical housings **110**, **120** may have multiple illumination assemblies **118**, **128** located therein to provide for different lighting options at different angles across the read zone. For example, as shown in FIG. **8**, two illumination assemblies **118**A, **118**B may be located within the vertical housing **110**, and four illumination assemblies **128**A, **128**B, **128**C, **128**D may be located within the horizontal housing **120**. The combined effect of illumination assemblies **118**A, **118**B and illumination assemblies **128**A, **128**B, **128**C, **128**D provides active illumination for the camera modules in the system—however, in general, illumination assemblies **118**A, **118**B, provide active illumination for the vertical MCs **112**, **114** and the vertical CCM **116**, while the illumination assemblies **128**A, **128**B, **128**C, **128**D provide active illumination for the horizontal MCs **122**, **124** and the horizontal CCM **126**. In some embodiments, illumination assemblies may be located external to the housing of the data reader **800** (e.g., mounted to an external surface or incorporated within another device).

Each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may include multiple light emitting diodes (LEDs) emitting different wavelengths (e.g., sub-groups) co-located within the same assembly (described in more detail below with respect to the subsequent figures). As an example, each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may include one or more red LEDs and one or more white LEDs that may be triggered independently of each other. Thus, while each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D themselves may be activated at the same time, different sub-groups of LEDs within a given illumination assembly may be activated with the other related sub-groups of the other illumination assemblies within the data reader **100**, **200**. In other words, the first LED sub-groups (e.g., red LEDs) among each of the each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be activated at a first time, and the second LED sub-groups (e.g., white LEDs) among each of the each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be activated at a second time that is different than the first time (different sub-groups of different types are not activated together).

The system controller may synchronize one set of sub-groups across the illumination assemblies with one or more camera modules, and another set of sub-groups across the illumination assemblies with one or more different camera modules. For certain situations or applications (e.g., operational modes), the system controller may mix and match sub-groups to different camera modules depending on which camera module/illumination sub-group combination is best suited for the particular situation. This determination may be changed in real-time on the fly or as part of a regular illumination/exposure sequence. For example, in some instances, the first LED sub-groups (e.g., red LEDs) of each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be synchronized with monochrome image modules, and the second LED sub-groups (e.g., white LEDs) of each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be synchronized with color image modules. At a later point in time (e.g., or as part of an ongoing sequence or pattern), it may be desirable for the LED sub-groups to change camera module with which they are synchronized. For example, the first LED sub-groups (e.g., red LEDs) may be activated with at least some of the exposures of the color camera modules for situations or analysis in which doing so may be beneficial. Likewise, the second LED sub-groups (e.g., white LEDs) may be activated with at least some of the exposures of the monochrome camera modules for situations or analysis in which doing so may be beneficial. In each situation, the different illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D are activated together even if only one set of LED sub-groups is activated together at a given time.

In some embodiments, the system controller may detect that one or more camera modules are not connected to the system. This may impact whether some of the sub-groups are utilized. For example, if no color camera modules (CCMs) are connected, the second LED sub-groups (e.g., white LEDs) may not be as beneficial for an environment with just monochrome camera modules. In response, the system controller may only activate the first LED sub-groups in each of the various illumination assemblies in synchronization with the monochrome camera modules. Of course, other sub-groups may be disabled (e.g., no control signal is sent) depending on camera module assignment and whether such camera module is present or operational, or depending on a particular mode of operation for a given application.

In some embodiments, one or more of the LEDs within the various illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be RGB LEDs configured to emit light at different wavelengths responsive to a control signal. As a result, "red LEDs" and "white LEDs" and similar phrases may refer to the light that is output at a given time. Some LEDs may be specifically configured for a particular wavelength, while others may others (e.g., RGB LEDs) may output different wavelengths at different times. In some embodiments, the first sub-group may be RGB LEDs that could produce different wavelengths for different situations, and the second sub-group may be LEDs that produce a single wavelength. Likewise, in some embodiments, the second sub-group may be RGB LEDs that could produce different wavelengths for different situations, and the first sub-group may be LEDs that produce a single wavelength.

As an example, some embodiments may include the first sub-group being red only LEDs and the second sub-group being RGB LEDs. At a first time, all LEDs (red only LEDs of first sub-group and RGB LEDs of second sub-group) may be controlled to produce red illumination, and at the second time only the second sub-group (RGB LEDs) may be controlled to produce white illumination (or some other wavelength). In another embodiment, with the second sub-group being white only LEDs and the first sub-group being RGB LEDs, at a first time, all LEDs (white only LEDs of second sub-group and RGB LEDs of first sub-group) may be controlled to produce white illumination, and at the second time only the first sub-group (red LEDs) may be controlled to produce red illumination (or some other wavelength). Using the flexibility of the RGB LEDs in these examples allows for some LEDs to be reused at different times with different wavelengths to provide additional illumination at that particular wavelength, if needed. In yet other embodiments, all LEDs in each of the illumination assemblies may be RGB LEDs could produce different wavelengths for different situations such that at one time and then some or all of the same LEDs could produce different wavelengths at another time to add additional flexibility to the illumination options.

As shown in FIG. **9**, multiple illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be connected to each other (e.g., as a pair) in a daisy chain arrangement to facilitate easier connections with the main board **130**. For example, within the horizontal housing, first cabling (e.g., cable, bus, wires, etc.) may connect the first illumination assembly **128**A with the main board **130**, and second cabling may connect the second illumination assembly **128**B with the first illumination assembly **128**A. Power and control signals may be provided from the main board **130** to the first illumination assembly **128**A, and to the second illumination assembly **128**B (via the first illumination assembly **128**A). As a result, only one connection to the main board **130** may be required for the first and second illumination assemblies **128**A, **128**B. Similarly, the third illumination assembly **128**C and the fourth illumination assembly **128**D may be connected to each other in a daisy chain arrangement, with the third illumination assembly **128**C having the direct connection to the main board **130**, and the third illumination assembly **128**C providing power and control signals from the main board **130** to the fourth illumination assembly **128**D. As a result, only one connection to the main board **130** may be required for the third and fourth illumination assemblies **128**C, **128**D.

Likewise, within the vertical housing, first cabling may connect the first illumination assembly **118**A with the main board **130** (e.g., via a control panel **950**), and second cabling may connect the second illumination assembly **118**B with the first illumination assembly **118**A. Power and control signals may be provided from the main board **130** to the first illumination assembly **118**A (e.g., via control panel **950**), and to the second illumination assembly **118**B (via the first illumination assembly **118**A). As a result, only one connection may be required for the first and second illumination assemblies **118**A, **118**B. As shown, the direct connection of the first illumination assembly **118**A in the vertical housing may be to the control panel **950** that is connected to the main board **130**, allowing for fewer direct connections to the main board **130**. Of course, in some embodiments, the first illumination assembly **118**A may be connected directly to the main board **130**. In general, the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may be connected to any device or module of the data reader **100**, **200** that can pass power and/or control signals from the system controller (e.g., system processor **404** and/or image processor **406** in FIG. **4**).

For ease of manufacturing and communication with the main board **130**, the illumination assemblies may come in connected pairs. It is, however, contemplated that some embodiments include any number of illumination assemblies that are connected in such an arrangement. For example, a daisy chain of three, four, etc. is also contemplated in some embodiments of the disclosure. A pair of illumination assemblies as shown in FIG. **9**, however, is beneficial for an embodiment such as in FIG. **9** as identical pairings of illumination assemblies may be manufactured, which then can be assembled in either the vertical or horizontal housings at their desired locations for full coverage of active illumination of the read zone.

In some embodiments, the illumination assemblies **118**A-B, **128**A-D, may be connected to each other in a "Y arrangement" as an alternative to the daisy chain arrangement described above. In such an arrangement, multiple illumination assemblies may be connected to cabling at a common connection that branches into multiple paths for the different illumination assemblies.

FIG. **10** shows a simplified perspective view of the data reader **100**, **200** according to an embodiment of the disclosure. Certain features (e.g., covers, platter, housing features, etc.) have been removed from the view in order to more clearly show the arrangement of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D with their associated cabling. For example, the vertical illumination assemblies **118**A, **118**B may be connected together as a first pair, which point generally downward from the vertical region onto the horizontal platter region. The first illumination assembly **118**A may be generally near a first corner of the vertical window, and the second illumination assembly **118**B may be generally near a second corner of the vertical window. Cabling may be provided to connect the pair of illumination assemblies **118**A, **118**B with each other in a daisy chain arrangement. Horizontal illumination assemblies **128**A, **128**B may be connected together as a second pair, which point generally upward from the horizontal region. The first illumination assembly **128**A may be generally near a first side of the horizontal platter region, and the second illumination assembly **128**B may be generally near a front end of the horizontal platter region. Cabling may be provided to connect the pair of illumination assemblies **128**A, **128**B with each other in a daisy chain arrangement. Horizontal illumination assemblies **128**C, **128**D may be connected together as a third pair, which point generally upward from the horizontal region. The third illumination assembly **128**C may be generally near a second side of the horizontal platter region (opposite the first side), and the fourth illumination assembly **128**D may be generally near the front end of the horizontal platter region. Cabling may be provided to connect the pair of illumination assemblies **128**C, **128**D with each other in a daisy chain arrangement.

As described in further detail below, each of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D may have different LED sub-groups that are independently activated such that all LED assemblies may be activated together but with only the first sub-groups from each corresponding LED assembly being activated together at a first time, and with only the second sub-groups from each corresponding LED assembly being activated together at a second time. This allows for each of the corresponding first LED sub-groups being synchronized with the exposure of a first camera (or first group of cameras), each of the corresponding second LED sub-groups being synchronized with the exposure of a second camera (or second group of cameras). Additional sub-groups and/or camera groups are contemplated.

FIGS. **11**A-**11**D are different views of one of the illumination assemblies **118**, **128** according to an embodiment of the disclosure. In particular, FIG. **11**A shows a front view, FIG. **11**B shows a perspective view, and FIG. **11**C shows a back perspective view of one of the illumination assemblies **118**, **128**. FIG. **11**D shows a simplified schematic representation of the illumination assemblies **118**, **128** with the illumination cone removed. For discussion of FIGS. **11**A-**11**D the reference numerals **118**, **128** are used because the illumination assembly **118**, **128** may be any one of the illumination assemblies **118**A, **118**B, **128**A, **128**B, **128**C, **128**D of FIG. **8** or **9**. In other words, the illumination boards of the illumination assemblies of FIG. **8** or **9** may be identically constructed for simplified manufacturing and installation. Reference numerals **118** and **128** are simply used as ways to distinguish the installation location (vertical or horizontal) and not necessarily as signifying any difference in the actual construction of the illumination board.

The illumination assembly **118**, **128** may be constructed with a first sub-group of LEDs **1102** having a first wavelength (e.g., red) and a second sub-group of LEDs **1104** having a second wavelength (e.g., white) that are co-located within the same illumination assembly **118**, **128**. Of course, different wavelengths (e.g., IR, blue, etc.) and combinations thereof are also contemplated. In addition, additional sub-groups are contemplated to be co-located within a single illumination assembly in some embodiments where more than two different wavelengths of active illumination are desired. The LEDs **1102**, **1104** are mounted on a printed circuit board (PCB) **1108** that together with other components mounted on the PCB **1108** are sometimes referred to herein as the "illumination board."

The illumination assembly **118**, **128** includes an illumination cone **1106** that connects to the PCB surrounding the LEDs **1102**, **1104**. The illumination cone **1106** may have an inner perimeter near the LEDs **1102**, **1104** that fans out to an outer perimeter having dimensions greater than the inner perimeter. The outer perimeter of the illumination cone **1106** may have a top length (d**1**) that is longer than the bottom length (d**2**) with the sides of outer perimeter angled inward connecting the top length and the bottom length. The illumination cone **1106** may have a reflective material (e.g., reflective coating, mirror, etc.) configured to direct light into the read zone and away from the user's eyes. This asymmetrical formation of the illumination cone **1106**, combined with the installed orientation, may be particularly well suited for directing the active illumination toward the read zone and generally away from the user's eyes. The illumination cone **1106** may also have a diffuser (not shown) attached thereto, which may attach at the front portion of the outer perimeter of the illumination cone **1106**. For example, the diffuser may be attached with ends inserted into the holes shown on the sides and bottom of the illumination cone **1106** or through other attachment mechanisms.

The LEDs **1102**, **1104** may be arranged within the illumination assembly **118**, **128** in a linear arrangement such that a single row of LEDs **1102**, **1104** may be arranged in a single dimension. In some embodiments, an LEDs **1102**, **1104** may be arranged as an array such that multiple rows of LEDs **1102**, **1104** may be arranged in multiple dimensions. The single row of LEDs **1102**, **1104** may be preferred in some embodiments to reduce visibility to the user.

As shown in FIGS. **11**A-**11**D the second sub-group of LEDs **1104** (e.g., two white LEDs) may be located in the middle of the row such that the first sub-group of LEDs **1102** (e.g., six red LEDs) are located on each side (e.g., three red LEDs on each side of the two white LEDs). Other arrangements (and numbers of LEDs in each sub-group) are also contemplated, including the second sub-group **1104** and the first sub-group **1102** being grouped in two distinct groups next two each other, or individual LEDs from each sub-group **1102**, **1104** being interspersed with each other in some other pattern or arrangement. Having a symmetrical arrangement (e.g., as shown in FIGS. **11**A-**11**D) may simplify the layout for the illumination board as well as enable the illumination assemblies **118**, **128** to be installed at the various locations within the data reader **100**, **200** with similar illumination coverage for each LED type. For example, referring again briefly to FIG. **10**, illumination assemblies **128**B, **128**D (part of different pairs) may have a similar illumination coverage from the front direction for both illumination types (e.g., red and white) even though the illumination boards are flipped in order to accommodate their particular installation to accommodate the cabling. Similarly, illumination assemblies **128**A, **128**C (part of different pairs) may have a similar illumination coverage from the side directions for both illumination types (e.g., red and white) even though the illumination boards are flipped in order to accommodate their particular installation to accommodate the cabling (e.g., to a common source).

Referring now to FIG. **11**C, the illumination cone **1106** may have a connection portion for connecting to the PCB **1108**. The connection portion may include connecting arms that snap around the PCB **1108** to secure the illumination cone **1106** to the PCB **1108**. In some embodiments, other securing mechanisms (e.g., screws) may also be used for such connection. The illumination cone **1106** may be easily attached and reattached, which may be beneficial for different attachment orientations to the PCB **1108**. Although the LED placement on the illumination board may be symmetrical, the illumination cone **1106** may not be symmetrical. In order to accommodate the flipped orientation of the different illumination boards to accommodate the cabling on the opposite side of the scanner, the illumination cone **1106** may also be flipped so that the cone is properly oriented within the data reader **100**, **200**.

Referring to FIG. **11**D, contact groups **1110**A, **1110**B connect to cabling. Input contacts **1110**A receive inputs (e.g., power, control signals) for the LEDs **1102**, **1104**, such as from the control panel, main board, another illumination assembly, or other source as described above. Output contacts **1110**B send outputs (e.g., power, control signals) to the next illumination assembly (if any) to receive as inputs in a daisy chain arrangement.

FIG. **12** is a simplified electrical schematic diagram of an illumination assembly **118**, **128** according to an embodiment of the disclosure. The first sub-group of LEDs **1102** may be serially coupled with each other, and the second sub-group **1104** may be serially coupled with each other. A first voltage

(V_1) is applied to power the first sub-group of LEDs **1102**. A second voltage (V_2) is applied to power the second sub-group of LEDs **1104**. The first voltage V_1 and the second voltage V_2 may have different voltages and may be received as different inputs to the illumination assembly **118**, **128**. For example, the first voltage (V_1) may be approximately 26 V. and the second voltage may be approximately 12 V. The different voltages may depend on the characteristics of the different LEDs of each sub-group as well as the number of LEDs used.

The first sub-group of LEDs **1102** receives a first control signal (CTL_1) that controls the activation of the LEDs **1102**. The second sub-group of LEDs **1104** receives a second control signal (CTL_2) that controls the activation of the LEDs **1104**. As described above, the activation of each sub-group may be synchronized to one or more different camera modules of the data reader. Because each sub-group has its own control signal, each sub-group may be controlled independently of each other and at different times as desired. Additional detail regarding control and synchronization of LEDs is described in U.S. patent application Ser. No. 17/154,512, filed Jan. 21, 2021, and entitled "IMAGE-READING DEVICE HAVING CONFIGURABLE MULTI-MODE ILLUMINATION AND MONOCHROME COLOR IMAGE CAPTURE AND RELATED METHODS," the disclosure of which is incorporated by reference in its entirety.

Disable circuitry **1202**, **1204** (e.g., multi-state buffer or switch) may be coupled to the LEDs **1102**, **1104** such that the control signals CTL_1, CTL_2 may be disabled before reaching the LEDs **1102**, **1104**. The disable circuitry **1202**, **1204** may be controlled by an enable signal (ENBL) that may be set by the system controller. As shown in FIG. **11**, the output contact (e.g., third from the top) may be tied to ground (GND), which is associated with the input contact for the ENBL signal of the next illumination assembly in the daisy chain. In this arrangement, the first illumination assembly of the pair may be disabled (e.g., via ENBL) independently of the second illumination assembly of the pair (which may remain constantly enabled via the GND connection). Disabling the first illumination assembly of the pair may be useful if there are situations in which one illumination assembly is not desired for operation. For example, referring briefly again to FIG. **10**, in certain installations of the data reader **100**, **200** the user may be positioned on the side of data reader **100**, **200** when scanning items. In this situation, either the first illumination assembly **128**A or the third illumination assembly **128**C on a side of the data reader **100**, **200** may be directed into the user's eyes when the user is positioned on side of the data reader **128**A, **128**C. The illumination assembly **128**A, **128**C that would cause this discomfort to the user may be disabled, which may be possible via setting the appropriate ENBL signal without disabling the remaining illumination assemblies throughout the data reader. For example, illumination assembly **128**A may be disabled (for both LED sub-groups), while the remaining illumination assemblies remain operational, including also illumination assembly **128**B that is part of the same daisy chain pair. In some embodiments, separate enable signals may be sent by the system controller for each of the illumination assemblies on the daisy chain. Doing so, however, may require additional pins to accommodate additional control signals.

The foregoing method descriptions and/or any process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art, the steps in the foregoing embodiments may be performed in any order. Words such as "then," "next," etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Although process flow diagrams may describe the operations as a sequential process, many of the operations may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination may correspond to a return of the function to the calling function or the main function.

The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed here may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

Embodiments implemented in computer software may be implemented in software, firmware, middleware, microcode, hardware description languages, or any combination thereof. A code segment or machine-executable instructions may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to and/or in communication with another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

The actual software code or specialized control hardware used to implement these systems and methods is not limiting of the disclosure. Thus, the operation and behavior of the systems and methods were described without reference to the specific software code being understood that software and control hardware can be designed to implement the systems and methods based on the description here.

When implemented in software, the functions may be stored as one or more instructions or code on a non-transitory computer-readable or processor-readable storage medium. The steps of a method or algorithm disclosed here may be embodied in a processor-executable software module which may reside on a computer-readable or processor-readable storage medium. A non-transitory computer-readable or processor-readable media includes both computer storage media and tangible storage media that facilitate transfer of a computer program from one place to another. A non-transitory processor-readable storage media may be any available media that may be accessed by a computer. By way of example, and not limitation, such non-transitory processor-readable media may comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other tangible storage medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer or processor. Disk and disc, as used here, include compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a non-transitory processor-readable medium and/or computer-readable medium, which may be incorporated into a computer program product.

The previous description is of various preferred embodiments for implementing the disclosure, and the scope of the invention should not necessarily be limited by this description. The scope of the present invention is instead defined by the claims.

What is claimed:

1. A fixed retail scanner including a data reader, comprising:
- a housing configured to be disposed within a checkout counter of a retail environment;
- a plurality of camera modules disposed within the housing;
- a plurality of illumination assemblies disposed within the housing, wherein each illumination assembly of the plurality includes:
  - a first sub-group of light emitting diodes (LEDs) emitting at a first wavelength; and
  - a second sub-group of LEDs emitting at a second wavelength and co-located with the first sub-group of LEDs on a common illumination board within its respective illumination assembly, wherein at least two illumination assemblies are connected to each other in a daisy chain arrangement; and
- a system controller disposed within the housing and operably coupled with the plurality of camera modules and the plurality of illumination assemblies, and configured to activate each illumination assembly together to provide active illumination for the plurality of camera modules such that:
  - the first sub-group of LEDs of each illumination assembly of the plurality is activated together across the different illumination assemblies to be synchronized with a first camera module of the plurality; and
  - the second sub-group of LEDs of each illumination assembly of the plurality is activated together across the different illumination assemblies to be synchronized with a second camera module of the plurality at times different from the first sub-group of LEDs.

2. The fixed retail scanner of claim 1, wherein the data reader is a bi-optic scanner, wherein the housing includes a horizontal housing and a vertical housing disposed in an orthogonal arrangement such that one or more of the illumination assemblies and camera modules are disposed within the horizontal housing, and one or more of the illumination assemblies and camera modules are disposed within the vertical housing.

3. The fixed retail scanner of claim 1, wherein the first wavelength is a red wavelength and the second wavelength is a white wavelength.

4. The fixed retail scanner of claim 1, wherein the at least two illumination assemblies include:
- a first illumination assembly connected to a main board to receive the power and control signals from the system controller; and
- a second illumination assembly connected to the first illumination assembly in the daisy chain arrangement to receive the power and control signals from the first illumination assembly.

5. The fixed retail scanner of claim 1, further comprising a control panel operably coupled with a main board to receive power and control signals therefrom. wherein the at least two illumination assemblies include:
- a first illumination assembly connected to a control panel to receive the power and control signals from the system controller via the control panel; and
- a second illumination assembly connected to the first illumination assembly in the daisy chain arrangement to receive the power and control signals from the first illumination assembly.

6. The fixed retail scanner of claim 1, wherein the first sub-group of LEDs and the second sub-group of LEDs are arranged on the common illumination board within the respective illumination assembly in a single linear arrangement.

7. The fixed retail scanner of claim 1, wherein the first sub-group of LEDs and the second sub-group of LEDs are arranged on the common illumination board the respective illumination assembly in a symmetric arrangement.

8. The fixed retail scanner of claim 7, wherein the second sub-group of LEDs are arranged in a middle location on the common illumination board within the illumination assembly with individual LEDs of the first sub-group being arranged on each side of the second-sub-group of LEDs on the common illumination board.

9. The fixed retail scanner of claim 1, wherein each illumination assemblies within the data reader are identically constructed.

10. A fixed retail scanner including a data reader, comprising:
- a housing configured to be disposed within a checkout counter of a retail environment;
- a first grouping of illumination assemblies disposed in a first housing plane of the data reader, the first grouping of illumination assemblies including:
- a first illumination assembly including a first LED sub-group emitting at a first wavelength and a second LED sub-group emitting at a second wavelength, and co-located within on a first common assembly illumination board; and
- a second illumination assembly including a first LED sub-group and a second LED sub-group co-located within on a second common assembly illumination board, wherein the first illumination assembly and the second illumination assembly of the first grouping are disposed at different locations and connected to each other in a daisy chain arrangement; and
- a system controller operably coupled with the first grouping of illumination assemblies, wherein the system controller is configured to simultaneously activate each of the first illumination assembly and the second illumination assembly with the first LED sub-groups of the first illumination assembly and the second illumination assembly of the first grouping being activated at a first time, and with the second LED sub-groups of the first illumination assembly and the second illumination assembly of the first grouping being activated at a second time different than the first time.

11. The fixed retail scanner of claim 10, further comprising:

a second grouping of illumination assemblies disposed in the first housing plane of the data reader, the second grouping of illumination assemblies including:

a first illumination assembly including a first LED sub-group and a second LED sub-group co-located on a first common illumination board; and

a second illumination assembly including a first LED sub-group and a second LED sub-group co-located on a second common illumination board, wherein the first illumination assembly and the second illumination assembly of the second grouping are disposed at different locations from each other and those of the first grouping, and wherein the first illumination assembly and the second illumination assembly connected to each other in a daisy chain arrangement,

wherein the system controller is configured to simultaneously activate each of the first illumination assembly and the second illumination assembly with the first LED sub-groups of the first illumination assembly and the second illumination assembly of the second grouping being activated at the first time along with those of the first grouping, and with the second LED sub-groups of the first illumination assembly and the second illumination assembly of the first grouping being activated at the second time along with those of the first grouping.

12. The fixed retail scanner of claim 11, further comprising:

a third grouping of illumination assemblies disposed in a second housing plane of the data reader, the third grouping of illumination assemblies including:

a first illumination assembly including a first LED sub-group and a second LED sub-group co-located on a first common illumination board; and

a second illumination assembly including a first LED sub-group and a second LED sub-group co-located on a second common illumination board, wherein the first illumination assembly and the second illumination assembly of the third grouping are disposed at different locations from each other and connected to each other in a daisy chain arrangement,

wherein the system controller is configured to simultaneously activate each of the first illumination assemblies and the second illumination assemblies with the first LED sub-groups of the first illumination assembly and the second illumination assembly of the third grouping being activated at the first time along with those of the first and second groupings, and with the second LED sub-groups of the first illumination assembly and the second illumination assembly of the third grouping being activated at the second time along with those of the first and second groupings.

13. The fixed retail scanner of claim 12, wherein each illumination board supporting the LEDs of the first illumination assembly and the second illumination assembly and their associated cabling are identically constructed among each of the groupings.

14. The fixed retail scanner of claim 12, wherein the first LED sub-group and the second LED sub-group for each illumination assembly among each grouping is arranged in a symmetrical linear arrangement on their respective illumination board.

15. The fixed retail scanner of claim 11, wherein the first illumination assembly and the second illumination assembly of the second grouping are flipped relative to the corresponding first illumination assembly and the second illumination assembly of the second grouping.

16. The fixed retail scanner of claim 15, wherein each of the first illumination assemblies and the second illumination assemblies of the first and second groupings includes an illumination cone connected to the respective illumination board, the illumination cone having an asymmetric shape with a top length of an outer perimeter that is longer than a bottom length of the outer perimeter.

17. The fixed retail scanner of claim 10, wherein the first illumination assembly further includes disable circuitry configured to disable the first illumination assembly including both the first LED sub-group and a second LED sub-group responsive to an enable signal received from the system controller, wherein the first illumination assembly is configured to pass all power and control signals to the second illumination assembly other than the enable signal.

18. A method of illuminating a read zone of a fixed retail scanner having a housing disposed within a checkout counter of a retail environment, the method comprising:

activating a first set of LED sub-groups emitting at a first wavelength across a plurality of LED assemblies located within a housing of a data reader to be synchronized with exposure of a first camera; and

activating a second set of LED sub-groups emitting at a second wavelength across the plurality of LED assemblies located within the housing of the data reader, wherein each LED assembly of the plurality includes a first LED subgroup co-located with a second LED sub-group within on a common assembly illumination board, wherein at least two LED assemblies are connected to each other in a daisy chain arrangement,

wherein all LED assemblies are activated together but with only the first sub-groups from each corresponding LED assembly being synchronized with exposure of a first camera, and with only the second sub-groups from each corresponding LED assembly being synchronized with exposure of a second camera.

19. The fixed retail scanner of claim 12, further comprising a control panel disposed within the second housing plane that is operably coupled to a main board disposed within the first housing plane, wherein:

the main board provides power and control signals to the control panel,

the first grouping of illumination assemblies and the second grouping of illumination assemblies are connected to the main board to receive power and control signals, and

the third grouping of illumination assemblies is connected to the control panel to receive power and control signals.

20. The fixed retail scanner of claim 6, wherein the second wavelength produces a white color for the second sub-group of LEDs arranged in the middle location of a single linear arrangement, and wherein the first wavelength produces a red color for the fist sub-group of LEDs having LEDs that are arranged on each side of the second-sub-group of LEDs on the common illumination board.

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