(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 September 2016 (15.09.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/142794 A1

(51) International Patent Classification:
H04N 5/74 (2006.01) *G06T 15/00* (2011.01) *G06Q 30/00* (2012.01)

(21) International Application Number: PCT/IB2016/050852

(22) International Filing Date: 17 February 2016 (17.02.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/129,729 6 March 2015 (06.03.2015) US

(71) Applicant: **WAL-MART STORES, INC** [US/US]; 702 Southwest 8th Street, Bentonville, AR 72716-0520 (US).

(72) Inventors: **HIGH, Donald**; 805 Moberly Lane, Bentonville, AR 72716 (US). **MCHALE, Brian**; 13 Edgeware Road, Chadderton, Oldham Greater Manchester OL9 9PU (GB).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) **Title**: ITEM MONITORING SYSTEM AND METHOD

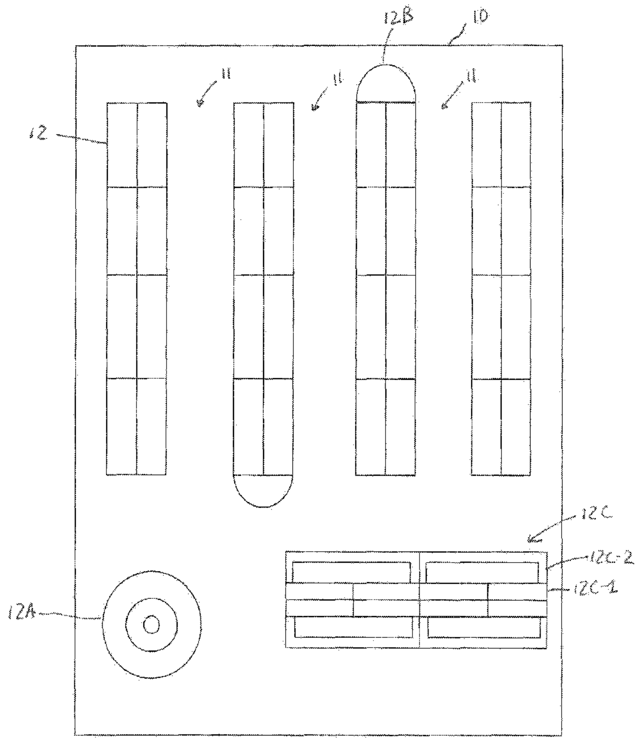

FIG. 1

(57) **Abstract**: Methods and apparatus are provided to monitor items on a storage unit (12). Some embodiments provide a system for monitoring items held on a storage unit (12), comprising: a scanner device (111) configured to capture a 3D model of the storage unit (12); a memory (130) configured to store a baseline 3D model of the storage unit (12) in a predetermined stocked state and a plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit (12); a difference extraction unit (140) configured to compare the captured 3D model to the baseline 3D model and generate 3D difference data corresponding to a difference between the captured and baseline 3D models, and a product identification unit (150) configured to identify items present in the 3D difference data based on the stored plurality of 3D item models.

WO 2016/142794 A1

Published:

— *with international search report (Art. 21(3))*

ITEM MONITORING SYSTEM AND METHOD

FIELD OF THE INVENTION

This invention relates to item monitoring systems and methods.

BACKGROUND OF THE INVENTION

Modern retail stores sell a wide variety of items, including foodstuffs, home and kitchen goods, electronic goods, clothing, sporting goods and so on. Typically, the items are displayed on storage units with other similar products. Often the storage units are shelving units, though of course other forms of storage unit are often employed. The items are removed from the display units by customers, and taken to a point of sale or checkout to be purchased, and the units are replenished with items by retail store staff on a periodic basis.

In one example, the items on the units are replenished periodically. For example, the units may be replenished after the store closes each day. In such an example, if a particular item on the unit is exhausted during the day, it may not be replaced until several hours later, potentially resulting in lost sales. Equally, if instead retail store staff attempt to replenish the items on a more frequent basis, it may be the case that not enough of the items have been sold to warrant replenishment.

Increasingly, retail stores stay open for longer hours to provide greater customer convenience, with some stores opening 24 hours a day. In such stores, the replenishment of items must take place during the opening hours of the store. Consequently, there is a desire to replenish the units in such a way that customers are minimally inconvenienced by the presence of containers of stock on the shop floor.

In other examples, the items on the units may be replenished on an ad hoc basis, for example on the basis of a staff member inspecting the retail units and noting which items require replenishment. Whilst this may be manageable in a small store and in quiet periods, in large retail stores, such a system is error prone and difficult to manage in today's very large retail stores, which can occupy areas well in excess of 10,000m^2 and stock hundreds of thousands of different products.

A further difficulty arises in that items may be removed from the storage units by customers or staff and later incorrectly replaced thereon, leading to untidy and visually unappealing storage units. Also, the storage units may not be correctly stocked when the items are replenished by store staff. These erroneously displayed items may inconvenience other shoppers and may result in fewer sales of the items displayed on the untidy units.

SUMMARY OF THE INVENTION

Some embodiments of the present invention address at least some of the above difficulties, or other difficulties which will be appreciated from the description below. Further some embodiments provide convenient, accurate and cost effective systems and methods for monitoring the items on a storage unit.

According to some embodiments, there is provided a system for monitoring items held on a storage unit, comprising:

a scanner device configured to capture a 3D model of the storage unit;

a memory configured to store a baseline 3D model of the storage unit in a predetermined stocked state and a plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit;

a difference extraction unit configured to compare the captured 3D model to the baseline 3D model and generate 3D difference data corresponding to a difference between the captured and baseline 3D models, and

a product identification unit configured to identify items present in the 3D difference data based on the stored plurality of 3D item models.

In one embodiment, the product identification unit is further configured to determine a stock level based on the identified items.

In one embodiment, the product identification unit is configured to identify items by determining whether a plurality of dimensions of the 3D difference data are within a tolerance of a plurality of dimensions of each 3D item model.

In one embodiment, the memory is further configured to store a location database comprising an intended location on the storage unit of each of the plurality of 3D item models, and the product identification unit is configured identify items by comparing the intended location and actual location.

In one embodiment, the product identification unit is configured to identify an incorrectly placed item based on the comparison of intended and actual locations.

In one embodiment, the system further comprises an alert generation unit configured to generate an alert if the determined stock level is less than a predetermined stock level, and transmit the alert to a user device coupled to the system by a communication network.

In one embodiment, the scanner device is configured to periodically capture the 3D model at a predetermined time interval, and the memory is configured to store the determined stock level associated with each captured 3D model.

In one embodiment, the scanner device comprises a portable laser scanner adapted to be operated by a user.

In one embodiment, the system further comprises a baseline generation unit configured to generate the baseline 3D model by combining a plurality of smaller models.

In one embodiment, the baseline 3D model of the storage unit is a part of a larger 3D model of a retail store.

According to some embodiments, there is provided a method of monitoring items held on a storage unit, the method comprising:

capturing a 3D model of the storage unit;

comparing the captured 3D model to a baseline 3D model;

generating 3D difference data corresponding to a difference between the captured and baseline 3D models, and

identifying items present in the 3D difference data based on a stored plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is a schematic plan view of an exemplary retail store in which an exemplary system for monitoring items operates;

Figure 2 is a schematic perspective view of exemplary storage units on which an exemplary system for monitoring items operates;

Figure 3 is a block diagram of an exemplary system for monitoring items;

Figure 4A is a cross-sectional view of an exemplary storage unit in a fully stocked state and the resulting 3D model generated by an exemplary system for monitoring items;

Figure 4B is a cross-sectional view of an exemplary storage unit in a partially stocked state and the resulting 3D model generated by an exemplary system for monitoring items;

Figure 4C is a diagram illustrating the operation of an exemplary difference extraction unit of an exemplary system for monitoring items in use; and

Figure 5 is a flowchart of an exemplary method of monitoring items.

DETAILED DESCRIPTION

Embodiments in accordance with the present invention may be embodied as an apparatus, method, or computer program product. Accordingly, the present invention may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.), or an embodiment combining software and hardware aspects that may all generally be referred to herein as a “module” or “system.” Furthermore, the present invention may take the form of a computer program product embodied in any tangible medium of expression having computer-usable program code embodied in the medium.

Any combination of one or more computer-usable or computer-readable media may be utilized. For example, a computer-readable medium may include one or more of a portable computer diskette, a hard disk, a random access memory (RAM) device, a read-only memory (ROM) device, an erasable programmable read-only memory (EPROM or Flash memory) device, a portable compact disc read-only memory (CDROM), an optical storage device, and a magnetic storage device. Computer program code for carrying out operations of the present invention may be written in any combination of one or more programming languages.

Embodiments may also be implemented in cloud computing environments. In this description and the following claims, "cloud computing" may be defined as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned via virtualization and released with minimal management effort or service provider interaction, and then scaled accordingly.

The flowchart and block diagrams in the flow diagrams illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function(s). It will also be noted that each block of the block diagrams and/or flowchart illustrations, and combinations of blocks in the block diagrams and/or flowchart illustrations, may be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions. These computer program instructions may also be stored in a computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including instruction means which implement the function/act specified in the flowchart and/or block diagram block or blocks.

In overview, some embodiments of the present invention take a baseline scan of the environment of a storage unit, such as a shelf, when it is correctly stocked and subsequently take periodic scans of the same unit to assess whether there has been any change. In some embodiments 3D pattern matching can be utilised to identify specific products. As a result of such monitoring, alerts can be generated at appropriate times to alert members of staff that restocking is required.

Figure 1 shows a schematic view of a physical environment in which embodiments of the invention may operate. In one example, the physical environment is a retail store 10. The retail store 10 comprises a plurality of storage units 12, each of which stores and displays items available for sale in the retail store.

Typically, the storage units 12 comprise a number of shelves to hold the items, and are arranged so as to define a plurality of aisles 11. Customers move around the retail store 10, progressing up and down the aisles 11 and selecting the items that they wish to purchase, before progressing to a checkout (not shown) to pay for the items.

In addition to the storage units 12 arranged to define the aisles 11, the retail store 10 may also comprise storage units 12 of differing configurations. For example, free-standing storage units 12A may be placed around the retail store 10, or additional display units 12B arranged on the end of the aisles 11. In further examples, the storage units 12 may be freezer storage units 12C for storing frozen goods, comprising several freezer cabinets 12C-1 disposed above chest freezers 12C-2. It will be understood by those skilled in the art that a variety of further types of storage units 12 may be employed within the retail 10, and that the embodiments described below are not dependent upon any particular arrangement or type of storage unit 12.

It will be further understood that the embodiments described below could equally be applied to other physical environments in which the monitoring of items on storage units 12 is desired. For example, the physical environment may be a warehouse in which stock is held, such as a warehouse attached to a retail store 10.

An example storage unit 12 will now be described with reference to Figure 2. Figure 2 shows a front perspective view of two storage units 12-1 and 12-2. Each of the storage units 12-1 and 12-2 comprise a plurality of shelves 13, on which the stock is held for display. It will be understood that the number of shelves 13 may be varied, for example according to the size of the goods to be displayed thereon.

In the example shown in Figure 2, both shelves 13 of the storage unit 12-1 are arranged to hold a plurality of items of a first product line 14A. On the other hand, the storage unit 12-2 is arranged to hold items of a second product line 14B on its upper shelf 13, and items of a third product line 14C on its lower shelf 13. The storage units 12-1 and 12-2 are shown in a fully-stocked state. As will be appreciated from Figure 2, the desired level of stock on each shelf 13 may vary according to the nature of the product, the size of the packaging and so on. Although in this example each shelf 13 holds items from a single product line 14, it will be understood that each shelf 13 may instead hold a plurality of product lines 14.

Figure 3 shows a schematic diagram of an example system 100 for monitoring items held on storage units 12.

In one example, the system 100 comprises a scanning apparatus 110, a controller 120, a memory 130, a difference extraction unit 140, a product identification unit 150 and an alert generation unit 160.

The scanning apparatus 110 comprises one or more 3D scanning devices 111. The or each 3D scanning device 111 is configured to scan the interior of the retail store 10, and particularly the storage units 12 therein and capture scan data representing the scanned area. In one example, the 3D scanning device 111 is a laser range finding device, configured to emit a pulse of light, receive the reflection of the emitted pulse from the surface of an object (e.g. a storage unit 12), and calculate the distance from the 3D scanning device 111 to the object based on the round-trip time of the pulse. The 3D scanning device 111 may calculate the distance of a large number of points (for example, millions or billions of points), thereby forming a point cloud which represents the scanned area.

In one example, the 3D scanning device 111 is a stationary 3D scanning device, placed in a fixed position within the retail store 10 so as to capture a scan. For example, the device 111 may be mounted to the ceiling of the store 10, or some other convenient vantage point which allows the device 111 to scan the portion of the retail store 10 which is of interest. In one example, the 3D scanning device 111 may be configured to be movable within the retail store 10. For example, the 3D scanning device 111 may be mounted on rails (not shown) in the ceiling of the store 10, so as to be conveyed along a predetermined path whilst scanning. In one example, the 3D scanning device 111 is a portable scanner, which may be held by a user whilst in use. It will be understood that the scanning apparatus 110 may comprise a mixture of the above-mentioned types of scanning device 111. For example, a stationary or rail-mounted scanning device 111 may be used to capture models of the whole store 10, or may be configured so as to capture models on a periodic basis, and a portable scanner may be used by a member of staff to scan a particular storage unit 12 of interest on an ad hoc basis.

The scanning apparatus 110 further comprises a model generation unit 112 configured to generate a 3D model from the scan data. In one example, the model generation unit 112 creates a polygonal mesh, in which the points of the point cloud are filled with polygons, such as triangles. In one example, the model generation unit 112 is configured to apply a 3D model simplification algorithm, which reduces the number of surfaces present in the model in order to reduce processing overheads, whilst still retaining sufficient detail in the model to accurately capture the dimensions of the items on the storage units 12.

In one example, the system 100 further comprises a baseline generation unit (not shown) configured to combine a plurality of smaller 3D models so as to create a single 3D model. For example, if scans are taken of several regions of the store, respective 3D models of each region result. The baseline generation unit is configured to identify areas of overlap between the respective models and “stitch” together the respective models, resulting in the single 3D model. In one example, the baseline generation unit may be part of the model generation unit 112.

In one example, the scanning apparatus 110 is configured to capture a baseline model of the retail store 10. The baseline model corresponds to the retail store 10 in a predetermined state, such as a state in which all of the storage units 12 are fully and correctly stocked with items. The scanning apparatus is further configured to capture further models of the retail store 10 during normal operation.

The controller 120 is configured to control the operations of the system 100 and manage access to the memory 130. The controller 120 may comprise a processor.

The memory 130 comprises a scan storage 131, a product database 132 and a product location database 133.

The scan storage 131 is configured to store the 3D models generated by the scanning apparatus 110, including a captured baseline 3D model of the retail store 10 in a predetermined state.

The product database 132 is configured to store 3D models of items of each product line 14 stocked by the retail store 10. These models may be routinely captured by the retailer as new product lines 14 are stocked by the retail store 10. In one example, the product database 132 is updated periodically with models of new product lines 14. In one example, the product database 132 is also configured to store the desired quantity of each product line 14. In one example, the product database 132 is configured to store the actual determined quantity of each product line 14, at a given point in time.

The product location database 133 is configured to store the intended location of each product line 14 within the store 10. In one example, the intended location is expressed in terms of a reference to the storage unit 12 and shelf 13 thereof on which the product line 14 should be displayed. In one example, the intended location is expressed in terms of spatial coordinates within a 3D model of the retail store 10.

The difference extraction unit 140 is configured to identify and extract the differences between 3D models of the same region or area of the store 10. Particularly, the difference extraction unit 140 is operable to perform a comparison of two 3D models, identify the regions in the 3D model which differ, and generate difference data corresponding to the differing regions. In one example, the difference data comprises a 3D model of the differing region. Particularly, the difference extraction unit 140 is configured to extract the differences between the baseline model and subsequent models of the retail store 10 in operation. In examples where the subsequent models relate to only a part of the retail store 10, the difference extraction unit 140 is configured to compare the subsequent model to only the corresponding portion of the baseline model, rather than the whole baseline model.

The product identification unit 150 is configured to identify the items present within the difference data, based on the 3D models of items stored in the product database 132. The difference data is compared to each of the 3D models stored in the product database 132. A portion of the difference data which has physical dimensions matching that of a 3D model of an item may be determined to be that item. In the case where the difference data refers to a plurality of items, the product identification unit 150 is configured to identify each item present in the difference data. The product identification unit 150 is configured to generate product difference data, which represents which product items, and the quantity thereof, and which are present in one scan but not another scan. Accordingly, the product identification unit 150 may identify and quantify the items which are present in the baseline model, but missing from a subsequently captured model.

In one example, the product identification unit 150 is further configured to identify items which are not placed in their intended location within the retail store 10, for example, items which have been placed on the wrong storage unit 12 or shelf 13. The product identification unit examines the product difference data, and identifies any products which are not present in the baseline model, but which are present in the subsequent scan. The identified products are then compared with their intended location, as stored in the product location database 133. Based on the comparison, the product identification unit generates misplaced item data, detailing the current position of each misplaced item. The misplaced item data may further comprise the correct location of the misplaced item.

In one example, the product identification unit 150 determines a stock level of each product line 14 based on the product difference data. The stock level is determined by retrieving the desired quantity of items of the product line 14 from the product database 132, and subtracting therefrom the quantity of that product line 14 which is determined to be missing based on the product difference data.

The alert generation unit 160 is configured to generate an alert based on the determinations made by the product identification unit 150, and transmit the generated alert to a user terminal 170. In one example, the alert generation unit 160 is coupled to a user terminal 170 by means of a suitable communication network. The user terminal 170 may be any suitable electronic device, including, but not limited to, a personal computer, a tablet computer, a smart phone, or a wearable device.

The alert generation unit 160 is configured to generate and transmit an alert when the product difference data and the misplaced item data meet certain criteria. In one example, if the determined stock level of a product line 14 is lower than a predetermined threshold, the alert generation unit 160 generates an alert indicating that the items should be replenished.

An example of the system 100 in use will now be described with reference to Figures 4A-C.

Figure 4A shows a cross-sectional view of the storage unit 12-2 in a fully stocked state. The storage unit 12-2 comprises two shelves 13. The upper shelf 13 holds a plurality of product items 14B and the lower shelf 13 holds a plurality of product items 14C.

Firstly, the scanning apparatus 110 captures a baseline 3D model 201 of the storage unit 12-2 in the fully stocked state. In one example, the 3D scanning device 111 is directed towards the storage 12-2 and a point cloud based on a large number of distance measurements. The model generation unit 112 subsequently generates a 3D model 201 from the point cloud, for example by transforming the point cloud into a polygonal mesh.

In one example, the capture of the baseline model 201 of the storage unit 12-2 may form part of a larger process of capturing a baseline model of the entire retail store 10. The baseline model may be composed by the baseline generation unit combining a plurality of captured models. For example several models may be captured of areas of the store 10, and combined to create one baseline model.

Optionally, the model generation unit 112 applies a 3D model simplification algorithm, so as to reduce the number of polygons present therein. A cross-sectional representation of the captured 3D baseline model 201 is shown in Figure 4A.

Next, the controller 120 stores the captured baseline in the scan storage 131 of the memory 130. The product database 132 and product location database 133 are pre-populated with details of the product items 14 and their intended location.

Next, the scanning apparatus 110 captures a subsequent 3D model 202 of the storage unit 12-2. Figure 4B shows the storage unit 12-2 in a partially stocked state, wherein several of the product items 14B and 14C have been removed. The 3D model 202 is then generated in the same way or a similar way as the baseline 3D model 202.

Next, as shown in Figure 4C, the difference extraction unit 140 compares the baseline 3D model 201 and the subsequent 3D model 202. The comparison results in difference data 203, which represents the difference between the two models 201 and 202.

Next, the product identification unit 150 determines the product items present in the difference data 203, based on the 3D models stored in the product database 132. In the example shown in Figure 4C, the product identification unit determines that a first region 203A of the difference data corresponds to three items of product 14B and a second region 203B of the difference data corresponds to two items of product 14C.

Optionally, the product identification unit 150 determines if the difference data 203 comprises any misplaced items, based on the product location database 133. In one example, the product identification unit 150 generates misplaced item data detailing the current position of any misplaced items. In one example, the misplaced item data also includes the correct, intended position of the misplaced items.

Next, the product identification unit 150 determines the stock level of the product lines 14B and 14C present on the storage unit 12-2. The product identification unit 150 queries the product database 132 to establish the intended stock level of each item. For example, the product identification unit 150 may establish that the storage unit 12-2 is intended to hold 6 items of product 14B. Subsequently, the product identification unit 150 determines the stock level by subtracting the number of items 14B present in the difference data 203 (i.e. 3) from the intended stock level. In the example of Figure 4C, the product identification unit 150 determines that the stock level of product 14B is 3. The system 100 stores the determined stock level in the product database 132.

In the event that the determined stock level of a particular product line 14 falls below a given threshold, the alert generation unit 160 generates an alert and transmits the alert to the user terminal 170. In one example, the alert indicates that the product line 14 needs replenishment. In one example, each product line 14 is delivered to the retail store in a plurality of packages, each package comprising a fixed number of items. For example, a given product may be supplied in a box comprising 25 items. In such an example, the threshold may be set based on the number of items in each package, such that an alert is only triggered when there is enough room on the storage unit 12 to add a whole package of stock.

In the event that the product identification unit 150 determines that items have been misplaced on the storage unit 12, the alert generation unit 160 generates an alert based on the misplaced item data and transmits the alert to the user terminal 170. In one example, the alert details the current position of the misplaced items and the correct position of the misplaced items.

Accordingly, members of retail store staff operating the user terminal 170 can be conveniently informed of product lines 14 in need of replenishment, or product items which have been incorrectly placed on their respective storage units 12.

Figure 5 is a flowchart of an exemplary method of monitoring items on a storage unit.

The method includes the step S51 comprises capturing a 3D model of the storage unit 12, using the scanning apparatus 110. The method includes the step S52 of comparing the captured 3D model to a stored baseline 3D model, using the difference extraction unit 140. The method includes the step S53 of generating 3D difference data corresponding to a difference between the captured and baseline 3D models, using the difference extraction unit 140. The method includes the step S54 of identifying items present in the 3D difference data based on a stored plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit 12, using the product identification unit 150. Further steps may be included in the method, as have been described herein.

The above-described systems and methods may advantageously allow a retail store to conveniently monitor the level of stock held on storage units in the retail store. The systems and methods may ensure that store staff are alerted to any relevant changes in stock level, so that appropriate replenishment can take place. Consequently, the storage units may be more easily maintained in a well stocked state, thereby avoiding customer inconvenience associated with items being out-of-stock. In addition, staff time spent examining the state of storage units and manually determining the stock level of items held thereon is saved. Furthermore, staff time spent needlessly attempting to refill storage units which have not been sufficiently depleted to warrant replenishment is saved.

The above-described systems and methods may also advantageously allow a retail store to conveniently identify and correct misplaced items on storage units. Consequently, customer confusion regarding the misplaced items is avoided, and the general appearance of the retail store may be improved, thereby increasing shopper convenience and sales of goods.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS:

1. A system for monitoring items held on a storage unit, comprising:

a scanner device configured to capture a 3D model of the storage unit;

a memory configured to store a baseline 3D model of the storage unit in a predetermined stocked state and a plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit;

a difference extraction unit configured to compare the captured 3D model to the baseline 3D model and generate 3D difference data corresponding to a difference between the captured and baseline 3D models, and

a product identification unit configured to identify items present in the 3D difference data based on the stored plurality of 3D item models.

2. The system of claim 1, wherein the product identification unit is further configured to determine a stock level based on the identified items.

3. The system of claim 1 or claim 2, wherein the product identification unit is configured to identify items by determining whether a plurality of dimensions of the 3D difference data are within a tolerance of a plurality of dimensions of each 3D item model.

4. The system of any of claims 1 to 3, wherein:

the memory is further configured to store a location database comprising an intended location on the storage unit of each of the plurality of 3D item models, and

the product identification unit is configured identify items by comparing the intended location and actual location.

5. The system of claim 4, wherein the product identification unit is configured to identify an incorrectly placed item based on the comparison of intended and actual locations.

6. The system of claim 2, wherein the system further comprises an alert generation unit configured to generate an alert if the determined stock level is less than a predetermined stock level, and transmit the alert to a user device coupled to the system by a communication network.

7. The system of claim 2, wherein the scanner device is configured to periodically capture the 3D model at a predetermined time interval, and the memory is configured to store the determined stock level associated with each captured 3D model.

8. The system of any preceding claim, wherein the scanner device comprises a portable laser scanner adapted to be operated by a user.

9. The system of any preceding claim, wherein the system further comprises a baseline generation unit configured to generate the baseline 3D model by combining a plurality of smaller models.

10. The system of any preceding claim, wherein the baseline 3D model of the storage unit is a part of a larger 3D model of a retail store

11. A method of monitoring items held on a storage unit, the method comprising:

capturing a 3D model of the storage unit;

comparing the captured 3D model to a baseline 3D model;

generating 3D difference data corresponding to a difference between the captured and baseline 3D models, and

identifying items present in the 3D difference data based on a stored plurality of 3D item models, each 3D item model corresponding to an item intended to be held on the storage unit.

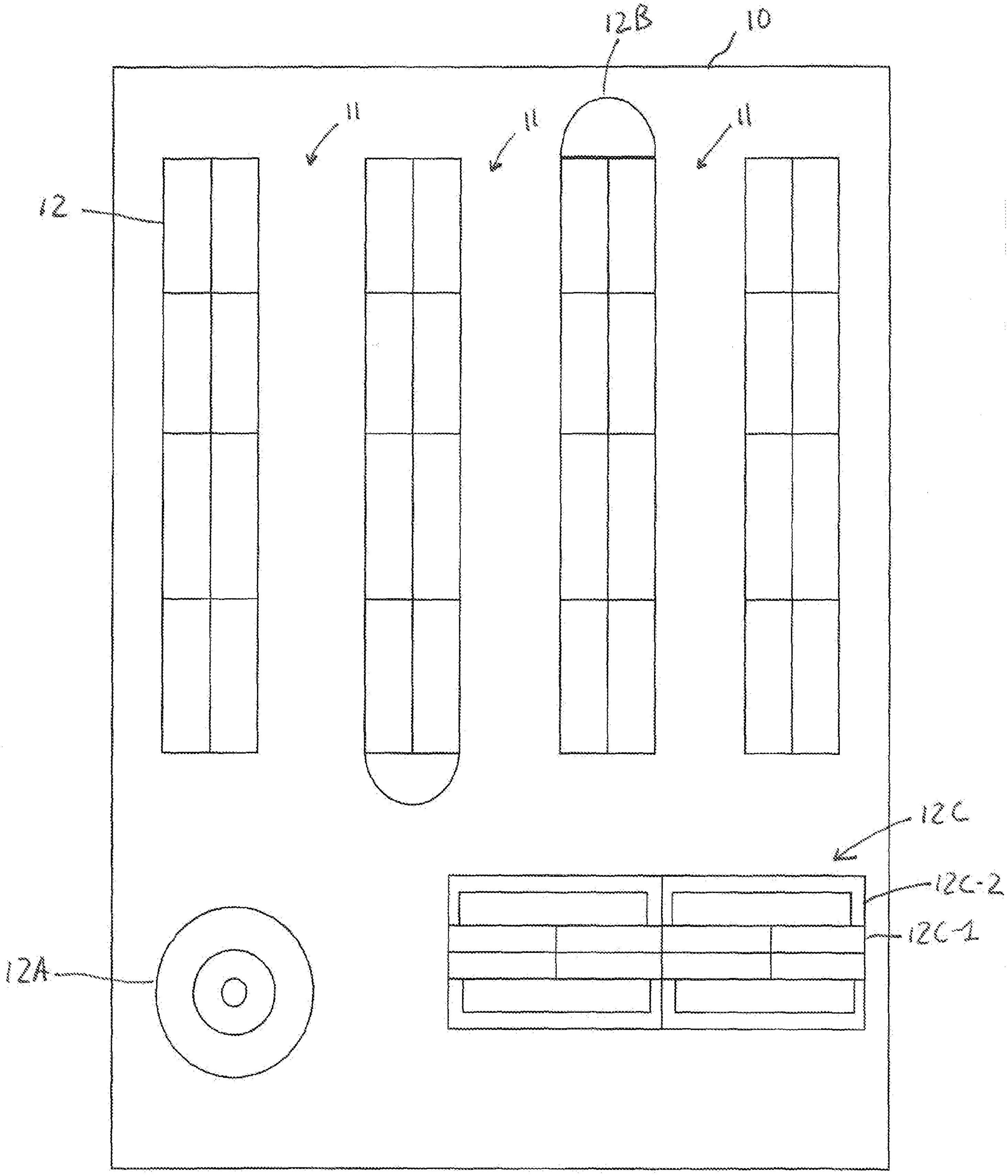

FIG. 1

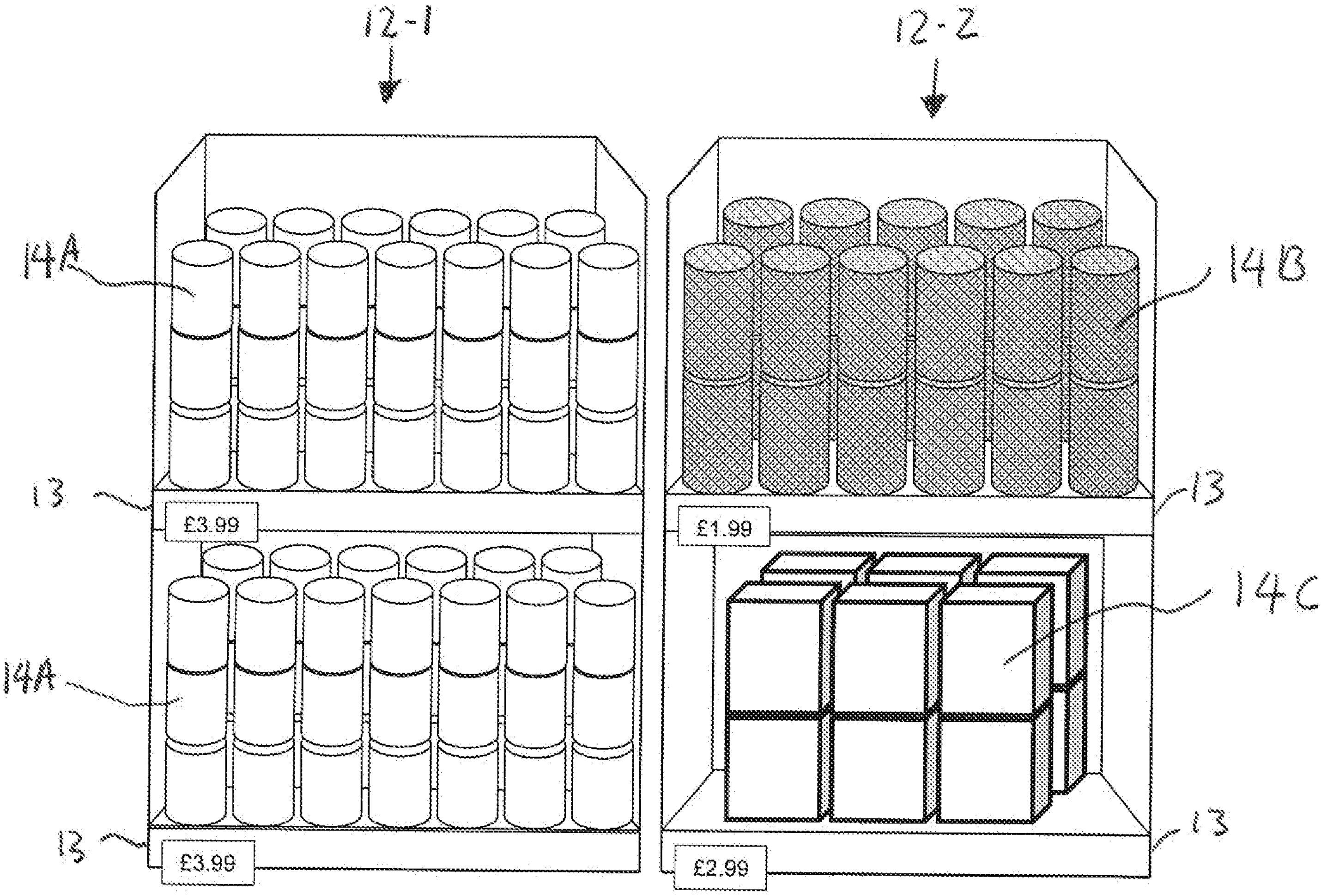

FIG. 2

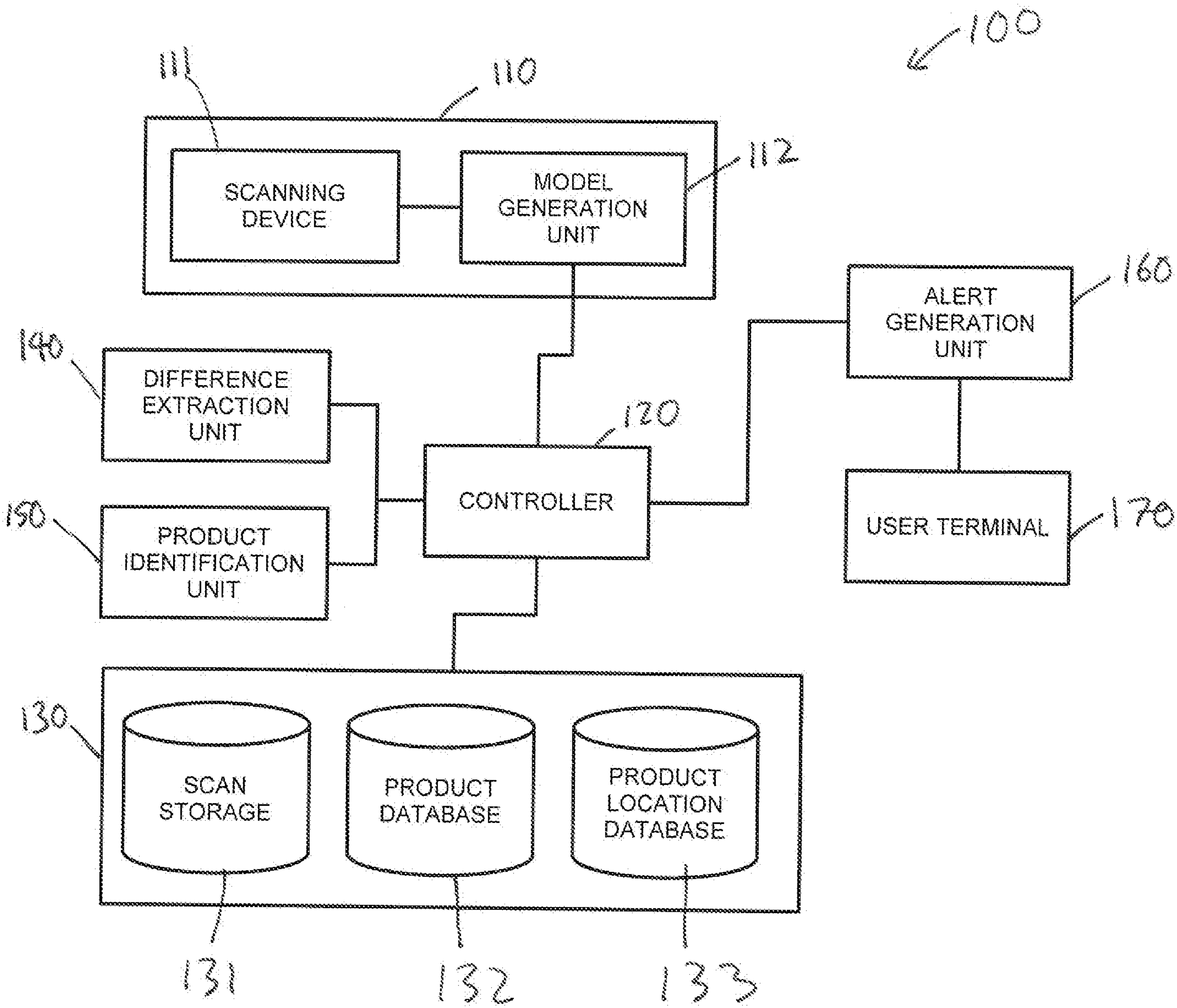
100
110
111
112
SCANNING DEVICE
MODEL GENERATION UNIT
140
DIFFERENCE EXTRACTION UNIT
150
PRODUCT IDENTIFICATION UNIT
120
CONTROLLER
160
ALERT GENERATION UNIT
170
USER TERMINAL
130
SCAN STORAGE
PRODUCT DATABASE
PRODUCT LOCATION DATABASE
131
132
133

FIG. 3

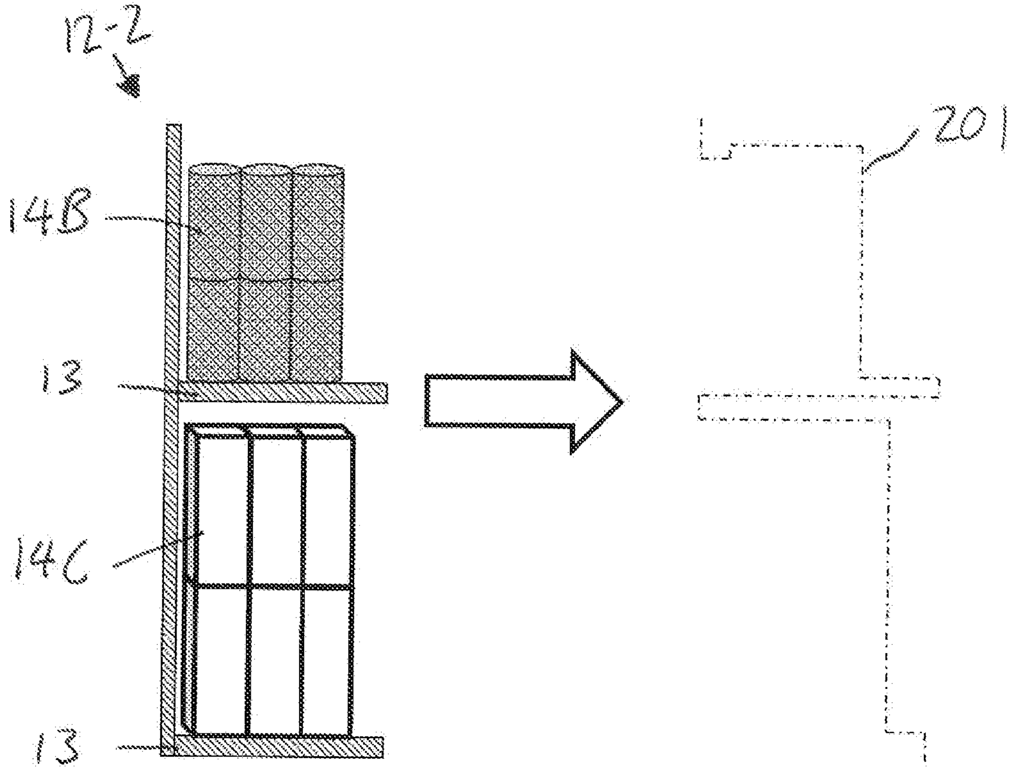

FIG. 4A

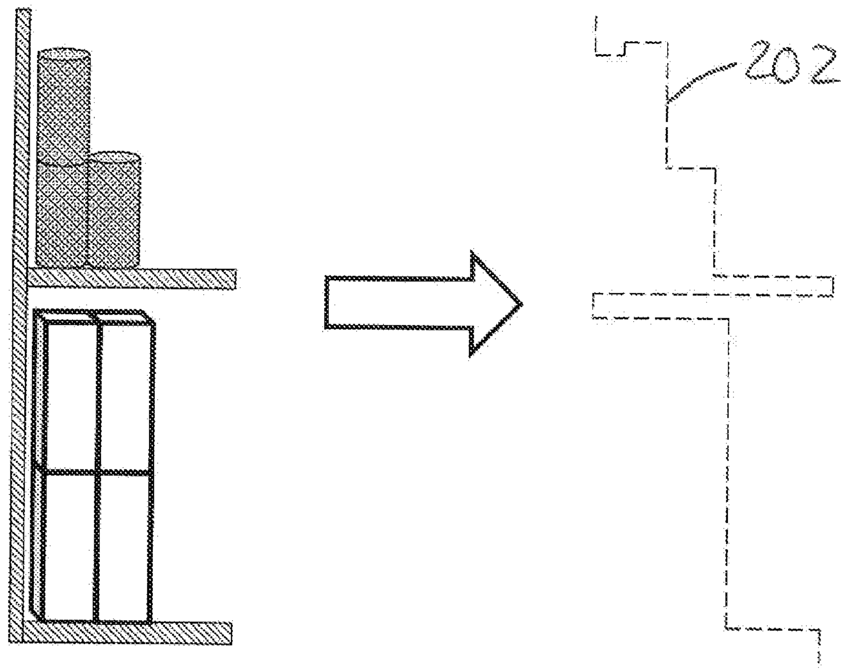

FIG. 4B

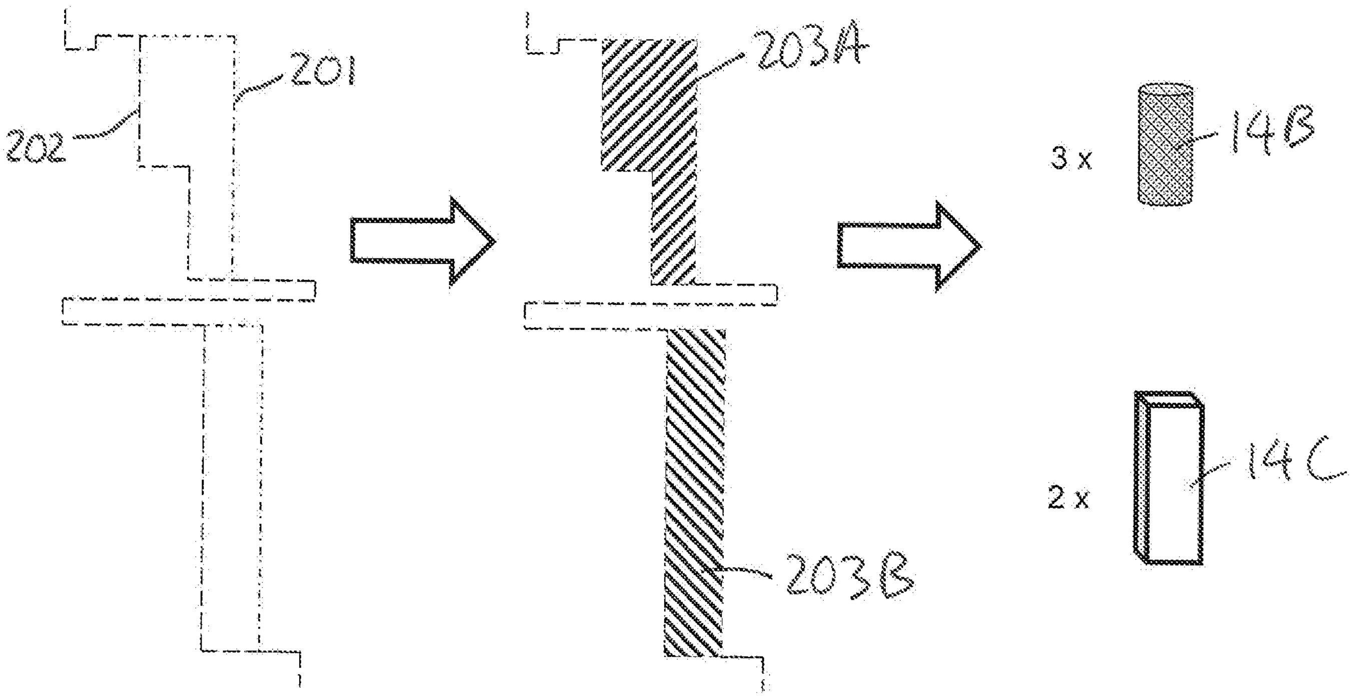

FIG. 4C

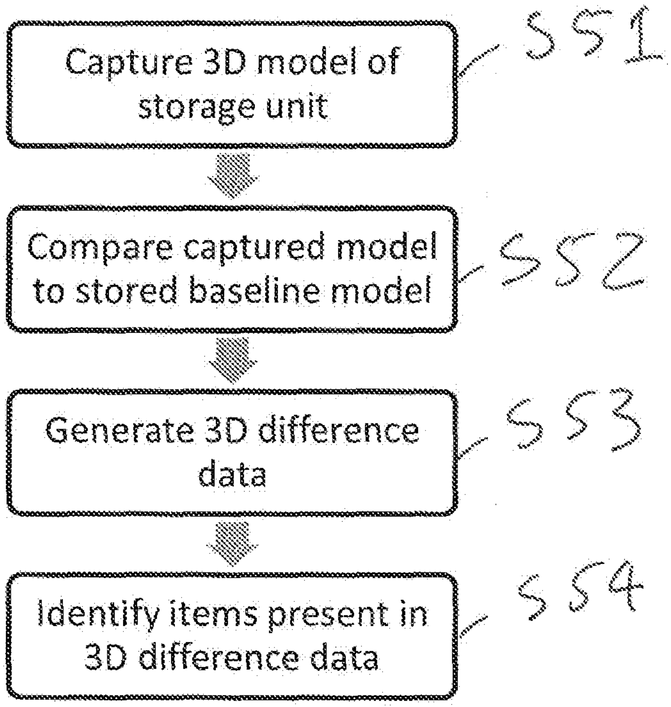
Capture 3D model of storage unit
S51
Compare captured model to stored baseline model
S52
Generate 3D difference data
S53
Identify items present in 3D difference data
S54

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/050852

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04N 5/74; G06Q 30/00; G06T 15/00 (2016.01)
CPC - H04N 5/74; G06Q 30/00; G06T 15/00 (2016.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - G06Q 30/00; G06T 15/00; H04N 5/74 (2016.01)
CPC - G06Q 30/00; G06T 15/00; H04N 5/74 (2016.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC 345/419; 705/28, 27.200, 27.100 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar, Google
Search terms used: three, dimension, capture, scan, model, product, baseline

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0138375 A1 (SCHWARTZ) 28 May 2009 (28.05.2009) entire document	1-3, 6, 7, 11
Y	US 2013/0300729 A1 (GRIMAUD et al) 14 November 2013 (14.11.2013) entire document	1-3, 6, 7, 11
Y	US 2010/0295847 A1 (TITUS) 25 November 2010 (25.11.2010) entire document	3
A	US 2010/0076959 A1 (RAMANI et al) 25 March 2010 (25.03.2010) entire document	1-3, 6, 7, 11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 May 2016	10 JUN 2016

Name and mailing address of the ISA/
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450
Facsimile No. 571-273-8300

Authorized officer
Blaine R. Copenheaver
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/050852

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4, 5, 8-10
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.