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(54) INDUSTRIAL TRUCK WITH IMPROVED CONTROL

(57) An industrial truck (10) including: a material handling device (20) for loading/unloading a ware item into/from one or more seats (12) of a plurality of seats of a ware storage system (11);a controller (21) configured to control a material handling function by means of the material handling device; a receiving unit (22) coupled with the controller and configured to receive, from a transmitting unit (13) of the ware storage system, information relating to an anomaly relating to one or more of the plurality of seats; and an output unit (23) configured to output a user notification to a user of the industrial truck based on the information relating to an anomaly.

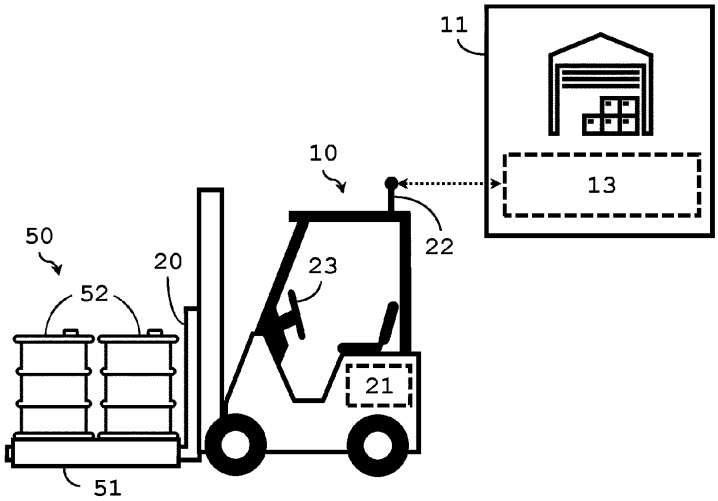

Fig. 1

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Description

[Technical Field]

[0001] The present invention relates to an industrial truck, and more particularly to an industrial truck cooperating with a ware storage system and capable of receiving and outputting a notification indicating an anomaly related to seats of the ware storage system.

[Background]

[0002] Warehouses are usually large-scale buildings for storing a large amount of ware items. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, and the like. The ware items are stored in seats, wherein a seat refers to a storage compartment e.g. in a storage rack. Typically, workers will operate cranes and forklifts or other industrial trucks in order to move one or more of the ware items, which are often placed on pallets and then loaded into the seats. Ware items can include any raw materials, packing materials, spare parts, components, or finished goods associated with agriculture, manufacturing, and production or the like.

[0003] For the workers working at the warehouse, there is, however, a risk of injury or worse arising, for example, from improperly secured ware items falling out of their respective seats while a worker is below the seat. For example, a worker driving a forklift truck might face a dangerous condition when driving close to a seat in which a ware item is not properly stored, e.g. a ware item that is not properly positioned inside the respective seat; in similar cases, an accidental collision of the mast of the forklift truck with an improperly stored ware item might occur, thus causing the fall of the ware item out of its respective seat and, therefore, a dangerous situation for the worker. Thus, there is a need for improving the safety conditions of workers operating in the warehouse.

[Summary]

[0004] In view of the above, an object of the present invention is to improve the safety conditions of workers in a warehouse. In some embodiments, a further object is to provide an industrial truck that enables an automatic control for effectively reducing the risk of accident due to a current status of the warehouse. In some embodiments, a further object is to provide an industrial truck including a user interface that enables an efficient and timely management of a dangerous situation in the warehouse.

[0005] The novel industrial truck for use in cooperation with a ware storage system is capable of receiving and outputting information indicating an anomaly related to one or more seats of the ware storage system in order to warn a user of potential safety hazards.

[0006] One embodiment relates to an industrial truck including: a material handling device for loading/unloading a ware item into/from one or more seats of a plurality of seats of a ware storage system; a controller configured to control a material handling function by means of the material handling device; a receiving unit coupled with the controller and configured to receive, from a transmitting unit of the ware storage system, information relating to an anomaly relating to one or more of the plurality of seats; and an output unit configured to output a user notification to a user of the industrial truck based on the information relating to an anomaly.

[0007] By receiving anomaly-related information and notifying a user of the industrial truck accordingly, the industrial truck is able to warn the user about potential hazards arising from displaced ware items, damaged ware items, unsecured seats, and the like, thereby improving the safety for the user at the warehouse.

[0008] Further preferred embodiments are described in the dependent claims.

[Brief description of the drawings]

[0009] Embodiments of the present invention, which are presented for better understanding the inventive concepts, but which are not to be seen as limiting the invention, will now be described with reference to the figures in which:

- Fig. 1 shows a side view of an industrial truck communicably coupled to a transmitting unit of a ware storage system;
- Fig. 2 shows a schematic perspective view of a ware storage system comprising a storage rack with ware items stored therein;
- Fig. 3A shows an example for an anomaly in which a ware item is not properly placed in the seat;
- Fig. 3B shows an example for an anomaly in which a ware item is deformed/damaged;
- Fig. 3C shows an example for an anomaly in which a boundary of the seat is deformed/damaged;
- Fig. 4 shows a plan view of an industrial truck and a ware storage system comprising a plurality of storage racks;
- Fig. 5 shows an output unit displaying an image of a group of seats as seen from a point of view corresponding to a predetermined area associated with the group of seats, wherein an anomalous seat is highlighted in the image; and
- Fig. 6 shows a perspective schematic view of a ware storage system comprising a storage rack with ware items stored therein and transport

means with an optical sensor;

Fig. 7A shows a side view of an embodiment of the optical sensor and transport means comprising a rail and a carriage;

Fig. 7B shows a side view of an embodiment of the optical sensor and transport means comprising a rail, a carriage and rotatable arm;

Fig. 7C shows a side view of an embodiment of the optical sensor and transport means comprising a rail, a carriage and extendable and contractable arm; and

Fig. 8 shows a plan view of the ware storage system comprising two storage racks and transport means for displacing the optical sensor between a plurality of points of observation.

[Detailed description]

[0010] The present invention shall now be described in conjunction with specific embodiments. The specific embodiments serve to provide the skilled person with a better understanding but are not intended to in any way restrict the scope of the invention, which is defined by the appended claims. In particular, the embodiments described independently throughout the description can be combined to form further embodiments to the extent that they are not mutually exclusive.

[0011] Fig. 1 shows a side view of an industrial truck 10 according to an embodiment of the present disclosure. The industrial truck 10 includes a material handling device 20 for loading/unloading a ware item 50 into/from one or more seats of a plurality of seats of a ware storage system 11. The plurality of seats may be located in a warehouse and the industrial truck may be operated within the warehouse by a user in order to transport the ware item 50 from a seat to a destination location, from an origin location to a seat, or from one seat to another. The industrial truck 10 may be a forklift truck as illustrated in the example of Fig. 1, but the present disclosure is not limited to this type of industrial truck and may refer also to a truck including a different material handling device, such as a pincer, a frame for handling a slab or a stack of slabs, a rotator, a telescopic arm or the like. The industrial truck can be equipped with an electric propulsion system and/or with a combustion motor.

[0012] Fig. 2 shows a perspective view of a ware storage system 11 comprising a storage rack with ware items 50 stored therein.

[0013] The storage rack comprises seats 12, wherein each seat 12 is configured to receive a ware item 50 to be stored in the ware storage system 11. That is, each seat 12 may serve as a storage compartment for a ware item 50. The seats 12 may be arranged in rows and columns of the storage rack. A storage rack may comprise shelves and supporting columns. A warehouse employing the ware storage system 11 may comprise a plurality of storage racks. Storage racks may have a substantially planar extension. The ware storage system 11 may includes a plurality of parallel storage racks that are spaced apart from each other to define one or more corridors, as further discussed in the following.

[0014] In the example of Fig. 2, the ware item 50 in the top row and left most column is properly placed within the corresponding seat 12. The ware item 50a in the top row and second column from the left is, however, not properly placed within the corresponding seat 12 because it protrudes outside the corresponding seat 12.

[0015] The industrial truck 10 may traverse the warehouse along corridors formed by opposing storage racks. That is, storage racks may be positioned to face each other on opposite sides of a corridor of the ware storage system 11. The industrial truck 11 may drive into a corridor to access seats 12 on each side of the corridor, wherein the seats 12 face the corridor. Seats 12 sharing a common corridor may be referred to as a group of seats in the present disclosure.

[0016] The ware item 50 may comprise a pallet 51 and one or more goods 52 placed thereon. In the example of Fig. 1, two barrels are placed on the pallet 51. The material handling device 20 may be adapted to match the ware item 50. In the present example, the material handling device 20 may comprise a fork adapted to slide under an upper supporting surface of the pallet in order to lift the ware item 50 and a mast to displace the ware item 50 vertically.

[0017] However, also a different type of material handling device 20 may be used depending on the type of ware item 50 to be picked up. For example, a ware item 50 comprising a barrel that is not placed on any pallet may be picked up using material handling device 20 comprising a barrel clamp. For another example, a ware item 50 comprising a roll of sheet metal may be picked up using material handling device 20 comprising a boom. For yet another example, a ware item 50 comprising bag of material may be picked up using material handling device 20 comprising a hook attachment.

[0018] The industrial truck 10 further includes a controller 21 configured to control a material handling function by means of the material handling device 20. The controller 21 may comprise a processor (e.g. a CPU) configured to control the material handling function of the industrial truck 10. The controller 21 may further comprise a working memory (e.g. a random-access memory) and a storage for storing a computer program having computer-readable instructions which, when executed by the processor, cause the processor to perform the material handling function of the industrial truck 10 and/or any other control function described herein. For example, the controller 21 may control the material handling device 20 to displace a loaded ware item 50 vertically or horizontally, or to tilt the loaded ware item 50 by an angle.

[0019] The industrial truck 10 further includes a receiv-

ing unit 22 coupled with the controller and configured to receive, from a transmitting unit 13 of the ware storage system 11, information relating to an anomaly relating to one or more of the plurality of seats. Preferably, the information is transmitted and received wirelessly. The transmitting unit 13 of the ware storage system 11 may be mounted on a wall or a ceiling of the warehouse or the like. In order to increase coverage, multiple transmitting units 13 may be used. Information relating to an anomaly may be transmitted e.g. using a local area network of the warehouse, however also other wireless communication technologies may be employed. For example, the transmitting unit 13 may be an access point of a wireless local area network of the warehouse. The ware storage system 11 may include a database in which information relating to anomalies of the plurality of seats are stored. The database may be located on an external server.

[0020] The industrial truck 10 further includes an output unit 23 configured to output a user notification to a user of the industrial truck based on the information relating to an anomaly. The notification may be a warning indicating a type of hazard corresponding to the anomaly. The notification may further indicate a location of the anomalous seat 25, i.e. the seat associated with the anomaly. The notification may include an audible warning such as an alarm. Alternatively or in addition thereto, the notification may include a visual warning such as flashing warning light and/or an image indicating the position of an anomaly in the ware storage system.

[0021] Fig. 3A shows an example for an anomaly in which a ware item 50 is not properly placed in the seat 12. More specifically, the ware item 50 protrudes beyond a front edge of a shelf of the seat 12 in which the ware item 50 is placed. Hence, the anomaly indicates a potential hazard related to the risk of the ware item 50 falling out of the seat 12.

[0022] Fig. 3B shows an example for an anomaly in which a ware item 50 is deformed and /or damaged. More specifically, the ware item 50 comprises a pallet 51 and a box 52, wherein a plank of the pallet 51 on which the box 52 is placed is broken. Hence, the anomaly indicates a hazard related to the ware item 50 being damaged and thus lacking structural integrity.

[0023] Fig. 3C shows an example for an anomaly in which a boundary of the seat 12 is deformed. More specifically, the shelf on which the ware item 50 is placed has a crack. Hence, the anomaly indicates a hazard related to the shelf being damaged and thus lacking structural integrity.

[0024] The information received by the receiving unit 22 may indicate a location of an anomalous seat 25, i.e. a seat affected by an anomaly. The corresponding notification may indicate a recommended safety precaution, a recommended solution to the anomaly, a warning, or the like. In this manner, a worker operating the industrial truck is informed about a potential hazard related to the anomaly.

[0025] The industrial truck 10 may further include position detection means configured to determine whether the industrial truck 10 is in a predetermined area 30 having a predetermined location in the proximity of a group 40 of seats of the ware storage system. The detecting means may include an ultra-wideband (UWB) sensor, or a tag reader configured to read a tag 18 (shown in Fig. 4) positioned at the entrance of a corridor of the ware storage system 11. In this manner, the industrial truck 10 may be capable to infer its position in the warehouse based on the determining that the industrial truck 10 is in the predetermined area 30.

[0026] Fig. 4 shows a plan view of an industrial truck 10 and a ware storage system 11 comprising a plurality of storage racks 60. Each storage rack comprises seats 12. In the present example, the group 40 of seats corresponds to the set of seats 12 of the two top storage racks 60 on the right-hand side of Fig. 4, wherein the group 40 of seats share a common corridor 70 between the two racks 60 by which the industrial truck 10 may access each of the seats 12 in the group 40. The group 40 of seats is associated with the predetermined area 30 located in front of the corridor 70, or at the entrance of the corridor 70. Using the tags 18 at the entrance of each of the corridors 70, the detection means of the industrial truck 10 may determine whether or not the industrial truck 10 is in the predetermined area 30.

[0027] The output unit 23 may be configured to output the user notification when the position detection means determine that the industrial truck is in the predetermined area 30 in the proximity of the group 40 of seats of the ware storage system 11. Thus, the user of the industrial truck 10 is notified about an anomaly before performing loading/unloading operations associated with the group 40 of seats. The predetermined area 30 may be at the entrance of the corridor 70 corresponding to the group 40 of seats. In this manner, the output unit 23 may be able to notify the user of the industrial truck 10 about an anomaly before the user enters the corridor 70.

[0028] Furthermore, the ware storage system 11 may include a plurality of groups of seats 40, 41, each associated to a predetermined area 30, 31 in the proximity of a respective group of seats. Each group of seats 40, 41 may be associated to a respective corridor 70, 71, i.e. a group of seat may be defined as the group of seats facing on a same corridor. When the position detection means determines that the industrial truck 10 is in one of the predetermined areas 30, 31 in the proximity of one of the groups 40, 41 of seats, the output unit 23 may further be configured to output a user notification based on information relating to an anomaly relating to one or more of the plurality of seats in the group 40, 41 of seats associated to the predetermined area 30, 31 in which the industrial truck 10 is detected to be. That is, the notification may be related to an anomaly that is limited to the one of the groups 40, 41 of seats associated with the predetermined area 30, 31 in which the industrial truck 10 is detected to be. Thus, the user may be notified about an

anomaly related only to those seats that are in the proximity of the predetermined area 30, 31 in which the industrial truck 10 is detected to be. In one embodiment, the information relating to an anomaly received by the industrial truck may contain an identifier associated to one of the predetermined areas 30, 31; the industrial truck may be configured to receive a plurality of information relating to an anomaly, each including a different identifier of a different predetermined area. In turn, the industrial truck may be configured to select the information relating to an anomaly based on the identifier included therein and based on the determination of position detection means, and to generate the user notification based on the selected information relating to an anomaly.

[0029] The output unit 23 may further include a display (shown in Fig. 5) and the user notification may include an image 24 of seats of the ware storage system 11 displayed by the display, wherein one or more anomalous seats 25 are highlighted in the image 24. In this manner, the image 24 may provide a visual aid for user (i.e. the pilot of the industrial truck) such that the user may compare the image 24 with a current environment of the industrial truck 10 in order to quickly locate the one or more anomalous seats 25 highlighted in the image 24.

[0030] Furthermore, the image 24 shows the plurality of seats in a group 40 of seats, preferably from a point of view corresponding to the predetermined area 30 associated with the group 40 of seats. In other words, when the position detection means determine that the industrial truck is in the predetermined area 30, the image 24 displayed on the display may only show the associated group 40 of seats as viewed from the predetermined area 30. For example, the image 24 may show a corridor and two storage racks positioned facing each other on opposite sides of the corridor of the ware storage system 11 (see Fig. 5).

[0031] Hence, a perspective of the environment captured by the image 24 may be similar to a perspective of the user of the industrial truck 10 at the predetermined area 30. In this manner, the user may more easily compare the image 24 with a current environment of the industrial truck 10 in order to quickly locate the one or more anomalous seats 25 highlighted in the image 24. This further contributes to enhancing the safety of the user.

[0032] The control unit 21 may further be configured to control a driving function of the industrial truck 10 so as to maintain the driving speed below a limited maximum driving speed that is lower than the maximum driving speed of the industrial truck, based on the information relating to an anomaly received by the receiving unit 22. By limiting the driving speed of the industrial truck 10 to lower values, the likelihood and severeness of a potential accident occurring due to the anomaly may be reduced.

[0033] Furthermore, the control unit 21 may be configured to limit the driving speed of the industrial truck 10 only as long as the industrial truck 10 is positioned in an area in the proximity of the group of seats for which an anomaly has been found according to the information received by the receiving unit 22 (e.g. in the corridor on which the group of seats are facing) ; in other words, the control unit may be configured such that the driving speed is limited only when the industrial truck 10 is in the corridor associated to the group of seats; the control unit may determine when the industrial truck is positioned in the corridor by means of the tags 18 and the position detection means of the industrial truck 10 that are communicably coupled to the control unit; otherwise, the control unit may detect the position of the industrial truck also based on a signal provided by another locating device, such as a GPS receiver or the like.

[0034] The control unit 21 may further be configured to prohibit the material handling function by means of the material handling device 20, based on the information relating to an anomaly. By prohibiting the material handling function by means of the material handling device 20, the user may be prohibited from loading or unloading a ware item 50 into or from an anomalous seat 25, thereby avoiding a potential accident occurring due to the anomaly.

[0035] Furthermore, the control unit 21 may be configured to prohibit the material handling function of the industrial truck 10 only as long as the industrial truck 10 is positioned in an area in the proximity of the group of seats (e.g. in the corridor on which the group of seats are facing) for which an anomaly has been found according to the information received by the receiving unit 22.

[0036] The industrial truck 10 may include an input unit, wherein, after the material handling function has been prohibited and the user has inputted an acknowledgment input by means of the input unit, the control unit 21 is configured to enable again the material handling function. For example, the input unit may receive an acknowledgement input by the user pressing a specific button of the input unit. The output unit 23 may ask the user as part of outputting the notification whether or not the user acknowledges the one or more anomalies indicated in the received information. For example, the output unit 23 may ask the user to acknowledge the one or more anomalies and resume unprohibited use of the material handling function by pressing an "OK" button or the like.

[0037] Furthermore, the input unit may be realized by a touchscreen 23 that forms the output unit, wherein the acknowledgement input includes the user touching a highlighted seat in the image 24. By combining the functionalities of the output unit and the input unit in the touchscreen 23, the user is presented with an intuitive interface for reviewing the notification and the one or more anomalous seats 25 highlighted in the image 24 displayed on the touchscreen.

[0038] Furthermore, by touching the highlighted seats in order to input the acknowledgement, the user's attention may remain focused on the anomalous seats 25 and is not directed away to another (virtual or physical) button.

[0039] Fig. 5 shows a touchscreen 23 displaying an image of a group of seats as seen from a point of view corresponding to a predetermined area associated with

the group of seats, wherein an anomalous seat 25 is highlighted in the image 24. In the present example, the image 24 displayed on the touchscreen 23 shows two storage racks facing each other on opposite sides of a corridor of the ware storage system 11.

[0040] The anomalous seat 25 may be highlighted in the image using a bounding box, a contour, a tint, a symbol and the like. In the present example, the anomalous seat 25 is highlighted in the image 24 via a hatched tint and warning sign symbol. Different colors may be used for the highlighting to indicate different types of anomalies.

[0041] When the user touches the touchscreen 23 at the area corresponding to the highlighted seat in the image 24, the touchscreen may interpret the touch as an acknowledgment of the corresponding anomaly by the user. Alternatively, the touch may cause the touchscreen 23 to display additional information related to the anomaly, a recommended safety precaution, a recommended solution to the anomaly, and the like, and then ask the user for the acknowledgement.

[0042] In the following, further details and preferred embodiments with regard to the ware storage system 11 are provided, in order to illustrate how information relating to an anomaly relating to one or more of the plurality of seats may be derived and/or generated.

[0043] The ware storage system 11 may be capable of automatically gathering data related to spatial features of seats and/or of ware items stored therein in order to monitor a current condition of the seats and ware items. By automatically recording the data relating to at least the spatial feature of the plurality of seats and/or of the ware items stored in the plurality of seats, the ware storage system may be able to identify potential hazards for workers arising from displaced ware items, damaged ware items, unsecured seats, and the like, thereby improving the safety for the workers at the warehouse. The data may be collected automatically using an optical sensor that is movable with respect to the ware storage seats, thereby efficiently monitoring the seats and ware items stored therein.

[0044] Fig. 6 shows a ware storage system 11 including a plurality of seats 12, similar to the one of Fig. 2, further provided with an optical sensor 15 configured to collect data relating to at least a spatial feature of the plurality of seats and/or of the ware items stored therein. The optical sensor 15 may collect the data by capturing one or more visual datasets such as one or more images, one or more videos and/or one or more 3-dimensional point clouds representing the plurality of seats and/or of the ware items stored therein. The one or more visual datasets may be combined and/or processed to derive the spatial feature.

[0045] The ware storage system may be configured to adapt the field of view (FOV) of the optical sensor 15. For example, the optical sensor 15 may be arranged to capture visual datasets corresponding to more than one viewing direction such as a forward and a backward direction. In other words, the optical sensor 15 may be configured to vary a viewing direction therefore among a plurality of viewing direction; preferably the plurality of viewing direction includes two opposite viewing directions. In this manner, the optical sensor 15 may capture visual datasets corresponding to two storage racks opposite to one another, thereby increasing the efficiency of the data collecting.

[0046] Spatial features of a plurality of objects relate to spatial characteristics of the plurality of objects, wherein each of the spatial characteristics is descriptive of at least one of an individual object of the plurality of objects and/or a combination of two or more objects of the plurality of objects. The object may be a seat 12 and/or a ware item 50.

[0047] For example, a spatial characteristic descriptive of an individual object may be the size, shape or orientation of the individual object. For example, a spatial characteristic descriptive of a combination of two or more objects may be the relative positioning or movement of the two or more objects with respect to each other or a total volume occupied by the two or more objects.

[0048] The ware storage system 11 may include transport means 14 for displacing the optical sensor 15 with respect to the plurality of seats. The transport means 14 may displace the optical sensor 15 along a predetermined path. The predetermined path may lead in parallel to one or more storage racks in the warehouse. The transport means 14 may be configured to move the optical sensor 15 forward and backward along the predetermined path. The transport means 14 may bring the optical sensor 15 to a halt at predetermined locations along the predetermined path. For example, a predetermined location may be in front of a column of seats in a storage rack. The predetermined locations may be points of observation 16 at which the optical sensor 15 may capture one or more visual datasets. Alternatively, the transport means 14 may not stop at the points of observation 16, but simply displace the optical sensor 15 along a path including a plurality of points of observation 16.

[0049] The transport means 14 may include a rail 141 and a carriage 142 mounted on the rail 141 to be movable along the rail 141, wherein the carriage 142 supports the optical sensor 15 (see e.g. Fig. 7A). The rail 141 may be formed from one or more rigid and elongated beams. The rail 141 may be mounted to be connected to the ceiling or to the floor of the warehouse in which the ware storage system is located, or may be mounted directly to a storage rack. The rail 141 may span across a plurality of storage racks of the warehouse, thereby allowing the optical sensor 15 to move between the plurality of storage racks. The rail 141 defines a predetermined path along which the optical sensor 15 is displaced by the transport means 14. The rail 141 may be rectilinear and be parallel to a storage rack. The rail 141 may be positioned above a corridor positioned between two parallel storage racks as shown in Fig. 8.

[0050] Fig. 7A shows an example of the transport

means 14 of Figs. 6 and 8, wherein the transport means 14 include a rail 141 and a carriage 142 with the optical sensor 15 being mounted beneath the carriage 142. The rail 141 may be fixed with respect to the plurality of seats 12. In this manner, the optical sensor 15 may be able to collect data from a consistent distance from and angle to the plurality of seats, thereby improving the consistency of quality of the data collected. In the embodiment of Fig. 7A, the optical sensor 15 is configured to vary the field of view, i.e. is configured to vary its orientation by rotating around a horizontal axis and/or a vertical axis with respect to the carriage 142.

[0051] The carriage 142 may be motorized. For example, the carriage 142 may comprise one or more wheels or cogs for displacing the carriage 142 along the rail 141 as shown in Fig. 7A. The motor of the carriage 142 may be powered by an on-board battery or by drawing current from the rail 141, wherein the rail 141 comprises a conductor rail that is energized.

[0052] The carriage 142 may comprise an arm 143 for displacing the optical sensor 15 mounted thereto in a direction different from the direction of the rail 141. The carriage 142 may move the arm 143 in a circular motion as shown in Fig. 7B, thereby allowing the optical sensor 15 to perform a sweeping motion (as indicated by the arrows). Alternatively or in addition thereto, the carriage 142 may extend or contract the arm 143 as shown in Fig. 7C, thereby allowing the optical sensor 15 to move along the direction of the arm 143 (as indicated by the arrows). In this manner, the optical sensor 15 may be positioned with greater freedom.

[0053] Furthermore, the rail 141 may be shaped so that the carriage 142, when moving along the rail, follows a path that includes a plurality of points of observation 16, wherein each point of observation 16 corresponds to one of the plurality of seats 12, wherein the mutual position of each point of observation 16 with respect to the corresponding seat is the same for all points of observation 16. In other words, the perspective of the optical sensor 15 at each of the plurality of points of observation 16 is the same for all points of observation 16. In this manner, the visual datasets captured by the optical sensor 15 may represent the respective seats 12 and/or ware items 50 stored therein from a common perspective, thereby improving the consistency of quality of the data collected.

[0054] Fig. 8 shows a plan view of the ware storage system 11 comprising two storage racks and transport means 14 for displacing the optical sensor 15 between a plurality of points of observation 16. The transport means 14 may bring the optical sensor 15 to a halt at each of the plurality of points of observation 16. Then, the optical sensor 15 may capture a visual dataset (i.e. data relating to at least a spatial feature of the plurality of seats and/or of the ware items stored therein) of one or more seats 12 and/or ware items 50 stored therein. The one or more seats 12 may be located opposite to the current point of observation. The optical sensor 15 may be configured to capture visual datasets of each of the opposing storage racks. For example, the optical sensor 15 may rotate by 180° around a vertical axis after capturing a visual dataset corresponding to one storage rack in order to afterwards capture another visual dataset corresponding to the other storage rack on the opposite side.

[0055] The rail 141 may be a rectilinear rail positioned parallel to a sequence of seats 12 positioned along a rectilinear row. In this manner, the optical sensor 15 may be able to capture visual datasets from a common height and thus from a common perspective, thereby improving the consistency of quality of the data collected.

[0056] When the seats are formed in a rack including a plurality of rows and a plurality of columns, the rail 141 may be positioned close to and above the highest row of the rack. By placing the rail 141 close to and above the highest row of the (storage) rack, the rail 141 does not interfere with loading and unloading operations performed at the storage rack.

[0057] The optical sensor 15 may include one of: a camera, a stereo camera, a LIDAR sensor or any combination thereof. The camera may be used to capture one or more visual datasets such as one or more images or one or more videos representing the plurality of seats 12 and/or of the ware items 50 stored therein. The stereo camera may be used to capture images or videos corresponding to more than one viewing direction such as a forward and a backward direction. The LIDAR (light detection and ranging) sensor may be used to capture one or more 3-dimensional point clouds representing the plurality of seats 12 and/or of the ware items 50 stored therein.

[0058] The ware storage system may further include a control unit 17 (schematically shown in Fig. 8) coupled to the optical sensor 15, the control unit 17 being configured to process the data relating to at least a spatial feature to determine an anomaly relating to one or more of the plurality of seats 12, wherein the anomaly includes any of: an anomaly relating to a position of a ware item 50 in the seat 12, an anomaly relating to a shape of the ware item 50 received in the seat 12, or an anomaly relating to a boundary of the seat 12, or any combination thereof. In other words, the control unit 17 may be configured to analyze the data collected by the optical sensor 15 and at least one spatial feature in order to determine an anomaly associated with one or more of the plurality of seats 12. Examples for such anomalies have been discussed above with reference to Figs. 3A to 3C.

[0059] The control unit 17 may comprise a processor (e.g. a CPU), a memory (e.g. a random-access memory, RAM) and a storage for storing computer-readable instructions which, when executed by the processor, cause the processor to perform an operation of the control unit, in particular any of the operations performed by the control unit as described in the present disclosure. The control unit 17 may include one or more controller devices organized in a distributed architecture or could be centralized. The one or more controller device may be locat-

ed remotely or locally, i.e. inside and/or outside a warehouse in which the ware storage system is located.

[0060] The control unit 17 may be physically coupled to the transport means 14. Alternatively, the control unit 17 may be wirelessly coupled to the transport means 14 and/or to the optical sensor 15. For example, data and control commands may be exchanged between the control unit 17 and the transport means 14 and/or to the optical sensor 15 using a local area network of the warehouse. To this end, the control unit 17 may be associated to a transceiver unit 17a to communicate with transceiver means coupled to the optical sensor 15 and/or the transport means 14 and/or with the receiving unit 22 of the industrial truck; in particular, the control unit 17 may cause the transceiver unit 17a to transmit information relating to an anomaly to the receiving unit 22 of the industrial truck. Accordingly, the transport means 14 and/or to the optical sensor 15 may include a transceiver unit (not shown) for transmitting the collected data to the control unit 17. The transceiver unit associated to the optical sensor 15 may advantageously be wireless. The control unit 17 may be configured to determine spatial features and or an anomaly based on the data collected by the optical sensor 15 by using any known data processing method, e.g. any known image processing methods.

[0061] The control unit 17 may be configured to determine the anomaly by processing the data relating to at least a spatial feature by means of trained neural network. The neural network may comprise a model that is trained in advance using training data. The training data may correspond to spatial features of a plurality of seats and/or of ware items stored therein, wherein each of the spatial features is associated with a corresponding truth label. The truth label may indicate the presence or absence of an anomaly associated with the corresponding spatial feature. In case of a presence of an anomaly, the truth label may further indicate a type of the anomaly. The neural network (model) may be trained to associate spatial features with anomalies based on the truth labels.

[0062] The trained neural network may be refined using data collected by the ware storage system 11 during its operation, wherein a worker additionally inputs feedback information into the control unit. The feedback information may indicate whether or not an anomaly detected by the control unit was correctly identified or not. In this manner, the set of training data for the neural network can be steadily increased during the operation of the ware storage system 11, thereby further improving the efficiency and reliability of the trained neural network.

[0063] The control unit 17 may be further coupled to the transport means 14 to control a movement of the optical sensor 15. The control unit may be configured to command a periodical movement of the optical sensor 15 to monitor periodically each of the plurality of seats 12. In other words, the control unit 17 may transmit commands to the transport means 14 such as to control periodical movements of the optical sensor 15 for monitoring each of the plurality of seats 12. For example, the control unit may control the transport means 14 to monitor each of the plurality of seats 12 once per day. The periodicity of the monitoring may be indicated by a preset schedule. The schedule may be set by a user of the ware storage system 11 such as a supervisor of the warehouse.

[0064] The control unit 17 may be configured to associate a determined anomaly to a position of the seat for which the anomaly has been determined and to store this association in a database. For example, the association may be performed based on the known position of the optical sensor at the time of collecting the data relating to at least a spatial feature of a seat and/or of a ware item in the seat. In this case, the optical sensor 15 may be configured to generate data relating to at least a spatial feature of a seat and/or of a ware item in the seat (e.g. an image data) with a spatial stamp indicating of a position of the respective seat and/or of a ware item to which the collected data relates. For example, the spatial stamp may relate to point of observation at which the data relating to at least a spatial feature is collected. In this manner, the control unit 17 can be configured to maintain and update stored information in which anomalies are stored in association with respective positions of the seat having an anomaly. Based on this information, the control unit may be configured to generate information relating to a determined anomaly to be transmitted to an industrial truck, wherein the information relating to a determined anomaly may include e.g. an image of (or image date related to) a group of seats (e.g. a group of seats facing on the same corridor) in which the seats having an anomaly are highlighted. For example, the information relating to a determined anomaly may include image information for displaying the image 24 in figure 5 on the display of the industrial truck.

[0065] The present disclosure also includes a system including one or more industrial trucks 10 as herein described and a ware storage system 11 as herein described.

[0066] However, the present disclosure is not limited to a ware storage system 11 as described above, and the information relating to the anomaly may derived in a different manner such as manually by one or more workers in the warehouse tasked with inspecting the seats.

[0067] Further embodiments are as follows:

Embodiment 1: a ware storage system (11) including a plurality of seats (12), wherein each of the plurality of seats (12) is configured to receive a ware item (13) to be stored in the ware storage system (11), the ware storage system (11) comprising an optical sensor (15) configured to collect data relating to at least a spatial feature of the plurality of seats (12) and/or of the ware items (13) stored therein; wherein the ware storage system (13) includes transport means (14) for displacing the optical sensor (15) with respect to the plurality of seats (12).

Embodiment 2: a ware storage system (11) according to embodiment 1, wherein the transport means (14) includes a rail (141) and a carriage (142) mounted on the rail (141) to be movable along the rail (141), wherein the carriage (142) supports the optical sensor (15).

Embodiment 3: a ware storage system (11) according to embodiment 2, the rail (14) is shaped so that the carriage, when moving along the rail, follows a path that includes a plurality of points of observation (16), wherein each point of observation (16) corresponds to one of the plurality of seats (12), wherein the mutual position of each point of observation (16) with respect to the corresponding seat is the same for all points of observation (16).

Embodiment 4: a ware storage system (11) according to embodiment 2 or 3, wherein the rail (141) is a rectilinear rail positioned parallel to a sequence of seats (12) positioned along a rectilinear row.

Embodiment 5: a ware storage system (11) according to any of embodiment 2 - 4, wherein the seats (12) are formed in a rack including a plurality of rows and a plurality of columns, the rail (141) being positioned close to and above the highest row of the rack.

Embodiment 6: a ware storage system (11) according to any of embodiment 1 - 5, wherein the optical sensor (15) includes one of: a camera, a stereo camera, a LIDAR sensor or any combination thereof.

Embodiment 7: a ware storage system (11) according to any of embodiment 1 - 6, further including a control unit (17) coupled to the optical sensor (15), the control unit being configured to process the data relating to at least a spatial feature to determine an anomaly relating to one or more of the plurality of seats (12), wherein the anomaly includes any of: an anomaly relating to a position of a ware item (13) in the seat (12), an anomaly relating to a shape of the ware item (50) received in the seat (12), or an anomaly relating to a boundary of the seat (12), or any combination thereof.

Embodiment 8: a ware storage system (11) according to embodiment 7, wherein the control unit (17) is configured to determine the anomaly by processing the data relating to at least a spatial feature by means of trained neural network.

Embodiment 9: a ware storage system (11) according to any of embodiment 1 - 8, further including a control unit (17) coupled to the transport means (14) to control a movement of the optical sensor (15), wherein the control unit is configured to command a periodical movement of the optical sensor (15) to monitor periodically each of the plurality of seats (12).

Embodiment 10: a ware storage system (11) according to any of embodiment 1 - 9, further comprising transmitting means (17a) for transmitting an information relating to a determined anomaly to an industrial truck configured for loading/unloading a ware item (13) from/to the plurality of seats (12).

[Reference Signs]

[0068]

10	industrial truck
11	ware storage system
12	seat
13	transmitting unit
14	transport means
141	rail
142	carriage
143	arm
15	optical sensor
16	point of observation
17	control unit
17a	transceiver means
18	tag
20	material handling device
21	controller
22	receiving unit
23	output unit
24	image
25	anomalous seat
30, 31	predetermined area
40, 41	group of seats
50	ware item
51	pallet
52	one or more goods
60	storage rack

Claims

1. An industrial truck (10) including:

a material handling device (20) for loading/unloading a ware item into/from one or more seats (12) of a plurality of seats of a ware storage system (11);
a controller (21) configured to control a material handling function by means of the material handling device;
a receiving unit (22) coupled with the controller and configured to receive, from a transmitting unit (13) of the ware storage system, information relating to an anomaly relating to one or more of the plurality of seats; and
an output unit (23) configured to output a user

notification to a user of the industrial truck based on the information relating to an anomaly.

2. An industrial truck according to claim 1, wherein the output unit (23) includes a display and the user notification includes an image (24) of seats of the ware storage system (11) displayed by the display, wherein the one or more anomalous seats (25) are highlighted in the image (24), wherein the control unit (21) is configured to prohibit the material handling function by means of the material handling device (20), based on the information relating to an anomaly, wherein the industrial truck (10) includes an input unit, wherein, after the material handling function has been prohibited and the user has inputted an acknowledgment input by means of the input unit, the control unit (21) is configured to enable again the material handling function, wherein the input unit is realized by a touchscreen (23) that forms the output unit, wherein the acknowledgement input includes the user touching the one or more highlighted seats in the image (24).

3. An industrial truck according to claim 1, further including position detection means configured to determine whether the industrial truck (10) is in a predetermined area (30) having a predetermined location in the proximity of a group (40) of seats of the ware storage system.

4. An industrial truck according to claim 3, wherein the output unit (23) is configured to output the user notification when the position detection means determine that the industrial truck is in the predetermined area (30) in the proximity of the group (40) of seats of the ware storage system.

5. An industrial truck according to claim 4, wherein the ware storage system (11) includes a plurality of groups of seats (40, 41), each associated to a predetermined area (30, 31) in the proximity of a respective group of seats, and wherein,
when the position detection means determines that the industrial truck is in one of the predetermined areas (30, 31) in the proximity of one of the groups (40, 41) of seats, the output unit (23) is configured to output a user notification based on information relating to an anomaly relating to one or more of the plurality of seats in the group (40, 41) of seats associated to the predetermined area (30, 31) in which the industrial truck is detected to be.

6. An industrial truck according to any of claims 1 or 3-5, wherein the output unit (23) includes a display and the user notification includes an image (24) of seats of the ware storage system (11) displayed by the display, wherein the one or more anomalous seats (25) are highlighted in the image (24) .

7. An industrial truck according to claims 3 and 6, wherein the image (24) shows the plurality of seats in a group (40) of seats, preferably from a point of view corresponding to the predetermined area (30) associated with the group (40) of seats.

8. An industrial truck according to any of claim 1-7, wherein the control unit (21) is configured to control a driving function of the industrial truck (10) so as to maintain the driving speed below a limited maximum driving speed that is lower than the maximum driving speed of the industrial truck, based on the information relating to an anomaly received by the receiving unit.

9. An industrial truck according to claim 1 or claims 3-8, wherein the control unit (21) is configured to prohibit the material handling function by means of the material handling device (20), based on the information relating to an anomaly.

10. An industrial truck according to claim 9, wherein the industrial truck (10) includes an input unit, wherein, after the material handling function has been prohibited and the user has inputted an acknowledgment input by means of the input unit, the control unit (21) is configured to enable again the material handling function.

11. An industrial truck according to claims 6 and 10, wherein the input unit is realized by a touchscreen (23) that forms the output unit, wherein the acknowledgement input includes the user touching a highlighted seat in the image (24).

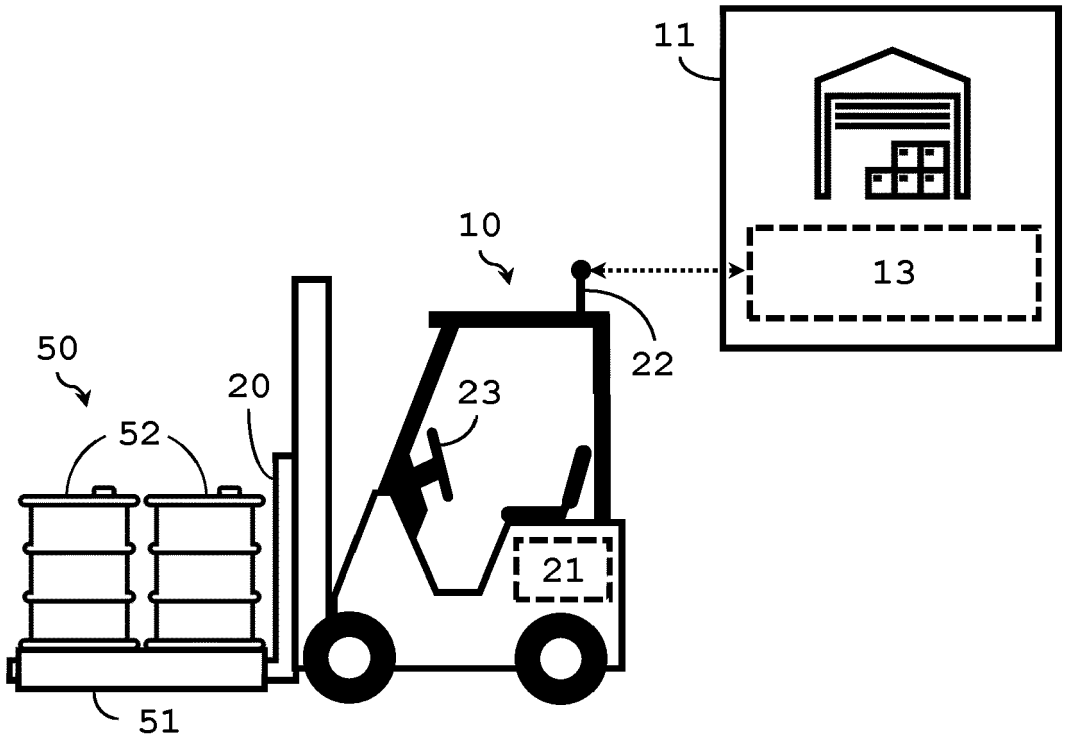

Fig. 1

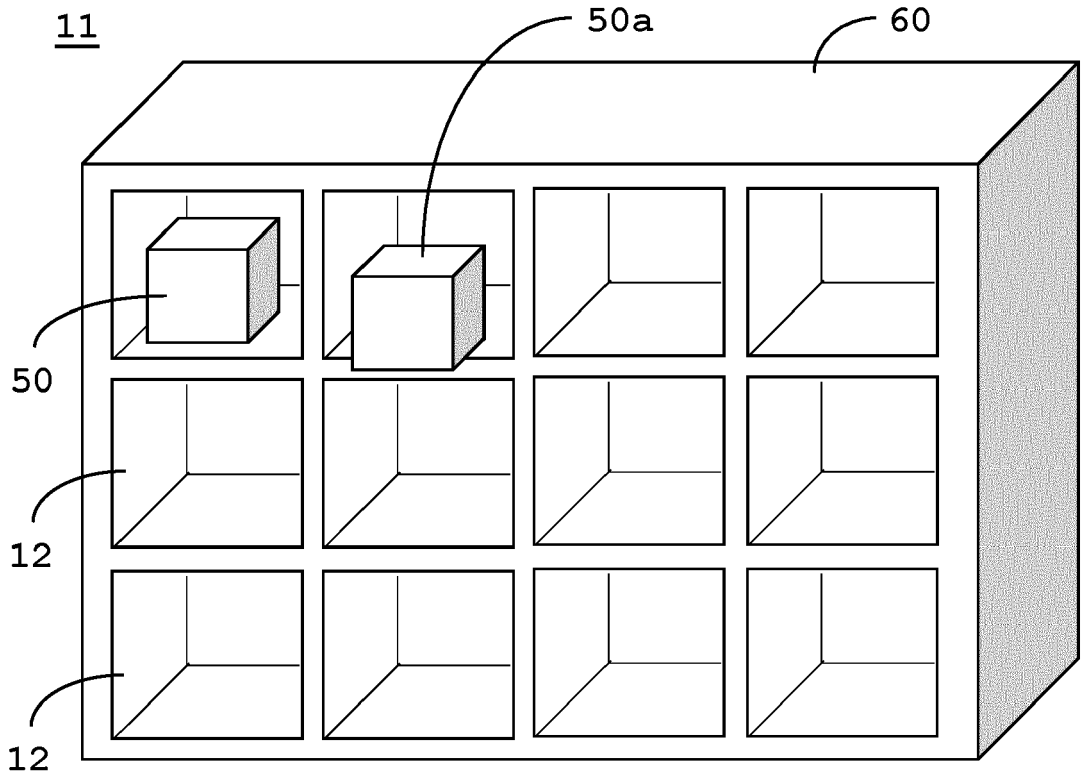

Fig. 2

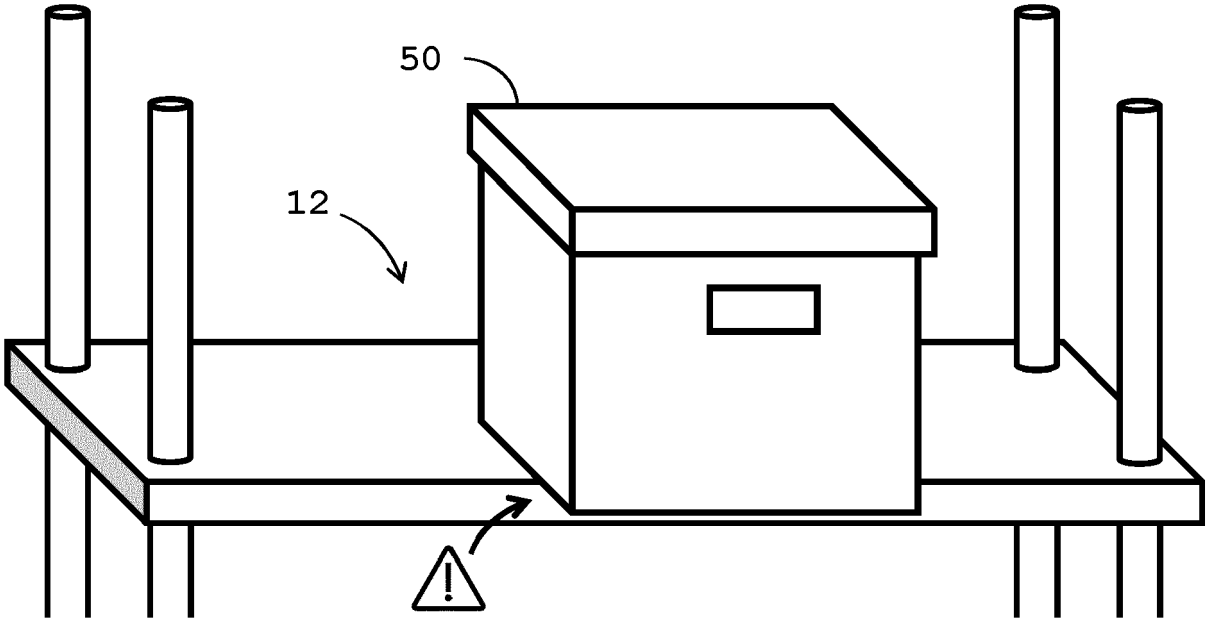

Fig. 3A

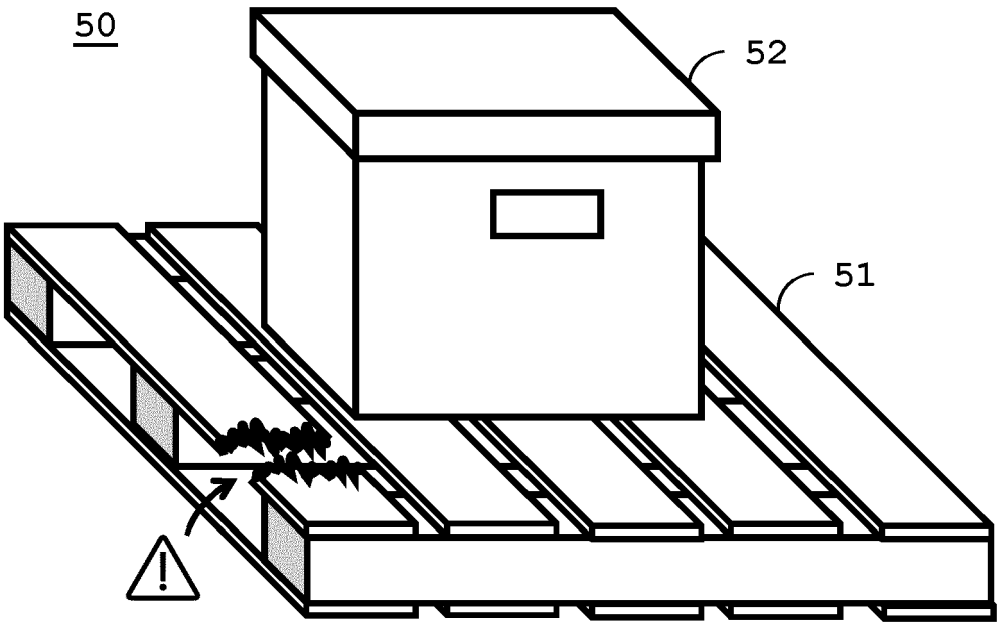

Fig. 3B

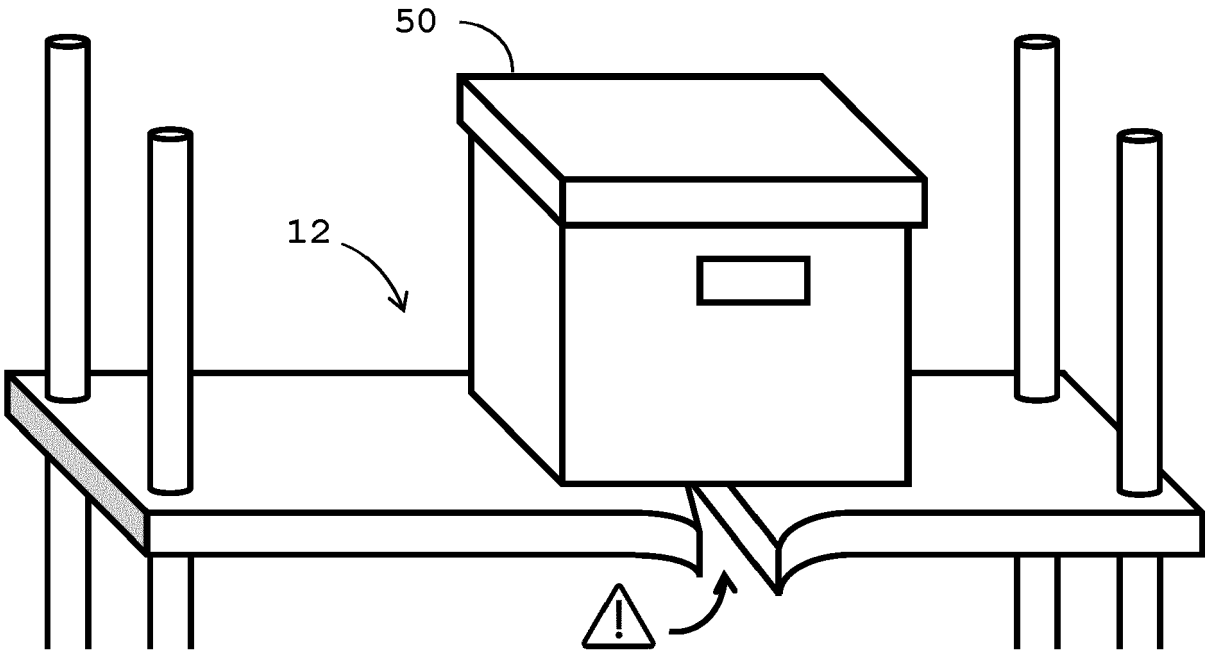

Fig. 3C

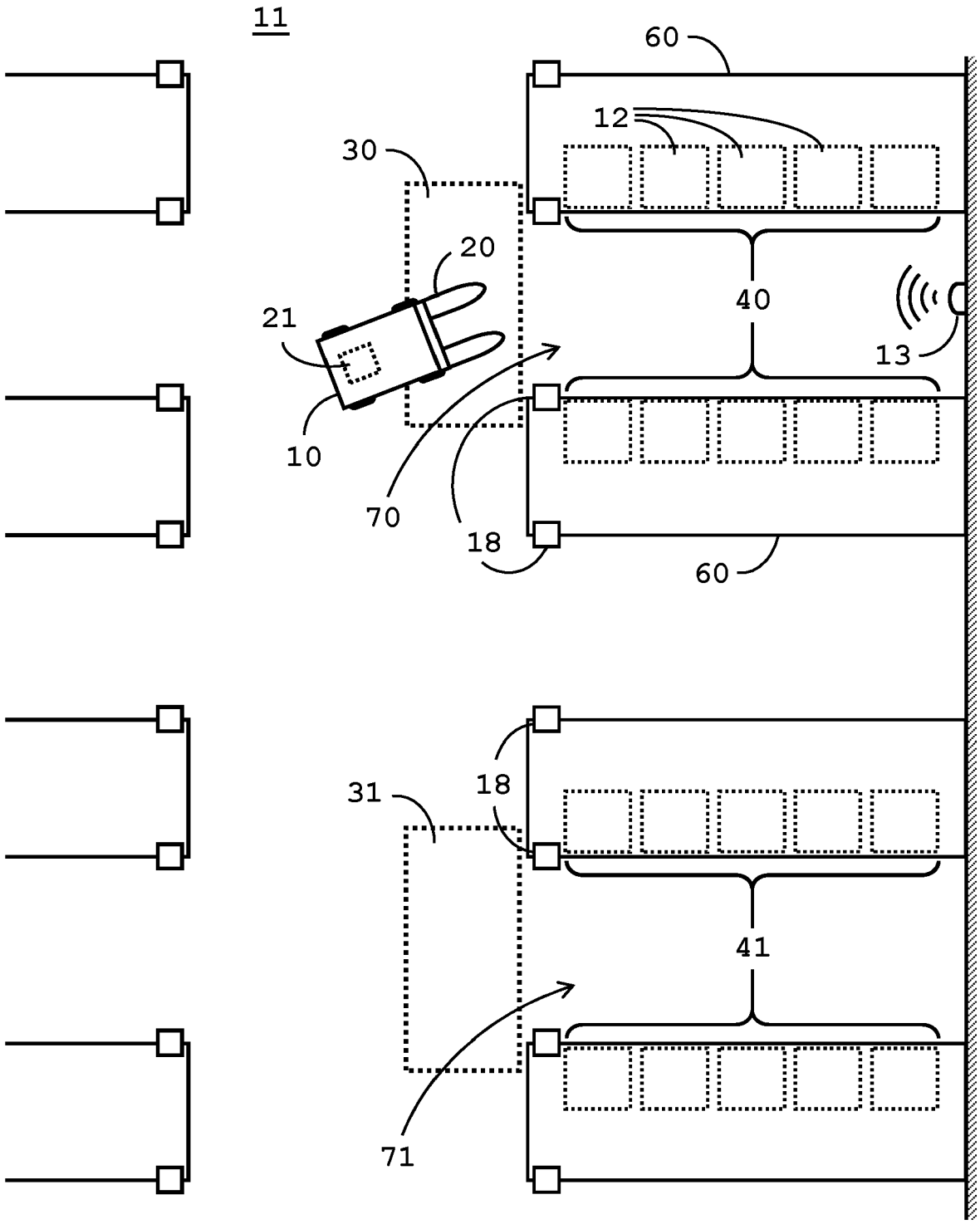

Fig. 4

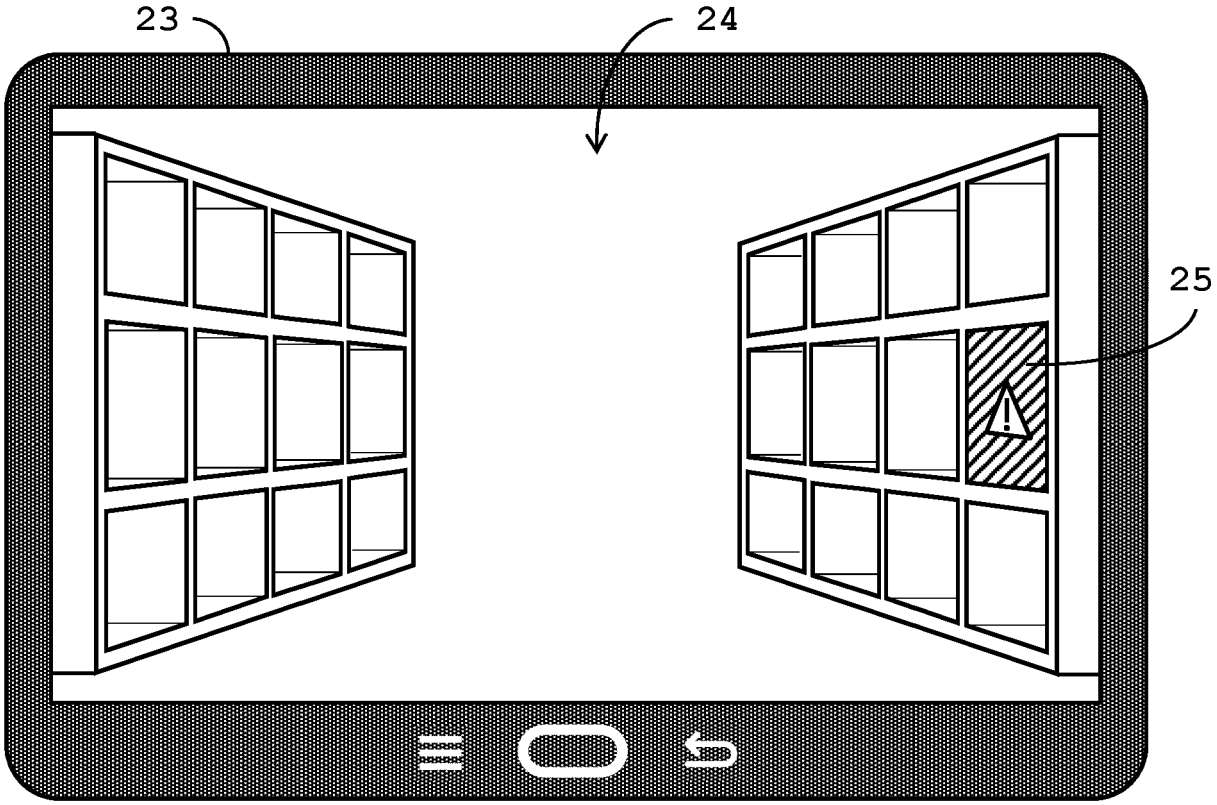

Fig. 5

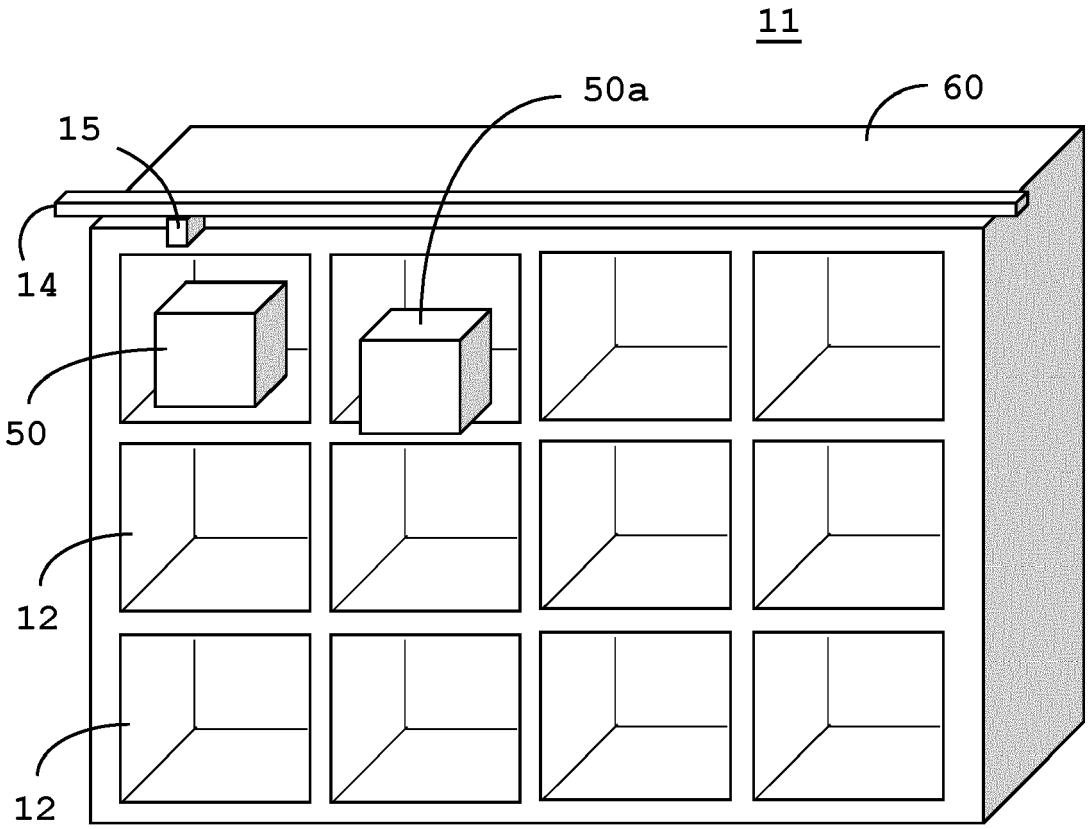

Fig. 6

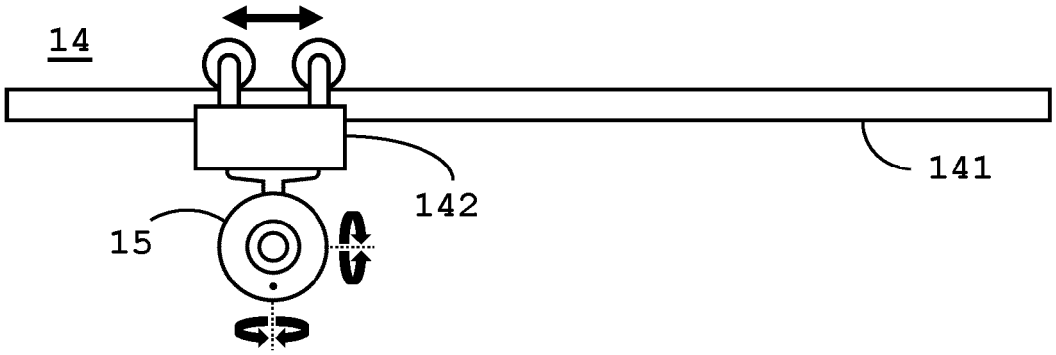

Fig. 7A

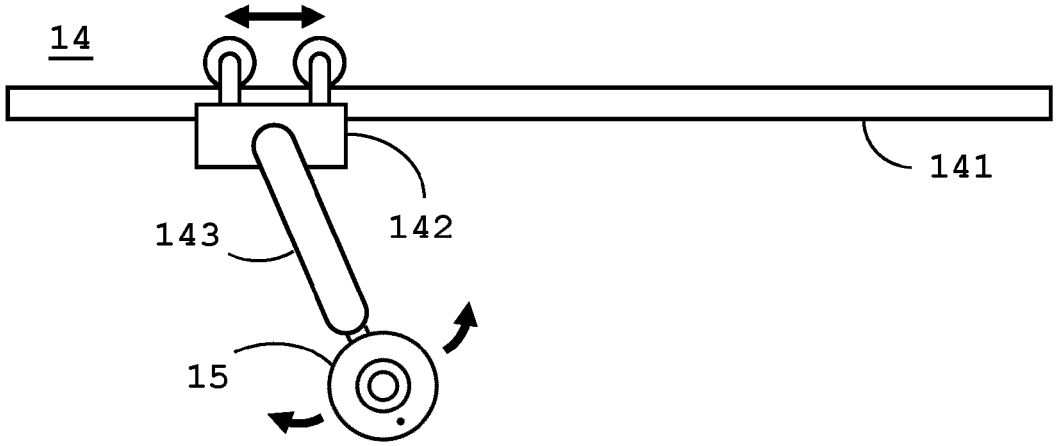

Fig. 7B

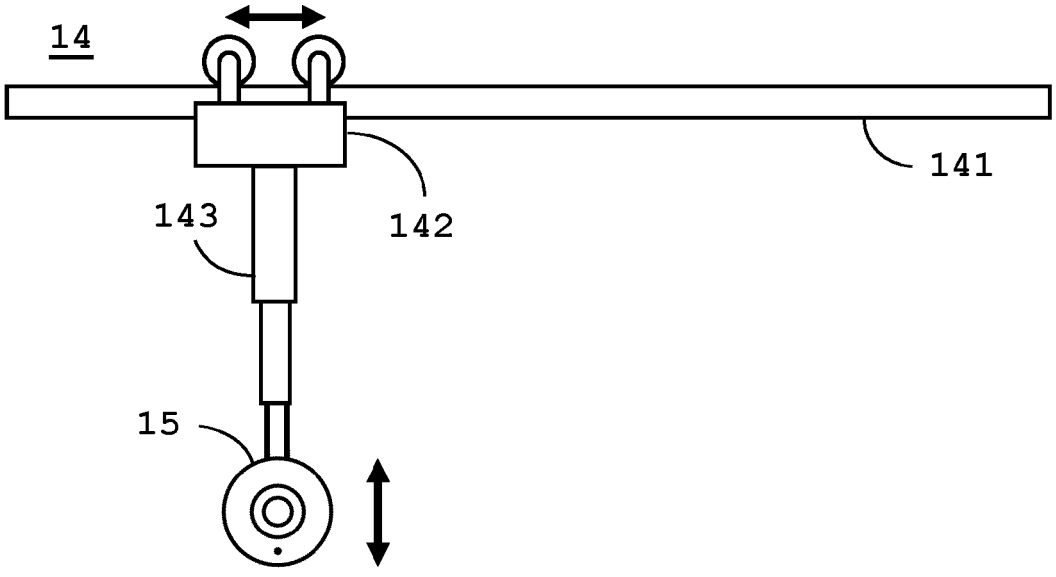

Fig. 7C

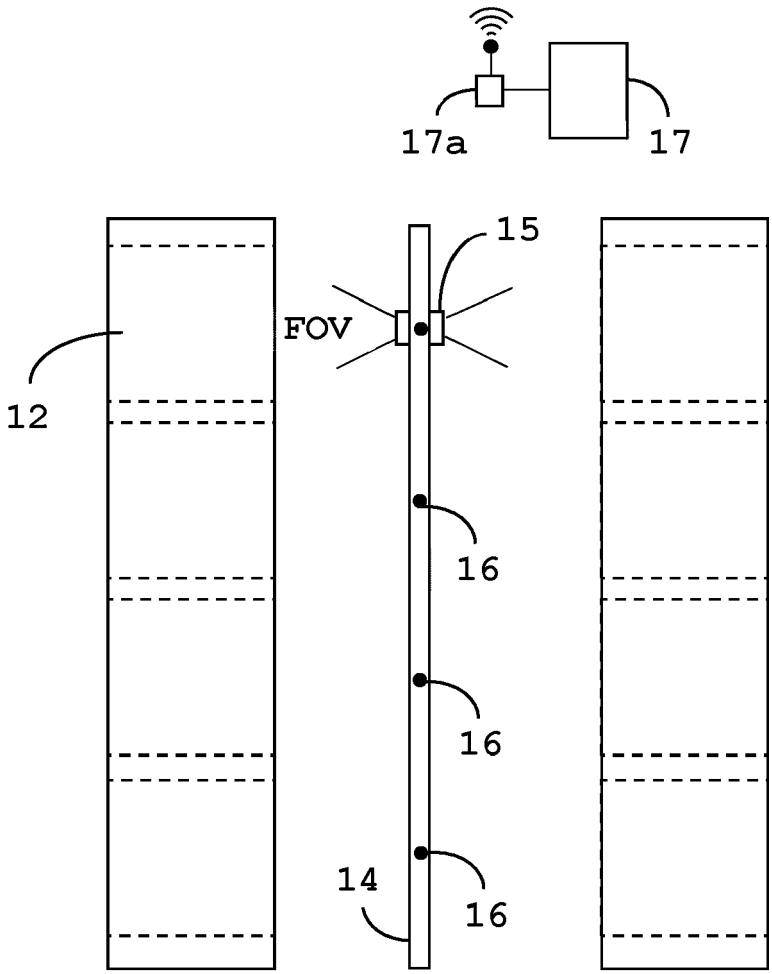

Fig. 8

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Application Number
EP 24 16 1976

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 July 2024	Popescu, Alexandru

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L : document cited for other reasons

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