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(54) **SMART AIRCRAFT OVERHEAD LUGGAGE BIN SYSTEM**

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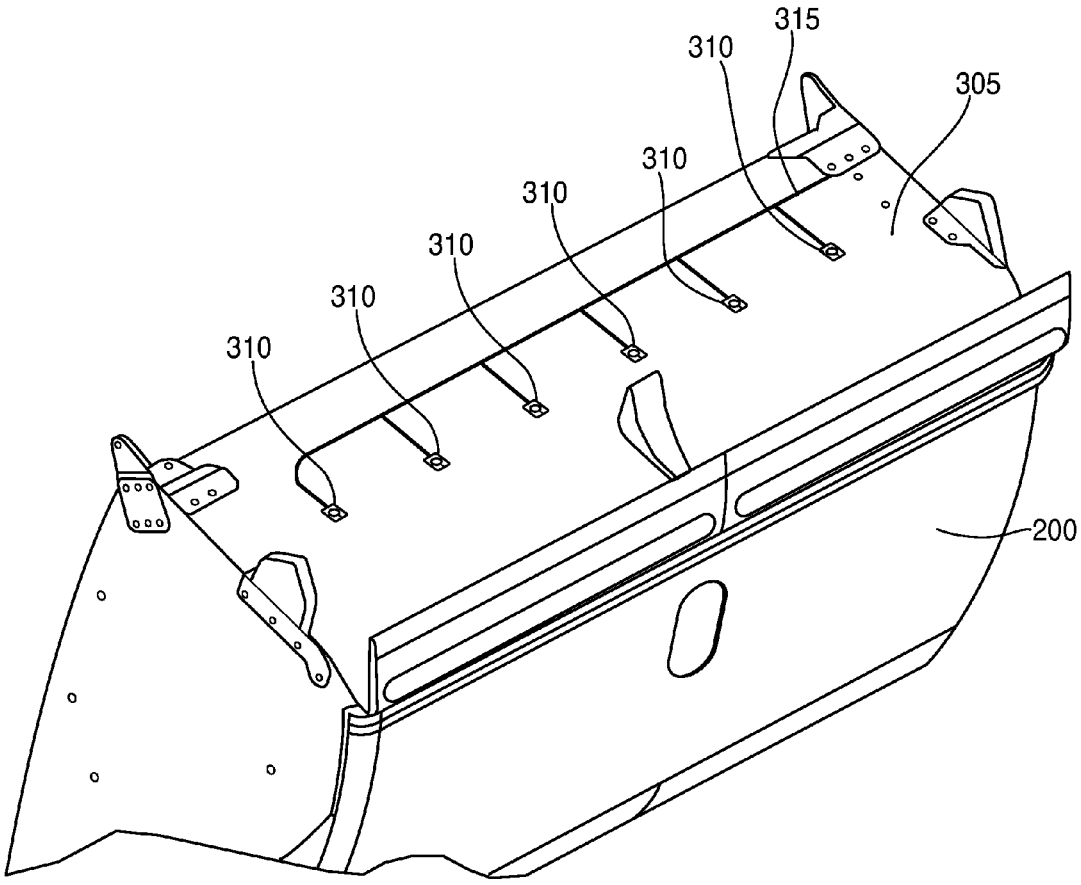
(57) **ABSTRACT**

A system is disclosed for displaying storage capacity status information for one or more passenger storage bins in an aircraft. Load sensors are coupled to each passenger storage bin and provide an output signal proportional to a weight of items within the bin. Range sensors are also coupled to each passenger storage bin and provide an output signal proportional to an amount of empty space available within the bin. A processor is coupled to the associated load sensors and range sensors and calculates, based upon the output signals from the load sensors and the range sensors, whether the associated storage bin is filled to capacity. The processor is also coupled to a display device to provide a status signal. The display device provides a visual indication based upon such status signal whether or not the associated storage bin is filled to capacity.



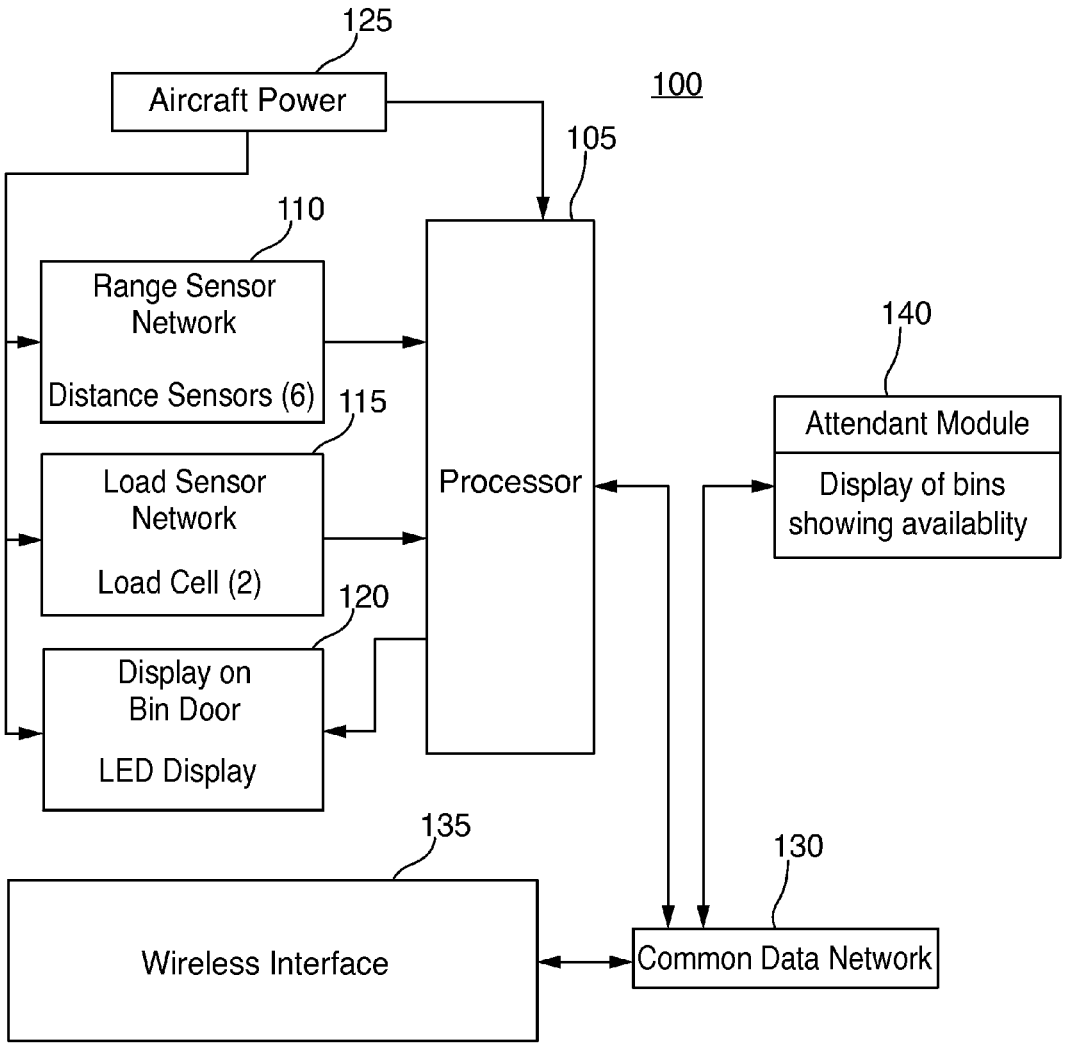

125
Aircraft Power
100
105
110
Range Sensor Network
Distance Sensors (6)
115
Load Sensor Network
Load Cell (2)
120
Display on Bin Door
LED Display
Processor
140
Attendant Module
Display of bins showing availablity
135
Wireless Interface
130
Common Data Network

FIG. 1

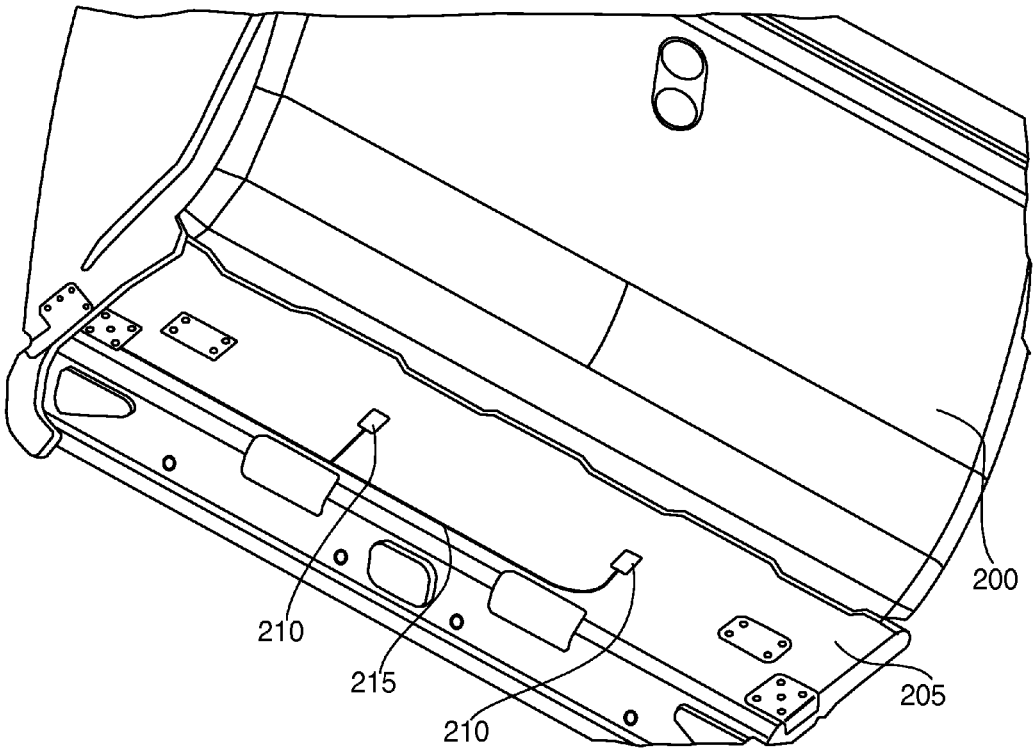



FIG. 2

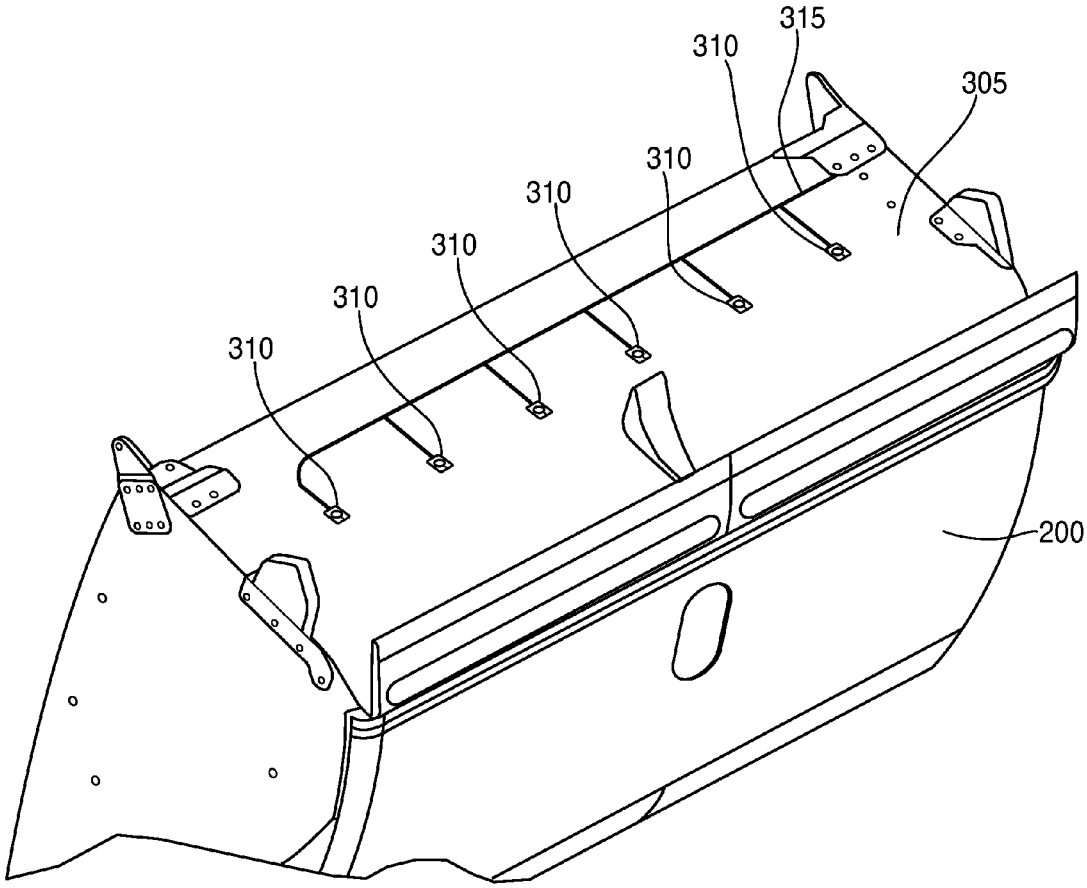



FIG. 3

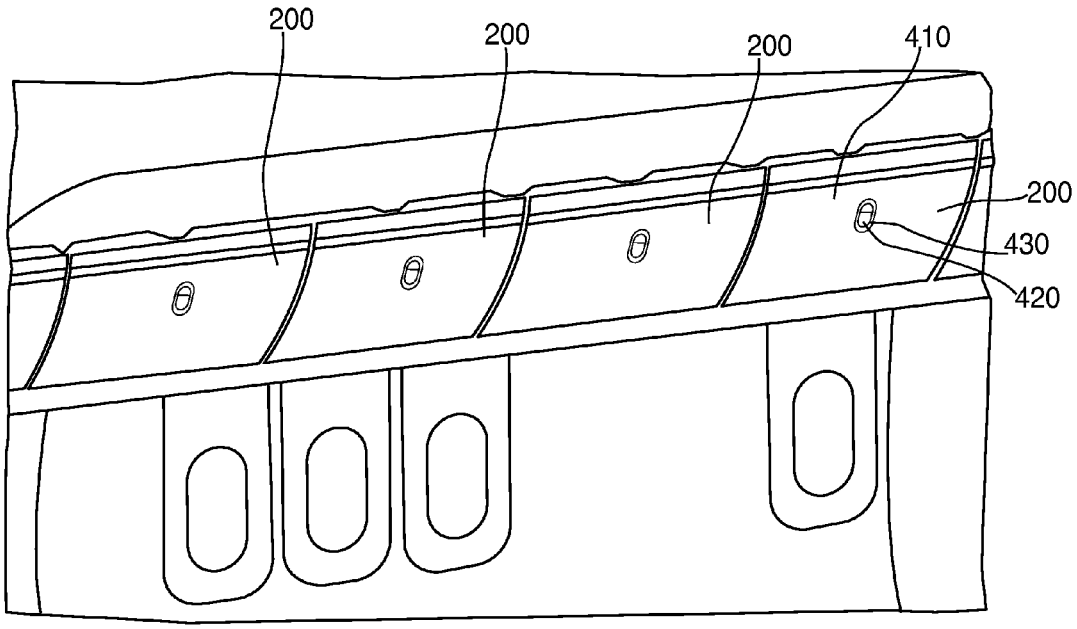



FIG. 4A

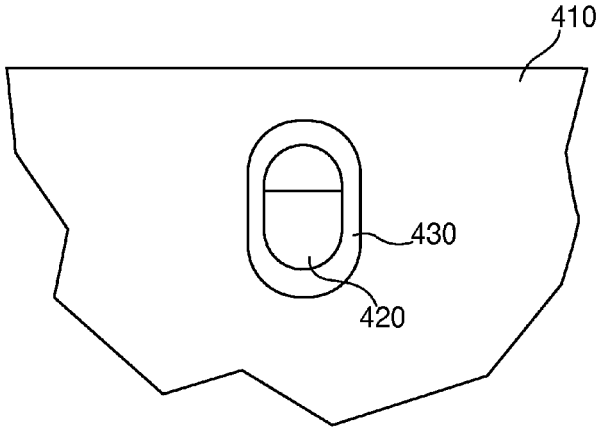



FIG. 4B

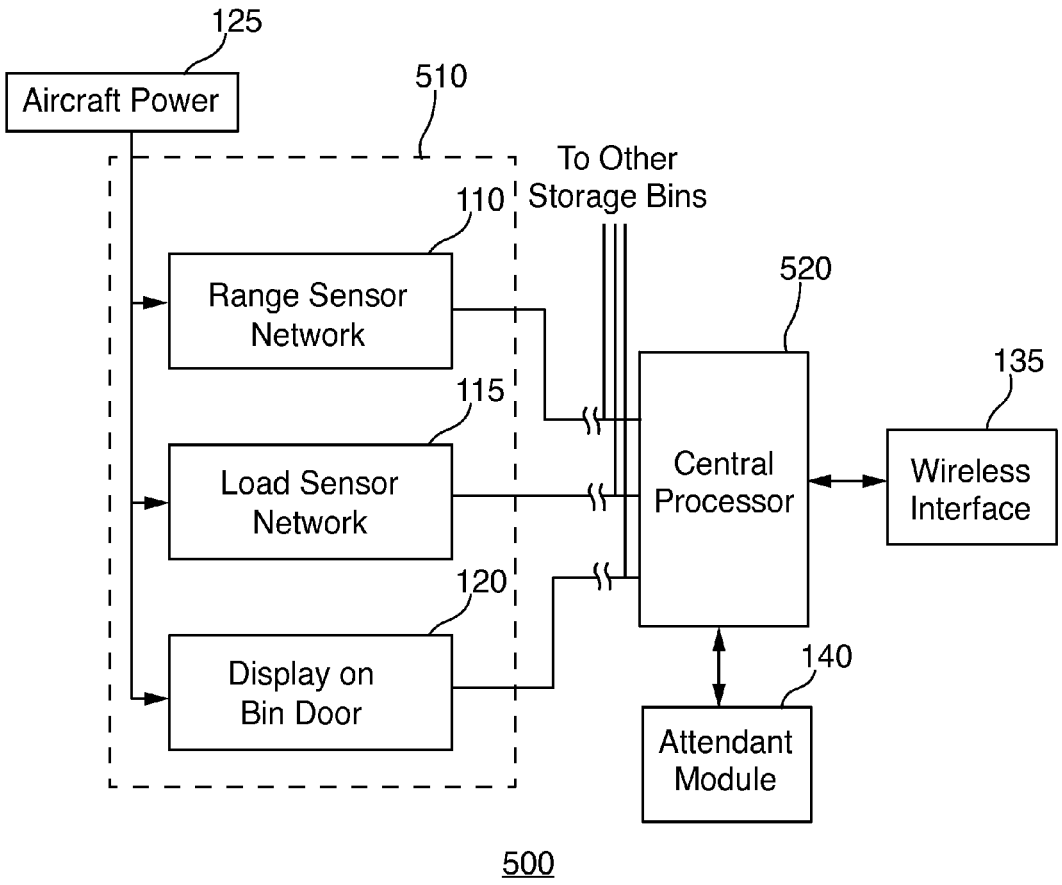

125
Aircraft Power
510
To Other
Storage Bins
110
Range Sensor
Network
520
135
115
Load Sensor
Network
Central
Processor
Wireless
Interface
120
Display on
Bin Door
140
Attendant
Module
500

FIG. 5

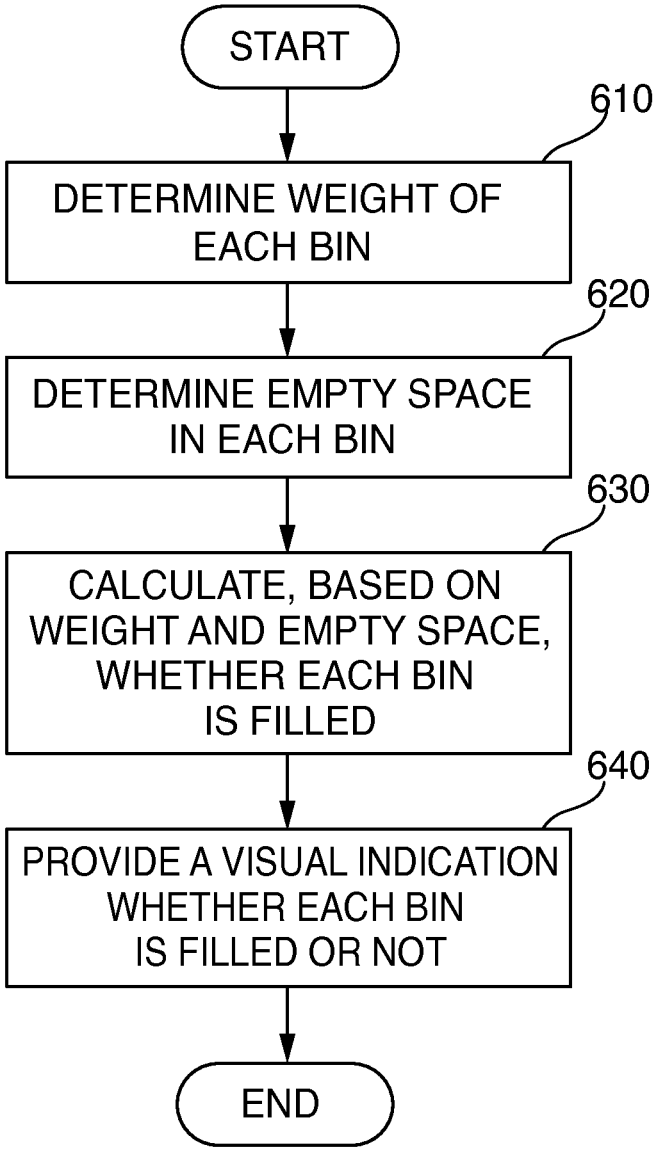

START
610
DETERMINE WEIGHT OF EACH BIN
620
DETERMINE EMPTY SPACE IN EACH BIN
630
CALCULATE, BASED ON WEIGHT AND EMPTY SPACE, WHETHER EACH BIN IS FILLED
640
PROVIDE A VISUAL INDICATION WHETHER EACH BIN IS FILLED OR NOT
END

FIG. 6

# SMART AIRCRAFT OVERHEAD LUGGAGE BIN SYSTEM

## FIELD

**[0001]** This disclosure relates generally to a smart overhead luggage bin system for use in an aircraft.

## BACKGROUND

**[0002]** Airplane turn time—the time required to unload an airplane after its arrival at the gate and to prepare it for departure again—has increased since the mid-1970s. This contributes to both flight delays and increased passenger frustration. One of the key elements of turn time in a single-aisle aircraft is passenger boarding. One factor that contributes to an increase in passenger boarding time is an increase in the amount of passenger carry-on luggage. Passengers have increased their carry-on baggage for a number of reasons, including the implementation of checked baggage fees by the airlines. During the boarding process, finding available overhead bin storage space for carry-on baggage becomes increasingly time consuming and frustrating for passengers and flight attendants, and can cause delayed departure.

**[0003]** Airlines and aircraft manufacturers have attempted to address boarding delays in a number of ways. For example, airlines have modified the order of passenger boarding, but studies have shown that new boarding algorithms have proven largely ineffective in reducing boarding time. Airlines and manufacturers have also changed the size and shape of overhead bin storage space to make the space more usable, but because this option is limited by space constraints this has also been found ineffective in reducing boarding time.

**[0004]** Accordingly, there is a need for an improved system which assists in speeding the aircraft boarding process.

## SUMMARY

**[0005]** In one aspect, a system is provided for displaying storage capacity status information for one or more passenger storage bins in an aircraft. The system includes at least one first sensor coupled to each of the passenger storage bins for providing a first output signal proportional to a first type of capacity level of the associated passenger storage bin. The system also includes a processor for each of the passenger storage bins coupled to the associated at least one first sensor and configured to calculate, based upon the output signal from the at least one first sensor, whether or not the associated storage bin is filled to capacity. The processor is also configured to provide an output signal indicating whether or not the associated storage bin is filled to capacity. Finally, the system includes a display device for each passenger storage bin coupled to receive the output signal from the associated processor and for providing a visual indication whether or not the associated storage bin is filled to capacity.

**[0006]** In one further aspect, each of the at least one first sensors may be a load sensor and the output signal from each of the at least one first sensors may be proportional to a weight of items within the associated passenger storage bin.

**[0007]** In another further aspect, each of the at least one first sensors may be a range sensor and the output signal from each of the at least one first sensors may be proportional to an amount of empty space available within the associated passenger storage bin.

**[0008]** In yet another further aspect, the system may also include at least one second sensor coupled to each of the passenger storage bins for providing an output signal proportional to a second type of capacity level of the associated passenger storage bin. The processor may also be coupled to the associated at least one second sensor and may be further configured to calculate whether or not the associated storage bin is filled to capacity based on the output signals from the at least one first sensor and the at least one second sensor. Each of the at least one first sensors may be a load sensor and the output signal from each of the at least one first sensors may be proportional to a weight of items within the associated passenger storage bin. Each of the at least one second sensors may be a range sensor and the output signal from each of the at least one second sensors may be proportional to an amount of empty space available within the associated passenger storage bin.

**[0009]** Each processor may be configured to calculate whether or not the associated storage bin is filled to capacity based, at least in part, on a predetermined weight level. In addition, each processor may be configured to calculate whether or not the associated storage bin is filled to capacity based, at least in part, on a predetermined amount of empty space.

**[0010]** The system may also include an attendant console coupled to each of the processors for the one or more passenger storage bins for receiving and displaying the storage capacity status of each of the one or more passenger storage bins. Also, each of the processors for the one or more passenger storage bins may be coupled to each other via a network and the system may also include a wireless interface coupled to the network and a handheld wireless device coupled to the wireless interface for receiving, via the wireless interface, and displaying the storage capacity status of each of the one or more passenger storage bins.

**[0011]** Each of the display devices may be a light emitting element or a display panel located on an external portion of or adjacent to the associated passenger storage bin. Each of the at least one load sensors may be coupled to a support structure of the associated passenger storage bin to measure load of the associated storage bin or may be mounted on a bottom panel of the associated passenger storage bin to measure load of the associated storage bin.

**[0012]** In another aspect, a system is provided for displaying storage capacity status information for one or more passenger storage bins in an aircraft. The system includes at least one first sensor coupled to each of the passenger storage bins for providing a first output signal proportional to a first type of capacity level of the associated passenger storage bin. The system also includes a processor coupled to each of the at least one first sensors and configured to calculate, for each of the at least one first sensors and based upon the output signal from the at least one first sensor, whether or not the storage bin associated with the at least one first sensor is filled to capacity. The processor is also configured to provide an output signal for each of the at least one first sensors indicating whether or not the storage bin associated with the at least one first sensor is filled to capacity. Finally, the system includes a display device for each passenger storage bin coupled to receive the output signal from the processor and for providing a visual indication whether or not the associated passenger storage bin is filled to capacity.

**[0013]** In one further aspect, each of the at least one first sensors may be a load sensor and the first output signal from each of the at least one first sensors may be proportional to a weight of items within the associated passenger storage bin.

**[0014]** In another further aspect, each of the at least one first sensors may be a range sensor and the first output signal from each of the at least one first sensors may be proportional to an amount of empty space available within the associated passenger storage bin.

**[0015]** In yet another further aspect, the system may also include at least one second sensor coupled to each of the passenger storage bins for providing an output signal proportional to a second type of capacity level of the associated passenger storage bin. The processor may also be coupled to each of the at least one second sensors and may be further configured to calculate whether or not the storage bin associated with each of the at least one second sensors is filled to capacity based on the output signals from the at least one first sensor and the at least one second sensor. Each of the at least one first sensors may be a load sensor and the output signal from each of the at least one first sensors may be proportional to a weight of items within the associated passenger storage bin. Each of the at least one second sensors may be a range sensor and the output signal from each of the at least one second sensors may be proportional to an amount of empty space available within the associated passenger storage bin.

**[0016]** An attendant console may be coupled to the processor for receiving and displaying the storage capacity status of each of the one or more passenger storage bins.

**[0017]** In yet another aspect, a method for displaying storage capacity status information for one or more passenger storage bins in an aircraft. First, for each of the passenger storage bins, a weight of items within the associated passenger storage bin is determined. Next, for each of the passenger storage bins, an amount of empty space available within the associated passenger storage bin is determined. Then, based upon the weight of items within the associated passenger storage bin and the amount of empty space available within the associated passenger storage bin, a processor calculates whether or not the associated storage bin is filled to capacity. Finally, based upon the calculation by the processor, a visual indication is provided indicating whether or not the associated storage bin is filled to capacity.

**[0018]** The features, functions, and advantages that have been discussed can be achieved independently in various embodiments or may be combined in yet other embodiments, further details of which can be seen with reference to the following description and drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]** The following detailed description, given by way of example and not intended to limit the present disclosure solely thereto, will best be understood in conjunction with the accompanying drawings in which:

**[0020]** FIG. **1** is block circuit diagram of an overhead luggage storage bin capacity sensing system according to a first embodiment of the present disclosure;

**[0021]** FIG. **2** is a diagram showing load sensors positioned on a bottom surface of an overhead luggage storage bin according to the present disclosure;

**[0022]** FIG. **3** is a diagram showing range sensors positioned on a top surface of an overhead luggage storage bin according to the present disclosure;

**[0023]** FIG. **4**A is a diagram showing visual indicators according to the present disclosure positioned on a front surface of overhead luggage storage bins, and FIG. **4**B is a diagram showing a close-up of a single visual indicator from FIG. **4**A;

**[0024]** FIG. **5** is block circuit diagram of an overhead luggage storage bin capacity sensing system according to a second embodiment of the present disclosure; and

**[0025]** FIG. **6** is a flowchart of a method of determining overhead luggage storage bin capacity according to the present disclosure.

## DETAILED DESCRIPTION

**[0026]** In the present disclosure, like reference numbers refer to like elements throughout the drawings, which illustrate various exemplary embodiments of the present disclosure.

**[0027]** The system disclosed herein helps to speed the boarding process by providing a clear visual indication of whether there is available space in each overhead luggage storage bin. Preferably, such indication is visible from a distance even if the overhead luggage storage bin is closed. With this system, passengers may proceed down an aircraft aisle quickly to an available bin, without having to open each closed bin to check for available space. The system disclosed herein allows passengers to easily identify and fill overhead luggage storage bins only partially filled but closed by other passengers. The present system eases the frustrating and time-consuming search for overhead space that occurs when other passengers close partially filled overhead luggage storage bins, and thus speeds the boarding process and provides a smoother and less stressful boarding experience for both flight attendants and passengers. In addition, when passengers spend less time searching for storage space and instead are able to move directly to an empty bin, there is less interference (and resultant passenger stress) in the aisles. A quicker boarding process is also instrumental in improving an airline's on-time performance.

**[0028]** Referring now to FIG. **1**, a block diagram is shown for an overhead luggage storage bin capacity sensing system **100** according to a first embodiment. Sensing system **100** includes, for each overhead luggage storage bin, a processor **105** having a first input coupled to a range sensor network **110** and a second input coupled to a load sensor network **115**. In addition, processor **105** may have an output coupled to a display device **120** which is preferably mounted on an external portion of a door of the overhead luggage storage bin. As one of ordinary skill in the art will readily recognize, display device **120** may be mounted in other positions adjacent to the associated overhead luggage storage bin and still provide adequate status notice to passengers. Processor **105**, range sensor network **110**, load sensor network **115** and display device **120** are all powered via the aircraft power system **125**, which in one embodiment provides power at 12 volt DC. In addition, processor **105** and the sensors selected for use in range sensor network **110** and load sensor network **115** are preferably selected to be low power, low voltage units to minimize the loading on aircraft power system **125**. Display device **120** is preferably an LED device which provides a clear indication that the associated overhead luggage storage bin is either "filled" or "not filled." For example, display device **120** may emit a first color (e.g., green) when the associated overhead luggage storage bin is not filled and a second color (e.g., red) when the overhead luggage storage bin is filled. In one alternative embodiment, display device **120** may only become active (lit) when the associated overhead luggage storage bin is filled (or when it is not filled)—e.g., an LED device positioned behind a translucent "FILLED" (or "NOT FILLED") panel. In another alternative

embodiment, display device **120** may be an LED display which provides more detailed description of the status of the associated overhead luggage storage bin, e.g., a display which states one of "FILLED" or "NOT FILLED."

**[0029]** The processor **105** for each overhead luggage storage bin may be coupled to a wireless interface **135** (discussed below) and/or one or more display consoles **140** via a common data network **130**. The display console **140** displays the status of each overhead luggage storage bin on the aircraft. Display console **140** may be provided for access only by the flight attendants, or may be publicly located at the entrance of the aircraft so that entering passengers can immediately access the status of each overhead luggage storage bin. In a further embodiment, more than one display consoles **140** may be provided, e.g., one for use by flight attendants and the other for use by entering passengers. Data network **120** may be, for example, an aircraft data network compliant with industry standard ARINC-664 network protocol. Since aircraft data network drops are already available in new aircraft for passenger services units and oxygen boxes, the additional wiring necessary to interface each processor **105** to the aircraft data network is minimal. In another embodiment, groups of processors **105** may be daisy-chained together, with each processor **105** linked to processors **105** in adjacent overhead luggage storage bins. In this embodiment, only one processor **105** among the group of processors is linked to the aircraft data network **130**. This allows for a reduced number of interfaces to the aircraft data network **130**, a reduced complexity, and a streamlined design and easier installation. This also decreases the overall system weight and cost of additional wiring by keeping the system self-contained.

**[0030]** As described above, in the present system each overhead luggage storage bin includes a range sensor network **110** and a load sensor network **115**, each network **110**, **115** coupled to an input of a processor **105**, preferably an on-board microcontroller. Processor **105** is configure to receive signals from each range sensor within range sensor network **110** and signals from each load sensor in load sensor network **115** and, based on such signals, to determine if the associated overhead luggage storage bin has mass or volume capacity available (i.e., if it is filled, either by weight or volume). Based on such determination, processor **105** is configured to output a signal to display device **120** that indicates current status information, i.e., at least whether the particular overhead luggage storage bin is either "FILLED" or "NOT FILLED," as discussed above. Processor **105** is also configured to communicate that status information to a display console **140** via the aircraft data network **130**. In a further embodiment, a wireless interface **135** (e.g., a Bluetooth® interface) may be provided coupled to the aircraft data network **130** for transmitting signals to a flight attendant's wireless device (e.g., a smart phone with a Bluetooth® interface and associated specialized application) to allow each flight attendant to access status information throughout the aircraft. In other embodiments, satisfactory operation may be obtained by using only a range sensor network **110** or only a load sensor network **115** to determine if full capacity of each respective overhead luggage storage bin has been reached.

**[0031]** Referring now to FIG. **2**, each load sensor **210** in the load sensor network **115** of FIG. **1** is preferably mounted on a bottom panel **205** of the overhead luggage storage bin **200**. Each load sensor **210** is preferably a conventional load cell (or equivalent as known to one of ordinary skill in the art). Each load sensor **201** is coupled to processor **105** (not shown in FIG. **2**) via wiring **215**. In alternative embodiments, load sensors **210** may be mounted either on support rods or attachment fittings for overhead luggage storage bin **200** (instead of on bottom panel **205**). Each load sensor **210** provides an output signal which enable processor **105** to determine, based upon predetermined settings, if a maximum weight for overhead luggage storage bin **200** has been met by the luggage or other items currently stored in that bin **200** (meaning that nothing further should be placed into overhead luggage storage bin **200**). Two load sensors **210** are shown in FIG. **2** for the load sensor network **115** of FIG. **1**, but, in an alternative embodiment, additional load sensors **210** may be included, and satisfactory results may be obtained in some cases with only one load sensor **210**.

**[0032]** Referring now to FIG. **3**, range sensor network **110** of FIG. **1** preferably consists of six ultrasonic rangefinder devices **310** mounted on a top panel **305** of overhead luggage storage bin **200** that are used in system **100** to determine available volume (space) within overhead luggage storage bin **200**. Each of the ultrasonic rangefinder devices **310** provides a volume signal to processor **105** (not shown in FIG. **3**) via wiring **315** to allow processor **105** to generate a map of the current volume of stowed luggage within overhead luggage storage bin **200** to determine, based on predetermined settings, whether there is any space remaining within overhead luggage storage bin **200**. In FIG. **3**, six ultrasonic rangefinder devices **310** are shown in range sensor network **110**. As one of ordinary skill in the art will readily recognize, the precise number of such devices **310** required in range sensor network **110** depends upon the size of overhead luggage storage bin **200** and the type of such device **310** selected for use in system **100**.

**[0033]** Referring now to FIGS. **4**A and **4**B, each overhead luggage storage bin **200** has a front panel **410** with a latch mechanism **420**. A display device **430** may be provided surrounding latch mechanism **420** which is, in the preferred embodiment, capable of being activated in two different colors, e.g., red and green. In operation, processor **105** is configured to determine, preferably based on both the received load data and the received volume data, whether or not the associated overhead luggage storage bin **200** has space available for additional luggage, and provides a status indication (i.e., causes display device **430** to be activated as a red light when overhead luggage storage bin **200** is filled and to be activated as a green light when overhead luggage storage bin **200** is not filled). As discussed above and as one of ordinary skill in the art will readily recognize, there are many ways to display status and all are intended to fall within the scope of the present disclosure. In a further embodiment, as discussed above, status information for each overhead luggage storage bin **200** may also be transmitted to display console **140**.

**[0034]** Referring now to FIG. **5**, a block diagram is shown for an overhead luggage storage bin capacity sensing system **500** according to a second embodiment. Sensing system **500** includes, for each overhead luggage storage bin (one storage bin is represented by dotted line **510**), a range sensor network **110**, a load sensor network **115** and a display device **120**. Sensing system **500** also includes a central processor **520** which is electrically coupled in a conventional manner to the range sensor network **110**, load sensor network **115** and display device **120** for each overhead luggage storage bin. Central processor **520** is also conventionally coupled to attendant module **140** and to a wireless interface **135**. Sensing system **500** operates in a similar manner to sensing system **100** of the

first embodiment shown in FIG. **1**, but with central processor **520** performing the processing for each overhead luggage storage bin (instead of having separate processors **105** for each storage bin as in the FIG. **1** embodiment).

**[0035]** Referring now to FIG. **6**, a flowchart **600** is shown of a method for displaying storage capacity status information for one or more passenger storage bins in an aircraft. First, at step **610**, the weight of items within the associated passenger storage bin is determined for each of the passenger storage bins. Next, at step **620**, an amount of empty space available within the associated passenger storage bin is determined for each of the passenger storage bins. Thereafter, at step **630**, a calculation is made based upon the weight of items within the associated passenger storage bin and the amount of empty space available within the associated passenger storage bin, whether or not the associated storage bin is filled to capacity for each of the passenger storage bins. Finally, at step **640**, a visual indication is provided indicating whether or not the associated storage bin is filled to capacity for each of the passenger storage bins.

**[0036]** Although the present disclosure has been particularly shown and described with reference to the preferred embodiments and various aspects thereof, it will be appreciated by those of ordinary skill in the art that various changes and modifications may be made without departing from the spirit and scope of the disclosure. It is intended that the appended claims be interpreted as including the embodiments described herein, the alternatives mentioned above, and all equivalents thereto.

What is claimed is:

**1**. A system for displaying storage capacity status information for one or more passenger storage bins in an aircraft, comprising:

at least one first sensor coupled to each of the passenger storage bins for providing a first output signal proportional to a first type of capacity level of the associated passenger storage bin;

a processor for each of the passenger storage bins coupled to the associated at least one first sensor and configured to calculate, based upon the output signal from the at least one first sensor, whether or not the associated storage bin is filled to capacity, the processor also configured to provide an output signal indicating whether or not the associated storage bin is filled to capacity; and

a display device for each passenger storage bin coupled to receive the output signal from the associated processor and for providing a visual indication whether or not the associated storage bin is filled to capacity.

**2**. The system of claim **1**, wherein each of the at least one first sensors is a load sensor and wherein the output signal from each of the at least one first sensors is proportional to a weight of items within the associated passenger storage bin.

**3**. The system of claim **1**, wherein each of the at least one first sensors is a range sensor and wherein the output signal from each of the at least one first sensors is proportional to an amount of empty space available within the associated passenger storage bin.

**4**. The system of claim **1**, further comprising at least one second sensor coupled to each of the passenger storage bins for providing an output signal proportional to a second type of capacity level of the associated passenger storage bin; and

wherein the processor is also coupled to the associated at least one second sensor and is further configured to calculate whether or not the associated storage bin is filled to capacity based on the output signals from the at least one first sensor and the at least one second sensor.

**5**. The system of claim **4**, wherein each of the at least one first sensors is a load sensor and wherein the output signal from each of the at least one first sensors is proportional to a weight of items within the associated passenger storage bin; and wherein each of the at least one second sensors is a range sensor and wherein the output signal from each of the at least one second sensors is proportional to an amount of empty space available within the associated passenger storage bin.

**6**. The system of claim **5**, wherein each processor is configured to calculate whether or not the associated storage bin is filled to capacity based, at least in part, on a predetermined weight level.

**7**. The system of claim **5**, wherein each processor is configured to calculate whether or not the associated storage bin is filled to capacity based, at least in part, on a predetermined amount of empty space.

**8**. The system of claim **1**, further comprising an attendant console coupled to each of the processors for the one or more passenger storage bins for receiving and displaying the storage capacity status of each of the one or more passenger storage bins.

**9**. The system of claim **1**, wherein each of the processors for the one or more passenger storage bins is coupled to each other via a network and further comprising:

a wireless interface coupled to the network; and

a handheld wireless device coupled to the wireless interface for receiving, via the wireless interface, and displaying the storage capacity status of each of the one or more passenger storage bins.

**10**. The system of claim **1**, wherein each of the display devices comprises a light emitting element located on an external portion of or adjacent to the associated passenger storage bin.

**11**. The system of claim **1**, wherein each of the display devices comprises a display panel located on an external portion of or adjacent to the associated passenger storage bin.

**12**. The system of claim **2**, wherein each of the at least one load sensors are coupled to a support structure of the associated passenger storage bin to measure load of the associated storage bin.

**13**. The system of claim **2**, wherein each of the at least one load sensors are mounted on a bottom panel of the associated passenger storage bin to measure load of the associated storage bin.

**14**. A system for displaying storage capacity status information for one or more passenger storage bins in an aircraft, comprising:

at least one first sensor coupled to each of the passenger storage bins for providing a first output signal proportional to a first type of capacity level of the associated passenger storage bin;

a processor coupled to each of the at least one first sensors and configured to calculate, for each of the at least one first sensors and based upon the output signal from the at least one first sensor, whether or not the storage bin associated with the at least one first sensor is filled to capacity, the processor also configured to provide an output signal for each of the at least one first sensors indicating whether or not the storage bin associated with the at least one first sensor is filled to capacity; and

a display device for each passenger storage bin coupled to receive the output signal from the processor and for

providing a visual indication whether or not the associated passenger storage bin is filled to capacity.

**15**. The system of claim **14**, wherein each of the at least one first sensors is a load sensor and wherein the first output signal from each of the at least one first sensors is proportional to a weight of items within the associated passenger storage bin.

**16**. The system of claim **14**, wherein each of the at least one first sensors is a range sensor and wherein the first output signal from each of the at least one first sensors is proportional to an amount of empty space available within the associated passenger storage bin.

**17**. The system of claim **14**, further comprising at least one second sensor coupled to each of the passenger storage bins for providing an output signal proportional to a second type of capacity level of the associated passenger storage bin; and

wherein the processor is also coupled to each of the at least one second sensors and is further configured to calculate whether or not the storage bin associated with each of the at least one second sensors is filled to capacity based on the output signals from the at least one first sensor and the at least one second sensor.

**18**. The system of claim **17**, wherein each of the at least one first sensors is a load sensor and the output signal from each of the at least one first sensors is proportional to a weight of items within the associated passenger storage bin; and wherein each of the at least one second sensors is a range sensor and the output signal from each of the at least one second sensors is proportional to an amount of empty space available within the associated passenger storage bin.

**19**. The system of claim **14**, further comprising an attendant console coupled to the processor for receiving and displaying the storage capacity status of each of the one or more passenger storage bins.

**20**. A method for displaying storage capacity status information for one or more passenger storage bins in an aircraft, comprising the steps of:

determining, for each of the passenger storage bins, a weight of items within the associated passenger storage bin;

determining, for each of the passenger storage bins, an amount of empty space available within the associated passenger storage bin;

calculating, based upon the weight of items within the associated passenger storage bin and the amount of empty space available within the associated passenger storage bin, whether or not the associated storage bin is filled to capacity; and

providing, based upon the calculating step, a visual indication whether or not the associated storage bin is filled to capacity.

* * * * *