

METHOD OF CONTROLLING DRIVING OF FAN OF SHIP CARGO HOLD, DEVICE, AND RECORDING MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

5 This application claims priority to and the benefit of Korean Patent Application No. 10-2019-0000000 filed on September 6, 2019, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

10 1. Field of the Invention

 The present disclosure relates to control of driving of a fan of a ship cargo hold, and more particularly, to a technical field that determines a fan operation level according to information obtained from a sensor and accordingly operates a fan, thereby saving energy.

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2. Discussion of Related Art

 Currently, shipowners and shipyards are constantly making efforts to satisfy environmental regulations by developing various technologies to reduce carbon emissions and applying eco-friendly systems to new and existing ships due to strict
20 environmental regulations related to ships. In particular, a method of effectively operating a ventilation fan of a cargo hold inside a container ship loading containers is required. Currently, in the case of the ventilation fan applied to the cargo hold inside a container ship, each fan motor is operated by a direct-on-line starter, and the fan motor is operated at a regular speed regardless of internal temperature, internal humidity, and
25 an internal CO₂ value. Further, a starter is installed for each fan motor in a fan for the

cargo hold applied to the container ship in a one-to-one basis, and when the fan is required to be operated regardless of an internal environment, the fan motor receives power by the direct-on-line starter and is operated at a regular speed. This leads to fuel consumption, carbon emissions, and increased operating costs due to inefficient operation as a result of operating the fan motor at a regular speed when an operation of the ventilation fan is required regardless of a condition in which a ship is operated. In particular, to satisfy the needs of shipowners such as increasing ship operation efficiency and reducing costs, shipyards are developing larger container ships, and a current ventilation fan operating method is inefficient in terms of an increasing demand for super-large container ships.

[Related Art Documents]

[Patent Documents]

Korean Patent Publication No. 10-2020-00399963 (2020.04.17), system for driving fan of ship cargo hold

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SUMMARY OF THE INVENTION

The present disclosure is directed to providing a method, a device, and a recording medium for efficiently saving energy by obtaining information related to internal environment of a ship cargo hold to control driving of a fan of the ship cargo hold and operating one or more fans based on the obtained environment information.

The purpose of the present disclosure is not limited to the purpose described above, and other purposes which are not described may be understood based on the following description.

A method of controlling driving of a fan of a ship cargo hold according to a first aspect of the present disclosure includes obtaining location-specific environment

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information including temperature, humidity and carbon dioxide concentration from one or more sensors installed in the ship cargo hold as a smart drive linked to one or more variable-frequency drives (VFDs) operates, obtaining a maximum temperature, a maximum humidity and a maximum carbon dioxide concentration in the ship cargo hold based on the location-specific environment information, obtaining fan operation reference information with respect to a reference temperature, a reference humidity, and a reference carbon dioxide concentration indicating a condition in which the fan of the ship cargo hold is to be operated, determining a fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration correspond to the fan operation reference information, and controlling the VFD to operate one or more fans according to the fan operation level.

The fan operation level may include one of a first level indicating a state in which the maximum temperature is greater than or equal to a first temperature, a second level indicating a state in which the maximum temperature is greater than or equal to a second temperature, a third level indicating a state in which the maximum temperature is greater than or equal to a third temperature, and a fourth level indicating a state in which that the maximum temperature is greater than or equal to a fourth temperature, the fourth temperature to the first temperature may be higher in this order, and the fourth level to the first level may be higher in this order.

The determining of the fan operation level may include determining the fan operation level as the third level when at least one of a state in which the maximum temperature is greater than or equal to the third temperature, a state in which the maximum humidity is greater than or equal to a first %, and a state in which the maximum carbon dioxide concentration is greater than or equal to a first ppm is

satisfied.

The determining of the fan operation level may include allocating a weight higher than that of the temperature to the humidity and the carbon dioxide concentration when the maximum temperature is lower than the third temperature and
5 updating the weight allocated to the humidity and the carbon dioxide concentration to zero when the maximum temperature is greater than or equal to the third temperature.

The determining of the fan operation level may include obtaining a temperature maintenance time for the maximum temperature and updating the fan operation level when the temperature maintenance time is greater than a first time.

10 The fan operation level may further include a 0th level indicating a state in which the maximum temperature is lower than the first temperature, and the controlling of the VFD may include performing a control to stop operation of the one or more fans when the fan operation level is determined to be the 0th level.

When the temperature maintenance time corresponding to a state in which the
15 maximum temperature is lower than the first temperature is greater than a second time, the operation of the one or more fans may be stopped, and the second time may be greater than the first time.

The method may further include determining a location-specific priority based on a location of the sensor and a variability of the location-specific environment
20 information and updating the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration based on a weight allocated according to the location-specific priority.

A device for controlling driving of a fan of a ship cargo hold according to a second aspect of the present disclosure includes a reception unit that obtains location-
25 specific environment information including temperature, humidity and carbon dioxide

concentration from one or more sensors installed in the ship cargo hold as a smart drive linked to one or more variable-frequency drives (VFDs) operates and a processor that obtains a maximum temperature, a maximum humidity and a maximum carbon dioxide concentration in the ship cargo hold based on the location-specific environment information, obtains fan operation reference information with respect to a reference temperature, a reference humidity, and a reference carbon dioxide concentration indicating a condition in which the fan of the ship cargo hold is to be operated, determines a fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration correspond to the fan operation reference information, and controls the VFD to operate one or more fans according to the fan operation level.

A third aspect of the present disclosure may provide a computer-readable recording medium in which a program for executing the method according to the first aspect on a computer is recorded. A fourth aspect of the present disclosure may provide a computer program stored in a recording medium to implement the method according to the first aspect.

In addition, other detailed matters are included in the detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The above matters and other objects, features, and advantages of the present disclosure will become more apparent to those of ordinary skill in the art by describing exemplary embodiments thereof in detail with reference to the accompanying drawings, in which:

FIG. 1 is a schematic view illustrating a configuration of a device according to

an embodiment;

FIG. 2 is a flowchart illustrating operations of controlling a VFD by the device according to the embodiment;

FIG. 3 is a schematic view illustrating a circuit diagram of controlling driving
5 of a fan of a conventional ship cargo hold;

FIG. 4 is a schematic view illustrating a circuit diagram for driving a fan of a ship cargo hold by the device according to the embodiment; and

FIG. 5 is a view for describing an example in which the device according to the embodiment allows one or more fans to be operated.

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DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

General terms currently widely used have been selected as terms used herein as greatly as possible while considering functions in the present disclosure, but the terms may be changed according to an intention or precedent of an engineer in the
15 field, an emergence of a new technology, etc. Further, in specific cases, terms are arbitrarily selected by the applicant, and in these cases, the meanings thereof will be described in detail in the corresponding description of the invention. Thus, the terms used herein should be defined based on meaning of the terms and the entire contents of the present disclosure rather than simple denotation of the terms.

20 Throughout the specification, when a part “includes” a component, this means that another component is not excluded but may be further included unless otherwise stated. Further, the terms “unit”, “module”, and the like described in the specification refer to a unit that processes at least one function or operation and may be implemented as hardware or software or a combination of hardware and software.

25 Throughout the specification, the wording “support” may be broadly

interpreted as meaning to include performance of a related operation to achieve a specific purpose and is not interpreted in a limited manner. For example, when a server C supports a server A so that the server A performs an operation B, the support of the server C for the server A may be interpreted as comprehensively including performance of a related operation required in the process of performing the operation B by the server A. For example, the server C may provide information required for performing the operation B by the server A, perform a previous operation expected to be required in the process of performing the operation B by the server A, and receive a message requested by the server A to perform the operation B.

Further, throughout the specification, the wording “provide” may be interpreted as comprehensively meaning to include a process of a target acquiring specific information or directly/indirectly transmitting/receiving the information to/from a specific target and performance of related operations required in this process.

Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that those skilled in the art to which the present disclosure pertains may easily carry out the present disclosure. However, the present disclosure may be implemented in various different forms and is not limited to the embodiments described herein.

Hereinafter, the embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

FIG. 1 is a schematic view illustrating a configuration of a device 100 according to an embodiment.

Referring to FIG. 1, the device 100 according to an embodiment may include a reception unit 110 and a processor 120.

The reception unit 110 according to the embodiment may obtain location-

specific environment information including temperature, humidity, and carbon dioxide concentration from one or more sensors installed in a ship cargo hold as a smart drive linked to one or more VFDs operates.

5 The processor 120 according to the embodiment may obtain a maximum temperature, a maximum humidity, and a maximum carbon dioxide concentration in the ship cargo hold based on the location-specific environment information. Further, the processor 120 may obtain fan operation reference information with respect to a reference temperature, a reference humidity, and a reference carbon dioxide concentration indicating a condition in which a fan of the ship cargo hold is to be
10 operated. Further, the processor 120 may determine a fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration correspond to the fan operation reference information. Further, the processor 120 may control the VFD so that one or more fans operate according to the fan operation level.

15 In addition, those skilled in the art may understand that other general-purpose components in addition to the components illustrated in FIG. 1 may be further included in the device 100. For example, the device 100 may further include a memory (not illustrated) for storing a received temperature, a received humidity, and a received carbon dioxide concentration. Alternatively, according to another embodiment, those
20 skilled in the art can understand that some of the components illustrated in FIG. 1 may be omitted.

The device 100 according to the embodiment may be used by a user or an operator, may be interlocked with all kinds of handheld-based wireless communication devices equipped with touch screen panels, such as mobile phones, smartphones,
25 personal digital assistants (PDAs), portable multimedia players (PMPs), and tablet

PCs, and in addition, may be included in or interlocked with devices provided with a basis for installing and executing applications, such as desktop PCs, tablet PCs, laptop PCs, and IPTVs including set-top boxes.

5 The device 100 may be implemented as a terminal, such as a computer, which is operated through a computer program for realizing a function described in the specification.

The device 100 according to the embodiment may include a fan driving control system (not illustrated) and a related server (not illustrated) for the ship cargo hold, but the present disclosure is not limited thereto. The system and the server according to 10 the embodiment may support fan driving control for the ship cargo hold and an application supporting/providing the same.

Hereinafter, an embodiment in which the device 100 according to the embodiment independently controls a filter to reduce harmonic waves will be mainly described, but as described above, the control may be performed through interlocking 15 with the server. That is, it may be seen that the device 100 and the server according to the embodiment may be implemented in an integrated manner in terms of functions thereof, the server may be omitted, and the present disclosure is not limited to any one embodiment.

FIG. 2 is a flowchart illustrating operations of controlling the VFD by the 20 device 100 according to the embodiment.

Referring to operation S210, the processor 100 according to the embodiment may obtain the location-specific environment information including the temperature, the humidity, and the carbon dioxide concentration from the one or more sensors installed in the ship cargo hold as the smart drive linked to the one or more VFDs 25 operates. In the embodiment, the smart drive may be a device included in a system

operated to effectively operate an internal ventilation fan of a cargo hold inside a container ship loading containers. In the embodiment, the VFD may correspond to a high frequency source. In the embodiment, the one or more VFDs may be connected to the smart drive in a circuit manner, and the smart drive may be used for operating the VFD. Further, as the VFD operates, the fan of the ship cargo hold may be operated through frequency conversion. Further, in the embodiment, the one or more sensors may be installed inside the ship cargo hold. The one or more sensors may include a temperature sensor, a humidity sensor, and a carbon dioxide sensor, and the device 100 may obtain (receive) a measured temperature value, a measured humidity value, and a measured carbon dioxide concentration value obtained from the sensors. In the embodiment, the location-specific environment information may refer to information on a measured value according to each location at which the sensor is installed. The one or more sensors may be installed in different locations. For example, one temperature sensor may be installed on each of an upper bow, an upper stern, an upper port side, and an upper starboard side in the cargo hold, and one humidity sensor may be installed on each of a lower port side and a lower starboard side in the cargo hold. Thus, the one or more sensors may obtain a measured location-specific temperature value, a measured location-specific humidity value, and a measured location-specific carbon dioxide concentration value in real time, and the device 100 may obtain the location-specific environment information by receiving the plurality of measured values from the sensors.

Referring to operation S220, the device 100 according to the embodiment may obtain the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration in the ship cargo hold based on the location-specific environment information. In the embodiment, the device 100 may obtain the maximum

temperature, the maximum humidity, and the maximum carbon dioxide concentration indicating maximum values among the plurality of measured temperature values, a plurality of measured humidity values, and a plurality of measured carbon dioxide concentration values, which are obtained for each location. The device 100 may
5 determine maximum values among the plurality of measured values obtained in real time as the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration.

Referring to operation S230, the device 100 according to the embodiment may obtain the fan operation reference information with respect to the reference
10 temperature, the reference humidity, and the reference carbon dioxide concentration indicating the condition in which the fan of the ship cargo hold is to be operated. In the embodiment, a threshold value, which is a reference for operating the fan of the ship cargo hold, may be pre-stored in the smart drive. That is, threshold values indicating reference values of the temperature, the humidity, and the carbon dioxide
15 concentration at which the fan is to be operated may be the reference temperature, the reference humidity, and the reference carbon dioxide concentration, and the device 100 may obtain the reference temperature, the reference humidity, and the reference carbon dioxide concentration, which are pre-stored, as the fan operation reference information.

20 Referring to operation S240, the device 100 according to the embodiment may determine the fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration correspond to the fan operation reference information. The device 100 according to the embodiment may determine the fan operation level based on the obtained
25 maximum temperature. For example, the device 100 may determine a state in which

the maximum temperature is greater than or equal to a first temperature to be a first level, determine a state in which the maximum temperature is greater than or equal to a second temperature to be a second level, determine a state in which the maximum temperature is greater than or equal to a third temperature to be a third level, and
5 determine a state in which the maximum temperature is greater than or equal to a fourth temperature to be a fourth level. In the embodiment, the temperature is higher in the order of the fourth temperature to the first temperature, and the fan operation level is higher in the order of the fourth level to the first level. As the fan operation level becomes greater, a fan driving rate may become higher. For example, in the
10 embodiment, the first level may be a level at which the fan operates at 25% (performs 25% VFD operation), the second level may be a level at which the fan operates at 50% (performs 50% VFD operation), the third level may be a level at which the fan operates at 75% (performs 75% VFD operation), and the fourth level may be a level at which the fan operates at 100% (performs 100% VFD operation). Further, the device
15 according to the embodiment may determine the fan operation level to be the third level when at least one of a state in which the maximum temperature is greater than or equal to the third temperature, a state in which the maximum humidity is greater than or equal to a first % (e.g., 60%), and a state in which the maximum carbon dioxide concentration is greater than or equal to a first ppm (e.g., 700 ppm) is satisfied. In the
20 embodiment, the reference temperature may include the first temperature, the second temperature, the third temperature, and the fourth temperature, the reference humidity may be the first % (e.g., 60%), and the reference carbon dioxide concentration may be the first ppm (e.g., 700 ppm). That is, when the maximum temperature is greater than or equal to the third temperature, the maximum humidity is greater than or equal to the
25 first %, or the maximum carbon dioxide concentration is greater than or equal to the

first ppm, the device 100 may determine the fan operation level to be the third level.

When the fan operation level is determined to be the third level, the fan may be operated such that the fan driving rate corresponds to 75%. Further, when the maximum temperature is lower than the third temperature, the device 100 according

5 to the embodiment may allocate a weight higher than that of the temperature to the humidity and the carbon dioxide concentration. For example, when the obtained maximum temperature is lower than the third temperature, the device 100 may allocate the weight higher than that of the temperature to the humidity and the carbon dioxide concentration, and thus determine the fan operation level by prioritizing the humidity

10 and the carbon dioxide concentration. For example, in the embodiment, when the maximum temperature is higher than or equal to the second temperature and lower than the third temperature, the fan operation level may be generally determined to be the second level (e.g., 50%), and when at least one of a state in which the maximum humidity is greater than or equal to the first % and a state in which the maximum

15 carbon dioxide concentration is greater than or equal to the first ppm is satisfied, the fan operation level may be determined to be the third level. That is, since the weight higher than that of the temperature is allocated to the humidity and the carbon dioxide concentration, even when the maximum temperature is lower than the third temperature (the fan operation level may be originally determined to be one of the first

20 level and the second level), in the case that the maximum humidity is greater than or equal to the first % or the maximum carbon dioxide concentration is greater than or equal to the first ppm, the fan operation level may be determined to be the third level.

Further, when the maximum temperature is greater than or equal to the third temperature, the device 100 may update the weight allocated to the humidity and the

25 carbon dioxide concentration to zero. In the embodiment, a weight concept may

correspond to multiplication. For example, when the maximum temperature is greater than or equal to the third temperature, the humidity and the carbon dioxide concentration are multiplied by 0, and thus the device 100 may determine the fan operation level regardless of the maximum humidity and the maximum carbon dioxide concentration when the maximum temperature is greater than or equal to the third temperature. That is, when the maximum temperature is higher than or equal to the third temperature and lower than the fourth temperature, the fan operation level may be determined to be and maintained at the third level regardless of the maximum humidity and the maximum carbon dioxide concentration, and when the maximum temperature is greater than or equal to the fourth temperature, the fan operation level may be updated to and maintained at the fourth level.

Referring to operation S250, the device 100 according to the embodiment may control the VFD to operate the one or more fans according to the fan operation level. The device 100 may control one or more VFDs connected to the smart drive, and the one or more fans may be operated by controlling the VFDs.

The device 100 according to the embodiment may obtain a temperature maintenance time for the maximum temperature. Further, when the temperature maintenance time is greater than a first time, the device 100 may update the fan operation level. In the embodiment, the temperature maintenance time may refer to a time during which the maximum temperature is greater than and maintained at any one of the plurality of reference temperatures based on the location-specific environment information obtained in real time. Further, the first time, which is a factor for determining the fan operation level, may refer to a minimum time during which the temperature should be maintained in order for the fan operation level to be updated within each range at which the fan operation level is determined. For example, the

device 100 may not determine and update the fan operation level to the first level which is a time point at which the maximum temperature is greater than or equal to the first temperature, but may determine and update the fan operation level to the first level when the maximum temperature obtained in real time is maintained for a time greater than the first time within a range higher than or equal to the first temperature and lower than the second temperature. Further, the device 100 according to the embodiment may determine the fan operation level to be a 0th level when the maximum temperature is lower than the first temperature. When the fan operation level is determined to be the 0th level, the device 100 may perform a control such that operations of the one or more fans. In the embodiment, the 0th level may be a level at which the fan operates at 0% (is stopped). When the temperature lower than the first temperature is maintained for a predetermined time, the device 100 may control the VFD to stop the operations of the one or more fans. For example, the device 100 may control the VFD such that the operations of the one or more fans are stopped when the temperature maintenance time corresponding to the maximum temperature that is lower than the first temperature is greater than a second time. The second time may be greater than the first time. In the embodiment, the first time, which refers to the temperature maintenance time, may be a temperature maintenance time corresponding to a case in which the fan operation level is determined and updated to be and to the first level, the second level, the third level, and the fourth level. Since the second time is a predetermined reference time corresponding to a situation in which the operation of the fan is stopped, a situation may occur in which the fan is stopped and then operated again, and thus it is preferable that more spare time is provided in that energy may be wasted in the event of this situation. Thus, when the maximum temperature maintained for the second time is greater than the first time within a range in which the maximum temperature is lower

than the first temperature, the operation of the fan may be stopped. Further, in the embodiment, a maintenance time may be applied to the humidity and the carbon dioxide concentration in the same manner as described with respect to the temperature. In another embodiment, the device 100 may differently determine the temperature

5 maintenance times corresponding to the levels. For example, as the temperature becomes higher, the need for temperature control becomes greater, and thus it is preferable that the fan operation level is quickly updated. In this respect, the temperature maintenance time corresponding to the updating to the 0th level may be determined to be a time corresponding to 150% of the first time, the temperature

10 maintenance time corresponding to the updating to the first level may be determined to be a time corresponding to the first time, the temperature maintenance time corresponding to the updating to the second level may be determined to be a time corresponding to 80% of the first time, the temperature maintenance time corresponding to the updating to the third level may be determined to be a time

15 corresponding to 60% of the first time, the temperature maintenance time corresponding to the updating to the fourth level may be determined to be a time corresponding to 50% of the first time. Further, the device 100 according to the embodiment may determine a location-specific priority based on the locations of the sensors and variability of the location-specific environment information. For example,

20 the locations of the sensors may be determined as a location of a first temperature sensor, a location of a second temperature sensor, a location of a third temperature sensor, and a location of a fourth temperature sensor according to an order of the locations expected to have a high temperature. Thus, a high weight may be allocated in an order of a measured value of the first temperature sensor to a measured value of

25 the fourth temperature sensor according to a magnitude of the variability. Further, the

device 100 may obtain time-specific variability for each of a plurality of measured values measured by the first temperature sensor to the fourth temperature sensor, a first humidity sensor, a second humidity sensor, and a first carbon dioxide sensor. Thus, higher weights are allocated to the temperature, the humidity, and the carbon dioxide concentration in this order. Generally, when the variability is high, a reflection percentage may increase in terms of updating the fan operation level, and when the variability is low, the existing fan operation level may frequently be maintained. In this respect, proportionally higher weights may be allocated in an order of the higher variabilities of the measured values measured by the first temperature sensor to the fourth temperature sensor in real time. That is, higher weights in an order of a first priority to a fourth priority may be allocated in an order of higher variabilities of the first temperature sensor to the fourth temperature sensor, higher weights in an order of a fifth priority and a sixth priority may be allocated in an order of higher variabilities of measured values measured by the first humidity sensor and the second humidity sensor, and a higher weight in a seventh priority may be allocated to a measured value measured by the first carbon dioxide sensor in real time. Thus, the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration may be updated based on the weights allocated according to the location-specific priority. That is, in the embodiment, maximum values (largest values) among a plurality of measured values obtained from the plurality of sensors may be determined to be the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration. Thereafter, the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration may be updated according to average values to which the above-described weights are allocated. As described above, an average operation level is determined by allocating different weights to the

elements according to various situations, and thus a method and service having higher accuracy and efficiency in terms of energy saving may be provided.

The device 100 according to the embodiment may allow a fan operation to be performed at 100% by instantaneously updating the fan operation level to the fourth level when the maximum carbon dioxide concentration is greater than or equal to a third ppm corresponding to 90% or more of an indoor air quality carbon dioxide concentration reference value and may update the fan operation level to the third level again when the carbon dioxide concentration is reduced to a second ppm corresponding to 80% or less of the carbon dioxide concentration reference value as the fan is operated at the fourth level. In this way, when the carbon dioxide concentration is increased to a certain level or higher, the device 100 may perform a control to decrease the carbon dioxide concentration as the fan operation level is updated to the fourth level. Further, the device 100 may allow the fan operation to be performed at 100% by instantaneously updating the fan operation level to the fourth level when the maximum humidity is greater than or equal to a third % (e.g., 85% or more), which is higher than the first %, and may update the fan operation level to the third level again when the humidity is decreased to a second % (e.g., 70% or less) between the first % and the third % as the fan is operated at the fourth level. In this way, even when the humidity is increased to a predetermined level or higher, the device 100 may perform a control to remove the humidity as the fan operation level is updated to the fourth level.

FIG. 3 is a schematic view illustrating a circuit diagram of controlling driving of a fan of a conventional ship cargo hold.

Referring to FIG. 3, in the fan for the cargo hold, which is generally applied to container ships, according to the related art, a starter is installed in a fan motor in one-

to-one basis, and when the fan operation is required regardless of an internal environment of a ship, the fan motor receives power by a direct-on-line starter and allows the fan to be operated at 100%. Thus, an internal temperature of the cargo hold may be continuously maintained based on an appropriate temperature. Generally, a
5 single container ship has as few as 20 to 30 sets and as many as hundreds of sets of fans applied to control the internal temperature of the cargo hold. In the related art, the fan is always operated at a 100% load regardless of the changes in internal temperature and humidity, which leads to increased fuel consumption, carbon emission, and operating costs.

10 FIG. 4 is a schematic view illustrating a circuit diagram for driving a fan of a ship cargo hold by the device 100 according to the embodiment.

Referring to FIG. 4, the device 100 may obtain the location-specific environment information through the plurality of temperature sensors, the humidity sensors, and the carbon dioxide sensor linked using the smart drive and allow one or
15 more fans to be operated according to the fan operation level determined based on the obtained location-specific environment information. As described above, one temperature sensor may be installed on each of the upper bow, the upper stern, the upper port side, and the upper starboard side in the cargo hold, and one humidity sensor may be installed on each of the lower port side and the lower starboard side in the
20 cargo hold. Each of the sensors may provide location-specific information to the smart drive in real time and may allow the fan to be operated through a control system by comparing the location-specific information with fan operation reference information previously stored in the smart drive. Further, the fan operation level may be determined according to the method described in operation S240 and operation S250, and one or
25 more fans may be operated according to the driving rate corresponding to the fan

operation level. Thus, the fan is operated in accordance with an environment during operation of the ship and an actual environment condition occurring inside the cargo hold, and thus problems of inefficient operation and energy generation, increased operating costs, increased fuel consumption, and increased carbon emission that occur
5 in the existing cargo hold ventilation system can be solved.

FIG. 5 is a view for describing an example in which the device 100 according to the embodiment allows one or more fans to be operated.

Referring to FIG. 5, when the maximum temperature obtained according to the location-specific environment information is lower than the first temperature, the fan
10 operation level is determined to be the 0th level, and thus the fan may not be operated such that the fan driving rate corresponds to 0%. When the maximum temperature is higher than or equal to the first temperature and lower than the second temperature, the fan operation level is determined to be the first level, the fan may be operated such that the fan driving rate is 25%. Further, when the maximum temperature is higher
15 than or equal to the second temperature and lower than the third temperature, the fan operation level is determined to be the second level, and thus the fan may be operated such that the fan driving rate is 50%. Further, when the maximum temperature is higher than or equal to the third temperature and lower than the fourth temperature, the maximum humidity is greater than or equal to the first %, or the carbon dioxide
20 concentration is greater than or equal to the first ppm, the fan operation level is determined to be the third level, and thus the fan may be operated such that the fan driving rate is 75%. Further, when the maximum temperature is greater than or equal to the fourth temperature, the fan operation level is determined to be the fourth level, and thus the fan may be operated such that the fan driving rate is 100%.

25 According to the embodiment, the fan is operated according to the fan

operation level, and thus efficiency related to energy saving can be improved. In updating the fan operation level, the level is updated as the same temperature is maintained for a preset time using the temperature maintenance time, and thus efficiency with respect to the fan operation can be improved. Further, different weights are allocated depending on the locations of the sensors to determine the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration, and in this respect, the fan operation level may be determined more accurately. Different weights are allocated to the temperature, the humidity, and the carbon dioxide concentration according to the conditions of the situations to determine the fan operation level, and in this respect, the fan operation level may be determined in flexible manner according to each situation. Further, since the fan is operated according to the fan operation level, inefficient operation may be omitted, thereby reducing operating costs, fuel consumption, and carbon emissions.

The order and combination of the operations described above is related to an embodiment, and it can be seen that an order, a combination, a branch, a function, and a subject of performance thereof may be variously implemented in an added form, an omitted form, or a modified form without departing from the essential characteristics of respective components described in the specification.

Various embodiments of the present disclosure may be implemented as software including one or more instructions stored in a storage medium (e.g., a memory) readable by a device (e.g., a display device or a computer). For example, the processor 120 (e.g., the processor 120) of the device may retrieve and execute at least one of the one or more stored instructions from the storage medium. This makes it possible for the device to be operated to perform at least one function according to the at least one retrieved instruction. The one or more instructions may include a code

generated by a compiler or a code executable by an interpreter. A device-readable storage medium may be provided in the form of a non-transitory storage medium. Here, the wording “non-transitory” merely means that the storage medium is a tangible device and does not include a signal (e.g., an electromagnetic wave), and this term
5 does not distinguish between a case in which data is semi-permanently stored in the storage medium and a case in which the data is temporarily stored in the storage medium.

According to the embodiment, a method according to various embodiments disclosed in the present disclosure may be provided and included in a computer
10 program product. The computer program product may be traded between a seller and a buyer as a product. The computer program product may be distributed in the form of a device-readable storage medium (e.g., a compact disk read only memory (CD-ROM)) or distributed on-line (e.g., downloaded or uploaded) directly through an application store (e.g., Play Store™) or between two user devices (e.g., smartphones).
15 In the case of on-line distribution, at least part of the computer program product may be at least temporarily stored or temporarily generated in the device-readable storage medium such as the memory of a manufacturer's server, an application store's server, or a relay server.

According to an embodiment of the present disclosure, since a fan is operated
20 according to a fan operation level, efficiency in terms of energy saving can be improved.

Further, since a level is updated as the same temperature is maintained for a preset time using a temperature maintenance time in terms of updating a fan operation level, efficiency of fan operation can be improved.

25 Further, since different weights are provided depending on locations of sensors

to determine a maximum temperature, a maximum humidity, and a maximum carbon dioxide concentration, a fan operation level can be determined more accurately.

Further, since the fan operation level is determined by providing different weights to temperature, humidity and carbon dioxide concentration depending on conditions of situations, the fan operation level can be flexibly determined according to each situation.

Further, since the fan is operated according to the fan operation level, inefficient operation may be eliminated, thereby reducing operating costs, fuel consumption, and carbon emissions.

The effects of the present disclosure are not limited to the above effects and should be understood to include all effects that may be deduced from the detailed description of the present disclosure or the configuration of the present disclosure described in the appended claims.

The above description of the present disclosure is merely illustrative, and those skilled in the art to which the present disclosure pertains can understand that the present disclosure can be easily modified in other specific forms without changing the technical spirit or essential features of the present disclosure. Therefore, it should be understood that the embodiments described above are illustrative but not limiting in all aspects. For example, components described as a single type may be implemented in a distributed manner, and likewise, components described in a distributed manner may also be implemented in a coupled form.

The scope of the present disclosure is indicated by the appended claims, and all changes or modifications derived from the meaning and scope of the appended claims and equivalent concepts thereof should be construed as being included in the scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A method of controlling driving of a fan of a ship cargo hold, the method comprising:

5 obtaining location-specific environment information including temperature, humidity, and a carbon dioxide concentration from one or more sensors installed in the ship cargo hold as a smart drive linked to one or more variable-frequency drives (VFDs) operates;

obtaining a maximum temperature, a maximum humidity, and a maximum
10 carbon dioxide concentration in the ship cargo hold based on the location-specific environment information;

obtaining fan operation reference information with respect to a reference temperature, a reference humidity, and a reference carbon dioxide concentration indicating a condition in which the fan of the ship cargo hold is to be operated;

15 determining a fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration correspond to the fan operation reference information; and

controlling the VFD to operate one or more fans according to the fan operation level.

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2. The method of claim 1, wherein the fan operation level includes one of a first level indicating a state in which the maximum temperature is higher than or equal to a first temperature, a second level indicating a state in which the maximum temperature is higher than or equal to a second temperature, a third level indicating a
25 state in which the maximum temperature is higher than or equal to a third temperature,

and a fourth level indicating a state in which that the maximum temperature is higher than or equal to a fourth temperature, wherein the fourth temperature to the first temperature are higher in this order, and the fourth level to the first level are higher in this order.

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3. The method of claim 2, wherein the determining of the fan operation level includes determining the fan operation level to be the third level when at least one of a state in which the maximum temperature is higher than or equal to the third temperature, a state in which the maximum humidity is higher than or equal to a first
10 %, and a state in which the maximum carbon dioxide concentration is higher than or equal to a first ppm is satisfied.

4. The method of claim 3, wherein the determining of the fan operation level includes:
15 allocating a weight higher than that of the temperature to the humidity and the carbon dioxide concentration when the maximum temperature is lower than the third temperature; and

updating the weight allocated to the humidity and the carbon dioxide concentration to zero when the maximum temperature is higher than or equal to the
20 third temperature.

5. The method of claim 2, wherein the determining of the fan operation level includes:
obtaining a temperature maintenance time for the maximum temperature; and
25 updating the fan operation level when the temperature maintenance time is

greater than a first time.

6. The method of claim 5, wherein the fan operation level further includes a 0th level indicating a state in which the maximum temperature is lower than the first temperature, and

the controlling of the VFD includes performing a control to stop operations of the one or more fans when the fan operation level is determined to be the 0th level.

7. The method of claim 6, wherein, when the temperature maintenance time corresponding to a state in which the maximum temperature is lower than the first temperature is greater than a second time, the operations of the one or more fans are stopped, and

the second time is greater than the first time.

8. The method of claim 1, further comprising:

determining a location-specific priority based on a location of the sensor and a variability of the location-specific environment information; and

updating the maximum temperature, the maximum humidity, and the maximum carbon dioxide concentration based on a weight allocated according to the location-specific priority.

9. A device for controlling driving of a fan of a ship cargo hold, the device comprising:

a reception unit configured to obtain location-specific environment information including temperature, humidity, and carbon dioxide concentration from

one or more sensors installed in the ship cargo hold as a smart drive linked to one or more variable-frequency drives (VFDs) operates; and

5 a processor configured to obtain a maximum temperature, a maximum humidity, and a maximum carbon dioxide concentration in the ship cargo hold based on the location-specific environment information, obtain fan operation reference information with respect to a reference temperature, a reference humidity, and a reference carbon dioxide concentration indicating a condition in which the fan of the ship cargo hold is to be operated, determine a fan operation level according to a degree to which the maximum temperature, the maximum humidity, and the maximum carbon
10 dioxide concentration correspond to the fan operation reference information, and control the VFD to operate one or more fans according to the fan operation level.

10. A computer-readable recording medium in which a program for executing the method of any one of claims 1 to 8 on a computer is recorded.

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