

DESCRIPTION

TITLE OF INVENTION: HULL SURFACE MANAGEMENT SYSTEM

Technical field

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The present invention relates to a hull surface management system. More specifically, the present invention relates to a hull surface management system capable of efficiently providing a cleaning history of a ship and a cleaning condition for each region of a hull, etc.

10 Background art

In general, a ship is operated with the lower portion of a hull submerged underwater. Thus, foreign substances such as various contaminants, etc., or various aquatic organisms such as sphagnum, barnacle, etc., may be attached to the bottom or side surfaces located underwater.

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These foreign substances and aquatic organisms attached to the hull damage the appearance of the ship, and also act as a resistance when operating the ship and cause the speed of the ship to slow down, leading to a significance increase in fuel consumption of the ship. Accordingly, it is very important to periodically clean various foreign substances and aquatic organisms off the hull.

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Conventionally, divers in person dive into the water and clean foreign substances and aquatic organisms off the outer surface of the hull to clean the outer surface of the hull. Whether the outer surface of the hull is properly cleaned could be confirmed using a plurality of images captured by the divers for each main part of the hull.

However, according to conventional cleaning confirmation methods, a cleaning condition can be confirmed only for the main parts of the hull, but a cleaning condition can hardly be specifically confirmed for the overall hull.

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Therefore, recently, a hull cleaning robot has been used which travels while being attached to the outer surface of the hull, to clean the hull with a brush, etc., and simultaneously capture images.

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A ship bottom cleaning robot management company provides a report on cleaning results based on the captured images to a client such as shipowner, etc., after cleaning the hull using a ship bottom cleaning robot. However, the report merely provides only the general cleaning results of the hull, but from the report, it cannot be specifically confirmed whether each region of the hull has been cleaned well, which reduces the reliability of hull cleaning.

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Summary of invention

Technical task

It is an object of the present invention to provide a hull surface management system, specifically a hull surface management system facilitating confirmation of a location of a ship bottom cleaning robot and a cleaning condition for each unit region through a web browser screen of a management server by dividing a region of a hull to be cleaned into a plurality of unit regions, mapping location information of the ship bottom cleaning robot cleaning the hull and cleaning image data obtained from the ship bottom cleaning robot to the plurality of unit regions, and

providing the mapping data to the management server.

The technical tasks to be achieved in the present invention are not limited to the technical tasks mentioned above, and other technical tasks not mentioned will be clearly understood by those of ordinary skill in the art to which the present invention belongs from the description below.

Means for solving technical task

In order to solve the above technical task, the present invention provides a hull surface management system for providing information about a hull cleaning condition by obtaining a captured image of an outer surface of a hull from a ship bottom cleaning robot cleaning the hull, the hull surface management system comprising: a control device which divides a region of the hull to be cleaned into a plurality of unit regions using pre-input ship information, and maps location information of the ship bottom cleaning robot and cleaning image data obtained by processing the captured image to the plurality of unit regions, to generate mapping data; and a management server which outputs a location of the ship bottom cleaning robot cleaning the hull and a cleaning condition for each unit region of the hull using the generated mapping data.

Also, the mapping data includes at least one of ship information, location information of the ship bottom cleaning robot, information of a plurality of unit regions set in the hull, and cleaning image data for each unit region of the hull, and the management server generates a hull image corresponding to a hull scale of a ship to be cleaned using the ship information, displays a plurality of cell blocks corresponding to the plurality of unit regions set in the hull as selectable forms in the hull image, marks the location of the ship bottom cleaning robot in the plurality of

cell blocks, and links the cleaning image data of the respective corresponding unit regions thereto.

Also, the management server outputs, on a screen, cleaning image data of a unit region corresponding to a cell block selected from the plurality of cell blocks displayed in the hull image, wherein an image before cleaning, an image after cleaning and a cleaning condition video of the unit region are output on the screen.

Also, the management server resizes and displays the plurality of cell blocks displayed in the hull image to facilitate selection of individual cell blocks.

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Also, the management server displays a cell block which is being cleaned by the ship bottom cleaning robot and a cell block which has been cleaned by the ship bottom cleaning robot distinguishably, among the plurality of cell blocks in the hull image.

Also, the management server is formed as a cloud server, and classifies and manages a cleaning history of a ship for which hull cleaning has been performed and relevant data for each ID.

Also, the control device obtains in real time a predetermined reference point to which the ship bottom cleaning robot is first attached and a location to which the ship bottom cleaning robot travels from the reference point, and maps the location information of the ship bottom cleaning robot to the plurality of unit regions.

Also, the control device comprises a control unit for controlling the operation of the ship

bottom cleaning robot; a unit region setting unit for dividing a region of the hull to be cleaned into a plurality of unit regions using the ship information and setting the unit regions; a communication unit for receiving location information and captured images from the ship bottom cleaning robot; a data mapping unit for matching and storing the location information of the ship bottom cleaning robot and the captured images for the plurality of unit regions; and an image processing unit for analyzing and processing a plurality of captured images stored for each unit region of the hull and generating cleaning image data for each unit region, wherein the data mapping unit maps the ship information, the location information of the ship bottom cleaning robot, the information of the plurality of unit regions set in the hull, and the cleaning image data for each unit region, to generate mapping data.

Effect of invention

The hull surface management system according to an embodiment of the present invention facilitates confirmation of a location of a ship bottom cleaning robot and a cleaning condition for each unit region through a web browser screen of a management server by dividing a region of a hull to be cleaned into a plurality of unit regions, mapping location information of the ship bottom cleaning robot cleaning the hull and cleaning image data obtained from the ship bottom cleaning robot to the plurality of unit regions, and providing the mapping data to the management server.

Also, the hull surface management system allows a user to confirm a hull cleaning condition for each unit region in detail by displaying a plurality of cell blocks corresponding to unit regions of a hull on a web browser screen of a management server, and visually outputting an image before cleaning, an image after cleaning and a cleaning condition video, etc., for a unit

region of the hull corresponding to a cell block according to selection of the corresponding cell block.

Also, the management server can provide convenience in ship cleaning management by storing and managing a cleaning history for each ship for which hull cleaning has been performed, listing information on the cleaning history for each ship, and providing the listed information to a user.

The effects obtainable in the present invention are not limited to the above-mentioned effects, and other effects not mentioned may be clearly understood by those of ordinary skill in the art to which the present invention pertains from the following description.

Brief description of drawings

Fig. 1 illustrates the configuration of a hull surface management system according to an embodiment of the present invention;

Fig. 2 illustrates the specific configuration of a control device according to an embodiment of the present invention;

Fig. 3 illustrates an example of a hull in which a plurality of unit regions are set according to an embodiment of the present invention;

Figs. 4 and 5 illustrate a web browser screen of a management server according to an embodiment of the present invention;

Fig. 6 illustrates the configuration of an image processing unit according to an embodiment of the present invention;

Fig. 7 illustrates captured images collected from a unit region of a hull according to an embodiment of the present invention;

Fig. 8 illustrates a process for selecting a representative image from a plurality of captured images of a unit region of a hull according to an embodiment of the present invention; and

5 Fig. 9 illustrates a process for analyzing and processing an image sequentially using an image processing unit according to an embodiment of the present invention.

Best mode for carrying out the invention

10 Hereinafter, preferred embodiments according to the present invention will be described in detail with reference to the accompanying drawings.

The detailed description set forth below in conjunction with the accompanying drawings is intended to describe exemplary embodiments of the present invention and is not intended to
15 represent the only embodiments in which the present invention may be carried out.

In order to clearly explain the present invention in the drawings, portions that are not related to the present invention are omitted, and like reference numerals are used to refer to like elements throughout the specification.

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In an embodiment of the present invention, expressions such as “or” and “at least one” may indicate one of the words listed together, or a combination of two or more.

Fig. 1 illustrates the configuration of a hull surface management system 100 according to

an embodiment of the present invention. Fig. 2 illustrates the specific configuration of a control device 110 according to an embodiment of the present invention. Fig. 3 illustrates an example of a hull in which a plurality of unit regions S are set according to an embodiment of the present invention.

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Referring to Figs. 1 to 3, the hull surface management system 100 according to an embodiment of the present invention may comprise a control device 110 and a management server 120.

10 The control device 110 may control a ship bottom cleaning robot 10 cleaning the outer surface of a hull.

Also, the control device 110 may divide a region of a hull to be cleaned into a plurality of unit regions S using pre-input ship information and map location information of a ship bottom
15 cleaning robot cleaning the hull and cleaning image data for confirming a cleaning condition to the plurality of unit regions S.

In an example, the control device 110 may comprise a control unit 111 for controlling the operation of the ship bottom cleaning robot 10, a unit region setting unit 112 for dividing a region
20 of the hull to be cleaned into a plurality of unit regions S using ship information of a ship to be cleaned and setting the unit regions, a communication unit 113 for receiving location information and captured images of the hull from the ship bottom cleaning robot 10, a data mapping unit 114 for matching and storing the location information and the captured images received from the ship bottom cleaning robot for the plurality of unit regions S, and an image processing unit 200 for

analyzing and processing the plurality of captured images stored for each unit region S of the hull and generating optimal cleaning image data for each unit region S.

Here, the control unit 111, which is provided to control the operation of the ship bottom cleaning robot 10, may control the moving speed and moving direction of the wheels, control the operation of a cleaning member cleaning the hull, and control image capture using a camera (not illustrated).

In other words, the ship bottom cleaning robot 10 cleaning the hull underwater is remotely controlled by the control unit 111 to clean the outer surface of the hull using a cleaning member, while traveling with the wheels attached to the outer surface of the hull. A camera (not illustrated) provided in a front body may capture an image of the front to capture an image of a condition of the outer surface of the hull before cleaning, and a camera (not illustrated) provided in a rear body may capture an image of the rear to capture an image of a condition of the outer surface of the hull after cleaning.

In addition, the ship bottom cleaning robot 10 may have a location sensor (not illustrated) which can obtain real-time location information while being attached to the hull, and transmit the obtained real-time location information to the control device 110.

In an example, the location sensor (not illustrated) may comprise an encoder (not illustrated) for detecting a number of revolutions of the wheels in the ship bottom cleaning robot 10 and calculating an amount of movement, and a gyro sensor (not illustrated) for detecting a direction of movement of the ship bottom cleaning robot 10.

Accordingly, with a reference point to which the ship bottom cleaning robot 10 is first attached, a location to which the ship bottom cleaning robot 10 travels from the reference point can be obtained in real time.

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Once ship information of a ship to be cleaned is input, the unit region setting unit 112 may divide a region of the outer surface of the hull to be cleaned into a plurality of unit regions S using the input ship information and set the unit regions.

10 Here, the ship information may include information about the type of ship, scale of hull, modeling data of hull and waterline, etc.

Particularly, the unit region setting unit 112 may set a portion of the hull around and below the waterline as a region to be cleaned using the ship information of the ship to be cleaned, divide
15 the region of the outer surface of the hull to be cleaned into a plurality of unit regions S, and set the unit regions.

Here, a unit region S may be set as a region of a square having a width of several meters and a length of several meters. A plurality of such unit regions S may be set on the outer surface
20 of the hull.

In an example, according to the present embodiment, a unit region S may be set as a region of a square having a width of 5 m and a length of 1 m, and a plurality of unit regions S may be set in a grid type in a region of the outer surface of the hull to be cleaned.

Accordingly, the unit region setting unit 112 may set, as a region to be cleaned, a portion of the hull around and below the waterline for which the ship bottom cleaning robot 10 performs hull cleaning, based on the modeling data of the hull designed by practical measurement, and the region to be cleaned may be divided into unit regions S in a grid type having a width of 5 m and a length of 1 m.

The communication unit 113 may communicate with the ship bottom cleaning robot 10 and the management server 120.

The communication unit 113 may be connected wiredly or wirelessly with the ship bottom cleaning robot 10 attached to the hull to transmit and receive data. The communication unit 113 may receive the location information and the captured images of the hull before and after cleaning from the ship bottom cleaning robot 10.

The data mapping unit 114 may match and store the location information of the ship bottom cleaning robot and the captured images before and after cleaning for the plurality of unit regions S set in the hull.

Specifically, referring to Fig. 3, when being attached to the hull to clean the outer surface of the hull, the ship bottom cleaning robot 10 may transmit, to the control device 110, information of location to which the ship bottom cleaning robot is first attached in the hull, and the data mapping unit 114 of the control device 110 may match a location to which the ship bottom cleaning robot 10 is first attached with a unit region S corresponding to the location.

Here, the location to which the ship bottom cleaning robot 10 is attached may be set in advance, and the corresponding location may be used as a reference point.

5 The ship bottom cleaning robot 10 cleans the outer surface of the hull and simultaneously captures images before and after cleaning while traveling from the reference point of the outer surface of the hull, and transmits real-time location information and captured images to the control device 110. The data mapping unit 114 of the control device 110 may match the real-time location of the ship bottom cleaning robot 10 with a unit region S corresponding to the real-time location.

10 Accordingly, the control device 110 may recognize which unit region S in the hull the ship bottom cleaning robot 10 is cleaning, and match and store images before and after cleaning of unit regions S for the corresponding unit regions S through which the ship bottom cleaning robot 10 has passed.

15 Here, according to the present embodiment, the data mapping unit 114 of the control device 110 matches and stores images before and after cleaning for a unit region S whenever the ship bottom cleaning robot 10 has passed through the unit region S and cleaned the corresponding unit region S. In another example, the data mapping unit 114 may match and store images before and
20 after cleaning for each of all unit regions S after the ship bottom cleaning robot 10 has cleaned all unit regions S in the hull.

 The image processing unit 200 may analyze and process a plurality of captured images stored for each unit region S of the hull and generate optimal cleaning image data for each unit

region S.

Specifically, the image processing unit 200 may generate cleaning image data such as an image before cleaning, an image after cleaning and a video on cleaning progress, etc., processed
5 to clearly detect a cleaning condition for each unit region S of the hull using the captured images stored for each unit region S, and store the generated cleaning image data in the data mapping unit 114.

Here, the images may include pictures, graphics, still frames, etc.

10 In an example, for a unit region S set on the outer surface of the hull, a plurality of captured images of the outer surface of the hull of the corresponding unit region S may be matched and stored in the data mapping unit 114. The image processing unit 200 may store the clearest images before and after cleaning among the plurality of captured images of the unit region S as
15 representative images of the corresponding unit region S, and also store a clearly processed cleaning condition video.

Accordingly, cleaning image data including an image before cleaning, an image after cleaning and a cleaning condition video may be matched and stored in the data mapping unit 114
20 for each unit region S which has been cleaned by the ship bottom cleaning robot 10.

In addition, the data mapping unit 114 may map ship information, information of a plurality of unit regions set on the outer surface of the hull, location information of the ship bottom cleaning robot and cleaning image data for each unit region S to generate mapping data, and provide the

generated mapping data to the management server 120.

Here, the location information of the ship bottom cleaning robot and the cleaning image data for each unit region S included in the mapping data may be updated in real time.

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The management server 120 may receive the mapping data from the control device 110, store the data, and use the mapping data to output a location of the ship bottom cleaning robot 10 cleaning the hull and a cleaning condition for each unit region S of the hull on a screen.

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In other words, the management server 120 may store, in database, the ship information of a ship to be cleaned, the location information of the ship bottom cleaning robot, the information of a plurality of unit regions set on the outer surface of the hull and the cleaning image data for each unit region S of the hull, which are included in the mapping data, and output a cleaning condition for each unit region S of the ship on a pre-set web browser.

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In an example, the management server 120, which may be formed as a cloud server, etc., that can store a vast amount of data, may classify relevant data for each ship which has been cleaned, store the data in database, and output the stored data on a web browser screen using a dedicated web application.

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Figs. 4 and 5 illustrate a web browser screen of a management server 120 according to an embodiment of the present invention.

Referring to Fig. 4, the management server 120 may output the mapping data received from

the control device 110 on a web browser screen, wherein the received information may be output after being converted according to screen setting for user's convenience.

In an example, the web browser screen of the management server 120 may display a hull image I in which a plurality of cell blocks B are set, and display an image before cleaning P1, an image after cleaning P2, a cleaning condition video P3, etc.

Specifically, the management server 120 may retrieve the hull image I corresponding to the hull scale of a ship to be cleaned to be output on a web browser screen, using the ship information included in the mapping data.

In addition, a plurality of cell blocks B may be inserted and displayed in the hull image I, using the information of unit regions of the hull included in the mapping data.

Here, the plurality of cell blocks B displayed in the hull image I, which are implemented in the hull image I on the web browser screen to correspond to the plurality of unit regions S set in the hull by the control device 110, may be present in the same number as the plurality of unit regions S set in the hull to match therewith, and be resized based on predetermined standards and displayed as blocks to allow a user to easily select individual cell blocks.

In an example, in the case of a small ship with a small scale of hull, it is easy to select cell blocks B on the screen by mouse click or touch screen. However, in the case of a large ship in which the number of cell blocks B increases, and the cell blocks B are small in size, the cell blocks B may be resized and displayed to allow a user to easily select individual cell blocks B separately.

In addition, the management server 120 may store, in database, cleaning image data for each unit region S of the hull in the mapping data received from the control device 110 in real time, and link the cleaning image data of unit regions to the respective corresponding cell blocks B in the hull image I.

Accordingly, when a user selects a cell block B displayed in the hull image I on the web browser screen, the cleaning image data of a unit region of the hull corresponding to the cell block B, i.e., an image before cleaning P1, an image after cleaning P2 and a cleaning condition video P3, may be output on the web browser screen.

In addition, the management server 120 may display a cell block B1 which is being cleaned by the ship bottom cleaning robot 10 distinguishably in the hull image I using the location information of the ship bottom cleaning robot in the mapping data received in real time from the control device 110. For example, the cell block B1 may be indicated in red.

In addition, a cell block B2 through which the ship bottom cleaning robot 10 has passed may be displayed distinguishably. For example, the cell block B2 through which the ship bottom cleaning robot 10 has passed may be indicated in green.

Accordingly, a user may confirm, on the web browser screen, the cell block B1 which is being cleaned by the ship bottom cleaning robot 10 and the cell block B2 which has been cleaned, among the plurality of cell blocks B in the hull image I, and confirm in which direction the ship bottom cleaning robot 10 travels in the hull and performs cleaning.

Referring to Fig. 5, the management server 120 may display a cleaning history of a ship on the web browser screen.

5 In an example, ships for which hull cleaning has been performed may be classified and listed by IDs, and when selecting a ship ID A1, the cleaning history by date may be classified and listed by the ID along with information A3 of the corresponding ship.

10 Here, when selecting the cleaning history ID A2, the screen illustrated in Fig. 4 may be displayed to confirm the detailed cleaning condition, and a user may select cell blocks B in the hull image I and confirm the detailed cleaning condition for the corresponding ship.

15 Hereinafter, a process for confirming a cleaning condition of a hull through a web browser screen of the management server 120 using the hull surface management system 100 according to an embodiment of the present invention is described in detail.

20 Referring to Figs. 3 and 4, when a ship bottom cleaning robot 10 is attached to a predetermined reference point of the hull, the control device 110 may receive real-time location information from the ship bottom cleaning robot 10.

 The control device 110 may set a plurality of unit regions S in modeling data of the hull using pre-input ship information of a ship to be cleaned, and match real-time location information of the ship bottom cleaning robot 10 to unit regions S, to generate mapping data.

The management server 120 may receive, from the control device 110, the mapping data, i.e., ship information of a ship to be cleaned, real-time location information of the ship bottom cleaning robot 10, information of the plurality of unit regions set on the outer surface of the hull, etc., to set a hull image I corresponding to the ship and a plurality of cell blocks B corresponding to the plurality of unit regions S on a web browser screen, and mark the location of the ship bottom cleaning robot 10 in cell blocks B.

The ship bottom cleaning robot 10 may clean the outer surface of the hull and simultaneously capture images before and after cleaning while traveling from the reference point of the outer surface of the hull, and transmit the real-time location information and the captured images to the control device 110. The control device 110 may match the real-time location of the ship bottom cleaning robot 10 with the unit region S in the hull corresponding to the real-time location.

For a unit region S through which the ship bottom cleaning robot 10 has passed and cleaned, the control device 110 may match images before and after cleaning to the corresponding unit region S and store the data. The image processing unit 200 in the control device 110 may perform image processing clearly, to match cleaning image data including an image before cleaning, an image after cleaning and a cleaning condition video to the corresponding unit region S and store the data.

Here, the control device 110 may update in real time the real-time location information of the ship bottom cleaning robot 10 and the cleaning image data for each unit region S in the mapping data.

The management server 120 may store, in database, the cleaning image data for each unit region S in the mapping data received from the control device 110 in real time, and link the cleaning image data of unit regions S to the respective corresponding cell blocks B displayed in the hull image I.

Here, a cell block B1 which is being cleaned by the ship bottom cleaning robot 10 and a cell block B2 which has been cleaned may be distinguishably displayed among the plurality of cell blocks B in the hull image I.

Accordingly, a user may confirm, on the web browser screen of the management server 120, the cell block B1 which is being cleaned by the ship bottom cleaning robot 10 and the cell block B2 which has been cleaned, among the plurality of cell blocks B in the hull image I, and confirm in which direction the ship bottom cleaning robot 10 travels in the hull and performs cleaning.

When a user selects one of the plurality of cell blocks B displayed in the hull image I on the web browser screen, the cleaning image data of a unit region S of the hull corresponding to the cell block B, i.e., an image before cleaning P1, an image after cleaning P2 and a cleaning condition video P3, may be output on the web browser screen.

Accordingly, a user may select cell blocks B for which a cleaning condition is to be confirmed and confirm the cleaning image data thereof.

The hull surface management system 100 according to the present embodiment may facilitate confirmation of a location of the ship bottom cleaning robot 10 and a cleaning condition for each unit region S through a web browser screen of the management server 120 by dividing a region of a hull to be cleaned into a plurality of unit regions S, mapping location information of the ship bottom cleaning robot cleaning the hull and cleaning image data obtained from the ship bottom cleaning robot 10 to the plurality of unit regions S, and providing the mapping data to the management server 120.

Also, the hull surface management system allows a user to confirm a hull cleaning condition for each unit region S in detail by displaying a plurality of cell blocks B corresponding to unit regions S of the hull on the web browser screen of the management server 120, and visually outputting an image before cleaning P1, an image after cleaning P2 and a cleaning condition video P3, etc., for a unit region S in the hull corresponding to a cell block B according to selection of the corresponding cell block B.

Also, the management server 120 may provide convenience in ship cleaning management by storing and managing the cleaning history for each ship of which the hull has been cleaned, listing information of the cleaning history for each ship and providing the information to a user.

Hereinafter, a process for analyzing and processing images performed by the image processing unit 200 in the control device of the present invention is described.

Fig. 6 illustrates the configuration of the image processing unit 200 according to an embodiment of the present invention. Fig. 7 illustrates captured images collected from a unit

region of the hull according to an embodiment of the present invention. Fig. 8 illustrates a process for selecting a representative image from a plurality of captured images of a unit region of the hull according to an embodiment of the present invention.

5 Referring to Figs. 6 to 8, the image processing unit 200 may comprise an image collection unit 210, an analysis processing unit 220, a control unit 230 and an output unit 240.

The image collection unit 210 may collect a plurality of captured images of the outer surface of the hull before and after cleaning for each unit region of the hull from a ship bottom
10 cleaning robot 10.

The ship bottom cleaning robot 10 according to the present embodiment may capture an image every certain distance or time to obtain a plurality of images when cleaning and traveling in a predetermined unit region while being attached to the hull. The obtained images may be
15 collected by the image collection unit 210.

For example, the ship bottom cleaning robot may capture images of 30 frames per 1 second and acquire images of 60 frames per 1 m, thereby obtaining images of 300 frames for each unit region when dividing a unit region by 5 m, and transmit the images to the image collection unit
20 210.

The analysis processing unit 220 may perform image processing on a plurality of captured images for each unit region collected by the image collection unit 210, i.e., a plurality of images capturing the state of the outer surface of the hull after cleaning, to clearly detect a cleaning

condition.

Specifically, the analysis processing unit 220 may convert each of the plurality of captured images for each unit region into at least one of an HSV image and a binary image, and process the
5 images to detect a cleaning condition of the outer surface of the hull in the images.

The analysis processing unit 220 according to the present embodiment may perform HSV image processing and binary image processing on each of the captured images of the state of the outer surface of the hull which has been cleaned.

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During a process for converting a captured image of the outer surface of the hull into an HSV image, the analysis processing unit 220 may convert a captured image of an RGB image expressed in three-dimensional color information of red (R), green (G) and blue (B) into an HSV image expressed in hue, saturation and value.

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In addition, the analysis processing unit 220 may extract colors corresponding to paint colors of the outer surface of the hull from the HSV image of the outer surface of the hull which has been cleaned.

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In an example, in the case of typical ships, the outer surface of the hull is coated with red antifouling paint. Thus, according to the present embodiment, the analysis processing unit 220 may extract red color from the HSV image of the outer surface of the hull.

Here, the more paint color, i.e., red, is extracted from the HSV image of the outer surface

of the hull, the more clearly the outer surface of the hull has been cleaned.

In addition, during a process for converting a captured image of the outer surface of the hull into a binary image, the analysis processing unit 220 may extract a region of interest (ROI) from the captured image of an RGB image, convert the ROI into a gray image to detect the outline, and then perform binarization to generate a mask image.

Here, the ROI refers to a region of the outer surface of the hull in a captured image. If only the outer surface of the hull is displayed in the captured image, the ROI may refer to the entire region of the captured image.

When performing binarization on a gray image, a pixel greater than a reference value in the gray image is represented by a binary value of 1, and a pixel less than or equal to a reference value is represented by a binary value of 0, according to a predetermined reference value, to generate a binarized mask image.

For example, in a binarized mask image, pixels represented by 1 may indicate clean portions of the outer surface of the hull. When a plurality of pixels represented by 1 form a zone, the zone is a clean portion, and the pixels represented by 1 at the periphery of the zone may be a boundary of the clean portion.

Also, the analysis processing unit 220 may match an ROI with a mask image to perform binarization thereon, to generate a binary image.

Here, each pixel in the ROI may be binarized according to a predetermined reference value, and a binary value for each pixel in the ROI and a binary value for each pixel in the mask image may be overlaid and matched with each other.

5 During this process, when a pixel in the ROI and a pixel in the mask image which are matched with each other have the same binary value, the corresponding binary value may be maintained, and when a pixel in the ROI and a pixel in the mask image which are matched with each other have different binary values, the different binary values may be changed into the same binary value according to predetermined standards.

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For example, when a pixel in the ROI and a pixel in the mask image which are matched with each other have the same binary value of 1, the overlaid pixel may maintain a binary value of 1.

15 Here, the boundary of a clean portion (portion of a plurality of pixels represented by 1) in the ROI and the boundary of a clean portion in the mask image which are overlaid and matched with each other may have different binary values. Each boundary may be changed to have the same binary value according to predetermined standards, to generate a binary image having the boundary of the overlaid clean portion processed clearly.

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In the aforementioned binarization method, an example of a process for binarization in which an image is represented by binary values of 1 and 0 is described. However, a process for binarization in white and black may be applied such that a pixel greater than a predetermined reference value in an image is indicated in white, and a pixel less than or equal to a reference value

is indicated in black.

The control unit 230 may use an HSV image and a binary image for each captured image to represent a cleaning condition of the outer surface of the hull in the captured image by a numerical value, and select a captured image having the highest numerical value from a plurality of captured images for each unit region.

In other words, the control unit 230 may select the best captured image enabling to clearly confirm a cleaning condition for each unit region of the hull.

Specifically, the control unit 230 may calculate an area of the paint color (e.g., red) on the outer surface of the hull extracted from the HSV image of the captured image, and also calculate an area of the clean portion from the binary image of the corresponding captured image.

In addition, a predetermined weighting may be assigned to each of the calculated area value of the paint color and the calculated area value of the clean portion in the binary image, to compute a clean point which represents a cleaning condition of the outer surface of the hull in the image by a numerical value for the corresponding captured image.

Here, a weighting assigned to the area value of the clean portion in the binary image may be set to be relatively higher than a weighting assigned to the area value of the paint color extracted from the HSV image.

In an example, as illustrated in Fig. 8, according to the present embodiment, a weighting

of 30 is assigned to the area value of the clean portion in the binary image, and a weighting of 0.5 is assigned to the area value of the paint color in the HSV image.

In addition, in computing a clean point for a captured image, for example, in the case the area value of the clean portion in the binary image is 150 and the area value of the paint color in the HSV image is 500, a clean point of 4750 is computed by adding a value obtained by multiplying the area value of 150 of the clean portion by a weighting of 30 and a value obtained by multiplying the area value of 500 of the paint color by 0.5.

Accordingly, the control unit 230 may compute a clean point for each of the plurality of captured images of a unit region of the hull, and select a captured image having the highest clean point among the plurality of captured images as a representative image of the corresponding unit region.

In this manner, the control unit 230 may select the best captured image having the highest clean point as a representative image for each unit region of the hull.

The output unit 240 may collect and output the representative image selected for each unit region.

Also, in an example, the output unit 240 may include the representative image for each unit region of the hull in cleaning image data as an image after cleaning and provide the data to the aforementioned data mapping unit 114 (see Fig. 2), the management server 120 or a manager.

As such, the image processing unit 200 according to the present embodiment may extract and provide only representative images from a vast amount of images captured during a process for cleaning a hull, by obtaining a plurality of captured images for each unit region of the hull from the ship bottom cleaning robot 10 cleaning the hull by dividing into a plurality of unit regions, and
5 analyzing the obtained captured images to select and provide the best captured image for each unit region, thereby enabling to clearly confirm a cleaning condition thereof.

In an example, a ship cleaning management company may provide a report on cleaning results to a client such as ship owner, etc., after cleaning the hull using the ship bottom cleaning
10 robot 10. The management server 120 (see Fig. 1) may prepare a report on cleaning results by selecting a representative image for each unit region provided by the image processing unit 200.

Fig. 9 illustrates a process for analyzing and processing an image sequentially using an image processing unit 200 according to an embodiment of the present invention.

15 In an example, according to the present embodiment, a process for selecting and providing a representative image after cleaning for each unit region set in the hull using the image processing unit 200 is described.

20 Referring to Fig. 9, a plurality of captured images of the outer surface of the hull before and after cleaning for each unit region of the hull obtained from a ship bottom cleaning robot 10 may be collected by an image collection unit 210 (S110).

Next, using an analysis processing unit 220, image processing may be performed on a

plurality of captured images of the state of the outer surface of the hull after cleaning for each unit region of the hull to clearly detect a cleaning condition thereof.

Here, HSV image processing and binary image processing may be performed
5 simultaneously on each captured image.

First, during the HSV image processing, a captured image of an RGB image of the outer surface of the hull may be converted into an HSV image (S120).

10 A color corresponding to the paint color of the outer surface of the hull may be extracted from the converted HSV image (S130), and an area of the extracted paint color may be calculated by the control unit 230 (S140).

In an example, in the case of typical ships, the outer surface of the hull is coated with red
15 antifouling paint. Thus, according to the present embodiment, red color may be extracted from the HSV image of the outer surface of the hull, and an area of red color may be calculated.

Here, the more red color is extracted from the HSV image of the outer surface of the hull, the more clearly the outer surface of the hull has been cleaned.

20

During the binary image processing, a region of interest (ROI) may be extracted from the captured image (S150), and the ROI may be converted into a gray image to detect the outline in the image (S160).

Here, the ROI refers to a region of the outer surface of the hull in the captured image. If only the outer surface of the hull is displayed in the captured image, the ROI may refer to the entire region of the captured image.

5 In addition, a mask image may be generated by performing binarization on the gray image (S170).

Then, the ROI and the mask image may be overlaid and matched with each other (S180), and binarization may be performed thereon to generate a binary image (S190).

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An area of a clean portion in the corresponding binary image may be calculated by the control unit 230 (S200).

15 Next, a predetermined weighting may be assigned to each of the calculated area value of the paint color in the HSV image and the calculated area value of the clean portion in the binary image, to compute a clean point which represents a cleaning condition of the outer surface of the hull in the image by a numerical value for the corresponding captured image (S210).

20 Accordingly, a clean point for each of the plurality of captured images of a unit region of the hull may be computed, and a captured image having the highest clean point among the plurality of captured images may be selected as a representative image (S220).

In this manner, the best captured image having the highest clean point may be selected as a representative image for each unit region of the hull.

Next, the representative image selected for each unit region may be collected and output by the output unit 240 (S230).

5 As such, the image processing unit 200 according to the present embodiment may extract and provide a representative image for each unit region from a vast amount of images captured during a process for cleaning a hull, by obtaining a plurality of captured images for each unit region of the hull from the ship bottom cleaning robot 10, and analyzing the obtained captured images to select and provide the best captured image for each unit region enabling to clearly confirm a
10 cleaning condition thereof, thereby enabling to provide a cleaning image and picture for each location of the hull and clearly confirm a cleaning condition of the hull.

The embodiments of the present invention disclosed in the present specification and drawings are merely illustrative examples of the present invention to easily explain the technical
15 disclosure of the present invention and facilitate understanding of the present invention, and are not intended to limit the scope of the present invention.

Accordingly, in addition to the embodiments disclosed above, all modifications or changes derived based on the technical idea of the present invention should be construed as being included
20 in the scope of the present invention.

What is claimed is:

1. A hull surface management system for providing an information about a hull cleaning condition by obtaining a captured image of an outer surface of a hull from a ship bottom cleaning robot cleaning the hull, the hull surface management system comprising:

a control device which divides a region of the hull to be cleaned into a plurality of unit regions using a pre-input ship information, and maps a location information of the ship bottom cleaning robot and a cleaning image data obtained by processing the captured image to the plurality of unit regions, to generate a mapping data; and

a management server which outputs a location of the ship bottom cleaning robot cleaning the hull and a cleaning condition for each unit region of the hull using the generated mapping data.

2. The hull surface management system of claim 1, wherein the mapping data includes at least one of a ship information, a location information of the ship bottom cleaning robot, an information of a plurality of unit regions set in the hull, and a cleaning image data for each unit region of the hull, and

wherein the management server is configured to generate a hull image corresponding to a hull scale of a ship to be cleaned using the ship information, display a plurality of cell blocks corresponding to the plurality of unit regions set in the hull as selectable forms in the hull image, mark the location of the ship bottom cleaning robot in the plurality of cell blocks, and link the cleaning image data of the respective corresponding unit regions thereto.

3. The hull surface management system of claim 2, wherein the management server is configured to output, on a screen, a cleaning image data of a unit region corresponding to a cell

block selected from the plurality of cell blocks displayed in the hull image, and

wherein an image before cleaning, an image after cleaning and a cleaning condition video of the unit region are configured to be output on the screen.

5 4. The hull surface management system of claim 2, wherein the management server is configured to resize and display the plurality of cell blocks displayed in the hull image to facilitate selection of individual cell blocks.

10 5. The hull surface management system of claim 2, wherein the management server is configured to display a cell block which is being cleaned by the ship bottom cleaning robot and a cell block which has been cleaned by the ship bottom cleaning robot distinguishably, among the plurality of cell blocks in the hull image.

15 6. The hull surface management system of claim 1, wherein the management server is formed as a cloud server, and is configured to classify and manage a cleaning history of a ship for which hull cleaning has been performed and relevant data for each ID.

20 7. The hull surface management system of claim 1, wherein the control device is configured to obtain in real time a predetermined reference point to which the ship bottom cleaning robot is first attached and a location to which the ship bottom cleaning robot travels from the reference point, and is configured to map the location information of the ship bottom cleaning robot to the plurality of unit regions.

8. The hull surface management system of claim 1, wherein the control device comprises:

a control unit configured to control an operation of the ship bottom cleaning robot;

a unit region setting unit configured to divide a region of the hull to be cleaned into a plurality of unit regions using the ship information and to set the unit regions;

5 a communication unit configured to receive a location information and captured images from the ship bottom cleaning robot;

a data mapping unit configured to match and store the location information of the ship bottom cleaning robot and the captured images for the plurality of unit regions; and

an image processing unit configured to analyze and process a plurality of captured images stored for each unit region of the hull and to generate a cleaning image data for each unit region,

10 wherein the data mapping unit is configured to map the ship information, the location information of the ship bottom cleaning robot, the information of the plurality of unit regions set in the hull, and the cleaning image data for each unit region, to generate mapping data.