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Accumulating and utilizing port information by sensor recognition

Abstract

A system, adapted for a boat to accumulate and utilize information of a port, the system including a control unit having a processor configured to function as a determining part that determines an open berth of the port; and a display part that displays the open berth determined by the determining part on a display. The control unit determines the open berth based on a first data and a second data, the first data includes information of the port obtained at a first timing by a sensor disposed on the boat, the second data includes information of the port obtained at a second timing, wherein the first timing is different from the second timing, and the first timing is a present time.

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Background/Summary

BACKGROUND OF THE DISCLOSURE

Technical Field

(1) The disclosure relates to a system of a boat, and more specifically relates to the system of the boat for identifying an open berth in a port.

Related Art

(2) Conventionally, when a boat is to be autonomously moored at a port or a harbor, a user may select a berth for mooring the boat via, for example, an HMI screen.

(3) Therefore, a way for automatically determining an open berth of the port is needed.

SUMMARY

(4) According to an embodiment of the disclosure, a system adapted for a boat to accumulate and utilize information of a port is provided. The system including a control unit having a processor configured to function as a determining part that determines an open berth of the port; and a display part that displays the open berth determined by the determining part on a display. The control unit determines the open berth based on a first data and a second data, the first data includes information of the port obtained at a first timing by a sensor disposed on the boat, the second data includes information of the port obtained at a second timing, wherein the first timing is different from the second timing, and the first timing is a present time.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Embodiments will now be described, by way of example only, with reference to the accompanying drawings which are meant to be exemplary, not limiting, and wherein like elements are numbered alike in several Figures.

(2) FIG. **1** is a schematic diagram illustrating a system for automatically determining an open berth of a port according to an embodiment of the disclosure.

(3) FIG. **2** is a schematic diagram illustrating some examples of image information according to an embodiment of the disclosure;

(4) FIG. **3** is a schematic diagram illustrating a second data and a second outline according to an embodiment of the disclosure;

(5) FIG. **4** is a schematic diagram illustrating a first data and a first outline according to an embodiment of the disclosure;

(6) FIG. **5** is a schematic diagram illustrating a difference in shape between the first outline and the second outline according to an embodiment of the disclosure;

(7) FIG. **6** is a schematic diagram illustrating a second data and a second outline according to an embodiment of the disclosure;

(8) FIG. **7** is a schematic diagram illustrating a first data and a first outline according to an embodiment of the disclosure;

(9) FIG. **8** is a schematic diagram illustrating a difference in shape between the first outline and the second outline according to an embodiment of the disclosure;

(10) FIG. **9** is a schematic diagram illustrating a method of obtaining a second data from a database according to an embodiment of the disclosure;

(11) FIG. **10** is a schematic diagrams illustrating a first data superimposed on the map of the port according to an embodiment of the disclosure;

(12) FIG. **11** is a schematic diagrams illustrating a display on a monitor according to an embodiment of the disclosure;

DESCRIPTION OF THE EMBODIMENTS

(13) FIG. **1** is a schematic diagram illustrating a system for automatically determining an open berth of a port according to an embodiment of the disclosure. Referring to FIG. **1**, the system is adapted for a boat **100** to accumulate and utilize information of a port. The boat **100** may be, for example, a water vessel, a water craft, a ship and/or the like. The boat **100** includes a propulsion system, for example, a motor for propelling the boat **100** in water. The motor may be, for example, an inboard motor, an outboard motor, a partially inboard-partially outboard motor and the like. A propeller is coupled to an output shaft of the motor. The boat **100** includes a steering system, for example, a steering wheel coupled to a rudder to steer a direction of the boat **100**. The steering wheel may be coupled to the rudder by, for example, a cable or a wire or the like.

(14) The boat **100** includes a control unit **10**. The control unit **10** includes, for example, a processor and a memory. The boat **100** may include a transmitter and a receiver to perform wireless communication with a database and/or access the internet. The boat **100** includes a manual driving mode and an automatic driving mode. More specifically, the boat **100** includes an automatic steering system **50** for automatically driving/steering the boat in the automatic driving mode. The control unit **10** is coupled to the automatic steering system **50**, wherein the control unit **10** outputs (sends/transmits) control signals to the automatic steering system **50** to automatically drive/steer the boat **100**. In more detail, the control unit **10** controls an automatic mooring of the boat **100** via the automatic steering system **50**. The control unit **10** may also determine an automatic mooring route of the boat **100**. The control unit **10** may also automatically determine an open berth for mooring the boat **100**. The control unit **10** may switch the control mode of the boat **100** to the automatic docking mode when the boat **100** is automatically steered to dock to a pier.

(15) Referring to FIG. **1**, a user may switch an operation mode of the boat **100** to the manual

driving mode by, for example, activating a manual switch **70**. In addition, the user may switch the operation mode of the boat **100** to the automatic driving mode by, for example, activating the auto dock switch **60**. The auto dock switch **60** and the manual switch **70** may each be, for example, a physical push button, a touch button on an HMI (for example, the monitor **15** may be a capacitive touch screen) and/or the like. Each of the auto dock switch **60** and the manual switch **70** is an example of an input unit. The auto dock switch **60** and the manual switch **70** are coupled to the control unit **10**, wherein the control unit **10** receives an input from the auto dock switch **60** and the manual switch **70**.

(16) Referring to FIG. **1**, when the user activates the auto dock switch **60**, the control unit includes a switching unit that automatically switches a control mode of the control unit **10** to an automatic driving mode. When the control mode is switched to the automatic driving mode, the control unit **10** is configured to output a control signal to the automatic steering system **50** for controlling an automatic steering of the boat **100**, which may be used to automatically dock the boat **100** to an open berth of a port. When the user activates the manual switch **70**, the switching unit of the control unit **10** automatically switches the control mode of the control unit **10** to the manual driving mode. When the control mode is switched to the manual driving mode, the control unit **10** is configured to not output the control signal for controlling the automatic steering of the boat **100**, or to disengage the automatic steering system **50** of the boat **100** such that the boat **100** may be steered and/or controlled manually by the user.

(17) In more detail, the control unit **10** controls an automatic steering of the boat **100** via the automatic steering system **50** when the control unit **10** is in the automatic driving mode. The control unit **10** may also determine an automatic steering route of the boat **100** when the control unit **10** is in the automatic driving mode. Namely, the control unit **10** may determine the automatic steering route of the boat **100** when the control unit **10** is in the automatic docking mode of the automatic driving mode. In the present disclosure, docking may be used interchangeably with mooring, berthing and/or the like. That is to say, the control unit **10** controls an automatic docking, mooring and/or berthing of the boat **100** via the automatic steering system **50**. The control unit **10** may also determine an automatic docking route, an automatic mooring route and/or an automatic berthing route of the boat **100**.

(18) The automatic steering system **50** may include, for example, sensors, switches and actuators and/or the like. For example, an actuator may be used for automatically turning the steering wheel. In another example, an actuator may be used for controlling the throttle. A switch may be used to switch the rotating direction of the motor to move forward or reverse. A sensor may be used to detect a position of the boat **100**. A sensor may be used for detecting objects in a surrounding of the boat **100**.

(19) Referring to FIG. **1**, the control unit **10** may receive image information **20**, GPS information **30** and IMU information **40**. More specifically, the boat **100** may include a GPS for obtaining the GPS information **30**. The GPS is an example of a Global Navigation Satellite System (GNSS). In addition, the boat **100** may include an inertial measurement unit (IMU) for obtaining the IMU information **40**. The IMU may include, for example, control moment gyros to provide orientation information such as pitch, roll, yaw information of the boat **100**.

(20) FIG. **2** is a schematic diagram illustrating some examples of image information according to an embodiment of the disclosure. Referring to FIG. **2**, the image information **20** may be, for example, an image from a range finding sensor such as a lidar, a radar, a sonar and/or the like, an aerial drone image, an underwater drone image, a satellite image, a cameral image and/or the like. The image information **20** may be an image that is obtained in real time or an image that is stored in a memory. For example, the image information **20** may be obtained in real time from the lidar, the underwater drone, the aerial drone, the camera on the boat **100**, the camera on satellite and/or the like. In another embodiment, the image information **20** may be obtained from an image stored in memory, such as images from the lidar, the underwater drone, the aerial drone, the camera on the

boat **100**, a camera of another boat, the camera on satellite and/or the like that are stored in a memory. The above examples of the image information **20** are described as examples only and are not intended to limit the disclosure.

(21) Lidar is an acronym for "light detection and ranging" or "laser imaging, detection, and ranging". The boat **100** may include the lidar for obtaining the lidar image. The boat **100** may include a camera having an image sensor for obtaining the camera image. The aerial drone image may be obtained from an aerial drone carrying a camera. The underwater drone image may be obtained from an underwater drone carrying a camera. The satellite image may be obtained from a satellite carrying a camera.

(22) Referring to FIG. **1**, a monitor **15** is disposed on the boat **10**. The monitor **15** is an example of a display unit. The monitor **15** includes a display for displaying an image. The monitor **15** is coupled to the control unit **10**.

(23) FIG. **3** is a schematic diagram illustrating a second data and a second outline according to an embodiment of the disclosure. Referring to FIG. **3**, a first other boat OB**1** and a second other boat OB**2** are moored at a port P. More specifically, the first other boat OB**1** and the second other boat OB**2** are moored at a first area A**1** of the port P.

(24) Referring to FIG. **3**, the boat **100** including the control unit **10** is configured to obtain the image information **20**. The image information **20** includes an image of the port P. The image information **20** includes information of the port P obtained at a second timing T**2**. The image information **20** is an example of a second data SD.

(25) Referring to FIG. **3**, a second outline SO may be extracted from the second data SD. The second outline SO includes an outline of a plurality of obstacles O of the port P at the second timing T**2**. The second outline SO is obtained from the second data SD (the image information **20**). The second outline SO is an outline delineating a plurality of obstacles O of the port P at the second timing T**2**. The second outline SO may be a continuous or discontinuous outline. In the present embodiment, the second outline SO is a continuous outline. The second outline SO is, for example, an outline of a outer most surface of the plurality of obstacles O, the outer most surface is the surface of the obstacle O that is closest to the boat **100** (or the surface of the obstacle O that is closest to an other boat that captured the second data SD). The first other boat OB**1** and the second other boat OB**2** are examples of the plurality of obstacles O. Furthermore, the port P is also an example of the plurality of obstacles O. The number of the plurality of obstacles O that the second outline SO identifies from the image information **20** is not intended to limit the disclosure. In the present embodiment, the second timing T**2** is a timing when the boat **100** departs from the port P. That is to say, the second data SD is data that is obtained by the boat **100** at the second timing T**2** when the boat **100** departed from the port P. However, the disclosure is not limited thereto. In another embodiment of the disclosure, the second timing T**2** may be a timing when the boat **100** returns to the port P, instead of departing from the port P.

(26) FIG. **4** is a schematic diagram illustrating a first data and a first outline according to an embodiment of the disclosure. Referring to FIG. **4**, the first other boat OB**1** and the second other boat OB**2** are no longer moored at the port P. More specifically, the first other boat OB**1** and the second other boat OB**2** are not moored at the first area A**1** of the port P.

(27) Referring to FIG. **4**, the boat **100** including the control unit **10** is configured to obtain the image information **20**. The image information **20** includes the image of the port P. The image information **20** includes information of the port P obtained at a first timing T**1**. The image information **20** is an example of a first data FD. The image information **20** of the first data FD is obtained by a sensor disposed on the boat **100**. The sensor may be, for example, the lidar, the radar, the sonar, the camera and the like disposed on the boat **100**.

(28) Referring to FIG. **4**, a first outline FO may be extracted from the first data FD. The first outline FO includes an outline of a plurality of obstacles O of the port P at the first timing T**1**. The first outline FO is obtained from first data FD (the image information **20**). The first outline FO is an

outline delineating a plurality of obstacles O of the port P at the first timing T**1**. The first outline FO may be a continuous or discontinuous outline. In the present embodiment, the first outline FO is a continuous outline. The first outline FO is, for example, an outline of a outer most surface of the plurality of obstacle O, the outer most surface is the surface of the obstacle O that is closest to the boat **100** (or the surface of the obstacle O that is closest to an other boat that captured the first data FD). The first other boat OB**1** and the second other boat OB**2** shown in FIG. **3** (at the second timing T**2**) are no longer moored at the port P shown in FIG. **4** (at the first timing T**1**). The port P is an example of the plurality of obstacles O. The number of the plurality of obstacles O the first outline FO identifies from the image information **20** is not intended to limit the disclosure. In the present embodiment, the first timing T**1** is a timing when the boat **100** returns to the port P. That is to say, the first data FD is data that is obtained by the boat **100** at the first timing T**1** when the boat **100** returned to the port P. The first timing T**1** is different from the second timing T**2**. For example, the second timing T**2** is a timing prior to the first timing T**1**. The first timing T**1** is a timing that is later than the second timing T**2**. The first timing T**1** may be, for example a present time (a current time). That is to say, the first data FD is obtained at the present time when the boat **100** returns to the port P. However, the disclosure is not limited thereto. In another embodiment of the disclosure, the first timing T**1** may not be the present time, but merely another time that is different from the second timing T**2**. In another embodiment of the disclosure, the first timing T**1** may be a timing when the boat **100** departs from the port P, instead of when the boat **100** returns to the port P.

(29) FIG. **5** is a schematic diagram illustrating a difference in shape between the first outline of FIG. **4** and the second outline of FIG. **3** according to an embodiment of the disclosure. The control unit **10** is configured to function as a determining part that determines an open berth of the port P for mooring the boat **100**. The control unit **10** is further configured to function as a display part that displays the open berth determined by the determining part on the monitor **15**.

(30) Referring to FIG. **5**, the control unit **10** determines the open berth based on the first data FD and the second data SD. That is to say, the control unit **10** compares the first data FD and the second data SD and detects/determines an other boat OB**1**, OB**2** that is berthed in the first data or the second data SD. More specifically, the control unit **10** compares the first outline FO obtained from the first data FD and the second outline SO obtained from the second data SD, and determines a difference in shape DS between the first outline FO and the second outline SO. An area of the difference in shape DS is determined to be an area of the open berth. In more detail, the control unit **10** may superimpose the first outline FO obtained at the first timing T**1** on the second outline SO obtained at the second timing T**2** to obtain the difference in shape DS. The control unit **10** compares the first data FD and the second data SD and identifies a possible berthing location, the possible berthing location is identified as the open berth for mooring the boat **100**.

(31) Referring to FIG. **3** and FIG. **4**, the first area A**1** is an example of a first position. When an obstacle O (the first other boat OB**1** and/or the second other boat OB**2**) is identified at the first position A**1** in the second data SD shown in FIG. **3**, but the obstacle O (the first other boat OB**1** and/or the second other boat OB**2**) is not identified at the first position A**1** in the first data FD shown in FIG. **4**, the control unit **10** may determine the first position A**1** as the open berth.

(32) FIG. **6** is a schematic diagram illustrating a second data and a second outline according to an embodiment of the disclosure. A difference between the embodiment shown in FIG. **6** and the embodiment shown in FIG. **3** lies in the presence of the first other boat OB**1** and the second other boat OB**2**. Specifically, in the embodiment of FIG. **6**, the first other boat OB**1** and the second other boat OB**2** are not moored at the first area A**1** at the second timing T**2**.

(33) FIG. **7** is a schematic diagram illustrating a first data and a first outline according to an embodiment of the disclosure. A difference between the embodiment shown in FIG. **7** and the embodiment shown in FIG. **4** lies in the presence of the first other boat OB**1** and the second other boat OB**2**. Specifically, in the embodiment of FIG. **7**, the first other boat OB**1** and the second other boat OB**2** are moored at the first area A**1** at the first timing T**1**.

(34) FIG. **8** is a schematic diagram illustrating a difference in shape between the first outline of FIG. **7** and the second outline of FIG. **6** according to an embodiment of the disclosure. The control unit **10** is configured to function as a determining part that determines a berth of the port P for mooring the boat **100** is presently occupied by an other boat. The control unit **10** is further configured to function as a display part that displays the presently occupied berth determined by the determining part on the monitor **15**.

(35) Referring to FIG. **8**, the control unit **10** determines the berth is presently occupied by another boat based on the first data FD and the second data SD. More specifically, the control unit **10** compares the first outline FO and the second outline SO, and determines a difference in shape DS between the first outline FO and the second outline SO, and an area of the difference in shape DS is determined to be the berth which is presently occupied by another boat. In more detail, the control unit **10** may superimpose the first outline FO obtained at the first timing T**1** on the second outline SO obtained at the second timing T**2** to obtain the difference in shape DS.

(36) Referring to FIG. **6** and FIG. **7**, the first area A**1** is an example of a first position. When an obstacle O (the first other boat OB**1** and/or the second other boat OB**2**) is identified at the first position A**1** in the first data FD shown in FIG. **7**, but the obstacle O (the first other boat OB**1** and/or the second other boat OB**2**) is not identified at the first position A**1** in the second data SD shown in FIG. **6**, then the control unit **10** determines the first position A**1** is a berth that is presently occupied by an other boat.

(37) It should be noted, the second data SD obtained at the second timing T**2** may be obtained by various methods. For example, the second data SD may be obtained from the image information **20** that is imaged by the boat **100**. However, the disclosure is not limited thereto. In another embodiment of the disclosure, the second data SD may be obtained from image information **20** that is imaged by an other boat, for example, the first other boat OB**1** and/or the second other boat OB**2**. In another embodiment of the disclosure, the second data SD may be obtained from a database that accumulates a plurality of data from a plurality of other boats OB and/or the boat **100**. The above are described as examples only and are not intended to limit the disclosure.

(38) FIG. **9** is a schematic diagram illustrating a method of obtaining a second data from a database according to an embodiment of the disclosure. Referring to FIG. **9**, a plurality of other boats OB**1**, OB**2**, OB**3**, OB**4** may be connected wirelessly to a database **200**. The other boat OB**5** may be, for example, the boat **100**. The boat **100** may also be connected to the database **200**. A number of the plurality of other boats is not intended to limit the disclosure. The database **200** may be, for example, a cloud server. The database **200** may include a processor and a memory. Each of the plurality of other boats OB**1**, OB**2**, OB**3**, OB**4** may obtain a second data SD and/or a second outline SO. Each of the second data SD and/or the second outline SO obtained by each of the plurality of other boats OB**1**, OB**2**, OB**3**, OB**4** may be an outline of a different port P or a same port P, and is not intended to limit the disclosure. The second data SD and/or the second outline SO obtained by the other boats OB**1**, OB**2**, OB**3**, OB**4** and the boat **100** may be uploaded to the database **200**. In more detail, the first data FD and/or the second data SD obtained by any of the boat **100** and/or the other boats OB**1**, OB**2**, OB**3**, OB**4** may be uploaded to the database **200** as second data SD. That is to say, the first data FD obtained by any of the other boats OB**1**, OB**2**, OB**3**, OB**4** and/or the boat **100** may be stored in the database **200** as second data SD. In this way, other users of the system may utilize (download) the second data SD (which may include first data FD and/or second data SD) stored in the database **200** as the second data SD. The database **200** stores the plurality of second data SD and/or the plurality of second outlines SO in the memory of the database **200** (SD**1**(SO**1**), SD**2**(**502**), SD**3**(**503**), SD**4**(**504**)). The plurality of second outlines SO, SO**1**, SO**2**, SO**3**, SO**4** are determined from the plurality of second data SD, SD**1**, SD**2**, SD**3**, SD**4** respectively. Any of the boat **100** and/or the other boats OB**1**, OB**2**, OB**3**, OB**4** may connect to the database **200** to retrieve/access the second data SD and/or second outline SO (SD**1**(SO**1**), SD**2**(**502**), SD**3**(**503**), SD**4**(**504**)) stored in the database **200**. In this way, the control unit **10** may obtain the second data

SD from the database **200** that accumulates a plurality of second data (SD**1**(SO**1**), SD**2**(**502**), SD**3**(**503**), SD**4**(**504**)) from a plurality of other boats OB**1**, OB**2**, OB**3**, OB**4**. In short, the control unit **10** of the boat **100** (or the other boats OB**1**, OB**2**, OB**3**, OB**4**) may upload and store at least one of the first data FD or the second data SD in the database **200** as second data SD, and other users of the system may utilize the second data SD stored in the database **200** for determining the open berth of the port P.

(39) Referring to FIG. **9**, the database **200** stores the plurality of the second data SD**1**, SD**2**, SD**3**, SD**4** and/or the plurality of the second outlines SO**1**, SO**2**, SO**3**, SO**4**. The plurality of the second outlines SO**1**, SO**2**, SO**3**, SO**4** may be an outline of a different port P or a same port P that the boat **100** is presently located in at the first time T**1**, and is not intended to limit the disclosure. A method is needed to determine which one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** is the outline of the port P. A method is needed to determine which one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** is the outline of the port P which is the same port P that the boat **100** is presently located in at the first time T**1**. Accordingly, the control unit **10** may compare the first outline FO to the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** stored in the memory, and when a similarity between a shape of the first outline FO and a shape of one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** is greater than a predetermined threshold, then the control unit **10** may determine the one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** is an outline of the port P, and not an outline of a different port. The control unit **10** then assigns the one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** as the second outline SO, and the one of the plurality of the second data SD**1**, SD**2**, SD**3**, SD**4** corresponding to the one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4** as the second data SD. It should be noted the second data SD obtained from the boat **100** (the other boat OB**5** of FIG. **9**) may also be uploaded to the database **200**, for example, as the second data SD**5** and the second outline SO**5**.

(40) Referring to FIG. **9**, there may be a case where more than one of the second outlines SO**1**, SO**2**, SO**3**, SO**4** stored in the database **200** are determined to be the outline of the same port P that the boat **100** is presently located in at the first time T**1**. When more than one of the second outlines SO**1**, SO**2**, SO**3**, SO**4** stored in the database **200** are determined to be the outline of the same port P that the boat **100** is presently located in at the first time T**1**, the one of the second outlines SO**1**, SO**2**, SO**3**, SO**4** having the least similarity to the first outline FO may be assigned as the second outline SO. In this way, there may be a higher chance of identifying an open berth or identifying a berth that is presently occupied by an other boat. However, the disclosure is not limited thereto, and the second outline SO may be assigned according to user requirements.

(41) In the above embodiments, it was described that the control unit **10** determines the open berth or the berth that is presently occupied by an other boat without using a GNSS receiver. Namely, the open berth and/or the berth that is presently occupied was determined based on the difference in shape DS between the first outline FO and the second outline SO obtained from the first data FD and the second data SD. However, the disclosure is not limited thereto. In another embodiment of the disclosure, the control unit **10** may determine the open berth and/or the berth that is presently occupied by using a GNSS receiver.

(42) For example, in another embodiment of the disclosure, the control unit **10** may determine the open berth and/or the berth that is presently occupied, by using a GNSS receiver. For example, the first data FD and the second data SD may be assigned position data respectively. That is so say, the first data FD may be assigned position data, and the second data SD may be assigned position data. The position data may be, for example, longitude and latitude coordinates. The longitude and latitude coordinates may be obtained by, for example, a GPS. For example, if position data assigned to second data SD is different from position data assigned to the first data FD, the control unit **10** may determine the second outline SO obtained from the second data SD is not the outline of the port P, even when the similarity between the shape of the first outline and the shape of the second outlines is greater than the predetermined threshold.

(43) Referring to FIG. **9**, in the case there are the plurality of the second data SD**1**, SD**2**, SD**3**, SD**4**, SD**5**, if position data assigned to the one of the plurality of second data SD**1**, SD**2**, SD**3**, SD**4**, SD**5** is different from position data assigned to the first data FD, the control unit **10** may determine the one of the plurality of second data SD**1**, SD**2**, SD**3**, SD**4**, SD**5** is not the outline of the port P, even when the similarity between the shape of the first outline FO and the shape of one of the plurality of second outlines SO**1**, SO**2**, SO**3**, SO**4**, SO**5** is greater than the predetermined threshold. In this way, position data is stored in association with the second data SD, and the control unit **10** determines the second data SD**1**, SD**2**, SD**3**, SD**4**, SD**5** to be obtained based on a present position (GPS location) of the boat **100** at the first timing T**1**.

(44) FIG. **10** is a schematic diagrams illustrating a first data superimposed on the map of the port according to an embodiment of the disclosure. Referring to FIG. **10**, the control unit **10** may receive a map of the port P from, for example, the database **200**. In the present embodiment, the map of the port P may be the second data SD. That is to say, the second outline SO may be determined from the map of the port P obtained from the database **200**. The first outline FO of the first data FD is superimposed on the second outline SO of the map of the port P.

(45) FIG. **11** is a schematic diagrams illustrating a display on a monitor according to an embodiment of the disclosure. Referring to FIG. **11**, the control unit **10** may store position data of a home berth HB of the boat **100**. An outline delineating an area of the home berth HB may be displayed on the monitor **15**. The position data of the home berth HB may be predetermined and may be stored in the memory of the control unit **10** by, for example, a user. The position data may be, for example, the longitude and latitude coordinates (or a range of longitude and latitude coordinates) corresponding to the area of the home berth HB. In addition, the map of the port P may be displayed on the monitor **15**.

(46) Referring to FIG. **11**, the control unit **10** may detect that an other boat OB**1** is berthed at the home berth HB of the boat **100**, via the image information **20** obtained at the first timing T**1**. When the control unit **10** detects that the other boat OB**1** is berthed at the home berth HB of the boat **100** via the image information **20** (or the first data FD), the control unit **10** may suggest an open berth to a user on display (the monitor **15**). In more detail, the area of the difference in shape DS obtained in FIG. **5** may be displayed on the monitor **15**. That is to say, for example, an outline delineating an area of the difference in shape DS may be displayed on the monitor **15** as a suggestion of an open berth.

(47) Referring to FIG. **11**, the control unit **10** may assign availability information to the open berth. The availability information may include, for example, at least one of a home berth information, a contract berth information, a free for use berth information. The home berth information specifies whether the berth is the home berth HB of the boat **100**. The contract berth information specifies whether the berth is a contract berth. The free for use berth information specifies whether the berth is free for any user to use. In this way, the availability information may be displayed on the display (the monitor **15**).

(48) In addition to the availability information, port information may be displayed on the display (the monitor **15**). The port information may include, for example, accident information or the construction information in the port P. The accident information and/or the construction information in the port P may be displayed on the display (the monitor **15**) to notify a user. The port information may be stored in, for example, the database **200**, and may be uploaded to the database **200** by, for example, a port authority.

(49) After the control unit **10** determines the location of the open berth, the control unit **10** calculates and/or sets an automatic mooring route MR of the boat **100** based on the position data of the open berth. The automatic mooring route MR of the boat **100** may be displayed on the monitor **15**.

(50) The control unit **10** may be configured to receive an input from a user via an input unit. The input unit may include, for example, a computer mouse and/or a keyboard. In another embodiment,

the monitor **15** may include, for example, a capacitive touch screen to act as a touch screen to receive input from the user. A number of open berths identified by the control unit **10** is not intended to limit the disclosure. In another embodiment of the disclosure, the open berth may include a plurality of open berths, for example, a first open berth and a second open berth. The open berth among the plurality of open berths for mooring the boat **100** may be selected/changed by a user via the input unit.

(51) In an embodiment of the disclosure, a time stamp may be assigned to the second data SD, and the control unit **10** may identify, based on a time series, whether a shape difference between the first data FD and the second data SD is the open berth or a change in area of a port wall. More specifically, the control unit **10** may identify, based on a time series, whether the difference in shape DS between the first outline FO and the second outline SO is the open berth or a change in area of a port wall. When the control unit **10** determines the difference in shape DS is due to the change in area of the port wall, the control unit **10** determines the difference in shape DS is not the open berth for mooring the boat **100**. The change in area of the port wall may occur due to, for example, construction or corrosion of the port P (port wall).

(52) Since there may be some variation in accuracy between the outlines of the first outline FO and the second outline SO, a predetermined area threshold may be set by a user. For example, when the area of the difference in shape DS is greater than the predetermined area threshold, the control unit **10** may determine the area of the difference in shape DS is the open berth. In another example, when the area of the difference in shape DS is less than the predetermined area threshold, the control unit **10** may determine the area of the difference in shape DS is not the open berth, but due to variation in accuracy between the outlines of the first outline FO and the second outline SO, or due to construction or corrosion. The predetermined area threshold may be, for example, 4 square meters, 5 square meters, 10 square meters and/or the like. However, the disclosure is not limited thereto, and the predetermined area threshold may be set according to requirements.

(53) It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure covers modifications and variations provided that they fall within the scope of the following claims and their equivalents.

Claims

1. A system, adapted for a boat to accumulate and utilize information of a port, the system comprising: a control unit, comprising a processor, configured to function as: a determining part that determines an open berth of the port; and a display part that displays the open berth determined by the determining part on a display; wherein the control unit determines the open berth based on a first data and a second data, the first data includes information of the port obtained at a first timing by a sensor disposed on the boat, the second data includes information of the port obtained at a second timing, the first timing is different from the second timing, a first outline of a plurality of obstacles of the port at the first timing is determined from the first data; a second outline of a plurality of obstacles of the port at the second timing is determined from the second data; the control unit superimposes the first outline with the second outline, and determines a difference in shape between the first outline and the second outline, and an area of the difference in shape is determined to be the open berth.

2. The system according to claim 1, wherein when an obstacle is identified at a first position in the second data but the obstacle is not identified at the first position in the first data, the control unit determines the first position as the open berth.

3. The system according to claim 1, wherein when an obstacle is identified at a first position in the first data but the obstacle is not identified at the first position in the second data, then the control unit determines the first position is a berth that is presently occupied by an other boat.

4. The system according to claim 1, wherein the second data is data that is obtained by the boat at the second timing when the boat departed from the port.

5. The system according to claim 4, wherein the first timing is a timing when the boat returned to the port, and the first timing is a present time.

6. The system according to claim 1, wherein the second data is data that is obtained by an other boat.

7. The system according to claim 1, wherein the control unit obtains the second data from a database that accumulates a plurality of second data from a plurality of other boats.

8. The system according to claim 1, wherein the control unit receives a map of the port from a database, the map of the port is assigned as the second data, and the first outline is superimposed on the second outline obtained from the map of the port.

9. The system according to claim 1, wherein a position information is stored in association with the second data, and the control unit determines the second data to be obtained based on a present position of the boat.

10. The system according to claim 1, wherein the control unit determines the open berth without using a GNSS receiver.

11. The system according to claim 1, wherein a time stamp is assigned to the second data, and the control unit identifies based on a time series, whether the difference in shape between the first outline of the first data and the second outline of the second data is the open berth or is a change in an area of a port wall.

12. The system according to claim 1, further comprising: a memory storing a plurality of second data, a plurality of second outlines are determined from the plurality of second data; the control unit compares the first outline to the plurality of second outlines stored in the memory, and when a similarity between a shape of the first outline and a shape of one of the plurality of second outlines is greater than a predetermined threshold, then the control unit determines the one of the plurality of second outlines is an outline of the port, and assigns the one of the plurality of second outlines as the second outline.

13. The system according to claim 1, wherein the control unit uploads and stores at least one of the first data or the second data in a database as second data, and other users of the system may utilize the second data stored in the database.

14. The system according to claim 1, wherein when the control unit detects that an other boat is berthed at a home berth of the boat, the control unit suggests the open berth to a user on the display.

15. The system according to claim 1, wherein the control unit assigns availability information to the open berth, the availability information including at least one of a home berth information, a contract berth information, a free for use berth information, the availability information is displayed on the display.

16. The system according to claim 1, wherein the control unit compares the first data and the second data and detects an other boat that is berthed.

17. The system according to claim 1, wherein the control unit compares the first data and the second data and identifies a possible berthing location, the possible berthing location is identified as the open berth.

18. The system according to claim 1, wherein port information is stored in a database, the port information including at least one of accident information or construction information, and the at least one of the accident information or the construction information is displayed on the display.

19. The system according to claim 1, wherein the first outline is an outline of an outer most surface of the plurality of obstacle of the port that is closest to the boat at the first timing, the second outline is an outline of an outer most surface of the plurality of obstacle of the port that is closest to the boat at the second timing.

20. A system, adapted for a boat to accumulate and utilize information of a port, the system comprising: a control unit, comprising a processor, configured to function as: a determining part

that determines an open berth of the port; and a display part that displays the open berth determined by the determining part on a display; wherein the control unit determines the open berth based on a first data and a second data, the first data includes information of the port obtained at a first timing by a sensor disposed on the boat, the second data includes information of the port obtained at a second timing, the first timing is different from the second timing, the system further comprising: a memory storing a plurality of second data, a plurality of second outlines are determined from the plurality of second data; wherein a first outline of a plurality of obstacles of the port at the first timing is determined from the first data, wherein the control unit compares the first outline to the plurality of second outlines stored in the memory, and when a similarity between a shape of the first outline and a shape of one of the plurality of second outlines is greater than a predetermined threshold, then the control unit determines the one of the plurality of second outlines is an outline of the port, and assigns the one of the plurality of second outlines as the second outline, wherein the control unit determines a difference in shape between the first outline and the second outline, and an area of the difference in shape is determined to be the open berth, wherein if position data assigned to the one of the plurality of second data is different from position data assigned to the first data, the control unit determines the one of the plurality of second data is not the outline of the port, even when the similarity between the shape of the first outline and the shape of one of the plurality of second outlines is greater than the predetermined threshold.