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(54) **AUTOMATICALLY NAVIGABLE VESSEL STEERING SYSTEM, METHOD FOR CONTROLLING VESSEL STEERING SYSTEM, AND MARINE VESSEL**

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(57) **ABSTRACT**

A marine vessel includes a vessel steering system including a boat controller configured or programmed to include an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes. When a password to release a locked state is input to a multifunction display in a locked state where the vessel steering mode is fixed in the automatic vessel steering mode, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

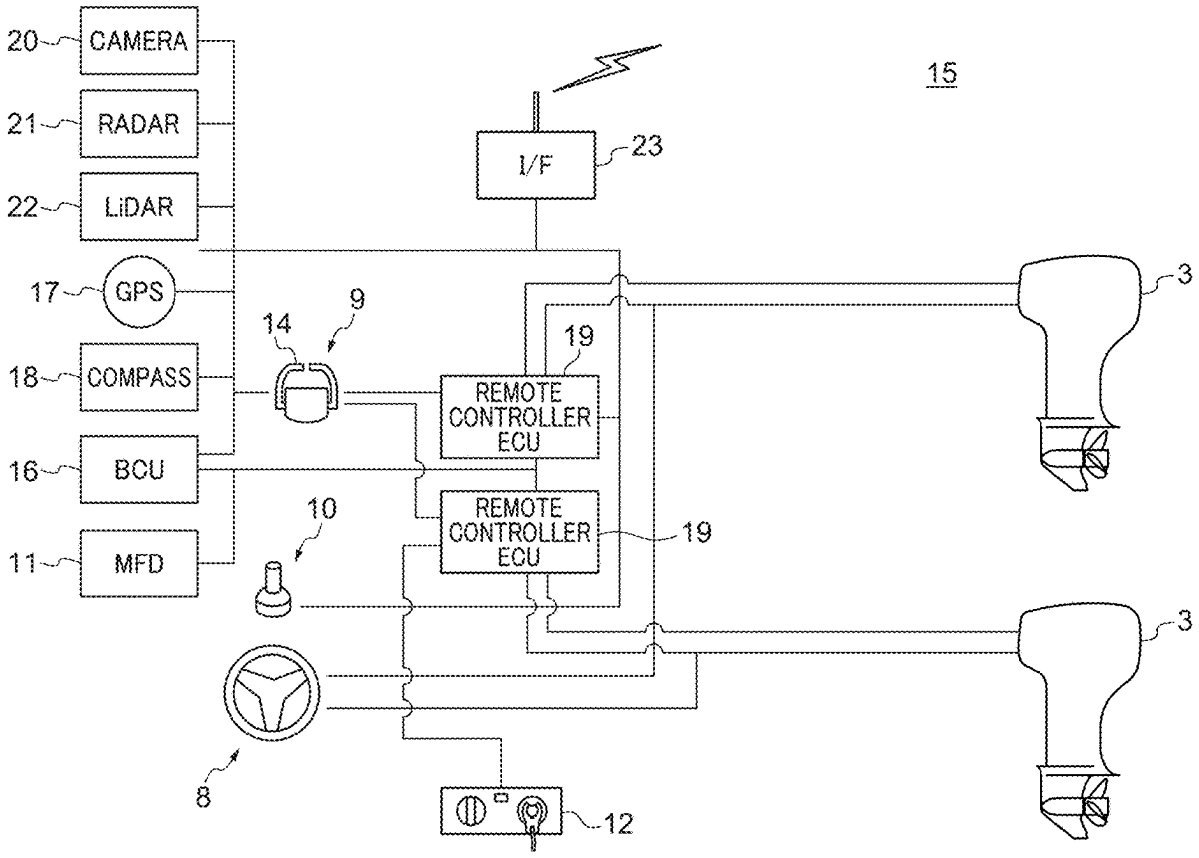


FIG. 1

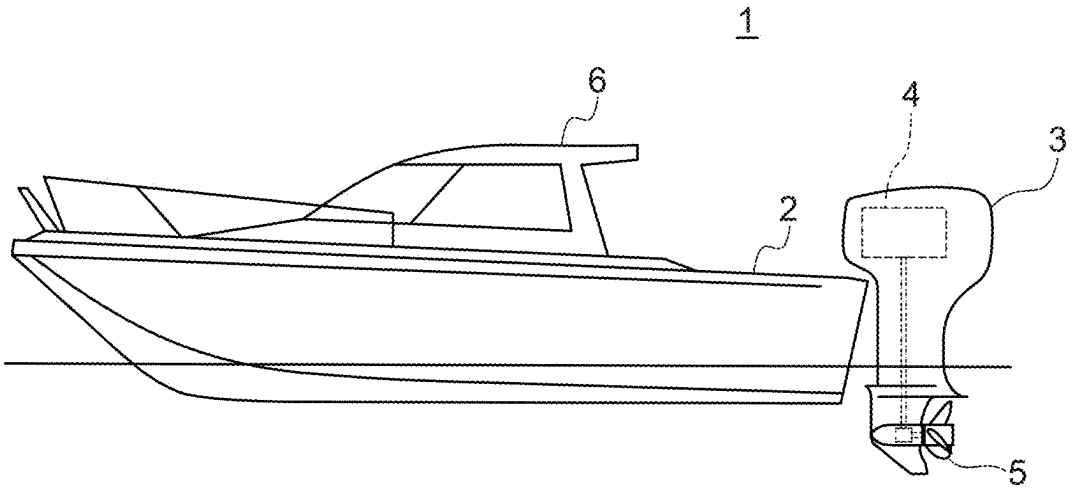


FIG. 2

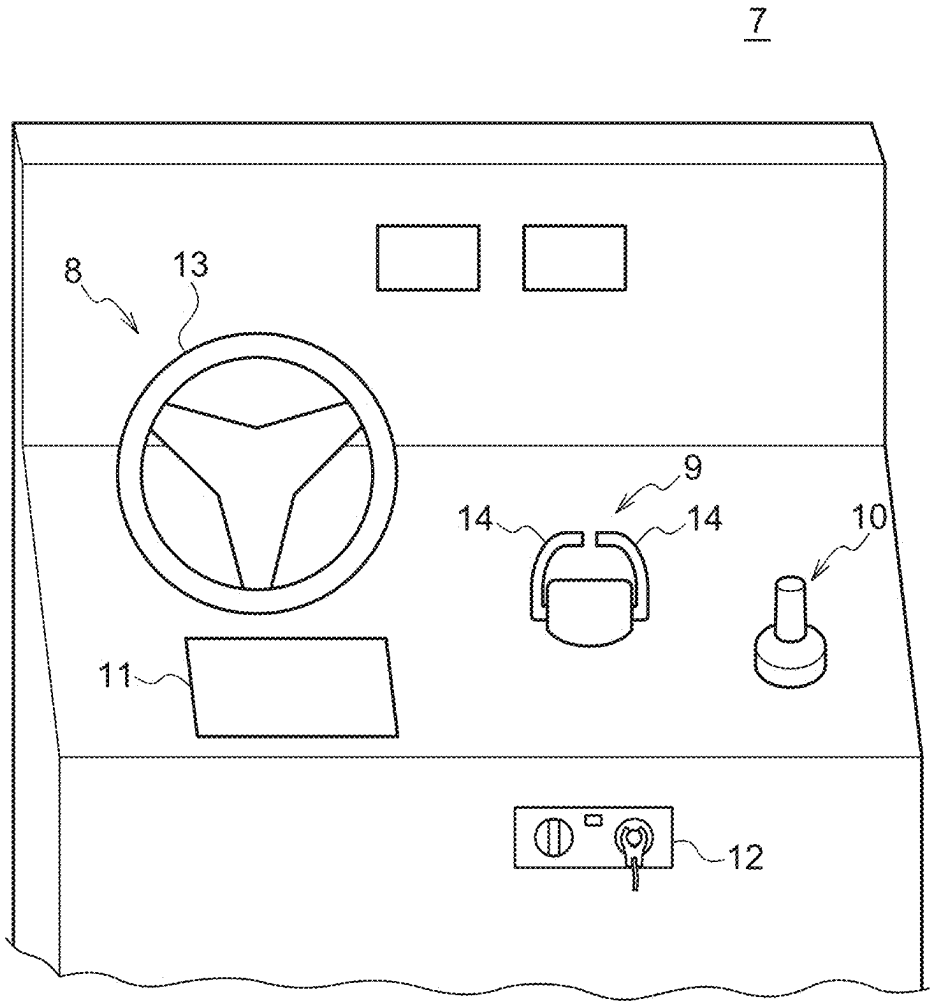


FIG. 3

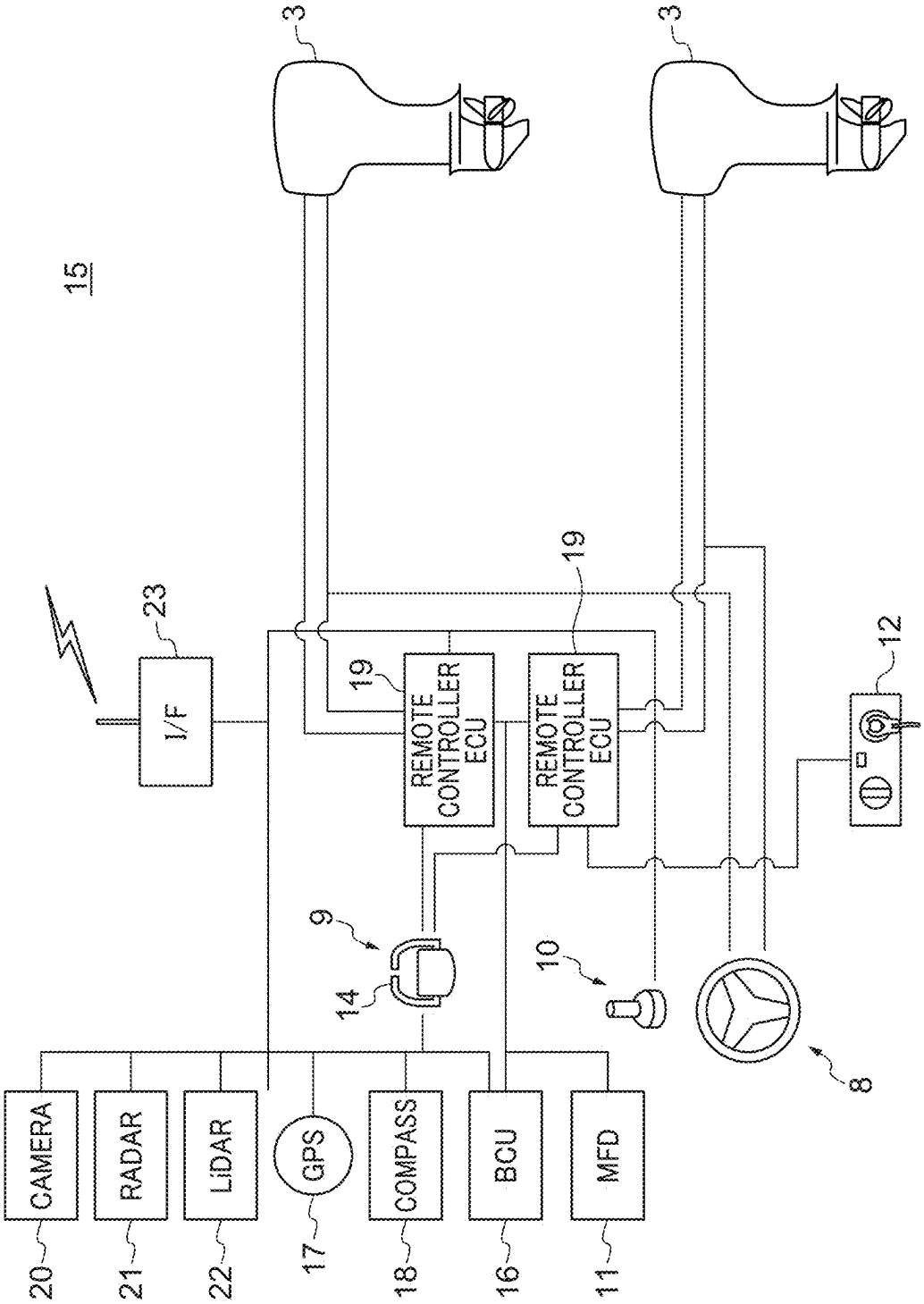

15
3
3
19
19
23
I/F
REMOTE CONTROLLER ECU
REMOTE CONTROLLER ECU
12
9
14
10
8
CAMERA
RADAR
LIDAR
GPS
COMPASS
BCU
MFD
20
21
22
17
18
16
11

FIG. 4

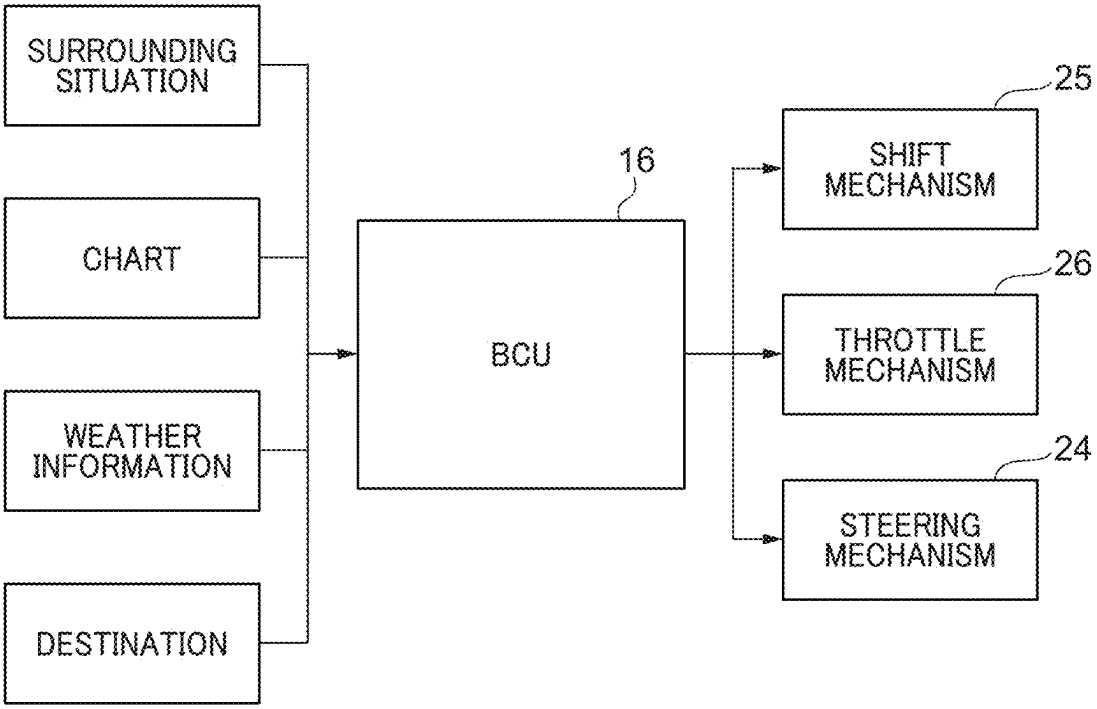

SURROUNDING SITUATION
CHART
WEATHER INFORMATION
DESTINATION
16
BCU
25
SHIFT MECHANISM
26
THROTTLE MECHANISM
24
STEERING MECHANISM

FIG. 5

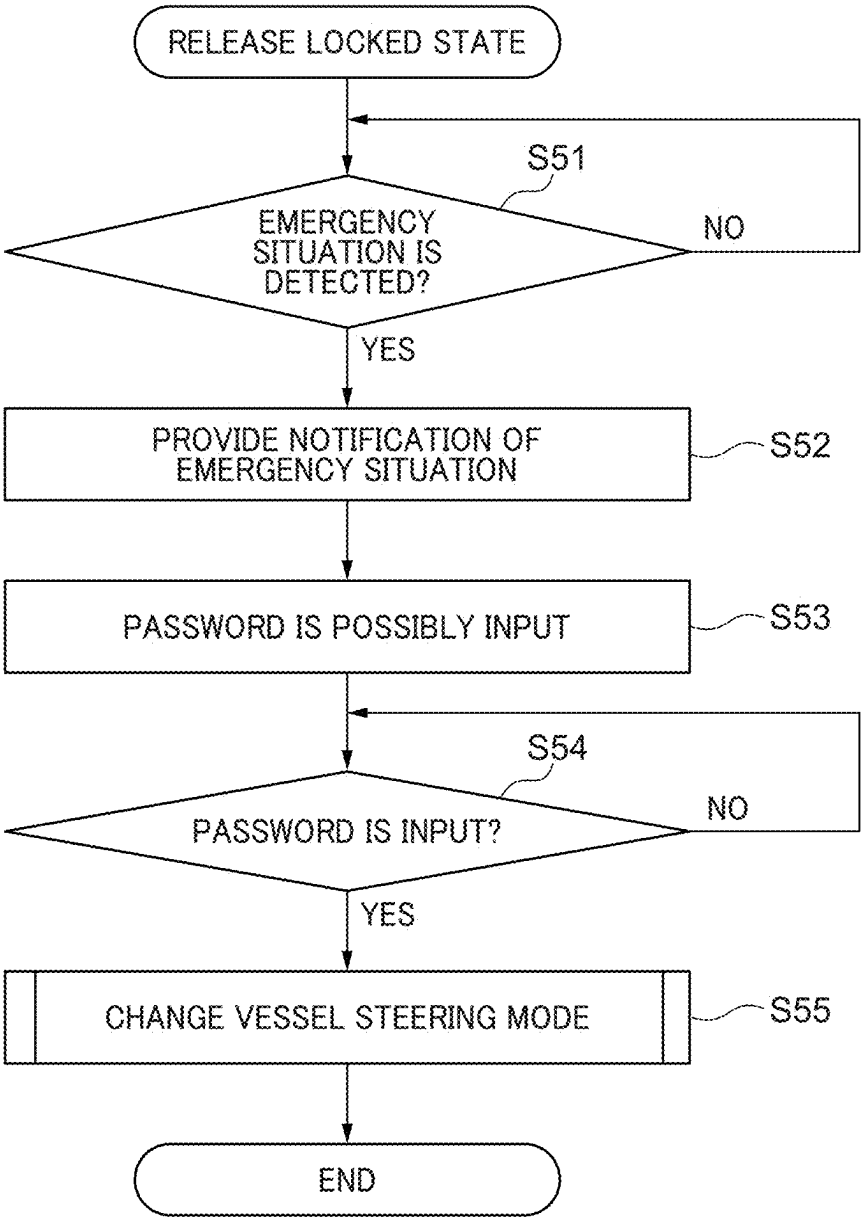

RELEASE LOCKED STATE
S51
EMERGENCY SITUATION IS DETECTED?
NO
YES
PROVIDE NOTIFICATION OF EMERGENCY SITUATION
S52
PASSWORD IS POSSIBLY INPUT
S53
S54
PASSWORD IS INPUT?
NO
YES
CHANGE VESSEL STEERING MODE
S55
END

FIG. 6

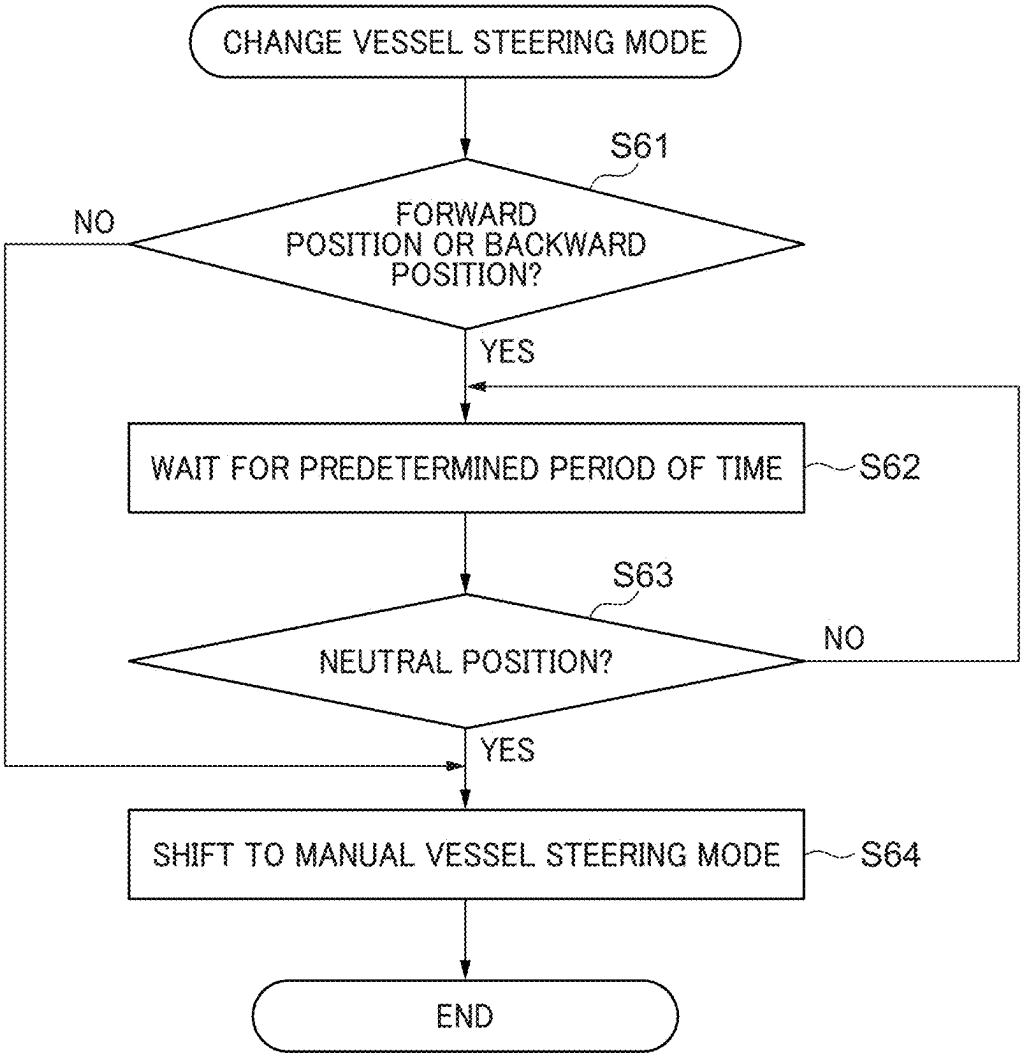

CHANGE VESSEL STEERING MODE
S61
FORWARD POSITION OR BACKWARD POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S62
S63
NEUTRAL POSITION?
NO
YES
SHIFT TO MANUAL VESSEL STEERING MODE
S64
END

FIG. 7

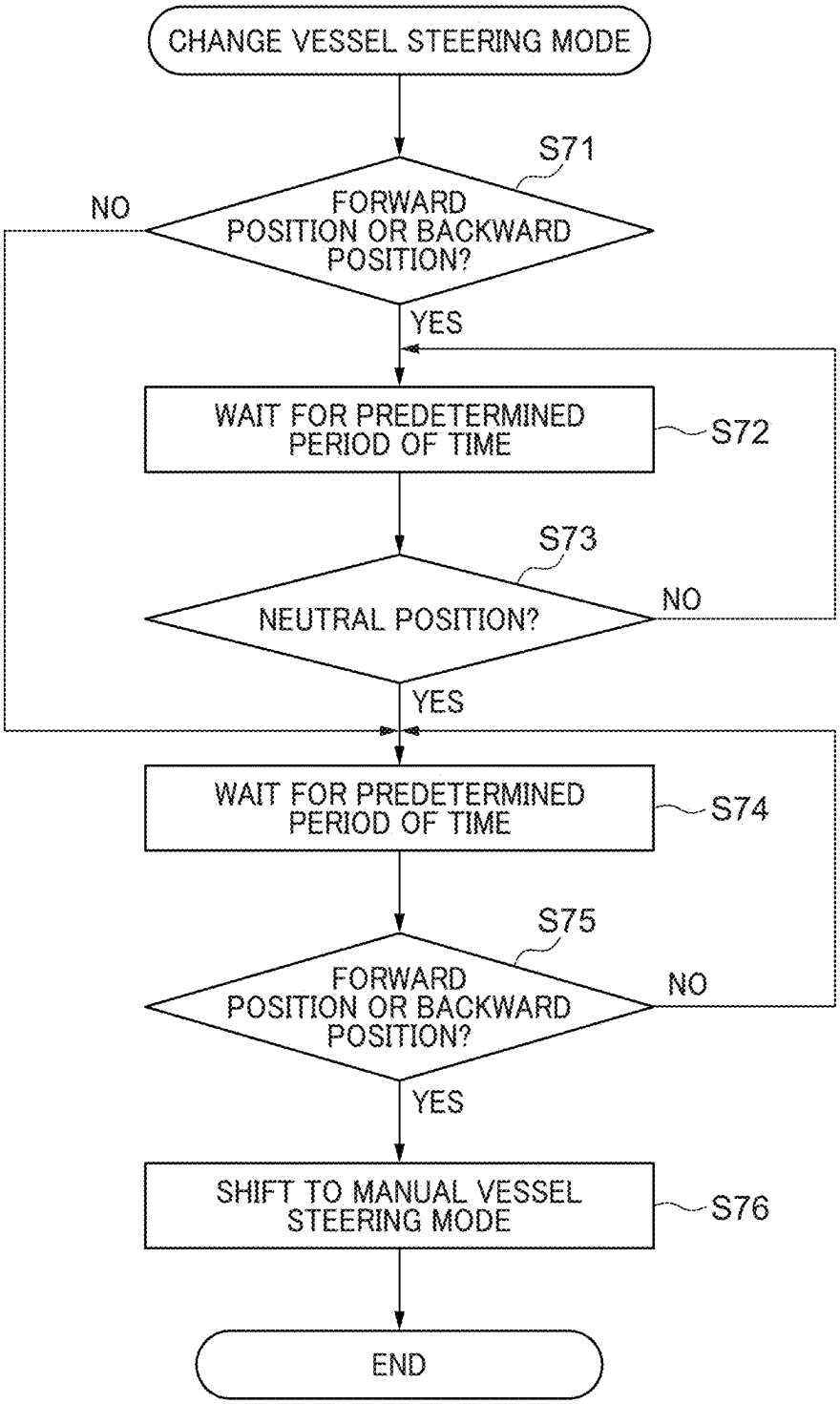

CHANGE VESSEL STEERING MODE
S71
FORWARD POSITION OR BACKWARD POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S72
S73
NEUTRAL POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S74
S75
FORWARD POSITION OR BACKWARD POSITION?
NO
YES
SHIFT TO MANUAL VESSEL STEERING MODE
S76
END

FIG. 8

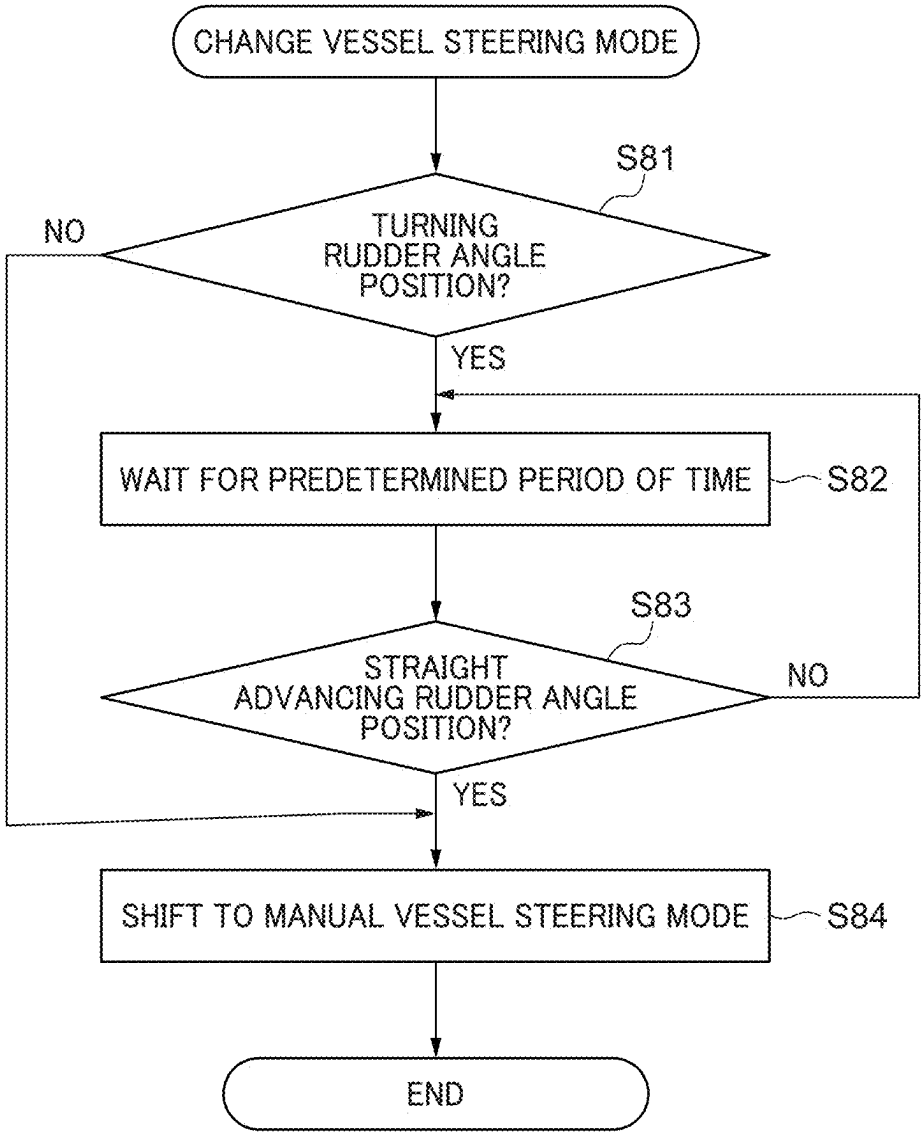
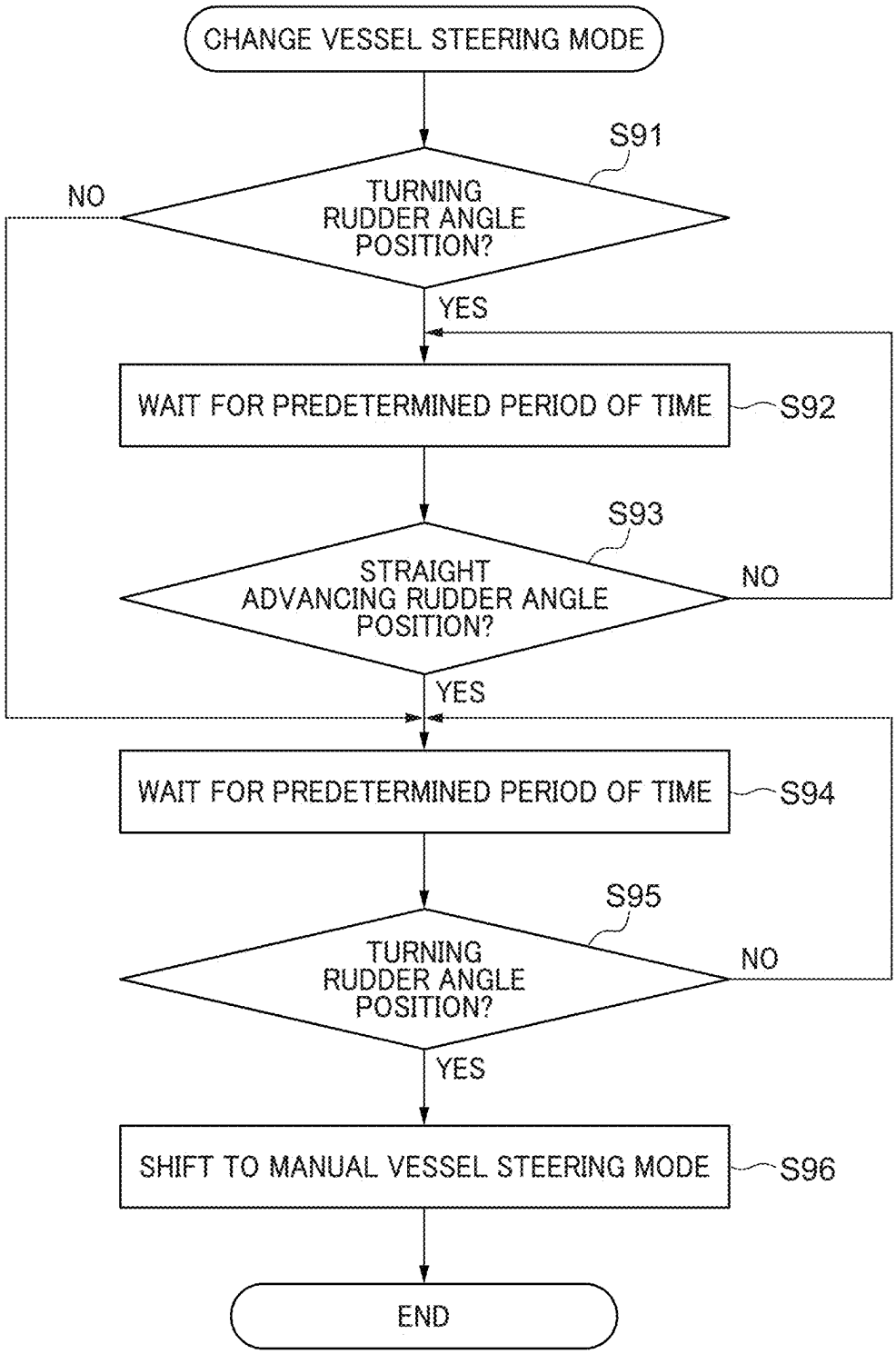

CHANGE VESSEL STEERING MODE
S81
TURNING RUDDER ANGLE POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S82
S83
STRAIGHT ADVANCING RUDDER ANGLE POSITION?
NO
YES
SHIFT TO MANUAL VESSEL STEERING MODE
S84
END

FIG. 9


CHANGE VESSEL STEERING MODE
S91
TURNING RUDDER ANGLE POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S92
S93
STRAIGHT ADVANCING RUDDER ANGLE POSITION?
NO
YES
WAIT FOR PREDETERMINED PERIOD OF TIME
S94
S95
TURNING RUDDER ANGLE POSITION?
NO
YES
SHIFT TO MANUAL VESSEL STEERING MODE
S96
END

AUTOMATICALLY NAVIGABLE VESSEL STEERING SYSTEM, METHOD FOR CONTROLLING VESSEL STEERING SYSTEM, AND MARINE VESSEL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Patent Application No. 2024-21531, filed on Feb. 15, 2024, which is hereby incorporated by reference wherein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to automatically navigable vessel steering systems, methods for controlling the vessel steering systems, and marine vessels.

2. Description of the Related Art

[0003] In recent years, a marine vessel equipped with an automatically navigable vessel steering system without a vessel operator operating vessel steering equipment has been developed. Such a vessel steering system of the marine vessel has, as a vessel steering mode, a manual vessel steering mode in which actuators of a throttle mechanism and a steering mechanism are operated based on an input operation received by the vessel steering equipment, and an automatic vessel steering mode in which the respective actuators are automatically operated without the input operation received by the vessel steering equipment (refer to, for example, Japanese Laid-open Patent Publication (Kokai) No. 2021-194957).

[0004] In a case where such a vessel steering system having the manual vessel steering mode and the automatic vessel steering mode is applied to an unmanned ship on which a vessel operator is not on board, even if a third party operates the vessel steering equipment, the vessel steering mode remains fixed in the automatic vessel steering mode in order to ignore the operation.

[0005] However, in the vessel steering system disclosed in JP 2021-194957 A, when an emergency situation in which continuation of automatic navigation of the marine vessel is difficult occurs, the marine vessel is not navigable while the vessel steering mode is fixed in the automatic vessel steering mode. Therefore, there is room for improvement from the viewpoint of maintaining the operation of the marine vessel.

SUMMARY OF THE INVENTION

[0006] Example embodiments of the present invention maintain operation of marine vessels even when continuation of automatic operation of the marine vessels becomes difficult.

[0007] According to an example embodiment of the present invention, a vessel steering system includes a boat controller configured or programmed to include an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes, wherein when an unlock key is received in a locked state in which the vessel steering mode is fixed in the automatic vessel steering mode, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

[0008] According to this configuration, when the marine vessel is in an emergency situation, the vessel steering mode can be shifted from the automatic vessel steering mode to the manual vessel steering mode by an unlock key. For this reason, when a vessel operator on the marine vessel or a third party who has a vessel steering qualification steers the marine vessel, the marine vessel can navigate and the operation of the marine vessel can be maintained.

[0009] The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the example embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a side view of a marine vessel including a vessel steering system according to an example embodiment of the present invention.

[0011] FIG. **2** is a perspective view of a main portion of a vessel steering seat of the marine vessel in FIG. **1**.

[0012] FIG. **3** is a block diagram schematically illustrating a configuration of a vessel steering system included in the marine vessel in FIG. **1**.

[0013] FIG. **4** is a diagram for explaining a control in an automatic vessel steering mode.

[0014] FIG. **5** is a flowchart illustrating a lock state release process to change a vessel steering mode from the automatic vessel steering mode to a manual vessel steering mode.

[0015] FIG. **6** is a flowchart illustrating a vessel steering mode change process.

[0016] FIG. **7** is a flowchart illustrating a first modification of the vessel steering mode change process.

[0017] FIG. **8** is a flowchart illustrating a second modification of the vessel steering mode change process.

[0018] FIG. **9** is a flowchart illustrating a third modification of the vessel steering mode change process.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

[0019] Hereinafter, example embodiments of the present invention will be described with reference to the drawings. FIG. **1** is a side view of a marine vessel including a vessel steering system according to an example embodiment of the present invention. The marine vessel **1** includes a hull **2** and two outboard motors **3** mounted on the hull **2**. Each outboard motor **3** includes an engine **4** and a propeller **5**, and generates a thrust by rotating the propeller **5** by a driving force of the engine **4**. The number of outboard motors **3** included in the marine vessel **1** is not limited to two, and the marine vessel **1** may include only one outboard motor **3**, or the marine vessel **1** may include three or more outboard motors **3**.

[0020] In the marine vessel **1**, a vessel steering room **6** is provided in the hull **2**, and a vessel steering seat **7** is disposed in the vessel steering room **6**. FIG. **2** is a perspective view of a main portion of the vessel steering seat **7**. A steering mechanism **8**, a remote controller **9**, a joystick **10**, a multi-function display (MFD) **11**, and a main switch **12** are disposed near the vessel steering seat **7**.

[0021] The steering mechanism **8** enables a vessel operator to determine a course of the marine vessel **1**. The steering mechanism **8** includes a steering wheel **13** (vessel steering equipment) that can be rotationally operated. When the vessel operator rotates the steering wheel **13** left or right

(clockwise or counterclockwise), a steering mechanism **24**, which will be described below, including an actuator and a bracket changes the direction of each outboard motor **3**. In the present example embodiment, the direction (rudder angle position) of each outboard motor **3** when each outboard motor **3** generates a thrust to turn the marine vessel **1** leftward or rightward is referred to as a turning rudder angle position. In addition, the direction (rudder angle position) of each outboard motor **3** when each outboard motor **3** generates a thrust to advance the marine vessel **1** straight is referred to as a straight advancing rudder angle position.

[0022] The remote controller **9** includes two levers **14** (vessel steering equipment) corresponding to the outboard motors **3**. The vessel operator can switch the direction of the thrust generated by the corresponding outboard motor **3** between a forward direction and a backward direction by operating each lever **14**, and adjust the output of the corresponding outboard motor **3** to adjust the speed of the marine vessel. For example, when the lever **14** is moved forward (forward position), the corresponding outboard motor **3** generates a thrust in the forward direction. When the lever **14** is moved backward (backward position), the corresponding outboard motor **3** generates a thrust in the backward direction. When the lever **14** is moved to a neutral position located between the forward position and the backward position, the connection between the engine **4** and the propeller **5** is disconnected by a clutch in the outboard motor **3**, and the corresponding outboard motor **3** does not apply a thrust to the marine vessel **1**.

[0023] The joystick **10** (vessel steering equipment) is a rod-shaped manual operator that can be tilted forward, backward, leftward, and rightward and can be rotated around an axis. By operating the joystick **10**, the vessel operator can move the marine vessel **1** along a course corresponding to a tilt direction of the joystick **10** by the thrust corresponding to a tilt amount (tilt angle) of the joystick **10**.

[0024] The multifunction display (MFD) **11** includes, for example, a color LCD display, and functions as a display to display various types of information including the rotation speed of the engine **4** of each outboard motor **3**, the speed of the marine vessel **1**, and the like. The MFD **11** also functions as a touch panel that receives an input from a vessel operator, and receives, for example, an input of a password to be described below.

[0025] FIG. **3** is a block diagram schematically illustrating a configuration of a vessel steering system **15** included in the marine vessel **1** in FIG. **1**. As illustrated in FIG. **3**, the vessel steering system **15** includes an outboard motor **3**, a steering mechanism **8**, a remote controller **9**, a joystick **10**, the MFD **11**, a main switch **12**, a boat control unit (BCU) or boat controller **16**, a GPS **17**, a compass **18**, a remote controller ECU **19**, a camera **20**, a radar (RADAR) **21**, a LiDAR **22**, and a communication interface (I/F) **23**. The respective components of the vessel steering system **15** are communicably connected to each other.

[0026] The steering mechanism **8** transmits a rudder angle signal corresponding to a rotation operation of the steering wheel **13** by the vessel operator to each remote controller ECU **19**. The remote controller **9** transmits a signal (forward signal or backward signal) corresponding to the operation of each lever **14** by the vessel operator to each remote controller ECU **19**. The joystick **10** transmits a signal corresponding to the tilt direction and the tilt amount by the operation of the vessel operator to each remote controller ECU **19**. The MFD **11** transmits a signal corresponding to the received input of the vessel operator to the BCU **16** and each remote controller ECU **19**.

[0027] The main switch **12** receives an instruction to turn on or start each outboard motor **3**, and transmits a signal corresponding to the received instruction to the BCU **16** and each remote controller ECU **19**. The BCU **16** determines the situation of the marine vessel **1** based on the signals transmitted from the respective components of the vessel steering system **15**, determines the magnitude of the thrust to be generated by each outboard motor **3** and an acting direction of the thrust to be taken, and transmits a control signal to each remote controller ECU **19**.

[0028] The GPS **17** determines the current position of the marine vessel **1** and transmits the current position of the marine vessel **1** to the BCU **16** as position information. The compass **18** determines the bearing (direction of bow) of the marine vessel **1** and transmits the bearing of the marine vessel **1** to the BCU **16**. The camera **20** determines the surrounding situation of the marine vessel **1** by optical imaging. The radar **21** determines the surrounding situation of the marine vessel **1** by reflection of radio waves. The LiDAR **22** determines the surrounding situation the marine vessel **1** by reflection of laser light. The camera **20**, the radar **21**, and the LiDAR **22** transmit information regarding the determined situation to the BCU **16**. The communication I/F **23** (communication unit) communicates with a server or the like outside the marine vessel **1**, and transmits a signal or the like received from the outside to the BCU **16**.

[0029] One remote controller ECU **19** is provided corresponding to each outboard motor **3**. The remote controller ECU **19** controls the respective actuators of the steering mechanism **24**, a shift mechanism **25**, and a throttle mechanism **26** corresponding to signals transmitted from the BCU **16**, the remote controller **9**, the joystick **10**, and the like, and adjusts the magnitude of the thrust of the outboard motor **3** and the acting direction of the thrust. Therefore, in the vessel steering system **15**, the vessel operator can control the speed and the direction of the bow of the marine vessel **1** by operating the joystick **10** and the lever **14** of the remote controller **9**. The shift mechanism **25** includes a clutch, a shift fork, and a gear, and changes the direction of the thrust in a front-rear direction by switching the rotation direction of the propeller **5**. The throttle mechanism **26** adjusts the intake air amount of the engine **4** to control the rotation speed of the engine **4**, and controls the magnitude of the thrust.

[0030] The vessel steering system **15** includes a manual vessel steering mode and an automatic vessel steering mode as vessel steering modes. In the automatic vessel steering mode, the BCU **16** controls the actuators of the steering mechanism **24**, the shift mechanism **25**, and the throttle mechanism **26** to navigate the marine vessel **1** without requiring an input operation by the vessel operator.

[0031] FIG. **4** is a diagram for explaining a control in the automatic vessel steering mode. In the automatic vessel steering mode, information about the surrounding situation is transmitted from the camera **20**, the radar **21**, and the LiDAR **22** to the BCU **16**. In addition, information related to a marine chart stored in a memory (not illustrated) included in the vessel steering system **15** is transmitted to the BCU **16**. Furthermore, weather information obtained via the communication I/F **23** or the like is transmitted to the BCU **16**. Further, destination information input by the vessel

operator via the MFD **11** and destination information obtained via the communication I/F **23** are transmitted to the BCU **16**. The BCU **16** transmits a control signal to each remote controller ECU **19** based on various types of information.

[0032] The BCU **16** determines the magnitude of the thrust to be generated by each outboard motor **3** and the acting direction of the thrust to be taken according to the program of the automatic vessel steering mode stored in the memory based on these pieces of information, and transmits a control signal to each remote controller ECU **19**. Each remote controller ECU **19** transmits a control signal to the steering mechanism **24**, the shift mechanism **25**, and the throttle mechanism **26**. The steering mechanism **24**, the shift mechanism **25**, and the throttle mechanism **26** operate the actuators in accordance with control signals to control the direction of each outboard motor **3**, the rotation direction of the propeller **5**, and the rotation speed of the engine **4**.

[0033] In the marine vessel **1**, when the vessel steering system **15** sets the vessel steering mode to the automatic vessel steering mode, the vessel steering mode is fixed in the automatic vessel steering mode in a locked state. In principle, the marine vessel **1** in the locked state is operated in an unmanned manner without the vessel operator, but there is a possibility that a third party on the marine vessel **1** may operate the lever **14**, the steering wheel **13**, the joystick **10**, and the main switch **12** of the remote controller **9** of the vessel steering seat **7**.

[0034] Therefore, in the locked state, even if the third party operates the lever **14**, the steering wheel **13**, the joystick **10**, or the main switch **12** of the remote controller **9**, the operation is ignored, and the touch panel function of the MFD **11** is stopped. Furthermore, in the locked state, the lever **14**, the steering wheel **13**, the joystick **10**, and the main switch **12** of the remote controller **9** may be fixed and physically inoperable.

[0035] However, when the marine vessel **1** is in an emergency situation, no person can steer the marine vessel **1** in the locked state, and the marine vessel **1** becomes unnavigable, which may cause trouble in the operation of the marine vessel. In response to this, in the present example embodiment, under a predetermined condition, the locked state is released and the vessel steering mode is changed from the automatic vessel steering mode to the manual vessel steering mode by an operation of the vessel operator on the marine vessel **1** that has become unnavigable or a third party who has a vessel steering qualification, or an instruction from the outside of the marine vessel **1**.

[0036] FIG. **5** is a flowchart illustrating a lock state release process to change the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode. This process is executed by the BCU **16** according to, for example, a program stored in the memory.

[0037] First, the BCU **16** detects whether or not the marine vessel **1** is in an emergency situation in which continuation of automatic navigation of the marine vessel is difficult (step S**51**). For example, when the marine vessel **1** is not movable although the marine vessel **1** is not in a fixed point holding state and each outboard motor **3** generates a thrust, the BCU **16** determines that the marine vessel **1** has been stranded, and detects that the marine vessel **1** is in an emergency situation. In addition, in a case where the BCU **16** determines that visibility is poor and visual navigation is impossible based on the information regarding the surrounding situation and the weather information, the BCU detects that the marine vessel **1** is in an emergency situation. Furthermore, in a case where the BCU **16** determines that the marine vessel **1** has entered a sea area where the marine vessel **1** is likely to be stranded based on the information regarding the current position of the marine vessel **1** and the marine chart, the BCU **16** detects that the marine vessel **1** is in an emergency situation.

[0038] Note that the BCU **16** may not detect whether the marine vessel **1** is in an emergency situation, but may transmit information regarding the surrounding situation, weather information, and information regarding the current position of the marine vessel **1** and the marine chart to an external device, for example, a server via the communication I/F **23**, and the server may detect whether the marine vessel **1** is in an emergency situation.

[0039] In step S**51**, in a case where it is not detected that the marine vessel **1** is in an emergency situation, the detection process is continued. In a case where it is detected in step S**51** that the marine vessel **1** is in an emergency situation, the BCU **16** notifies the external device that the marine vessel **1** is in an emergency situation via the communication I/F **23** (step S**52**). Note that the MFD **11** may also display that the marine vessel **1** is in an emergency situation. As a result, an employee of an operating company that externally manages the operation of the marine vessel **1** can know that the marine vessel **1** is in an emergency situation.

[0040] Next, the BCU **16** cancels the stop (locked state) of the touch panel function of the MFD **11**, and shifts the MFD **11** to a state in which a password can be input to the touch panel (step S**53**). At this time, the BCU **16** shifts the vessel steering system **15** to a state where a password can be input from an external device via the communication I/F **23**.

[0041] Next, the BCU **16** determines whether or not a password has been input to the MFD **11** by a vessel operator on the marine vessel **1** in response to a request from an employee of the operating company or a third party who has a vessel steering qualification, or whether or not a password has been input by an employee of the operating company from an external device (step S**54**). At this time, the BCU **16** also determines whether the input password is a password to release the locked state. Note that, in a case where the third party who has the vessel steering qualification needs to input a password to release the locked state to the MFD **11**, for example, the employee of the operating company notifies the third party of the password to release the locked state by communication or the like.

[0042] When the password is not input or the input password is not the password to release the locked state, the input of the password to release the locked state is kept on standby. During this period, the locked state is continued.

[0043] On the other hand, as a result of the determination in step S**54**, when the password has been input and the password is the password to release the locked state, the BCU **16** releases the locked state and changes the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode under certain conditions (step S**55**), and then terminates the process.

[0044] When the vessel steering mode is changed to the manual vessel steering mode, the vessel operator on the marine vessel **1** or the third party who has the vessel steering qualification takes over the vessel steering, and operates the lever **14**, the steering wheel **13**, and the joystick **10** of the

remote controller **9** to allow the marine vessel **1** to resolve or avoid the emergency situation. Alternatively, the employee of the operating company remotely operates the marine vessel **1** to cause the marine vessel **1** to resolve or avoid the emergency situation.

[0045] Note that, in the process of FIG. **5**, a general password including a combination of characters, numbers, and symbols, for example, is used as an unlock key to release the locked state. However, instead of the password, any of a passcode, a barcode, and a quick response code, e.g., a QR code (registered trademark) may be used as the unlock key.

[0046] FIG. **6** is a flowchart illustrating a vessel steering mode change process executed in step S**55** of FIG. **5**. This process is also executed by the BCU **16** according to, for example, a program stored in the memory. Each lever **14** of the remote controller **9** can be physically operated, but a control signal is not transmitted to each remote controller ECU **19** by the operation.

[0047] First, the BCU **16** checks the positions of the respective levers **14** of the remote controller **9**, and determines whether respective levers **14** are located at the forward position or the backward position, or at a neutral position between the forward position and the backward position (step S**61**). When each lever **14** is located at the neutral position, the process proceeds to step S**64**. On the other hand, when each lever **14** is located at the forward position or the backward position, the BCU **16** waits for a predetermined period of time (step S**62**), and then determines whether each lever **14** is moved to the neutral position (step S**63**).

[0048] As a result of the determination in step S**63**, when each lever **14** is not moved to the neutral position, the process returns to step S**62**. On the other hand, when each lever **14** is moved to the neutral position, the process proceeds to step S**64**, the vessel steering mode is shifted from the automatic vessel steering mode to the manual vessel steering mode, and then this process is ended.

[0049] That is, in the process of FIG. **6**, when each lever **14** of the remote controller **9** is located at the neutral position, the vessel steering mode is immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. When each lever **14** is located at the forward position or the backward position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. Therefore, when the vessel steering mode shifts to the manual vessel steering mode, the marine vessel **1** is not suddenly accelerated or suddenly decelerated, and it is possible to prevent the ride comfort of the marine vessel **1** from deteriorating.

[0050] In the process of FIG. **6**, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode is controlled based only on the position of each lever **14** of the remote controller **9**. However, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode may be controlled based on not only the position of each lever **14** of the remote controller **9** but also the tilt state of the joystick **10**.

[0051] In this case, when the joystick **10** is not tilted, the vessel steering mode is immediately shifted from the automatic vessel steering mode to the manual vessel steering mode, and when the joystick **10** is tilted in one of the front, rear, left, and right directions, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. Therefore, even if each lever **14** of the remote controller **9** is located at the neutral position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode when the joystick **10** is tilted in one of the front, rear, left, and right directions.

[0052] In addition, even when each lever **14** of the remote controller **9** is located at the neutral position, the vessel steering mode may not be immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. FIG. **7** is a flowchart illustrating a first modification of the vessel steering mode change process executed in step S**55** in FIG. **5**. This process is also executed by the BCU **16** according to, for example, a program stored in the memory.

[0053] First, the BCU **16** checks the position of each lever **14** of the remote controller **9**, and determines whether each lever **14** is located at the forward position, the backward position, or the neutral position (step S**71**). When each lever **14** is located at the neutral position, the process proceeds to step S**74**. On the other hand, when each lever **14** is located at the forward position or the backward position, the BCU **16** waits for a predetermined period of time (step S**72**), and then determines whether each lever **14** is moved to the neutral position (step S**73**).

[0054] As a result of the determination in step S**73**, when each lever **14** is not moved to the neutral position, the process returns to step S**72**. On the other hand, when each lever **14** is moved to the neutral position, the process proceeds to step S**74**.

[0055] Next, the BCU **16** waits for a predetermined period of time (step S**74**), and then determines whether each lever **14** has been moved to the forward position or the backward position (step S**75**). Then, when each lever **14** is not moved to the forward position or the backward position, the process returns to step S**74**. On the other hand, when each lever **14** is moved to the forward position or the backward position, the process proceeds to step S**76**, the vessel steering mode is shifted from the automatic vessel steering mode to the manual vessel steering mode, and then the process is terminated.

[0056] In the process of FIG. **7**, similarly to the process of FIG. **6**, when each lever **14** is located at the forward position or the backward position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode.

[0057] In the process of FIG. **7**, even when each lever **14** is located at the neutral position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode, and thereafter, when each lever **14** is moved to the forward position or the backward position, the vessel steering mode is shifted to the manual vessel steering mode. As a result, before the vessel operator on the marine vessel **1** or the third party who has the vessel steering qualification takes over the vessel steering, there is time for the vessel operator or the third party who has the vessel steering qualification to confirm the surrounding situation in a state where each lever **14** is located at the neutral position, that is, in a state where the thrust of each outboard motor **3** does not act on the marine vessel **1**. Therefore, it is possible to reduce the probability that the vessel operator or the third party who has the vessel steering

qualification and takes over the vessel steering overlooks a dangerous object or situation in the surroundings. In addition, since the vessel steering mode is shifted to the manual vessel steering mode only when the vessel operator has confirmed the safety of the surroundings or the third party who has the qualification of vessel steering moves each lever **14** to the forward position or the backward position, the vessel operator or the third party who has the qualification of vessel steering can start vessel steering after confirming the safety of the surroundings.

[0058] Also in the process of FIG. **7**, whether to shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode may be controlled based on not only the position of each lever **14** of the remote controller **9** but also the tilt state of the joystick **10**.

[0059] In this case, even when the joystick **10** is not tilted, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode, and thereafter, when the joystick **10** is tilted forward or backward, the vessel steering mode is shifted to the manual vessel steering mode. Therefore, even if each lever **14** of the remote controller **9** moves to the forward position or the backward position after being located at the neutral position, the vessel steering mode is not shifted from the automatic vessel steering mode to the manual vessel steering mode unless the joystick **10** is tilted.

[0060] In the process of FIGS. **6** and **7**, the vessel operator or the third party who has the vessel steering qualification operates each lever **14** of the remote controller **9** and the joystick **10**.

[0061] In the process of FIGS. **6** and **7** described above, whether or not to change the vessel steering mode depends on the position of each lever **14** of the remote controller **9** and the tilt state of the joystick **10**, that is, whether or not the thrust of each outboard motor **3** acts on the marine vessel **1**. However, whether or not to change the vessel steering mode may depend on whether or not the marine vessel **1** travels straight or turns.

[0062] FIG. **8** is a flowchart illustrating a second modification of the vessel steering mode change process executed in step S**55** in FIG. **5**. This process is also executed by the BCU **16** according to, for example, a program stored in the memory.

[0063] First, the BCU **16** checks the direction (rudder angle position) of each outboard motor **3**, and determines whether the rudder angle position is the turning rudder angle position or the straight advancing rudder angle position (step S**81**). Then, in a case where the rudder angle position is the straight advancing rudder angle position, the process proceeds to step S**84**. On the other hand, when the rudder angle position is the turning rudder angle position, the BCU **16** waits for a predetermined period of time (step S**82**), and then, determines whether the rudder angle position has been changed to the straight advancing rudder angle position (step S**83**).

[0064] As a result of the determination in step S**83**, in a case where the rudder angle position has not been changed to the straight advancing rudder angle position, the process returns to step S**82**. On the other hand, when the rudder angle position is changed to the straight advancing rudder angle position, the process proceeds to step S**84**, the vessel steering mode is shifted from the automatic vessel steering mode to the manual vessel steering mode, and then this process is ended.

[0065] In the process of FIG. **8**, when the rudder angle position is the straight advancing rudder angle position, the vessel steering mode is immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. On the other hand, when the rudder angle position is the turning rudder angle position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. With this, the vessel steering mode is not shifted to the manual vessel steering mode while the marine vessel **1** is turning. As a result, since the vessel steering mode is not shifted to the manual vessel steering mode in an unstable state while the marine vessel **1** is turning, it is possible to prevent the vessel operator or the third party who has the qualification of vessel steering from making an operation error due to shaking of the hull **2** or the like.

[0066] As described above, in the process of FIG. **8**, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode is controlled based on the rudder angle position. Meanwhile, it is also conceivable to control whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode based on the rotation angle of the steering wheel **13** related to the rudder angle position.

[0067] However, the correspondence relationship between the rotation angle of the steering wheel **13** and the rudder angle position does not always match. For example, even when the power supply of the vessel steering system **15** is turned off, the steering wheel **13** can be rotated. For this reason, when the power of the vessel steering system **15** is temporarily turned off while the rudder angle position is the straight advancing rudder angle position, and the power of the vessel steering system **15** is turned on after the steering wheel **13** is rotated, the BCU **16** recognizes that the rotation angle of the steering wheel **13** at this time corresponds to the straight advancing rudder angle position. That is, the correspondence relationship between the rotation angle of the steering wheel **13** and the rudder angle position changes.

[0068] Therefore, when it is controlled whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode based on the rotation angle of the steering wheel **13**, there is a possibility that the vessel steering mode is shifted to the manual vessel steering mode in a state where the marine vessel **1** is turning. Therefore, in the present example embodiment, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode is controlled based on the rudder angle position instead of the rotation angle of the steering wheel **13**.

[0069] In addition, even when the rudder angle position is the straight advancing rudder angle position, it is not necessary to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode. FIG. **9** is a flowchart illustrating a third modification of the vessel steering mode change process executed in step S**55** in FIG. **5**. This process is also executed by the BCU **16** according to, for example, a program stored in the memory.

[0070] First, the BCU **16** confirms the rudder angle position, and determines whether the rudder angle position is the turning rudder angle position or the straight advancing rudder angle position (step S**91**). Then, in a case where the

rudder angle position is the straight advancing rudder angle position, the process proceeds to step S**94**. On the other hand, when the rudder angle position is the turning rudder angle position, the BCU **16** waits for a predetermined period of time (step S**92**), and then, determines whether the rudder angle position has been changed to the straight advancing rudder angle position (step S**93**).

[0071] As a result of the determination in step S**93**, in a case where the rudder angle position has not been changed to the straight advancing rudder angle position, the process returns to step S**92**. On the other hand, in a case where the rudder angle position has been changed to the straight advancing rudder angle position, the process proceeds to step S**94**.

[0072] Next, the BCU **16** waits for a predetermined period of time (step S**94**), and then, it is determined whether the rudder angle position has been changed to the turning rudder angle position (step S**95**). When the rudder angle position has not been changed to the turning rudder angle position, the process returns to step S**94**. On the other hand, when the rudder angle position has been changed to the turning rudder angle position, the process proceeds to step S**96**, the vessel steering mode is shifted from the automatic vessel steering mode to the manual vessel steering mode, and then the process is terminated.

[0073] In the process of FIG. **8**, when the rudder angle position is the straight advancing rudder angle position (NO in step S**81**), the vessel steering mode is immediately shifted from the automatic vessel steering mode to the manual vessel steering mode.

[0074] In the process of FIG. **9**, even when the rudder angle position is the straight advancing rudder angle position (NO in step S**91**), the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. Therefore, it is possible to reduce or prevent an operation error by the vessel operator or the third party who has the vessel steering qualification.

[0075] In addition, in the process of FIG. **9**, even when the rudder angle position is the straight advancing rudder angle position, the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode, and thereafter, when the rudder angle position is changed to the turning rudder angle position, the vessel steering mode is shifted to the manual vessel steering mode. As a result, before the vessel operator or the third party who has the vessel steering qualification takes over the vessel steering, there is time for the vessel operator or the third party who has the vessel steering qualification to confirm the surrounding situation in a state where the rudder angle position is located at the straight advancing rudder angle position, that is, in a stable state where the turning force does not act on the marine vessel **1**. Therefore, it is possible to reduce or prevent the probability that the vessel operator or the third party who has the vessel steering qualification overlooks a dangerous object or situation in the surroundings.

[0076] Note that, in the process of FIGS. **8** and **9**, the vessel operator or the third party who has the vessel steering qualification operates the steering wheel **13** or the joystick **10** to change the rudder angle position.

[0077] According to the present example embodiment, the locked state is released by the input of the password, and the vessel steering mode is changed from the automatic vessel steering mode to the manual vessel steering mode. With this, even if the marine vessel **1** is in an emergency situation, the vessel operator on the marine vessel **1** or the third party who has the vessel steering qualification can take over the vessel steering and steer the marine vessel **1** to cause the marine vessel **1** to resolve or avoid the emergency situation, or an employee of an operating company can remotely control the marine vessel **1** to cause the marine vessel **1** to resolve or avoid the emergency situation. As a result, the marine vessel **1** becomes navigable, and the operation of the marine vessel can be maintained.

[0078] Example embodiments of the present invention have been described above, however, the present invention is not limited to the example embodiments described above, and various modifications and changes are possible within the scope of the present invention.

[0079] For example, in principle, the vessel operator should not board the marine vessel **1** that is fixed in the automatic vessel steering mode, but in actuality, the vessel operator or the employee of the operating company may board the marine vessel **1** that is fixed in the automatic vessel steering mode. In this case, the vessel operator or the employee inputs a password to release the locked state to the MFD **11**, and after the vessel steering mode is changed to the manual vessel steering mode, the vessel operator or the employee steers the marine vessel **1**.

[0080] In addition, in the process of FIGS. **6** and **7**, the shift of the vessel steering mode to the manual vessel steering mode is controlled based on only the position of each lever **14** of the remote controller **9** or the position of each lever **14** of the remote controller **9** and the tilt state of the joystick **10**, and in the process of FIGS. **8** and **9**, the shift of the vessel steering mode to the manual vessel steering mode is controlled based on the rudder angle position.

[0081] However, by combining the process of FIG. **6** or FIG. **7** with the process of FIG. **8** or FIG. **9**, the shift of the vessel steering mode to the manual vessel steering mode may be controlled based on the position of each lever **14** of the remote controller **9**, and the rudder angle position, or based on the position of each lever **14** of the remote controller **9**, the tilt state of the joystick **10**, and the rudder angle position.

[0082] Furthermore, in the process of FIGS. **8** and **9**, when the rudder angle position is the turning rudder angle position after the execution of step S**54**, the vessel operator or the third party who has the vessel steering qualification operates the steering wheel **13** or the joystick **10** to change the rudder angle position to the straight advancing rudder angle position. However, when the rudder angle position is the turning rudder angle position after the execution of step S**54**, the BCU **16** may control each actuator of the steering mechanism **24** to change the rudder angle position to the straight advancing rudder angle position without operating the steering wheel **13** or the joystick **10** by the vessel operator or the third party who has the vessel steering qualification. In this case, after the rudder angle position is changed to the straight advancing rudder angle position, the vessel steering mode is shifted from the automatic vessel steering mode to the manual vessel steering mode.

[0083] In the process of FIGS. **6** and **7**, when each lever **14** is located at the forward position or the backward position after step S**54** is executed (YES in step S**61** or step S**71**), the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. However, in the remote controller **9**, when the for-

ward position and the backward position are set in several stages or the forward position and the backward position are set within a certain range, even if each lever **14** is located at the forward position or the backward position, when the shift amount of each lever **14** from the neutral position is equal to or less than a predetermined amount, the vessel steering mode may be immediately shifted from the automatic vessel steering mode to the manual vessel steering mode.

[0084] Furthermore, in the process of FIGS. **8** and **9**, when the rudder angle position is the turning rudder angle position after execution of step S**54** (YES in step S**81** or step S**91**), the vessel steering mode is not immediately shifted from the automatic vessel steering mode to the manual vessel steering mode. However, even when the rudder angle position is the turning rudder angle position, the vessel steering mode may be immediately shifted from the automatic vessel steering mode to the manual vessel steering mode when the amount of change in the direction of the outboard motor **3** from the straight advancing rudder angle position is equal to or less than a predetermined amount.

[0085] Further, in the above-described example embodiments, the case where the marine vessel **1** including the outboard motor **3** has been described, but example embodiments of the present invention may be applied to a marine vessel including an inboard motor or an inboard/outboard motor. In this case, in the process of FIGS. **8** and **9**, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode is controlled according to the direction of the rudder and/or the direction of the drive unit. Further, example embodiments of the present invention may be applied to a jet propulsion boat. In this case, in the process of FIGS. **8** and **9**, whether or not to immediately shift the vessel steering mode from the automatic vessel steering mode to the manual vessel steering mode is controlled according to the direction of a deflector of the jet propulsion unit.

[0086] While example embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A vessel steering system comprising:

a boat controller configured or programmed to include an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes; wherein

when an unlock key is received in a locked state in which the vessel steering mode is fixed in the automatic vessel steering mode, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

2. The vessel steering system according to claim **1**, wherein the boat controller is configured or programmed to receive the unlock key when a marine vessel including the vessel steering system is in an emergency situation.

3. The vessel steering system according to claim **2**, wherein the emergency situation includes stranding of the marine vessel, unnavigability of the marine vessel due to poor visibility, or entry into a sea area where the marine vessel is likely to be stranded.

4. The vessel steering system according to claim **1**, further comprising a manual operator to receive the unlock key.

5. The vessel steering system according to claim **1**, further comprising:

a communicator; wherein

the unlock key is received from outside a marine vessel including the vessel steering system via the communicator.

6. The vessel steering system according to claim **5**, wherein

in a case where the unlock key is received from the outside of the marine vessel via the communicator, the boat controller is configured or programmed to enable remote control of the marine vessel in the manual vessel steering mode.

7. The vessel steering system according to claim **1**, further comprising:

marine vessel steering equipment operable after the unlock key is received and the automatic vessel steering mode is shifted to the manual vessel steering mode.

8. The vessel steering system according to claim **7**, wherein

the marine vessel steering equipment includes a remote controller including a lever; and

when the unlock key is received, the boat controller is configured or programmed to:

in a case where the lever is located at a neutral position where a thrust is not applied to the marine vessel, immediately shift the automatic vessel steering mode to the manual vessel steering mode; and

in a case where the lever is not located at the neutral position, shift the automatic vessel steering mode to the manual vessel steering mode after the lever is shifted to the neutral position.

9. The vessel steering system according to claim **7**, wherein

the marine vessel steering equipment includes a remote controller including a lever; and

when the unlock key is received in a case where the lever is located at a forward position that advances the marine vessel or a backward position that reverses the marine vessel, the boat controller is configured or programmed to not shift the automatic vessel steering mode to the manual vessel steering mode; and

when the lever is moved to a neutral position that does not apply thrust to the marine vessel, the boat controller is configured or programmed to immediately shift the automatic vessel steering mode to the manual vessel steering mode, or when the lever is once moved to the neutral position and then moved to the forward position or the backward position, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

10. The vessel steering system according to claim **1**, wherein

when the unlock key is received in a case where a rudder angle position of a marine vessel including the vessel steering system is located at a straight advancing rudder angle position that moves the marine vessel straight, the boat controller is configured or programmed to immediately shift the automatic vessel steering mode to the manual vessel steering mode, or shift the automatic vessel steering mode to the manual vessel steering mode after the rudder angle position of the marine vessel is changed to a turning rudder angle position that turns the marine vessel leftward or rightward.

11. The vessel steering system according to claim **1**, wherein

when the unlock key is received, the boat controller is configured or programmed to not shift the automatic vessel steering mode to the manual vessel steering mode when a rudder angle position of a marine vessel including the vessel steering system is at a turning rudder angle position that turns the marine vessel to leftward or rightward; and

when the rudder angle position of the marine vessel is changed to a straight advancing rudder angle position that moves the marine vessel straight, the boat controller is configured or programmed to immediately shift the automatic vessel steering mode to the manual vessel steering mode, or when the rudder angle position of the marine vessel is once changed to the straight advancing rudder angle position and then changed to the turning rudder angle position, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

12. The vessel steering system according to claim **1**, wherein

when the unlock key is received in a case where a rudder angle position of a marine vessel including the vessel steering system is a turning rudder angle position that turns the marine vessel to leftward or rightward, the boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode after the rudder angle position of the marine vessel is changed to a straight advancing rudder angle position that moves the marine vessel straight.

13. The vessel steering system according to claim **1**, wherein the unlock key is a password, a passcode, a barcode, or a quick response code.

14. A method for controlling a vessel steering system including an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes, the method comprising:

shifting the automatic vessel steering mode to the manual vessel steering mode when an unlock key is received in a locked state in which the vessel steering mode is fixed in the automatic vessel steering mode.

15. A marine vessel comprising:

a vessel steering system including a boat controller configured or programmed to include an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes; wherein

when an unlock key is received in a locked state in which the vessel steering mode is fixed in the automatic vessel steering mode, boat controller is configured or programmed to shift the automatic vessel steering mode to the manual vessel steering mode.

16. A vessel steering system comprising:

a boat controller configured or programmed to include an automatic vessel steering mode and a manual vessel steering mode as vessel steering modes; wherein

when an unlock key is received in a locked state in which the vessel steering mode is fixed in the automatic vessel steering mode, the boat controller is configured or programmed to release the locked state.

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