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SEAFARER SAFETY DEVICE, SEAFARER SAFETY SYSTEM, SEAFARER SAFETY PROGRAM, VESSEL ACTIVITY INFERENCE DEVICE, REPORT GENERATION ASSISTANCE SYSTEM, AND VESSEL ACTIVITY INFERENCE PROGRAM

Abstract

A seafarer safety device (**500**) includes an evaluator (**510***a*) and an inboard outputter (**510***k*). The evaluator (**510***a*) executes an evaluation process of evaluating whether a crew in emergency circumstances, on the basis of the intensities of notification radio waves indicating the existence of the crew on a craft and transmitted from a wearable transmitting device that repetitively transmits the notification radio waves, and on the basis of the strengths of rocking motions of the craft detected by a craft rocking-motion sensor that detects the strengths of rocking motions. The inboard outputter (**510***k*) outputs, to an alarm unit, an emergency evaluation signal indicating a result of evaluation, when the evaluator (**510***a*) evaluates that the crew is in emergency circumstances.

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Background/Summary

TECHNICAL FIELD
[0001] The present disclosure relates to a crew watching apparatus, a crew watching system, a crew watching program, a craft activity estimating apparatus, a report generation assistance system, and a craft activity estimating program.
BACKGROUND ART
[0002] As disclosed in Patent Literature 1, a system has been known including a transmitting device worn by a crew, and a management device that receives radio waves transmitted from the transmitting device and thus manages the location of the crew.
[0003] As disclosed in Patent Literature 2, another system has been known that facilitates generation of a report for reporting achievements of a navigation. The process of facilitating generation of a report uses data, such as craft location data indicating the locations of a craft during a navigation.
CITATION LIST
Patent Literature
[0004] Patent Literature 1: Unexamined Japanese Patent Application Publication No. 2020-8492
[0005] Patent Literature 2: Unexamined Japanese Patent Application Publication No. 2021-157722
SUMMARY OF INVENTION
Technical Problem
[0006] The system disclosed in Patent Literature 1 evaluates whether the crew is in emergency circumstances and needs an alarm, on the basis of only the level of attenuation of radio waves received from the transmitting device by the management device. The system having such a simple configuration may find it difficult to properly detect emergency circumstances.
[0007] A first objective of the present disclosure, which has been accomplished to solve the above problem, is to provide a device designed to monitor crew members, detect emergency situations, and trigger appropriate responses to ensure their safety.
[0008] In the system disclosed in Patent Literature 2, the vessel's location data is used solely to pinpoint the exact location of the fishing operation. The system disclosed in Patent Literature 2 lacks the capability to automatically infer the specific activities undertaken during the vessel's navigation. This limitation prevents the system from realizing potential benefits, such as streamlined report generation.
[0009] A second objective of the present disclosure, which has been accomplished to solve the above problem, is to provide a craft activity estimating apparatus, a report generation assistance system, and a craft activity estimating program capable of estimating specific activities of a craft during a navigation.
Solution to Problem
[0010] A crew watching apparatus according to a first aspect of the present disclosure includes:

[0011] an evaluator to perform an evaluation process to determine whether or not an emergency has occurred for a crew member based on the strength of the notification radio wave received from a crew-worn transmitter that repeatedly transmits the notification radio wave to indicate the presence of the crew member, and the detection result of a ship motion sensor that repeatedly detects the severity of the ship's motion on which the crew member is boarding; and [0012] an outputter to output an emergency evaluation signal indicating a result of evaluation, when the evaluator evaluates that the crew is in emergency circumstances.
[0013] The evaluator may include [0014] a low-intensity period determiner to compare the intensities of the notification radio waves with a threshold radio-wave intensity, and to determine a length of a low-intensity period while the intensities of the notification radio waves are lower than the threshold radio-wave intensity, the threshold radio-wave intensity being preliminarily set as a threshold implying existence of the crew on the craft, [0015] an initial locking-motion strength determiner to determine, based on the strengths of the rocking motions detected by the craft rocking-motion sensor, an initial locking-motion strength that indicates a strength of locking motions of the craft at start of the low-intensity period, and [0016] an evaluation process executor to execute the evaluation process of evaluating, based on the length of the low-intensity period determined by the low-intensity period determiner and the initial locking-motion strength determined by the initial locking-motion strength determiner, whether the crew is in emergency circumstances.
[0017] When the length of the low-intensity period exceeds an allowable length of low-intensity period, the evaluation process executor evaluates that the crew is in emergency circumstances, the allowable length of low-intensity period being set as a threshold implying normal circumstances of the crew, and [0018] the evaluator may further include [0019] an allowable low-intensity period setter to set the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength determined by the initial locking-motion strength determiner.
[0020] The notification radio wave includes a detection result that detects the crew member's movement or biological activity. The evaluator may determine whether or not an emergency has occurred for the crew member based not only on the strength of the notification radio wave and the detection result of the ship motion sensor, but also on the detection result of the crew member's movement or health/physical activity included in the notification radio waves.
[0021] The notification radio waves may contain detected values indicating motions of the crew, [0022] the evaluator may include a corrector [0023] to remove a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the detected values indicating the motions of the crew contained in the notification radio waves and the strengths of the rocking motions detected by the craft rocking-motion sensor, and [0024] to generate corrected crew data indicating motions of the crew relative to the craft, and [0025] the corrected crew data may be used in the evaluation process.
[0026] A crew watching program according to a first aspect of the present disclosure is configured to cause a computer to serve as: [0027] an evaluator to perform an evaluation process to determine whether or not an emergency has occurred for a crew member based on the strength of the notification radio wave received from a crew-worn transmitter that repeatedly transmits the notification radio wave to indicate the presence of the crew member, and the detection result of a ship motion sensor that repeatedly detects the severity of the ship's motion on which the crew member is boarding; and [0028] an outputter to output an emergency evaluation signal indicating a result of evaluation, when the evaluator evaluates that the crew is in emergency circumstances.
[0029] A craft activity estimating apparatus according to a first aspect of the present disclosure includes: [0030] a craft location data acquirer to acquire craft location data containing a chronological series of detected values indicating locations of a craft during a navigation; [0031] an estimator to estimate, based on the craft location data acquired by the craft location data acquirer, specific activities performed during the navigation of the craft; and [0032] an outputter to output

activity data indicating the specific activities estimated by the estimator.

[0033] The vessel activity estimation device according to a first aspect of the present invention further includes: [0034] a crew data acquisition unit that acquires crew data in which detection values representing a movement or a physical activity of a crew member on board the vessel are arranged in chronological order; and the estimation unit may estimate the activity content, using not only the vessel position data, but also the crew data during the navigation period.

[0035] The crew data may contain a chronological series of detected values indicating motions of the crew, [0036] the craft activity estimating apparatus may further include [0037] a craft rocking-motion data acquirer to acquire craft rocking-motion data containing a chronological series of detected values indicating strengths of locking motions of the craft, and [0038] a corrector [0039] to remove a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the crew data and the craft rocking-motion data, and [0040] to generate corrected crew data indicating motions of the crew relative to the craft, and [0041] the estimator may estimate the specific activities, not only based on the craft location data but also the corrected crew data during the navigation.

[0042] The craft activity estimating apparatus according to the first aspect of the present disclosure may further include: [0043] an equipment state data acquirer to acquire equipment state data containing a chronological series of detected values indicating states of operation or usage of fishing and navigation equipment installed in the craft, wherein [0044] the estimator may estimate the specific activities, based on not only the craft location data but also the equipment state data during the navigation.

[0045] The estimator may be achieved by a trained model generated through machine learning for estimation of the specific activities from the craft location data.

[0046] A craft activity estimating program according to a first aspect of the present disclosure is configured to cause a computer to serve as: [0047] a craft location data acquirer to acquire craft location data containing a chronological series of detected values indicating locations of a craft during a navigation; [0048] an estimator to estimate, based on the craft location data acquired by the craft location data acquirer, specific activities performed during the navigation of the craft; and [0049] an outputter to output activity data indicating the specific activities estimated by the estimator.

[0050] A crew watching apparatus according to a second aspect of the present disclosure includes: [0051] at least one processor, wherein [0052] the at least one processor executes [0053] an evaluation process of evaluating, based on intensities of notification radio waves indicating existence of a crew on a craft and strengths of rocking motions of the craft detected by a craft rocking-motion sensor, whether the crew is in emergency circumstances, the notification radio waves being received from a wearable transmitting device that repetitively transmits the notification radio waves, the craft rocking-motion sensor repetitively detecting the strengths of the rocking motions, and [0054] an outputting process of outputting an emergency evaluation signal indicating a result of evaluation, when the crew is evaluated to be in emergency circumstances in the evaluation process.

[0055] The evaluation process may involve [0056] a low-intensity period determining process of comparing the intensities of the notification radio waves with a threshold radio-wave intensity, and determining a length of a low-intensity period while the intensities of the notification radio waves are lower than the threshold radio-wave intensity, the threshold radio-wave intensity being preliminarily set as a threshold implying existence of the crew on the craft, [0057] an initial locking-motion strength determining process of determining, based on the strengths of the rocking motions detected by the craft rocking-motion sensor, an initial locking-motion strength that indicates a strength of locking motions of the craft at start of the low-intensity period, and [0058] an evaluation execution process of evaluating, based on the length of the low-intensity period determined in the low-intensity period determining process and the initial locking-motion strength determined in the initial locking-motion strength determining process, whether the crew is in emergency circumstances.

[0059] When the length of the low-intensity period exceeds an allowable length of low-intensity period, the crew is evaluated to be in emergency circumstances in the evaluation execution process, the allowable length of low-intensity period being set as a threshold implying normal circumstances of the crew, and [0060] the evaluation process may further involve [0061] an allowable low-intensity period setting process of setting the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength determined in the initial locking-motion strength determining process.

[0062] The notification radio waves may contain detected values indicating motions or organic activities of the crew, and [0063] the at least one processor may evaluate, based on not only the intensities of the notification radio waves and the strengths of the rocking motions detected by the craft rocking-motion sensor but also the detected values indicating the motions or organic activities of the crew contained in the notification radio waves, whether the crew is in emergency circumstances, in the evaluation process.

[0064] The notification radio waves may contain detected values indicating motions of the crew, [0065] the evaluation process may further involve [0066] a correction process of [0067] removing a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the detected values indicating the motions of the crew contained in the notification radio waves and the strengths of the rocking motions detected by the craft rocking-motion sensor, and [0068] generating corrected crew data indicating motions of the crew relative to the craft, and [0069] the corrected crew data may be used in evaluation of whether the crew is in emergency circumstances.

[0070] A crew watching system according to a first aspect of the present disclosure includes: [0071] the crew monitoring device according to the first or second aspect of the present invention described above; [0072] an alarm device that is installed on the vessel and performs an alarm operation to issue an alarm upon acquisition of the emergency detection signal from the crew monitoring device; and [0073] an alarm release device that is installed on the vessel, and when receiving an operation from the crew member to stop the alarm operation when the alarm operation is being performed by the alarm device, causes the alarm device to stop the alarm operation.

[0074] The crew watching apparatus may inform a server outside the vessel that the crew is in emergency circumstances, when the alarm operation of the alarm unit continues for a period longer than a confirmation period preliminarily set as a period required by the crew for canceling the alarm operation.

[0075] The crew watching system according to the first aspect of the present disclosure may further include: [0076] the wearable transmitting device worn by the crew to transmit the notification radio waves; and [0077] the craft rocking-motion sensor installed in the craft to detect the strengths of the locking motions of the craft.

[0078] A craft activity estimating apparatus according to a second aspect of the present disclosure includes: [0079] at least one processor, wherein [0080] the at least one processor executes [0081] a craft-location-data acquiring process of acquiring craft location data containing a chronological series of detected values indicating locations of a craft during a navigation, [0082] an estimation process of estimating, based on the craft location data acquired in the craft-location-data acquiring process, specific activities performed during the navigation of the craft, and [0083] an outputting process of outputting activity data indicating the specific activities estimated in the estimation process.

[0084] The at least one processor may further execute [0085] a crew data acquiring process of acquiring crew data containing a chronological series of detected values indicating motions or organic activities of a crew on the craft, and [0086] the at least one processor estimates the specific activities, based on not only the craft location data but also the crew data during the navigation, in

the estimation process.
[0087] The crew data may contain a chronological series of detected values indicating motions of the crew, [0088] the at least one processor may further execute [0089] a craft rocking-motion data acquiring process of acquiring craft rocking-motion data containing a chronological series of detected values indicating strengths of locking motions of the craft, and [0090] a correction process of [0091] removing a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the crew data and the craft rocking-motion data, and [0092] generating corrected crew data indicating motions of the crew relative to the craft, and [0093] the at least one processor may estimate the specific activities, not only based on the craft location data but also the corrected crew data during the navigation, in the estimation process.
[0094] The at least one processor may further execute [0095] an equipment-state data acquiring process of acquiring equipment state data containing a chronological series of detected values indicating states of operation or usage of equipment installed in the craft, and [0096] the at least one processor may estimate the specific activities, based on not only the craft location data but also the equipment state data during the navigation, in the estimation process.
[0097] The estimation process may be executed using a trained model generated through machine learning for estimation of the specific activities from the craft location data.
[0098] A report generation assistance system according to a first aspect of the present disclosure includes: [0099] the craft activity estimating apparatus according to the first aspect or the second aspect of the present disclosure; and [0100] a report generating server [0101] to acquire the activity data from the craft activity estimating apparatus, and [0102] to generate, based on the acquired activity data, report data indicating results of the navigation.
Advantageous Effects of Invention
[0103] The crew watching apparatus according to the first and second aspects of the present disclosure, the crew watching system according to the first aspect of the present disclosure, and the crew watching program according to the first aspect of the present disclosure can estimate whether the crew is in emergency circumstances, on the basis of not only the intensities of the notification radio waves but also the strengths of rocking motions of the craft. These configurations can thus properly detect emergency circumstances of the crew.
[0104] The craft activity estimating apparatus according to the first and second aspects of the present disclosure, the report generation assistance system according to the first aspect of the present disclosure, and the craft activity estimating program according to the first aspect of the present disclosure can estimate specific activities of the craft during the navigation.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0105] FIG. **1** is a conceptual diagram illustrating a configuration of a crew watching system according to Embodiment 1;
[0106] FIG. **2** is a conceptual diagram illustrating a configuration of a wearable transmitting device according to Embodiment 1;
[0107] FIG. **3** is a conceptual diagram illustrating a configuration of a crew watching apparatus according to Embodiment 1;
[0108] FIG. **4** is a conceptual diagram illustrating functions of the crew watching apparatus according to Embodiment 1;
[0109] FIG. **5** is a flowchart illustrating a crew watching process according to Embodiment 1;
[0110] FIG. **6** is a conceptual diagram illustrating functions of a crew watching apparatus according to Embodiment 2;

[0111] FIG. **7** is a conceptual diagram illustrating a configuration of a report generation assistance system according to Embodiment 3;
[0112] FIG. **8** is a conceptual diagram illustrating a configuration of a craft activity estimating apparatus according to Embodiment 3;
[0113] FIG. **9** is a conceptual diagram illustrating functions of the craft activity estimating apparatus according to Embodiment 3;
[0114] FIG. **10** is a conceptual diagram illustrating a trajectory specified by craft location data according to Embodiment 3;
[0115] FIG. **11** is a conceptual diagram illustrating another trajectory specified by the craft location data according to Embodiment 3;
[0116] FIG. **12** is a conceptual diagram illustrating a configuration of a learned model generating device according to Embodiment 3; and
[0117] FIG. **13** is a conceptual diagram illustrating functions of a craft activity estimating apparatus according to Embodiment 4.

DESCRIPTION OF EMBODIMENTS

[0118] The following describes Embodiments 1 to 3 with reference to the accompanying drawings. In the drawings, the components identical or corresponding to each other are provided with the same reference symbol.

Embodiment 1

[0119] As illustrated in FIG. **1**, a crew watching system (a seafarer safety system) **100**A according to Embodiment 1 includes a crew watching apparatus (a seafarer safety device) **500** installed in a craft FS, and an external monitoring server **710** capable of communication with the crew watching apparatus **500** via a communication line NE. A typical example of the craft FS is a fishing craft.
[0120] The crew watching system **100**A includes a wearable transmitting device **200** worn by a crew FP on the craft FS, and a craft rocking-motion sensor **310** installed in the craft FS. The wearable transmitting device **200** repetitively transmits notification radio waves **200***e* indicating the existence of the crew FP.
[0121] The craft rocking-motion sensor **310** repetitively detects strengths of locking motions of the craft FS, and generates craft rocking-motion data containing a chronological series of detected values indicating the strengths of locking motions of the craft FS. Specifically, the craft rocking-motion sensor **310** includes an acceleration sensor.
[0122] The crew watching apparatus **500** receives the notification radio waves **200***e* from the wearable transmitting device **200**, and acquires the craft rocking-motion data from the craft rocking-motion sensor **310**, so as to execute a crew watching process of determining in real time whether the crew FP is in safety.
[0123] The crew watching system **100**A also includes an alarm unit **410** and an alarm canceling unit **420** individually installed in the craft FS. The alarm unit **410** performs an alarm operation for issuing an alarm for confirmation of the safety of the crew FP. The alarm canceling unit **420**, when receiving a manipulation of the crew FP for stopping the alarm operation during the alarm operation of the alarm unit **410**, causes the alarm unit **410** to stop the alarm operation.
[0124] The crew watching apparatus **500** causes the alarm unit **410** to initiate the alarm operation, when the safety of the crew FP is not confirmed in the crew watching process. The crew watching apparatus **500** outputs an emergency notification signal **500***e* indicating that the crew FP is in emergency circumstances, wirelessly to the external monitoring server **710**, when the alarm operation of the alarm unit **410** is not canceled by the alarm canceling unit **420**.
[0125] The monitoring server **710**, which receives the emergency notification signal **500***e*, executes a rescue requesting process of calling for rescue to the location of the craft FS. The rescue requesting process is directed to other crafts, fisheries cooperative associations, and coast guards during the navigation around the craft FS, or other predetermined places, for example.
[0126] As described above, the crew watching system **100**A according to the embodiment

automatically calls for rescue when the crew FP is in emergency circumstances. The following specifically describes the individual components of the crew watching system **100**A.

[0127] FIG. **2** is a conceptual diagram illustrating a configuration of the wearable transmitting device **200** worn by the crew FP. In the case of multiple crews FP on the craft FS, each of the crews FP wears the wearable transmitting device **200**.

[0128] The wearable transmitting device **200** includes an ID signal outputter **220** that outputs an ID signal for identifying the crew FP wearing the wearable transmitting device **200**, and a crew motion sensor **230** that detects motions of the crew FP. Specifically, the crew motion sensor **230** includes an acceleration sensor.

[0129] The wearable transmitting device **200** also includes a transmitter **210** that transmits the above-mentioned notification radio waves **200***e*, containing an ID signal output from the ID signal outputter **220** and a result of detection by the crew motion sensor **230** superimposed on carrier signals. The transmitter **210** transmits the notification radio wave **200***e* at each predetermined repetition period. The repetition period is equal to or longer than 10 milliseconds (ms) and equal to or shorter than 120 seconds(s), for example.

[0130] FIG. **3** is a conceptual diagram illustrating a configuration of the crew watching apparatus **500** installed in the craft FS. The crew watching apparatus **500** includes a communication device **520** that receives the above-mentioned notification radio waves **200***e* from the wearable transmitting device **200**. The communication device **520** also has a function of receiving the craft rocking-motion data as a result of detection from the craft rocking-motion sensor **310** illustrated in FIG. **1**, and a function of outputting the emergency notification signal **500***e* to the monitoring server **710** illustrated in FIG. **1**, for example.

[0131] The crew watching apparatus **500** also includes a storage device **530** that stores a crew watching program (a seafarer safety program) **531** that defining the steps of the crew watching process of watching the crew FP in real time, and a processor **510** that executes the crew watching program **531**. The following describes functions achieved by execution of the crew watching program **531** by the processor **510**.

[0132] As illustrated in FIG. **4**, the crew watching apparatus **500** includes an evaluator (determination unit) **510***a* that executes an evaluation process of evaluating whether the crew FP is in emergency circumstances.

[0133] The evaluator **510***a* includes a notification-radio-wave intensity determiner **510***b* that executes a notification-radio-wave intensity determining process of determining the intensities of the notification radio waves **200***e* (hereinafter referred to as “intensities of the received waves”) received by the communication device **520**, and a low-intensity period determiner **510***c* that executes a low-intensity period determining process of determining the length of the period (hereinafter referred to as “low-intensity period”) while the determined intensities of the received notification radio waves **200***e* are lower than a predetermined threshold radio-wave intensity.

[0134] The threshold radio-wave intensity is preliminarily set as a threshold implying the existence of the crew FP on board. For example, in the case of a falling accident of the crew FP into the ocean, the intensities of the received notification radio waves **200***e* fall below the threshold radio-wave intensity, because of a general principle of extremely large attenuation of radio waves in the ocean.

[0135] The evaluator **510***a* also includes an evaluation process executor **510***d* that executes an evaluation execution process of determining whether the crew FP is in emergency circumstances on the basis of the length of the low-intensity period determined by the low-intensity period determiner **510***c*. The evaluation process executor **510***d* evaluates that the crew FP is in emergency circumstances, when the length of the low-intensity period exceeds an allowable length of low-intensity period, which is set as a threshold implying the normal circumstances of the crew FP.

[0136] The evaluator **510***a* further includes a craft rocking-motion data acquirer **510***e* that executes a craft rocking-motion data acquiring process of acquiring craft rocking-motion data indicating the strengths of locking motions of the craft FS from the craft rocking-motion sensor **310** illustrated in FIG. **1**, an initial locking-motion strength determiner **510***f* that executes an initial locking-motion strength determining process of determining the strength of locking motions of the craft FS (hereinafter referred to as "initial locking-motion strength") at the start of the low-intensity period on the basis of the acquired craft rocking-motion data, and an allowable low-intensity period setter **510***g* that executes an allowable low-intensity period setting process of setting the allowable length of low-intensity period in accordance with the initial locking-motion strength.

[0137] The allowable low-intensity period setter **510***g* sets the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength. Such a larger initial locking-motion strength means that the low-intensity period is more likely to be caused by a falling accident of the crew FP into the ocean due to strong locking motions of the craft FS. Because of high probability of a falling accident of the crew FP into the ocean, the allowable length of low-intensity period is set to be shorter to increase the detection sensitivity for accurate and rapid detection of such emergency circumstances.

[0138] The evaluator **510***a* also includes a crew data acquirer **510***h* that executes a crew data acquiring process of acquiring a result of detection (hereinafter referred to as "crew data") from the crew motion sensor **230** illustrated in FIG. **2** on the basis of the notification radio waves **200***e* received by the communication device **520**. The crew data is chronological data containing a chronological series of detected values indicating motions of the crew FP, specifically, detected accelerations.

[0139] The evaluator **510***a* further includes a corrector **510***i* that executes a correction process of correcting the crew data acquired by the crew data acquirer **510***h*.

[0140] The corrector **510***i* corrects the crew data, on the basis of the craft rocking-motion data acquired by the craft rocking-motion data acquirer **510***e*.

[0141] The corrector **510***i* corrects the crew data by removing a contribution of the locking motions of the craft FS to the motions of the crew FP, from the detected values indicating motions of the crew FP. Specifically, the corrector **510***i* subtracts, from each of the detected values contained in the crew data, the value contained in the craft rocking-motion data and detected at the same time.

[0142] The corrector **510***i* thus generates corrected crew data indicating motions of the crew FP relative to the craft FS. The crew data and the craft rocking-motion data are each chronological data, as described above. The corrected crew data is also chronological data containing a chronological series of values (hereinafter referred to as "relative motion values") indicating motions of the crew FP relative to the craft FS.

[0143] The evaluator **510***a* also includes a no crew-motion period determiner **510***j* that executes a no crew-motion period determining process of determining the length of the period (hereinafter referred to as "no crew-motion period") while the crew FP is not moving relative to the craft FS on the basis of the corrected crew data. The "no crew-motion period" indicates a period while the relative motion values contained in the corrected crew data are not necessarily zero but lower than a threshold, which is preliminarily set as a threshold implying substantially no motion of the crew FP.

[0144] The evaluation process executor **510***d* evaluates that the crew FP is in emergency circumstances, when the length of the no crew-motion period exceeds an allowable length of no-motion period, which is preliminarily set as a threshold implying the normal circumstances of the crew FP.

[0145] The crew watching apparatus **500** includes an inboard outputter **510***k* that executes an inboard outputting process of causing the alarm unit **410** illustrated in FIG. **1** to initiate an alarm operation. The inboard outputter **510***k*, when the evaluation process executor **510***d* evaluates that the crew FP is in emergency circumstances, outputs an emergency evaluation signal indicating the result of evaluation to the alarm unit **410**, and thus causes the alarm unit **410** to initiate the alarm operation.

[0146] The crew watching apparatus **500** also includes an outboard outputter **5101** that executes an outboard outputting process of outputting the emergency notification signal **500***e* to the monitoring server **710** illustrated in FIG. **1**. The outboard outputter **5101**, when the alarm operation of the alarm unit **410** is not canceled by the alarm canceling unit **420** within a predetermined confirmation period, outputs the emergency notification signal **500***e* to the monitoring server **710**.
[0147] The following specifically describes the crew watching process achieved by cooperation of the above-described components, with reference to FIG. **5**.
[0148] As illustrated in FIG. **5**, the evaluation process executor **510***d* first evaluates whether the length of the no crew-motion period determined by the no crew-motion period determiner **510***j* exceeds the allowable length of no-motion period, which is preliminarily set as a threshold implying the normal circumstances of the crew FP (Step S**11**).
[0149] When the length of the no crew-motion period exceeds the allowable length of no-motion period (Step S**11**; YES), the crew FP may be immovable on board due to a heart attack or other emergency circumstances. The evaluation process executor **510***d* in this case evaluates that the crew FP is in emergency circumstances.
[0150] In response to this evaluation, the inboard outputter **510***k* outputs an emergency evaluation signal indicating the result of evaluation indicating emergency circumstances of the crew FP, to the alarm unit **410**. The alarm unit **410** thus initiates the alarm operation (Step S**15**).
[0151] The outboard outputter **5101** then determines whether the alarm operation of the alarm unit **410** is canceled within the predetermined confirmation period (Step S**16**). The crew FP, who is not in emergency circumstances, is able to cancel the alarm operation of the alarm unit **410** by means of the alarm canceling unit **420**. When the alarm operation is canceled within the confirmation period (Step S**16**; YES), which means non-emergency circumstances of the crew FP, then the process returns to Step S**11** and continues the real-time watching operation.
[0152] In contrast, when the alarm operation is not canceled within the confirmation period (Step S**16**; NO), the outboard outputter **5101** outputs the emergency notification signal **500***e* to the external monitoring server **710** to call for rescue (Step S**17**), followed by termination of this process.
[0153] When the length of the no crew-motion period does not exceed the allowable length of no-motion period in Step S**11** (Step S**11**; NO), the initial locking-motion strength determiner **510***f* determines whether the intensity of the received notification radio wave **200***e* determined by the notification-radio-wave intensity determiner **510***b* is lower than the predetermined threshold radio-wave intensity (Step S**12**).
[0154] When the intensity of the received notification radio wave **200***e* is at least the threshold radio-wave intensity (Step S**12**; NO), which means the existence of the crew FP on board, then the process returns to Step S**11** and continues the real-time watching operation.
[0155] In contrast, when the intensity of the received notification radio wave **200***e* is lower than the threshold radio-wave intensity (Step S**12**; YES), the initial locking-motion strength determiner **510***f* determines the initial locking-motion strength, which is the strength of locking motions of the craft FS at that time point when the intensity of the received notification radio wave **200***e* falls below the threshold radio-wave intensity.
[0156] A specific example of the initial locking-motion strength when the intensity of the received notification radio wave **200***e* falls below the threshold radio-wave intensity, is the time average of strengths of locking motions of the craft FS during a period around the time point when the intensity of the received notification radio wave **200***e* falls below the threshold radio-wave intensity. This time average is calculated by the initial locking-motion strength determiner **510***f*, on the basis of the craft rocking-motion data.
[0157] The allowable low-intensity period setter **510***g* then sets the allowable length of low-intensity period, as a threshold implying the normal circumstances of the crew FP, in accordance with the initial locking-motion strength determined by the initial locking-motion strength

determiner **510***f* (Step S**13**).

[0158] The allowable low-intensity period setter **510***g* sets the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength to increase the sensitivity of detecting emergency circumstances, because such a larger initial locking-motion strength means higher probability of a falling accident of the crew FP into the ocean, as described above. In contrast, the allowable low-intensity period setter **510***g* sets the allowable length of low-intensity period to be longer for a smaller initial locking-motion strength to avoid misdetection, because such a smaller initial locking-motion strength means lower possibility of a falling accident of the crew FP into the ocean.

[0159] The evaluation process executor **510***d* then evaluates whether the length of the low-intensity period, while the intensities of the received notification radio waves **200***e* are lower than the threshold radio-wave intensity, exceeds the allowable length of low-intensity period set in Step S**13** (Step S**14**).

[0160] When the length of the low-intensity period is at most the allowable length of low-intensity period (Step S**14**; NO), which does not necessarily mean emergency circumstances of the crew FP, then the process returns to Step S**11** and continues the real-time watching operation.

[0161] In contrast, when the length of the low-intensity period exceeds the allowable length of low-intensity period (Step S**14**; YES), which means some possibility of a falling accident of the crew FP into the ocean, then the evaluation process executor **510***d* evaluates that the crew FP is in emergency circumstances. In response to this evaluation, the inboard outputter **510***k* outputs the emergency evaluation signal to the alarm unit **410**, and the alarm unit **410** initiates the alarm operation (Step S**15**). Step S**16** and the following steps proceed as described above.

[0162] As described above with reference to FIG. **2**, the notification radio wave **200***e* transmitted from the wearable transmitting device **200** contains the ID signal for identifying the crew FP. In the case of multiple crews FP on the craft FS, the crew watching process illustrated in FIG. **4** is executed for each of the crews FP. The crews FP may share the alarm unit **410** and the alarm canceling unit **420**.

[0163] Regardless of multiple crews FP on the craft FS, when any of the intensities of the received notification radio waves **200***e* is determined to be zero in Step S**12**, the crew FP associated with this notification radio wave **200***e* having an intensity of zero can be readily identified on the basis of the preliminarily known ID signals corresponding to all the crews FP on the craft FS.

[0164] As described above, the crew watching system **100**A according to the embodiment repetitively executes real-time evaluation of whether the crew FP is in emergency circumstances, on the basis of not only the intensities of the received notification radio waves **200***e* but also the strengths of locking motions of the craft FS. The crew watching system **100**A can thus properly detect emergency circumstances of the crew FP.

[0165] Specifically, the allowable low-intensity period setter **510***g* sets the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength. This process increases the sensitivity of detection of emergency circumstances. The emergency circumstances can therefore be more certainly and rapidly detected without being overlooked, in the case of high probability of a falling accident of the crew FP into the ocean.

[0166] The allowable low-intensity period setter **510***g* sets the allowable length of low-intensity period to be longer for a smaller initial locking-motion strength. This process decreases the sensitivity of detection of emergency circumstances, and thus prevents the alarm unit **410** from being unnecessarily activated in the case of low probability of a falling accident of the crew FP into the ocean.

[0167] The crew watching system **100**A according to the embodiment determines whether the crew FP is in emergency circumstances, on the basis of not only the intensities of the notification radio waves **200***e* and the strengths of locking motions of the craft FS but also the detected values indicating motions of the crew FP.

[0168] Specifically, the crew FP is evaluated to be in emergency circumstances, when the length of the no crew-motion period of substantially no motion of the crew FP exceeds the predetermined allowable length of no-motion period. The crew FP can therefore be evaluated to be in emergency circumstances, not only when the crew FP falls into the ocean but also when the crew FP is immovable onboard.

Embodiment 2

[0169] FIG. **2** illustrates an exemplary configuration of the wearable transmitting device **200** including the crew motion sensor **230** that detects motions of the crew FP. Alternatively, the wearable transmitting device **200** may include a crew vital sensor that detects organic activities of the crew FP, in place of or in addition to the crew motion sensor **230**. The following describes some specific examples thereof.

[0170] As illustrated in FIG. **6**, the crew data acquirer **510***h* in this embodiment acquires crew data from a crew vital sensor **240** that detects organic activities of the crew FP. The crew data in this embodiment is chronological data containing a chronological series of detected values indicating organic activities of the crew FP, specifically, detected amplitudes of pulse of the crew FP.

[0171] The crew vital sensor **240** is included in the wearable transmitting device **200**, in place of the crew motion sensor **230** illustrated in FIG. **2**. The crew data in this embodiment is also superimposed on the notification radio wave **200***e* and transmitted, as in Embodiment 1. The crew data acquirer **510***h* demodulates the notification radio wave **200***e* and thus acquires the crew data.

[0172] The evaluator **510***a* according to the embodiment includes a body abnormal period determiner **510***m* that executes a body-abnormal-period determining process of determining the length of the period (hereinafter referred to as “body abnormal period”) while any abnormality occurs in the body of the crew FP, on the basis of the crew data acquired by the crew data acquirer **510***h*. The body abnormal period indicates a period of extraordinarily rapid pulse, a period of extraordinary slow pulse, or a period of extraordinary small amplitude of pulse, for example.

[0173] The evaluation process executor **510***d* according to the embodiment compares the length of the body abnormal period determined by the body abnormal period determiner **510***m*, with an allowable length of the body abnormal period, which is preliminarily set as a threshold implying the normal circumstances of the crew FP, in the evaluation step corresponding to Step S**11** in FIG. **5**. When determining that the length of the body abnormal period exceeds the allowable length of the body abnormal period, the evaluation process executor **510***d* evaluates that any abnormality occurs in the crew FP.

[0174] Although the crew vital sensor **240** in the embodiment detects the pulse of the crew FP, this crew vital sensor **240** is a mere example. Another exemplary crew vital sensor **240** may detect the blood oxygen saturation level of the crew FP. The other configurations and effects are identical to those in Embodiment 1.

Embodiment 3

[0175] The following describes a report generation assistance system according to an embodiment, focusing on an exemplary craft FS serving as a fishing craft.

[0176] As illustrated in FIG. **7**, a report generation assistance system (a report generation assistance system) **100**B according to the embodiment includes a craft activity estimating apparatus (a vessel activity inference device) **600** installed in the craft FS, and an external report generating server **720** capable of communication with the craft activity estimating apparatus **600** via the communication line NE.

[0177] The report generation assistance system **100**B also includes a craft location sensor **320** installed in the craft FS. The craft location sensor **320** generates craft location data containing a chronological series of detected values, specifically, coordinate values indicating the locations of the craft FS during a navigation. The craft location sensor **320** includes a global navigation satellite system (GNSS) receiver that detects the locations on the basis of signals from a GNSS satellite, for example.

[0178] The report generation assistance system **100**B further includes an equipment sensor **330** installed in the craft FS. The equipment sensor **330** generates equipment state data containing a chronological series of detected values indicating the states of operation or usage of the equipment for fishing and navigation, which is not illustrated but installed in the craft FS. The equipment means facilities included in the craft FS, examples of which include engine, capstan for winding a longline, capstan for winding a fishing net, and refrigerator.
[0179] In addition, the report generation assistance system **100**B also includes the wearable transmitting device **200** worn by the crew FP, and the craft rocking-motion sensor **310** installed in the craft FS. These components and functions are described above in Embodiment 1.
[0180] The craft activity estimating apparatus **600** estimates specific activities performed during the navigation of the craft FS, on the basis of the craft location data generated by the craft location sensor **320**, the equipment state data generated by the equipment sensor **330**, the craft rocking-motion data generated by the craft rocking-motion sensor **310**, and the crew data generated by the wearable transmitting device **200**.
[0181] The craft activity estimating apparatus **600** then outputs activity data D**4** indicating a result of estimation of the specific activities, to the report generating server **720**, at the timing of establishment of communication with the report generating server **720**. The report generating server **720** generates report data indicating achievements of the navigation, on the basis of the activity data D**4** acquired from the craft activity estimating apparatus **600**.
[0182] The report generation assistance system **100**B according to the embodiment thus facilitates generation of report data. The following specifically describes a configuration of the craft activity estimating apparatus **600**.
[0183] As illustrated in FIG. **8**, the craft activity estimating apparatus **600** includes a communication device **620**. The communication device **620** performs the function of receiving the craft location data from the craft location sensor **320**, the function of receiving the equipment state data from the equipment sensor **330**, the function of receiving the craft rocking-motion data from the craft rocking-motion sensor **310**, the function of receiving the crew data from the wearable transmitting device **200** by means of the notification radio waves **200***e*, and the function of transmitting the activity data **600***e* to the report generating server **720**.
[0184] The craft activity estimating apparatus **600** also includes a storage device **630**. The storage device **630** stores a craft activity estimating program (a vessel activity inference program) **631** that defines the steps of an estimation process of estimating specific activities performed during the navigation of the craft FS. The storage device **630** also stores a learned model (a trained model) **632** applied to the estimation process.
[0185] The craft activity estimating apparatus **600** also includes the processor **610** that executes the craft activity estimating program **631**. The following describes functions achieved by execution of the craft activity estimating program **631** by the processor **610**.
[0186] As illustrated in FIG. **9**, the craft activity estimating apparatus **600** includes a craft location data acquirer **610***a* that executes a craft-location-data acquiring process of acquiring craft location data D**1** from the craft location sensor **320** via the communication device **620**. The craft location data D**1** is chronological data containing a chronological series of coordinate values indicating the locations of the craft FS, as described above.
[0187] The craft activity estimating apparatus **600** also includes an equipment state data acquirer **610***b* that executes an equipment-state data acquiring process of acquiring equipment state data D**2** from the equipment sensor **330** via the communication device **620**. The equipment state data D**2** is chronological data containing a chronological series of detected values indicating the states of operation or usage of the equipment, examples of which include engine, capstan for winding a longline, capstan for winding a fishing net, and refrigerator, as described above.
[0188] The craft activity estimating apparatus **600** further includes a craft rocking-motion data acquirer **610***c* that executes a craft rocking-motion data acquiring process of acquiring the craft

rocking-motion data from the craft rocking-motion sensor **310** via the communication device **620**. The craft rocking-motion data is chronological data containing a chronological series of detected strengths of locking motions of the craft FS, specifically, detected accelerations, as described above.

[0189] The craft activity estimating apparatus **600** also includes a crew data acquirer **610***d* that executes a crew data acquiring process of acquiring the crew data on the basis of the notification radio waves **200***e* received by the communication device **620**. The crew data is chronological data containing a chronological series of detected values indicating motions of the crew FP, specifically, detected accelerations, as described above.

[0190] The craft activity estimating apparatus **600** further includes a corrector **610***e* that executes a correction process of correcting the crew data acquired by the crew data acquirer **610***d.* The corrector **610***e* corrects the crew data by removing a contribution of the locking motions of the craft FS to the motions of the crew FP from the detected values indicating motions of the crew FP, on the basis of the crew data acquired by the crew data acquirer **610***d* and the craft rocking-motion data acquired by the craft rocking-motion data acquirer **610***c.*

[0191] The corrector **610***e* thus generates corrected crew data D**3**. The corrected crew data D**3** is chronological data containing a chronological series of relative motion values indicating motions of the crew FP relative to the craft FS.

[0192] The craft activity estimating apparatus **600** also includes an estimator **610***f* that executes an estimation process of estimating specific activities (hereinafter referred to as “activities of the craft FS”) performed during the navigation of the craft FS on the basis of the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**. The functions of the estimator **610***f* are achieved by the learned model **632** illustrated in FIG. **8**.

[0193] Specific examples of the “activities of the craft FS” include departure, travel toward a fishery, search for a fishery, fishing, offshore stay, and arrival, in the case of the craft FS serving as a fishing craft.

[0194] The “fishing” in this case also contains information on specific types of caught aquatic products. That is, the estimator **610***f* can estimate not only that fishing was performed as an activity of the craft FS but also what types of aquatic products were caught in the fishing.

[0195] The activity data D**4** has a data structure containing the above-mentioned specific activities of the craft FS associated with the times of the respective activities. The activity data D**4** can contribute to specification of the types and times of activities of the craft FS from the departure until the arrival.

[0196] The craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3** are correlated with the activities of the craft FS. The activities of the craft FS can thus be estimated from the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3** in principle.

[0197] The following describes an exemplary correlation between the activities of the craft FS and the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**, focusing on exemplary activities of the craft FS involving “fishing”.

[0198] FIG. **10** is a conceptual diagram illustrating a trajectory TA of the craft FS indicated by the craft location data D**1**. The craft location data D**1** is chronological data containing a chronological series of coordinate values indicating the locations of the craft FS, as described above. The trajectory TA is defined by plotting the coordinate values contained in the craft location data D**1** on a two-dimensional coordinate plane, and connecting the adjacent plots to each other with line segments.

[0199] The trajectory TA is provided with arrows representing traveling directions of the craft FS with the same time interval, in order to clarify the velocity of the craft FS. A shorter interval between arrows means a lower velocity of the craft FS.

[0200] The trajectory TA contains some segments TA**1** (hereinafter referred to as “extremely slow segments”) in which the craft FS travels extremely slowly while being drifted. Such extremely slow segments TA**1** are characteristic in drift squid fishing.

[0201] The craft FS in the squid fishing is not actively traveling. The engine included in the equipment of the craft FS is stopped or idling, as is indicated by the equipment state data D**2** in the period of the navigation of the extremely slow segments TA**1**.

[0202] The crew FP in the squid fishing has relatively large motions at random on the craft FS. Such characteristic motions are indicated by the corrected crew data D**3** in the period of the navigation of the extremely slow segments TA**1**.

[0203] FIG. **11** is a conceptual diagram illustrating another trajectory TB of the craft FS indicated by the craft location data D**1**. The trajectory TB in this example contains a combination of outward segments TB**1** representing a linear travel, and return segments TB**2** representing a tortuous return travel along the outward segments TB**1**.

[0204] Such a combination of the outward segments TB**1** and the return segments TB**2** are characteristic in longline fishery for adult yellowtails. Specifically, the outward segments TB**1** correspond to development of a longline, and the return segments TB**2** correspond to collection of the longline.

[0205] The equipment state data D**2** in the period of the navigation of the outward segments TB**1** indicates that the capstan for the longline included in the equipment is unwinding the longline. In contrast, the equipment state data D**2** in the period of the navigation of the return segments TB**2** indicates that the capstan for the longline is winding the longline.

[0206] The corrected crew data D**3** in the period of the navigation of the return segments TB**2** indicates periodic motions of the crew FP for repetitively releasing adult yellowtails from longline hooks. In contrast, the corrected crew data D**3** in the period of the navigation of the outward segments TB**1** indicates smaller motions of the crew FP than those in the period of the navigation of the return segments TB**2**.

[0207] The craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3** are correlated with the activities of the craft FS, as described above. Although FIGS. **10** and **11** illustrate exemplary activities of the craft FS involving “fishing”, persons skilled in the art will recognize that other activities, such as departure, travel toward a fishery, search for a fishery, offshore stay, and arrival, can also be estimated from the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**.

[0208] The above-described correlation can be used to achieve the functions of the estimator **610***f* illustrated in FIG. **9**. The functions of the estimator **610***f* in this embodiment can be achieved by means of the learned model **632** illustrated in FIG. **8**, as described above.

[0209] The learned model **632** illustrated in FIG. **8** is generated by machine learning for estimating activities of the craft FS at each time point, on the basis of the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**.

[0210] The following describes a learned model generating device for generating the learned model **632**.

[0211] As illustrated in FIG. **12**, the learned model generating device **800** is provided with combinations of learning craft location data **811**, learning equipment state data **812**, learning corrected crew data **813**, and learning activity data **814**, which are prepared in advance.

[0212] The learning craft location data **811** is supervision data corresponding to the craft location data D**1** illustrated in FIG. **9**, and may be measured sample values of the craft location data D**1**. The learning equipment state data **812** is supervision data corresponding to the equipment state data D**2** illustrated in FIG. **9**, and may be measured sample values of the equipment state data D**2**. The learning corrected crew data **813** is supervision data corresponding to the corrected crew data D**3** illustrated in FIG. **9**, and may be measured sample values of the corrected crew data D**3**.

[0213] The learning activity data **814** is supervision data corresponding to the activity data D**4** illustrated in FIG. **9**. The learning activity data **814** indicates the actual activities of the craft FS exactly identified at each time point, on the basis of the provided learning craft location data **811**, learning equipment state data **812**, and learning corrected crew data **813**. The learning activity data **814** is manually generated, for example.

[0214] The learned model generating device **800** includes a generator **820** that generates the learned model **632**, on the basis of the learning craft location data **811**, the learning equipment state data **812**, the learning corrected crew data **813**, and the learning activity data **814**.

[0215] The generator **820** learns a policy for estimating the learning activity data **814** from the learning craft location data **811**, the learning equipment state data **812**, and the learning corrected crew data **813**. This machine learning generates the learned model **632**.

[0216] The description refers back to FIG. **9**. The learned model **632** generated as described above achieves the estimator **610***f*. The estimator **610***f* receives input of the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**.

[0217] The learned model **632** serving as the estimator **610***f* outputs the activity data D**4**, as a result of estimation of activities of the craft FS. The activity data D**4** indicates estimated types and times of activities of the craft FS from the departure until the arrival.

[0218] The craft activity estimating apparatus **600** also includes an outboard outputter **610***g* that acquires the activity data D**4** from the learned model **632** serving as the estimator **610***f*. The outboard outputter **610***g* outputs the acquired activity data D**4** to the report generating server **720** illustrated in FIG. **7**. The report generating server **720** generates report data on the basis of the activity data D**4**.

[0219] As described above, the craft activity estimating apparatus **600** according to the embodiment is able to estimate activities of the craft FS on the basis of the craft location data D**1**. Specifically, the craft activity estimating apparatus **600** automatically generates the activity data D**4** indicating estimated activities of the craft FS. The generated activity data D**4** is used for generation of a report that demonstrates achievements of the navigation. The craft activity estimating apparatus **600** can further reduce the tasks for generation of a report than existing apparatuses.

[0220] The estimation of activities of the craft FS uses, not only the craft location data D**1**, but also the equipment state data D**2** during the navigation and the crew data indicating motions of the crew FP during the navigation. This estimation can achieve higher accuracy than the estimation using only the craft location data D**1**.

[0221] The crew data is corrected on the basis of the craft rocking-motion data indicating the strengths of locking motions of the craft FS, and then used for estimation of activities of the craft FS. Specifically, the crew data is corrected by removing a contribution of the locking motions of the craft FS, and thus provides the corrected crew data D**3** indicating relative motions of the crew FP relative to the craft FS. This corrected crew data D**3** is used for estimation of activities of the craft FS. The estimation of activities of the craft FS using the corrected crew data D**3** can reveal more accurate motions of the crew FP, and thus achieve higher accuracy, than the estimation using crew data before correction.

Embodiment 4

[0222] In Embodiment 3 described above, the wearable transmitting device **200** may include a crew vital sensor that detects organic activities of the crew FP in place of or in addition to the crew motion sensor **230**, as in Embodiment 2. The following describes some specific examples of this embodiment.

[0223] As illustrated in FIG. **13**, the crew data acquirer **610***d* in the embodiment acquires the crew data from the crew vital sensor **240** that detects organic activities of the crew FP. The crew data D**3**′ in the embodiment is chronological data containing a chronological series of detected values indicating organic activities of the crew FP, specifically, detected amplitudes of pulse of the crew FP.

[0224] The estimator **610***f* in the embodiment estimates activities of the craft FS, on the basis of the craft location data D**1**, the equipment state data D**2**, and the crew data D**3**′.

[0225] The crew data D**3**′, which indicates a chronological series of detected values indicating organic activities of the crew FP, also reflects the strengths of motions of the crew FP relative to the craft FS, like the corrected crew data D**3** described above. Persons skilled in the art will thus recognize that this crew data D**3**′ can be used for estimation of activities of the craft FS in place of or in addition to the corrected crew data D**3**.
[0226] Although the crew vital sensor **240** in the embodiment detects the pulse of the crew FP, this crew vital sensor **240** is a mere example. Another exemplary crew vital sensor **240** may detect the blood oxygen saturation level of the crew FP. The other configurations and effects are identical to those in Embodiment 3.
Embodiment 5
[0227] In Embodiments 3 and 4 described above, the estimator **610***f* estimates activities of the craft FS. The estimator **610***f* in the embodiment estimates, in addition to the activities of the craft FS, an amount of fish catch and an amount of fuel consumption.
[0228] As described above with reference to FIGS. **10** and **11**, the craft location data D**1** reveals the period of fishing of the craft FS. As the crew FP on the craft FS has larger motions in the period, the craft FS is expected to achieve a larger amount of fish catch. These motions of the crew FP are indicated by the corrected crew data D**3** or the crew data D**3**′. The amount of fish catch is also reflected by the states of usage of the refrigerator and other equipment. These states of usage of equipment are indicated by the equipment state data D**2**.
[0229] The amount of fish catch is reflected by the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3** or the crew data D**3**′, as described above. Persons skilled in the art will thus recognize that the amount of fish catch can be estimated from these types of data in principle.
[0230] As described above with reference to FIGS. **10** and **11**, the craft location data D**1** reveals the time variation of velocity of the craft FS. As described above with reference to FIG. **10**, the craft location data D**1** reveals the state of the engine of the craft FS, specifically, a stop state, idling state, or active state of generating a thrust force. Persons skilled in the art will thus recognize that the amount of fuel consumption can be estimated using the craft location data D**1** in principle.
[0231] The Embodiments 1 to 5 described above may be modified as described below.
[0232] (1) In Embodiment 3, the estimator **610***f* estimates activities of the craft FS, from the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3**. Alternatively, the estimator **610***f* may estimate activities of the craft FS from the craft location data D**1** alone, from the craft location data D**1** and the equipment state data D**2** alone, from the craft location data D**1** and the corrected crew data D**3** alone, or from the craft location data D**1** and the crew data D**3**′ alone.
[0233] (2) Embodiment 3 illustrates the learned model **632** generated by a supervised learning algorithm. Alternatively, the learned model **632** may be generated by a learning algorithm, such as an unsupervised learning algorithm, other than the supervised learning algorithm. The unsupervised leaning does not require results or the learning activity data **814**, which is illustrated in FIG. **12**. The generator **820** is preliminarily provided with the definition of distance between data points, learns characteristics of the learning craft location data **811**, the learning equipment state data **812**, and the learning corrected crew data **813** through clustering techniques, and thus generates the learned model **632**.
[0234] (3) The craft activity estimating apparatus **600** according to Embodiment 3 may also include an updater that updates the learned model **632** through reinforcement learning. In this case, the crew FP may check for the report data generated by the report generating server **720** later, and provide the report data with a reward indicating the accuracy of the report data. The data indicating the reward is fed back to the updater. The updater then updates the policy for estimating activities in the learned model **632**, using the conditions that can achieve the largest reward.
[0235] (4) Embodiments 3 to 5 illustrate the learned model **632** used for estimation of activities of

the craft FS. Alternatively, the activities of the craft FS may be estimated by a procedure other than the artificial intelligence. For example, the estimator **610***f* may analyze the craft location data D**1**, the equipment state data D**2**, and the corrected crew data D**3** or the crew data D**3′**, extracts patterns that identify the activities of the craft FS from the data through pattern recognition, and thus estimate activities of the craft FS.
[0236] (5) Embodiment 3 illustrates the craft location data D**1** detected by the craft location sensor **320**. The craft location data D**1** is only required to indicate a chronological series of values indicating the locations of the craft, and may be generated by any procedure. For example, the craft location data D**1** may be generated through satellite remote sensing, or by means of a craft radar or an automatic identification system (AIS).
[0237] (6) Although FIG. **2** illustrates the crew motion sensor **230** included in the
[0238] wearable transmitting device **200**, the wearable transmitting device **200** does not necessarily include the crew motion sensor **230**. The crew data, containing a chronological series of detected values indicating motions of the crew FP, is not necessarily generated by the crew motion sensor **230** serving as an acceleration sensor. The crew data may also be generated by a non-contact procedure for detecting motions of the crew FP, for example, by irradiating the crew FP with radio waves, ultrasonic waves, or infrared rays, or by capturing images of the crew FP.
[0239] (7) Although Embodiments 3 to 5 illustrate the craft FS serving as a fishing craft, the craft FS is not necessarily a fishing craft. In an exemplary case of a craft FS serving as a patrol vessel, the estimator **610***f* estimates activities of the craft FS serving as a patrol vessel, example of which include patrol, crackdown, rescue, and departure.
[0240] (8) The configuration according to Embodiment 1 or 2 may be combined with the configuration according to any one of Embodiments 3 to 5. Specifically, the monitoring server **710** illustrated in FIG. **1** may also have the functions of the report generating server **720** illustrated in FIG. **7**. The crew watching apparatus **500** illustrated in FIG. **1** may also have the functions of the activity estimating apparatus **6100** illustrated in FIG. **7**. The craft FS illustrated in FIG. **1** may be further provided with the craft location sensor **320** and the equipment sensor **330** illustrated in FIG. **7**.
[0241] (9) The crew watching program **531** illustrated in FIG. **2** may be installed in a computer, such as existing smartphone or tablet, and thus cause the computer to serve as the crew watching apparatus **500**. The crew watching program **531** may be distributed via a communication line, or stored in a non-transitory computer-readable recording medium and then distributed.
[0242] (10) The craft activity estimating program **631** and the learned model **632** illustrated in FIG. **8** may be installed in a computer, such as existing smartphone or tablet, and thus cause the computer to serve as the craft activity estimating apparatus **600**. The craft activity estimating program **631** and the learned model **632** may be distributed via a communication line, or stored in a non-transitory computer-readable recording medium and then distributed.
[0243] The foregoing describes some example embodiments for explanatory purposes. Although the foregoing discussion has presented specific embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. This detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined only by the included claims, along with the full range of equivalents to which such claims are entitled.
[0244] This application claims the benefit of Japanese Patent Application No. 2022-119000, filed on Jul. 26, 2022, the entire disclosure of which is incorporated by reference herein.
REFERENCE SIGNS LIST
[0245] **100**A Crew watching system [0246] **100**B Report generation assistance system [0247] **200** Wearable transmitting device [0248] **200***e* Notification radio wave [0249] **210** Transmitter [0250] **220** ID signal outputter [0251] **230** Crew motion sensor [0252] **240** Crew vital sensor [0253] **310**

Craft rocking-motion sensor [0254] **320** Craft location sensor [0255] **330** Equipment sensor [0256] **410** Alarm unit [0257] **420** Alarm canceling unit [0258] **500** Crew watching apparatus [0259] **500***e* Emergency notification signal [0260] **510** Processor [0261] **510***a* Evaluator [0262] **510***b* Notification-radio-wave intensity determiner [0263] **510***c* Low-intensity period determiner [0264] **510***d* Evaluation process executor [0265] **510***e* Craft rocking-motion data acquirer [0266] **510***f* Initial locking-motion strength determiner [0267] **510***g* Allowable low-intensity period setter [0268] **510***h* Crew data acquirer [0269] **510***i* Corrector [0270] **510***j* No crew-motion period determiner [0271] **510***k* Inboard outputter (outputter) [0272] **510***l* Outboard outputter [0273] **510***m* Body abnormal period determiner [0274] **520** Communication device [0275] **530** Storage device [0276] **531** Crew watching program [0277] **600** Craft activity estimating apparatus [0278] **610** Processor [0279] **610***a* Craft location data acquirer [0280] **610***b* Equipment state data acquirer [0281] **610***c* Craft rocking-motion data acquirer [0282] **610***d* Crew data acquirer [0283] **610***e* Corrector [0284] **610***f* Estimator [0285] **610***g* Outboard outputter (outputter) [0286] **620** Communication device [0287] **630** Storage device [0288] **631** Craft activity estimating program [0289] **632** Learned model [0290] **710** Monitoring server [0291] **720** Report generating server [0292] **800** Learned model generating device [0293] **811** Learning craft location data [0294] **812** Learning equipment state data [0295] **813** Learning corrected crew data [0296] **814** Learning activity data [0297] **820** Generator [0298] D**1** Craft location data [0299] D**2** Equipment state data [0300] D**3** Corrected crew data [0301] D**3**′ Crew data [0302] D**4** Activity data [0303] FS Craft [0304] FP Crew [0305] NE Communication line [0306] TA, TB Trajectory [0307] TA**1** Extremely slow segment [0308] TB**1** Outward segment [0309] TB**2** Return segment

Claims

1-6. (canceled)
7. A vessel activity inference device, comprising: at least one processor, wherein the at least one processor executes a craft-location-data acquiring process of acquiring craft location data containing a chronological series of detected values indicating locations of a craft during a navigation, a specifying process of specifying, based on the craft location data acquired in the craft-location-data acquiring process, activities performed by the craft, and an outputting process of outputting activity data indicating the activities specified in the specifying process, in the specifying process, the at least one processor has a function of specifying, based on the craft location data, each of (a) travel toward a search region in which search for a fishery is performed, (b) the search for the fishery in the search region, (c) fishing in the fishery searched, (d) offshore stay, and (e) travel to return to a port after the fishing, as the activities, and specifies the activities multiple times based on the craft location data from departure until arrival of the craft to specify the activities of different types performed during the period from the departure until the arrival of the craft, and the activity data indicates the activities of different types performed during the period from the departure until the arrival of the craft, and a time at which each activity is performed.
8. The vessel activity inference device according to claim 7, wherein in the specifying process, the at least one processor has a function of specifying, based on the craft location data, that longline fishery is performed as the fishing, and, when the fishing is specified as the longline fishery based on the activities, specifies, based on the craft location data, an outward period during which a longline is developed in the longline fishery, and a return period during which the longline is collected in the longline fishery.
9. The vessel activity inference device according to claim 7, wherein the at least one processor further executes a crew data acquiring process of acquiring crew data containing a chronological series of detected values indicating motions or organic activities of a crew on the craft, and in the specifying process, the at least one processor specifies the activities, based on not only the craft location data but also the crew data during the navigation.

10. The vessel activity inference device according to claim 9, wherein the crew data contains a chronological series of detected values indicating motions of the crew, the at least one processor further executes a craft rocking-motion data acquiring process of acquiring craft rocking-motion data containing a chronological series of detected values indicating strengths of locking motions of the craft, and a correction process of removing a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the crew data and the craft rocking-motion data, and generating corrected crew data indicating motions of the crew relative to the craft, and in the specifying process, the at least one processor specifies the activities, based on not only the craft location data but also the corrected crew data during the navigation.
11. The vessel activity inference device according to claim 7, wherein the at least one processor further executes an equipment-state data acquiring process of acquiring equipment state data containing a chronological series of detected values indicating states of operation or usage of equipment installed in the craft, and in the specifying process, the at least one processor specifies the activities, based on not only the craft location data but also the equipment state data during the navigation.
12. The vessel activity inference device according to claim 7, wherein the specifying process is executed using a learned model generated through machine learning for specifying the activities from the craft location data.
13. A report generation assistance system, comprising: the vessel activity inference device according to claim 7; and a report generating server to acquire the activity data from the vessel activity inference device, and to generate, based on the acquired activity data, report data indicating achievements of the navigation.
14. A non-transitory computer-readable recording medium storing a vessel activity inference program, the vessel activity inference program causing a computer to serve as: a craft location data acquirer to acquire craft location data containing a chronological series of detected values indicating locations of a craft during a navigation; a specifier to specify, based on the craft location data acquired by the craft location data acquirer, activities performed by the craft; and an outputter to output activity data indicating the activities specified by the specifier, wherein the specifier has a function of specifying, based on the craft location data, each of (a) travel toward a search region in which search for a fishery is performed, (b) the search for the fishery in the search region, (c) fishing in the fishery searched, (d) offshore stay, and (e) travel to return to a port after the fishing, as the activities, and specifies the activities multiple times based on the craft location data from departure until arrival of the craft to specify the activities of different types performed during a period from the departure until the arrival of the craft, and the activity data indicates the activities of different types performed during the period from the departure until the arrival of the craft, and a time at which each activity is performed.
22. (canceled)
20. A seafarer safety device, comprising: at least one processor, wherein the at least one processor executes an evaluation process of evaluating, based on intensities of notification radio waves indicating existence of a crew on a craft and strengths of rocking motions of the craft detected by a craft rocking-motion sensor, whether the crew is in emergency circumstances, the notification radio waves being received from a wearable transmitting device that repetitively transmits the notification radio waves, the craft rocking-motion sensor repetitively detecting the strengths of the rocking motions, and an outputting process of outputting an emergency evaluation signal indicating a result of evaluation, when the crew is evaluated to be in emergency circumstances in the evaluation process.
21. The seafarer safety device according to claim 20, wherein the evaluation process further includes a low-intensity period determining process of comparing the intensities of the notification radio waves with a threshold radio-wave intensity, and determining a length of a low-intensity

period while the intensities of the notification radio waves are lower than the threshold radio-wave intensity, the threshold radio-wave intensity being preliminarily set as a threshold implying existence of the crew on the craft, an initial locking-motion strength determining process of determining, based on the strengths of the rocking motions detected by the craft rocking-motion sensor, an initial locking-motion strength that indicates a strength of locking motions of the craft at start of the low-intensity period, and an evaluation execution process of evaluating, based on the length of the low-intensity period determined in the low-intensity period determining process and the initial locking-motion strength determined in the initial locking-motion strength determining process, whether the crew is in emergency circumstances.

22. The seafarer safety device according to claim 21, wherein when the length of the low-intensity period exceeds an allowable length of low-intensity period, the crew is evaluated to be in emergency circumstances in the evaluation execution process, the allowable length of low-intensity period being set as a threshold implying normal circumstances of the crew, and the evaluation process further includes an allowable low-intensity period setting process of setting the allowable length of low-intensity period to be shorter for a larger initial locking-motion strength determined in the initial locking-motion strength determining process.

23. The seafarer safety device according to claim 20, wherein the notification radio waves contain detected values indicating motions or organic activities of the crew, and in the evaluation process, the at least one processor evaluates, based on not only the intensities of the notification radio waves and the strengths of the rocking motions detected by the craft rocking-motion sensor but also the detected values indicating the motions or organic activities of the crew contained in the notification radio waves, whether the crew is in emergency circumstances.

24. The seafarer safety device according to claim 23, wherein the notification radio waves contain detected values indicating motions of the crew, the evaluation process further includes a correction process of removing a contribution of the locking motions of the craft to the motions of the crew, from the detected values indicating the motions of the crew, using the detected values indicating the motions of the crew contained in the notification radio waves and the strengths of the rocking motions detected by the craft rocking-motion sensor, and generating corrected crew data indicating motions of the crew relative to the craft, and the corrected crew data is used in evaluation of whether the crew is in emergency circumstances.

25. A seafarer safety system, comprising: the seafarer safety device according to claim 20; an alarm unit installed in the craft, the alarm unit being configured to perform an alarm operation of emitting an alarm in response to acquisition of the emergency evaluation signal from the seafarer safety device; and an alarm canceling unit installed in the craft, the alarm canceling unit being configured to cause the alarm unit to stop the alarm operation, when the alarm canceling unit receives a manipulation for stopping the alarm operation from the crew during the alarm operation of the alarm unit.

26. The seafarer safety system according to claim 25, wherein the seafarer safety device informs an external server that the crew is in emergency circumstances, when the alarm operation of the alarm unit continues for a period longer than a confirmation period preliminarily set as a period required by the crew for canceling the alarm operation.

27. The seafarer safety system according to claim 25, further comprising: the wearable transmitting device worn by the crew to transmit the notification radio waves; and the craft rocking-motion sensor installed in the craft to detect the strengths of the locking motions of the craft.

28. A non-transitory computer-readable recording medium storing a seafarer safety program, the seafarer safety program being configured to cause a computer to serve as: an evaluator to execute an evaluation process of evaluating, based on intensities of notification radio waves indicating existence of a crew on a craft and strengths of rocking motions of the craft detected by a craft rocking-motion sensor, whether the crew is in emergency circumstances, the notification radio waves being received from a wearable transmitting device that repetitively transmits the notification radio waves, the craft rocking-motion sensor repetitively detecting the strengths of the rocking motions; and an outputter to output an emergency evaluation signal indicating a result of evaluation, when the evaluator evaluates that the crew is in emergency circumstances.