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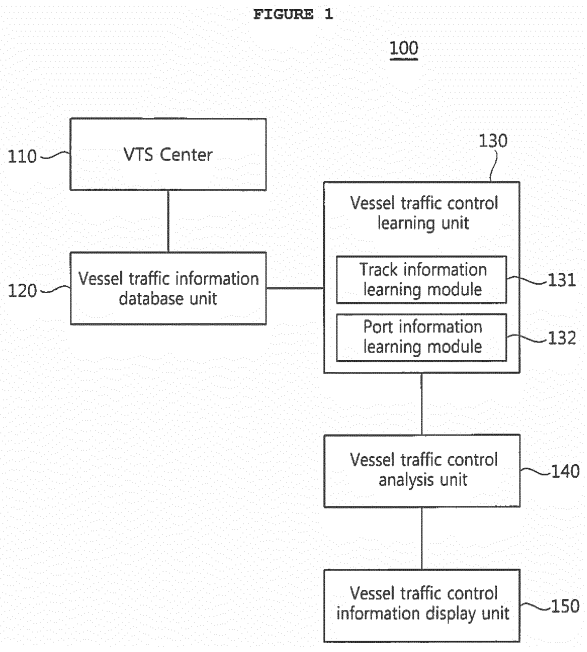
# (54) VESSEL TRAFFIC SERVICE EXPERT SYSTEM USING DEEP LEARNING ALGORITHM, AND CONTROL METHOD THEREOF

(57) The present invention relates to a vessel traffic service expert system using a deep learning algorithm. The vessel traffic service expert system using a deep learning algorithm comprises: a vessel traffic service (VTS) center providing oversea communication information including vessel information on a vessel being sailing and harbor area information; an oversea communication information database unit storing the oversea communication information provided from the VTS center in real time; a vessel traffic service leaning unit receiving the oversea communication information in a set range from the oversea communication information and generating control standard information determining a state of vessel and a state of area using the deep learning algorithm; a vessel traffic service analyzing unit generating the oversea control information including the information on vessel and the information on area in real time by comparing and analyzing the oversea communication information and the control standard information stored in real time; and an vessel traffic service information displaying unit displaying the generated control standard information through an electronic navigation chart. The control standard information includes vessel state standard information and area state standard information.

FIGURE 1




EP 3 291 206 A1

## Description

### Technical Field

**[0001]** The present invention relates, in general, to a Vessel Traffic Service (VTS) system and, more particularly, to a vessel traffic service expert system using a deep learning algorithm and a control method for the system, which may prevent marine accidents by identifying a vessel in an abnormal state and detecting a dangerous zone in a port using deep learning technology based on a large amount of data.

### Background Art

**[0002]** Generally, a Vessel Traffic Service (VTS) system may provide sailing vessels with a wide range of services using various sensors such as radar or the like in order to enable the vessels to sail safely.

**[0003]** In particular, a VTS system may improve the safety of a port and the efficiency of port management under conditions of heavy vessel traffic, increased amounts of dangerous cargo, the risk of environmental pollution and the like, and may provide a navigation service in order to prevent marine accidents.

**[0004]** Specifically, the VTS system may provide information service in which information about the surroundings and vessel traffic in the area covered by the VTS system is provided in a timely manner, whereby a vessel may receive help in making navigational decisions.

**[0005]** Here, because information from the VTS system is provided in such a way that a controller who works in a VTS center provides the information in consideration of the characteristics of a corresponding port, the time, and the distinct characteristics of the vessel navigated by the controller, the condition and skill of the controller may strongly affect the provided information. Furthermore, gaining the ability of skillful control needs a lot of experience, and thus the controller is required to expend a lot of time and effort.

**[0006]** In order to help a controller to control vessel traffic, many systems are being developed. However, most existing VTS systems operate as rule-based systems. In other words, criteria are set when a system is constructed.

**[0007]** Therefore, when a situation deviating from the defined rules occurs, it is difficult to correctly judge the situation. Furthermore, because it is impossible to predefine all possible vessel traffic situations, it is disadvantageous in that a controller is required to recognize dangerous situations as they emerge.

### Disclosure

### Technical Problem

**[0008]** Accordingly, the present invention has been made keeping in mind the above problems, and an object of the present invention is to provide a vessel traffic service expert system using a deep learning algorithm and a control method for the system, which may automatically detect the state of a vessel and the situation of a port from a large amount of data using a deep learning algorithm (method), rather than setting criteria for judging the situation in advance.

**[0009]** Also, another object of the present invention is to provide a vessel traffic service expert system using a deep learning algorithm and a control method for the system, in which, rather than setting criteria based on the state of the sea, the system creates criteria, automatically identifies a vessel in an abnormal state, detects a dangerous zone in a port, and forwards results to a controller, whereby marine accidents may be effectively prevented.

**[0010]** However, the object of the present invention is not limited to the above-mentioned objects, and other objects may be clearly understood by those skilled in the art through the following description.

### Technical Solution

**[0011]** A vessel traffic service expert system using a deep learning algorithm according to the present invention includes a Vessel Traffic Service (VTS) center for providing vessel traffic information, which includes vessel information about a sailing vessel and information about a port area, in real time; a vessel traffic information database unit for storing the vessel traffic information, provided from the VTS center, in real time; a vessel traffic control learning unit for receiving the vessel traffic information within a set range from the vessel traffic information database unit and creating control reference information for determining a state of a vessel and a state of an area using a deep learning algorithm; a vessel traffic control analysis unit for creating vessel traffic control information, which includes vessel state information and area state information, in real time by comparing and analyzing the vessel traffic information, stored in real time, with the control reference information; and a vessel traffic control information display unit for displaying the created vessel traffic control information through an electronic navigation chart, wherein the control reference information includes vessel state reference information and area state reference information.

### Advantageous Effects

**[0012]** The vessel traffic expert system using a deep learning algorithm and the control method for the system according to the present invention are advantageous in that criteria for determining dangerous situations are not set in advance when a system is constructed, but the state of a vessel and the situation of a port are automatically detected through a large amount of data stored in real time using a deep learning method based on Artificial Intelligence (AI).

**[0013]** Also, according to the present invention, criteria

are not set in advance, but a system creates criteria by itself and thereby automatically identifies a vessel in an abnormal state, detects a dangerous zone in a port, and forwards results to a controller. Accordingly, the controller may detect a dangerous situation, which has not been found by the controller, and respond thereto in advance, whereby marine accidents may be effectively prevented.

## Description of Drawings

**[0014]**

FIG. 1 is a block diagram schematically illustrating the configuration of a vessel traffic service expert system using a deep learning algorithm according to an embodiment of the present invention;

FIG. 2 is a flowchart illustrating a control method for a vessel traffic service expert system using a deep learning algorithm according to an embodiment of the present invention; and

FIG. 3 shows an example of vessel traffic control information provided according to the present invention.

## Best Mode

**[0015]** Hereinafter, a preferred embodiment of the present invention is described with reference to the accompanying drawings. In the following description of the present invention, detailed descriptions of known functions and configurations which are deemed to make the gist of the present invention obscure will be omitted.

**[0016]** The embodiment according to the present invention may be variously changed and have various forms. Accordingly, specific embodiments will be described in detail below with reference to the attached drawings. However, it should be understood that those embodiments are not intended to limit the present invention to specific disclosure forms and they include all changes, equivalents or modifications included in the spirit and scope of the present invention.

**[0017]** FIG. 1 is a block diagram schematically illustrating the configuration of a vessel traffic service expert system using a deep learning algorithm according to an embodiment of the present invention, FIG. 2 is a flowchart illustrating a control method for the vessel traffic service expert system using a deep learning algorithm, and FIG. 3 shows an example of vessel traffic control information.

**[0018]** Referring to the drawings, a vessel traffic service expert system 100 using a deep learning algorithm according to the present invention may be configured to include a Vessel Traffic Service (VTS) center 110, a vessel traffic information database unit 120, a vessel traffic control learning unit 130, a vessel traffic control analysis unit 140, and a vessel traffic control information display unit 150.

**[0019]** The vessel traffic service expert system and a control method for the system are described through these components. First, although not specifically illustrated in the drawing, the VTS center 110 may be built in many locations and provide vessel traffic information, which includes information about sailing vessels and information about a port area, in real time at step S101.

**[0020]** Generally, the VTS center 110 may detect vessel traffic conditions using an Automatic Identification System (AIS), installed in each vessel, and a radar device, installed on land (on the shore).

**[0021]** Here, the AIS contains information about the name, the type, the specification, the position, and the speed of the corresponding vessel, and the like.

**[0022]** The vessel traffic information database unit 120 stores the vessel traffic information, provided from the VTS center 110 in real time, therein at step S102.

**[0023]** Here, the vessel traffic information database unit 120 may store categorized vessel traffic information. Specifically, the vessel traffic information may include vessel information and port area information.

**[0024]** Also, the vessel information may include the name of a vessel, the type of the vessel, the specification of the vessel, information about variation in the position of the vessel over time, information about the speed of the vessel over time, information about the course of the vessel over time, information about the accident history of the vessel, and information about the cargo carried by the vessel.

**[0025]** Also, the vessel traffic information database unit 120 may store various kinds of maritime information, such as weather information and the like, in addition to the vessel traffic information.

**[0026]** Subsequently, the vessel traffic control learning unit 130 may be provided with the vessel traffic information within a set range from the vessel traffic information database unit at step S103, and may create control reference information for determining the state of a vessel and the state of an area using a deep learning algorithm.

**[0027]** The vessel traffic control learning unit 130 may create control reference information for separating the input information into a normal state and an abnormal state through neural learning based on multi-layer neural networks.

**[0028]** Also, the vessel traffic control learning unit 130 may continuously receive the vessel traffic information, which is stored in real time, and thereby update the control reference information. Here, the vessel traffic control learning unit 130 may perform the update at a preset interval or in real time.

**[0029]** Also, the control reference information may include vessel state reference information and area state reference information.

**[0030]** Specifically, the vessel traffic control learning unit 130 may include a track information learning module 131 and a port information learning module 132, as shown in the drawing.

**[0031]** The track information learning module 131 may receive information about vessels, acquired during a certain period, as input data and create the vessel state ref-

erence information for differentiating between the normal state of a vessel and an abnormal state of the vessel.

**[0032]** Also, the port information learning module 132 may receive information about a port area, which is divided so as to have the form of a grid having consistent spacing, as input data, and may create the area state reference information for determining the dangerous state of the area (port area).

**[0033]** Also, the track information learning module 131 and the port information learning module 132 may continuously create and update the vessel state reference information and the area state reference information through a deep learning algorithm.

**[0034]** Particularly, the vessel traffic control learning unit 130 of the present invention is characterized in that criteria are established and continuously updated using information input in real time through a deep learning algorithm or method based on Artificial Intelligence (AI).

**[0035]** The vessel traffic control analysis unit 140 receives the control reference information, which is created and updated by the vessel traffic control learning unit 130, at step S105 and receives the vessel traffic information, which is stored in the vessel traffic information database unit 120 in real time, at step S106, simultaneously with the control reference information.

**[0036]** The vessel traffic control analysis unit 140 compares and analyzes the vessel traffic information, which is stored in real time, with the control reference information or the updated control reference information, and thereby creates vessel traffic control information, which includes the vessel state information and area state information, in real time at step S107.

**[0037]** For example, the vessel traffic control analysis unit 140 may acquire the probability of an abnormal state (which is in the range from 0.0 to 1.0) for each vessel or for each area using the information created by the vessel traffic control learning unit 130.

**[0038]** Here, the vessel traffic control analysis unit 140 may create vessel state information by applying a weighted value based on the accident history of the vessel and the cargo carried by the vessel or in consideration of such information. Also, the risk level for each area, that is, the risk level in the areas divided in the form of a grid, may be used to create the area state information.

**[0039]** Then, the vessel traffic control information, created by the vessel traffic control analysis unit 140, is provided to the vessel traffic control information display unit 150 at step S108 and is displayed through a separate display at step S109.

**[0040]** The vessel traffic control information display unit 150 may display the vessel traffic control information for each vessel and for each area on an electronic navigation chart 151, as shown in FIG. 3.

**[0041]** Specifically, the vessel traffic control information display unit 150 may display the vessel state information and the area state information using different colors for different levels (for example, using a color set depending on a certain range of calculated probability) or using different shapes.

**[0042]** For example, a vessel may be marked with '○', an area may be marked with '□', an abnormal or a dangerous state may be marked with a red color (or diagonal lines), a safe state may be marked with a blue color (or large dots), and a warning may be marked with a green color (or small dots) on the electronic navigation chart 151.

**[0043]** Therefore, through the vessel traffic service expert system 100, a vessel in an abnormal state is automatically detected, a dangerous zone in a port is detected, and the result is displayed on the electronic navigation chart 151, whereby the real-time state may be delivered to a controller.

**[0044]** Also, although not specifically illustrated, when the vessel state information or the area state information corresponds to an abnormal state, the vessel traffic control analysis unit 140 may send a warning signal to a controller, a central control center, a rescue center or the like, whereby they may be made aware of the dangerous situation.

**[0045]** As described above, according to the present invention, because information is processed using a deep learning method, the states of vessels and the situation of a port may be automatically detected using data stored in real time, and may be provided to a controller.

**[0046]** Although the present invention has been described with reference to the embodiment shown in the accompanying drawings, it should be understood that the embodiment is merely an example and those skilled in the art will appreciate that various modifications, additions and substitutions are possible. Accordingly, the scope of the present invention must be viewed as being defined in appended claims.

## Mode for Invention

**[0047]** A vessel traffic service expert system using a deep learning algorithm according to an embodiment of the present invention includes a Vessel Traffic Service (VTS) center for providing vessel traffic information, which includes vessel information about a sailing vessel and information about a port area, in real time; a vessel traffic information database unit for storing the vessel traffic information, provided from the VTS center, in real time; a vessel traffic control learning unit for receiving the vessel traffic information within a set range from the vessel traffic information database unit and creating control reference information for determining a state of a vessel and a state of an area using a deep learning algorithm; a vessel traffic control analysis unit for creating vessel traffic control information, which includes vessel state information and area state information, in real time by comparing and analyzing the vessel traffic information, stored in real time, with the control reference information; and a vessel traffic control information display unit for displaying the created vessel traffic control information through an electronic navigation chart, wherein the control refer-

ence information may include vessel state reference information and area state reference information.

**[0048]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the vessel traffic control learning unit may include a track information learning module for receiving the vessel information acquired during a certain period as input data and creating the vessel state reference information for differentiating between a normal state of a vessel and an abnormal state of the vessel; and a port information learning module for receiving the information about the port area, which is divided in the form of a grid having consistent spacing, as input data and creating the area state reference information for determining an area in a dangerous state.

**[0049]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the vessel traffic control learning unit may update the created control reference information by being provided with new vessel traffic information, stored in real time, from the vessel traffic information database unit, and may provide the updated control reference information to the vessel traffic control analysis unit.

**[0050]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the track information learning module may use information about remaining vessels, excluding a vessel that is involved in an accident, as input data.

**[0051]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the vessel information may include the name of the vessel, the type of the vessel, the specification of the vessel, information about variation in the position of the vessel over time, information about the speed of the vessel over time, information about the course of the vessel over time, information about the accident history of the vessel, and information about the cargo carried by the vessel, and the information about the port area may include information about a position at which accidents frequently occur and information about the location of dangerous areas.

**[0052]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the vessel traffic control analysis unit may create the vessel state information by applying a weighted value based on the information about the accident history of the vessel and information about the cargo carried by the vessel.

**[0053]** Also, in the vessel traffic service expert system using a deep learning algorithm according to the present invention, the vessel traffic control information display unit may display the vessel state information and the area state information using a color corresponding to a level.

**[0054]** A control method for a vessel traffic service expert system according to the present invention may include receiving, by a Vessel Traffic Service (VTS) center, vessel traffic information, which includes vessel information about a sailing vessel, information about a port area, and weather information, in real time; storing, by a vessel traffic information database unit, the vessel traffic information, which is received in real time from the VTS center; receiving, by a vessel traffic control learning unit, the vessel traffic information within a set range, and creating, by the vessel traffic control learning unit, control reference information, which includes vessel state reference information and area state reference information, using a deep learning algorithm in order to determine the state of a vessel and the state of an area; creating, by a vessel traffic control analysis unit, vessel traffic control information, which includes vessel state information and area state information, in real time by comparing and analyzing the vessel traffic information, stored in real time, with the control reference information; and displaying, by a vessel traffic control information display unit, the created vessel traffic control information.

## Industrial Applicability

**[0055]** The present invention uses a deep learning method based on Artificial Intelligence (AI), and may thus be applied to a vessel traffic service expert system using a deep learning algorithm and a control method for the system, in which criteria for determining a dangerous situation are not set in advance when a system is constructed, but in which the states of a vessel and a port are automatically detected using a large amount of data stored in real time.

**[0056]** Also, the present invention may be applied to a vessel traffic service expert system using a deep learning algorithm and a control method for the system, in which, because the system is configured to create criteria by itself without the need to set the criteria, to automatically detect a vessel in an abnormal state, to detect a dangerous zone in a port, and to deliver the result to a controller, the controller may detect a dangerous situation, which has not been found by the controller, and respond thereto in advance, whereby marine accidents may be effectively prevented.

## Claims

1. A vessel traffic service expert system using a deep learning algorithm, comprising:

   a Vessel Traffic Service (VTS) center for providing vessel traffic information, which includes vessel information about a sailing vessel and information about a port area, in real time;
   a vessel traffic information database unit for storing the vessel traffic information, provided from the VTS center, in real time;
   a vessel traffic control learning unit for receiving the vessel traffic information within a set range from the vessel traffic information database unit and creating control reference information for

determining a state of a vessel and a state of an area using a deep learning algorithm;
a vessel traffic control analysis unit for creating vessel traffic control information, which includes vessel state information and area state information, in real time by comparing and analyzing the vessel traffic information, stored in real time, and the control reference information; and
a vessel traffic control information display unit for displaying the created vessel traffic control information through an electronic navigation chart,
wherein the control reference information includes vessel state reference information and area state reference information.

**2.** The vessel traffic service expert system of claim 1, wherein the vessel traffic control learning unit comprises:

a track information learning module for receiving the vessel information acquired during a certain period as input data and creating the vessel state reference information for differentiating between a normal state of a vessel and an abnormal state of the vessel; and
a port information learning module for receiving the information about the port area, which is divided in a form of a grid having consistent spacing, as input data and creating the area state reference information for determining a dangerous state of an area.

**3.** The vessel traffic service expert system of claim 1, wherein the vessel traffic control learning unit is configured to:

update the created control reference information by being provided with new vessel traffic information, stored in real time, from the vessel traffic information database unit; and
provide the updated control reference information to the vessel traffic control analysis unit.

**4.** The vessel traffic service expert system of claim 2, wherein the track information learning module uses information about remaining vessels, excluding a vessel involved in an accident, as input data.

**5.** The vessel traffic service expert system of claim 1, wherein the vessel information includes a name of the vessel, a type of the vessel, a specification of the vessel, information about variation in a position of the vessel over time, information about a speed of the vessel over time, information about a course of the vessel over time, information about an accident history of the vessel, and information about cargo carried by the vessel.

**6.** The vessel traffic service expert system of claim 1, wherein the information about the port area includes information about a position at which an accident frequently occurs and position information about a dangerous area.

**7.** The vessel traffic service expert system of claim 5, wherein the vessel traffic control analysis unit creates the vessel state information by applying a weighted value based on the information about the accident history of the vessel and information about the cargo carried by the vessel.

**8.** The vessel traffic service expert system of claim 1, wherein the vessel traffic control information display unit displays the vessel state information and the area state information using a color according to a level.

**9.** A control method for a vessel traffic service expert system using a deep learning algorithm, comprising:

receiving, by a Vessel Traffic Service (VTS) center, vessel traffic information, which includes vessel information about a sailing vessel, information about a port area, and weather information, in real time;
storing, by a vessel traffic information database unit, the vessel traffic information, which is received in real time from the VTS center;
receiving, by a vessel traffic control learning unit, the vessel traffic information within a set range, and creating, by the vessel traffic control learning unit, control reference information, which includes vessel state reference information and area state reference information, using a deep learning algorithm in order to determine a state of a vessel and a state of an area;
creating, by a vessel traffic control analysis unit, vessel traffic control information, which includes vessel state information and area state information, in real time by comparing and analyzing the vessel traffic information, stored in real time, and the control reference information; and
displaying, by a vessel traffic control information display unit, the created vessel traffic control information.

**10.** The control method for claim 9, wherein in the creating the control reference information,
the vessel traffic control learning unit is configured to:

create the vessel state reference information for differentiating between a normal state of a vessel and an abnormal state of the vessel by receiving the vessel information, acquired during a certain period, as input data; and
create the area state reference information for

determining a dangerous state of an area by receiving the information about the port area, which is divided in a form of a grid having consistent spacing, as input data.

**11.** The control method of claim 9, wherein:

the vessel information includes a name of the vessel, a type of the vessel, a specification of the vessel, information about variation in a position of the vessel over time, information about a speed of the vessel over time, information about a course of the vessel over time, information about an accident history of the vessel, and information about cargo carried by the vessel; and
the information about the port area includes information about a position at which an accident frequently occurs and position information about a dangerous area.

**12.** The control method of claim 9, wherein
after creating the control reference information, the vessel traffic control learning unit updates the created control reference information by receiving new vessel traffic information, which is stored in real time, from the vessel traffic information database unit and provides the updated control reference information to the vessel traffic control analysis unit.

FIGURE 1

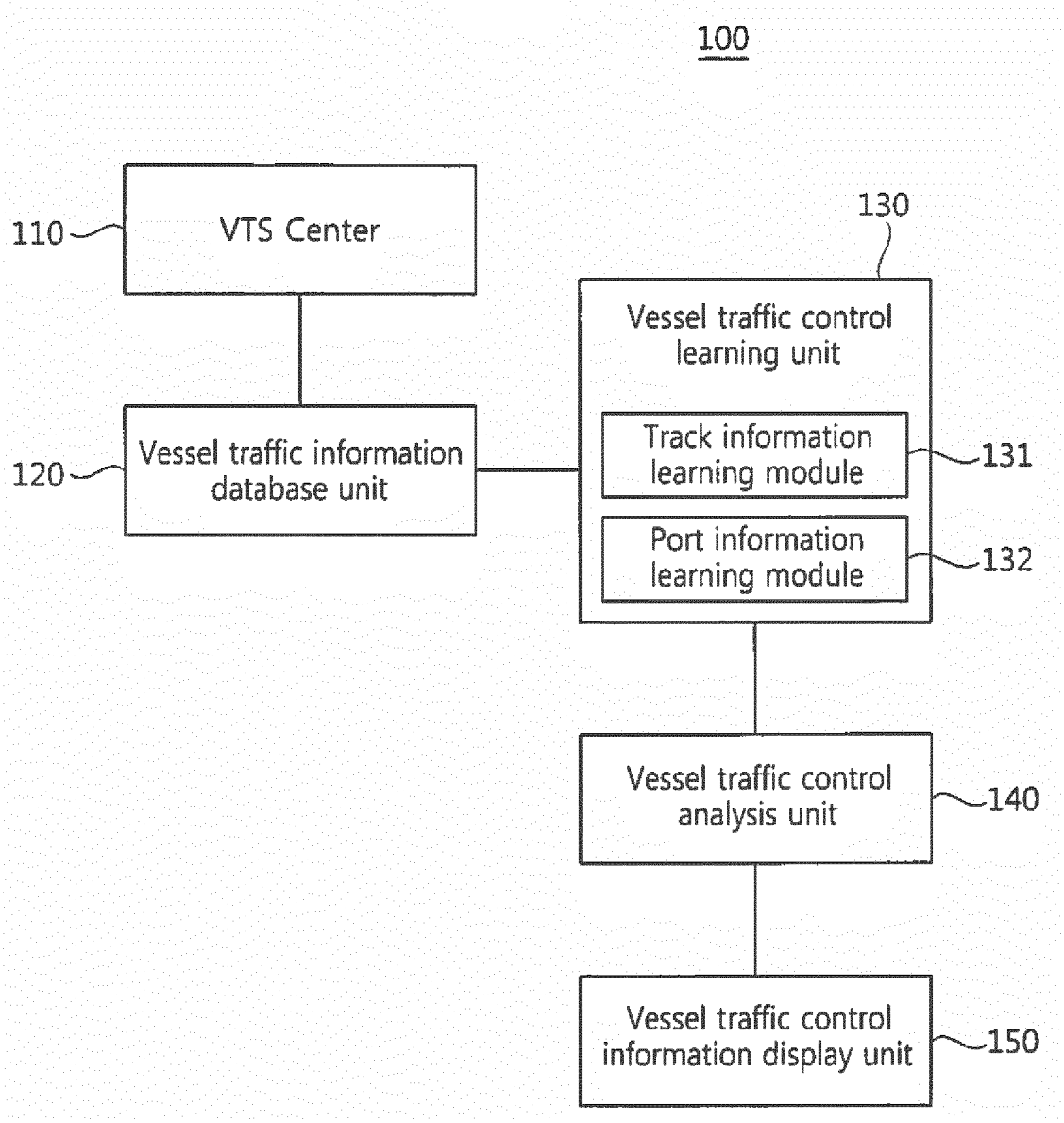

100
110
VTS Center
130
Vessel traffic control learning unit
120
Vessel traffic information database unit
Track information learning module
131
Port information learning module
132
Vessel traffic control analysis unit
140
Vessel traffic control information display unit
150

FIGURE 2

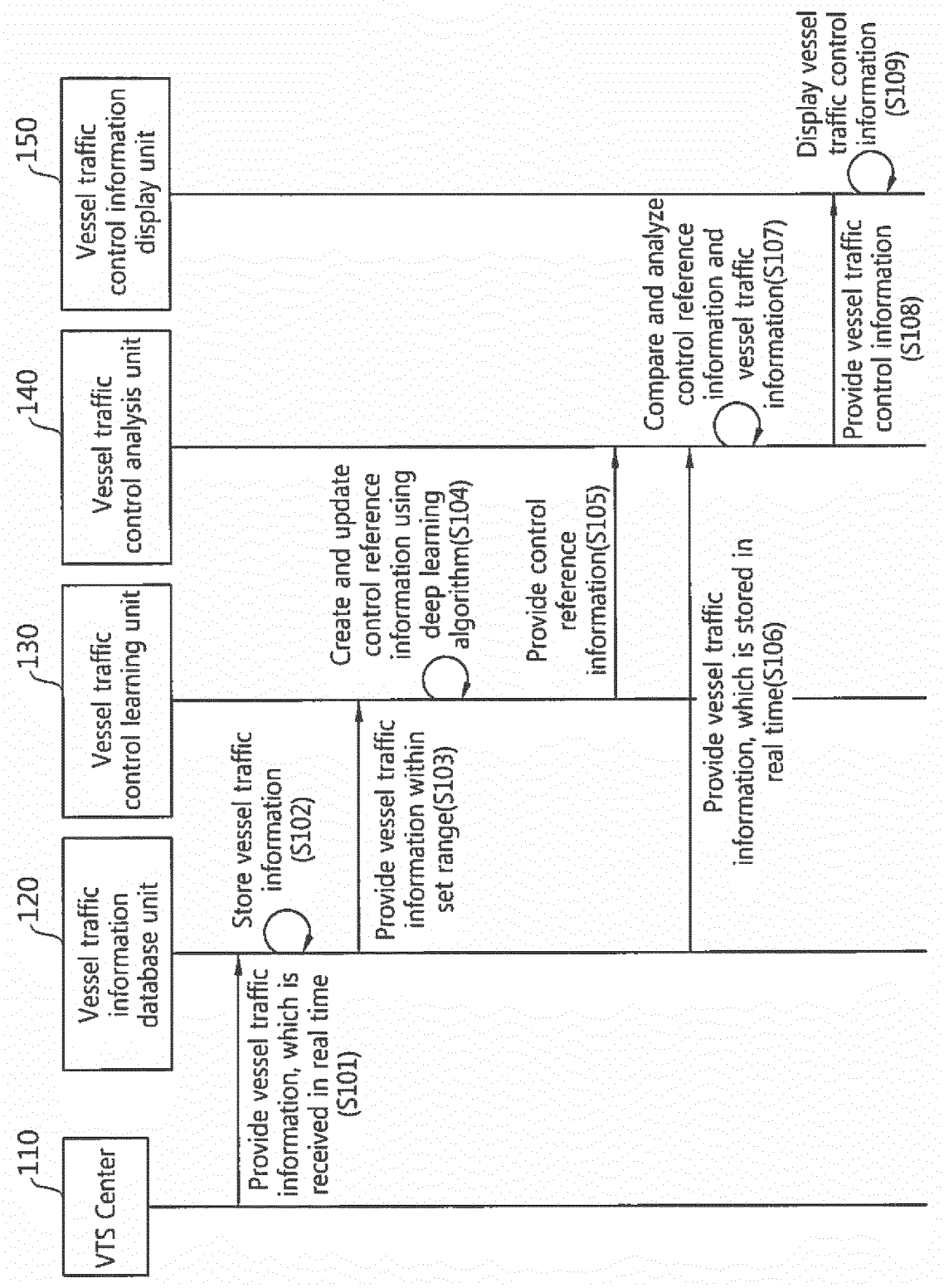
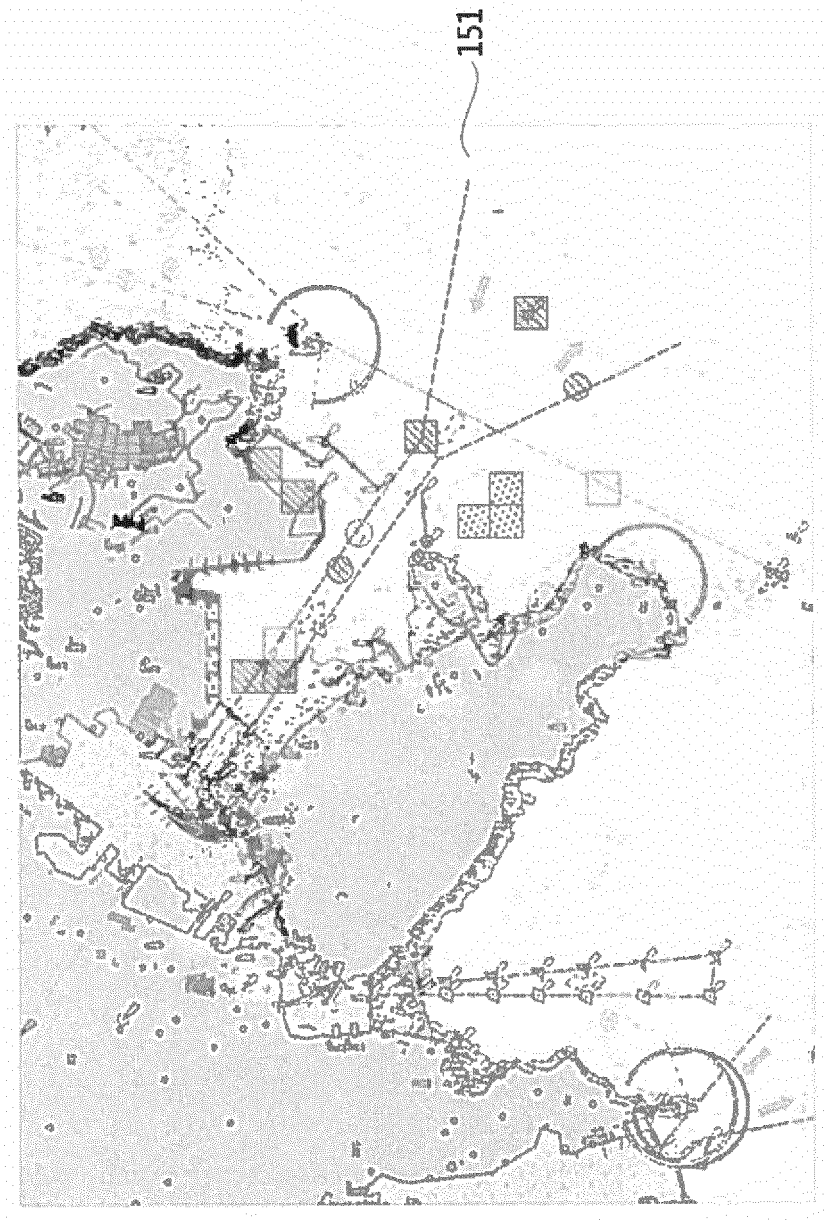

110
VTS Center
120
Vessel traffic information database unit
130
Vessel traffic control learning unit
140
Vessel traffic control analysis unit
150
Vessel traffic control information display unit
Provide vessel traffic information, which is received in real time (S101)
Store vessel traffic information (S102)
Provide vessel traffic information within set range(S103)
Create and update control reference information using deep learning algorithm(S104)
Provide control reference information(S105)
Provide vessel traffic information, which is stored in real time(S106)
Compare and analyze control reference information and vessel traffic information(S107)
Provide vessel traffic control information (S108)
Display vessel traffic control information (S109)

FIGURE 3



## INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/014180

A. CLASSIFICATION OF SUBJECT MATTER

*G08G 3/00(2006.01)i, G08G 3/02(2006.01)i*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G08G 3/00; G01S 13/91; G06Q 50/30; G08G 3/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: vessel traffic service(VTS), deep learning, ship state, region state, electronic navigational chart

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
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| A | | 2,4,7-8,10 |
| Y | KR 10-2008-0006294 A (KOREA OCEAN RESEARCH AND DEVELOPMENT INSTITUTE) 16 January 2008<br>See paragraphs [0020], [0035]; claim 1 and figure 1. | 1,3,5-6,9,11-12 |
| A | US 2014-0022107 A1 (ELECTRONICS AND TELECOMUNICATIONS RESEARCH INSTITUTE) 23 January 2014<br>See paragraphs [0012]-[0029]; claim 1 and figure 1. | 1-12 |
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| A | KR 10-1050376 B1 (DONGNAM TDS CO., LTD.) 19 July 2011<br>See paragraphs [0010]-[0023]; claim 1 and figure 2. | 1-12 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 05 APRIL 2016 (05.04.2016) | **06 APRIL 2016 (06.04.2016)** |
| Name and mailing address of the ISA/KR<br>Korean Intellectual Property Office<br>Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea<br>Facsimile No. 82-42-472-7140 | Authorized officer<br><br>Telephone No. |

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**
Information on patent family members

International application No.
**PCT/KR2015/014180**

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