

CONTROL SYSTEM FOR A CARGO SHIP

DESCRIPTION OF BACKGROUND

5 The disclosure relates to controlling cargo ships and particularly controlling cargo ships with regard loading and operating conditions.

Cargo ships and cargo comes in different sizes and shapes. Cargo ships are used to transport the cargo from one location to another. It is possible
10 that the cargo ships have intermediate stops during their journey. Loading a cargo ship optimally, particularly a container ship, is a delicate problem. Containers are loaded to a ship in a particular order. Loading takes into account the possible removal at the
15 next port, security issues and operability issues. For example, containers that include heavy items or items that may move during the journey can be loaded first so that they are loaded close to the deck and are not top of the stack. By this arrangement the stacks are
20 more stable as the momentums caused by rolling are smaller. Similar problems may be present also in other types of cargo that may move, fall or change the shape otherwise during a journey. One important factor in loading is how the cargo changes the operability of
25 the cargo ship.

The planning may also be done in view of the coming journey. Thus, containers are loaded to the container ship in a manner that the ship may be operated at the full speed or in more severe
30 conditions if such conditions are expected. Furthermore, the planning may need to be compromised because it is desired to operate using higher payload or smaller margins. The loading as such, for each journey, has always an effect to the operability of
35 the cargo ship. The loading may have an effect to, for example, to draught and wind surface. Furthermore, the

center of gravity of a cargo ship may have an effect to the operability. A problem of the planning is that the plan is not always implemented correctly. Thus, the containers may be in different order or the amount
5 of other cargo may be smaller or larger than initially planned. Thus, the cargo ship may be lighter or heavier than planned.

A further problem of the planning is that it is not easy detect the limits, for example, when
10 parametric rolling may happen, because the problem do not occur only because of the loading but are influenced by weather conditions and ship operation. An experienced captain is required in difficult conditions and even in such case the captain may
15 notice the high risk of parametric rolling or similar problem only after it first occurs. Furthermore, even if the cargo does not move the change of weather or sailing conditions may cause problems, for example, with regard the draught. As the loading conditions
20 typically significantly vary from time to time it is difficult to operate cargo ships optimally.

SUMMARY

A control system for a cargo ship is
25 disclosed. The control system uses information received from at least one loading computer and produces a model of the cargo ship. The model comprises at least one representative point that is determined based on the received loading information.
30 The information provides information how the cargo is actually loaded into the cargo ship, how it effects to the operability of the cargo ship and how stable the loaded cargo is. The information may be used for various purposes including optimizing routes and
35 monitoring operating margins with regard the weather and other operating conditions.

In an embodiment a method for operating a cargo ship is disclosed. The method comprises receiving information from at least one loading computer using a network connection; and generating
5 a model of said ship based on said received information, wherein said model comprises at least one representative point of the loaded cargo of said ship. This is beneficial as it provides a model of the cargo ship, wherein the model corresponds with current
10 loading conditions. The loading conditions may then be used for helping in operating the cargo ship.

In another embodiment the method further comprises receiving additional information with regard said cargo ship operation and current weather
15 conditions. This is beneficial because it combines the actual weather and operation conditions with the loading conditions. In a further embodiment method further comprises applying said additional information into said generated model. This is
20 beneficial as it provides a possibility to simulate the operation of the cargo ship. In a further embodiment the further comprises determining, based on said model and received additional information, a route and speed for said cargo ship. This is
25 beneficial as it may be used in autonomous operation. In an embodiment the method further comprises using a dynamic positioning system, for following said determined route. This is beneficial as it combines a dynamic positioning system with the model and provides
30 more information that may be used, for example, in autonomous operation. This reduces problems and operational costs. In an embodiment the method further comprises updating said determined route and speed. This is beneficial as it provides possibility to apply
35 the method with the current real weather and operational conditions which provides better operation in the prevailing conditions.

In an embodiment a computer program is disclosed. The computer program comprises computer program code configured to perform the method as described above when said computer program is executed
5 in a computing device.

In an embodiment a controller for a cargo ship is disclosed. The controller comprises at least one processor, at least one network connection and at least one memory, wherein said at least one processor
10 is configured to receive information from at least one loading computer using said at least one network connection, generate a model of said ship based on said received information, wherein said model comprises at least one representative point of the
15 loaded cargo of said ship and receive additional information with regard said cargo ship operation and current weather conditions and apply said additional information into said generated model. This is beneficial as it is possible to provide a single
20 controller for controlling the operation of a cargo ship by performing a method as described. Thus, the controller is able of taking the loading conditions into account. In an embodiment the processor is further configured to determine, based on said model
25 and received additional information, a route and speed for said cargo ship. This is beneficial as the controller is able to provide a route and speed for the cargo ship in the prevailing conditions. In another embodiment the controller is further connected
30 to a dynamic positioning system, wherein said dynamic positioning system is configured to follow said determined route. In a further embodiment the controller is configured to update said determined route and speed. This is beneficial as it provides
35 possibility to react to changing conditions.

In an embodiment a cargo ship comprising the controller explained above is disclosed. In another

embodiment the cargo ship further comprises a dynamic positioning system.

The benefits of described embodiments include increasing safety and operability of a cargo ship. The crew of the cargo ship may decide on the operation depending on the weather conditions and on the loading conditions. A benefit of the described embodiments include that they are capable of giving warnings to the operator if any of the criteria, such as accelerations, stability, bending forces, or similar is in risk of being exceeded. Furthermore, it is possible automatically adjust the propulsion parameters to eliminate the problem, for example, by slowing down, speeding up or changing heading. A further benefit is that the crew can acquire their actual margin at any given moment. Furthermore, it is possible to automatically adjust the ship operation so that the margins are kept at desired level. A benefit of the control system is that it can be used both in manned and unmanned ships.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the control system and constitute a part of this specification, illustrate embodiments and together with the description help to explain the principles of the control system. In the drawings:

Fig. 1 is a block diagram illustrating of an example of a control system,

Fig. 2 is a flow chart of an example method, and

Fig. 3 is a flow chart of an example method,

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DETAILED DESCRIPTION

Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings.

Figure 1 is a block diagram illustrating of
5 an example of a control system. In the figure a vessel cargo ship 100 is illustrated. The cargo ship may be a cargo ship of any type. For example, the cargo ship 100 may be a container ship, tanker, bulk carrier, multipurpose carrier or any other cargo ship where the
10 movement of the cargo or change of weather may cause a need for changing the speed or heading.

In figure 1 the cargo ship includes a ship controlling system 101, environmental measurement system 102 and dynamic positioning system 103. Ship
15 controlling system includes all subsystems that are needed for operating a marine vessel. For example, there may be information about the position of the marine vessel, steering controlling, power controlling, acceleration measurement, measurements
20 on lashing bridge forces and similar. Such systems are common in cargo ships, however, the available selection of measurement tools and devices may vary. Thus, not every cargo ship has all possible measurement devices.

25 The environmental measurement system 102 may measure, for example, current wind speed and direction, wave height, wave length, water temperature, air temperature and similar. The cargo ship 100 typically includes a data communication
30 connection 105, which may be connected to the environmental measurement system for receiving environmental measurements from external devices, for example, from a weather service center or other ships in the vicinity.

35 The dynamic positioning system 103 may be used for controlling the movement of the cargo ship. Typically it is a computer controlled system for

maintaining vessels position and heading using propellers, rudders and thrusters. It is possible to have a route comprising route points so that the dynamic position system 103 will drive the ship automatically from a first point to a second point and further. Thus, in some cargo ships the dynamic positioning system is used as an autonomous pilot. In order to improve autonomous features the cargo ship may be equipped with further systems, for example, collision detection system. However, it is possible to use the dynamic positioning system only as a tool for the captain and other crew. Thus, the dynamic positioning system may be used for maintaining the heading and in case of any event requiring changes to the instructions a captain or other crew is required.

The cargo ship 100 of figure 1 further comprises a controller 104 that is connected to each of the mentioned systems so that it can receive ship and environment related information and send instructions to control the movement of the ship, for example by adjusting the route points followed by the dynamic positioning system 103 or by directly changing propulsion power or direction of the cargo ship. The controller 104 may be further connected to additional external systems and the decisions taken by the system may be subjected to an approval of the captain.

The controller 104 comprises typically at least one computing device comprising a processor 107, memory 108, storage capacity and other conventional computing resources. It may share the data communication connection 105. The data communication connection 105 typically comprises a plurality of access technologies. For example, on open sea the communication is typically arranged over a satellite connection. When the ship 100 is docked to the port for loading or unloading it may use mobile communication technologies, wireless local area

network or even cabled connection. The access technology used can be changed according to the demand and conditions. For example, when the cargo ship is approaching the coast or sailing near islands that can be equipped with a mobile communication network base station the cargo ship may change the access technology in order to provide higher data transfer rates or cost savings.

The controller 104 is coupled to a loading computer 106 over the data communication connection 105. The loading computer 106 is a device that is aware of the cargo properties. For example, in case of a container ship, loading computers may be connected to cranes loading the containers to the container ship. Loading computers comprise a diverse set of functionality but typically they include a computer hardware and may be connected to measuring devices. It is also possible that they are configured to receive additional information from external measurement devices, such as weighing devices. In such case it is possible that the loading computer identifies the container or other cargo carrier and receives the weight information or similar based on the identification number. This is naturally applicable when the contents of containers or other cargo carriers are not changed during the processing.

Loading computers are typically used for planning of stowage, cargo and ballast for different ships and ship types. Computer programs ran on loading computers are used to perform several tasks. For example, programs relating to the stability, dynamic stability simulation, lashing and other technical programs may be executed. Even if in the description a loading computer is referred as a single entity it may be a computing system comprising a plurality of interconnected computing devices. In this description it is assumed that the loading computer is connected

to at least one measurement device for measuring the loaded cargo. Typically this measurement is the weight.

In the example of figure 1 the loading
5 computer 106 is configured to receive information with regard the properties of the container to be loaded. For example, it is possible to measure the weight of a container. Furthermore, the loading computer 106 keeps track on the locations of the loaded containers.
10 Thus, it is possible to compute weights for container stacks when the weight and location of containers is known. Based on the weight, possible weight distribution and location it is possible to compute representative values for individual containers,
15 stack of containers or a block of containers.

The controller 104 is configured to collect the information received from the loading computer 106. From the information received a representative model is constructed. This model may comprise, for
20 example, a grid of representative values that form a model of the ship. As the information has been received from the loading computer and the properties of the ship 100 are known the model is realistic. For example, the representative model may include a
25 representative point for each of the containers so that the weight distribution can be computed for the whole cargo and the cargo ship. This, however, is not necessary and the model may also be coarser so that the required computations are fewer and can be done
30 with less computing power.

During the journey the model can be compared with current values received from ship controlling system 101 and environment measurement system 102. For example, it is possible to compute if on the given
35 loading conditions and wind direction it would be to change the heading of the ship. This may be done, for example, in order to save fuel. Furthermore, the

similar calculations may be done in order to prevent problems such as parametric rolling. If the representative model comprises a representative point for each of the containers they need not to be used
5 in all computations. For example, it is possible to computer likelihoods for the cause of parametric rolling. It is not probable that the container that is located in the middle of the container ship and in the bottom of the stack is the cause for parametric
10 rolling. Correspondingly, the representative model may comprise a plurality of information items but they need not to be used always. For example, for some computations it is acceptable that only the weight of the cargo is known.

15 As the computed representative model is known is it possible to estimate the effect of the cargo on the operation of the cargo ship. Furthermore, it is possible to determine if there is a risk of parametric rolling on given weather and operation conditions. If
20 the risk seems to be high the captain, or in some cases the automated cruising control, may determine that in order to prevent parametric rolling the speed or heading of the ship needs to be changed. Correspondingly, if the ship is late in the schedule
25 it is possible to determine if the ship can be driven faster on the given conditions in order to gain time. It should be understood that the parametric rolling is only an example of a cargo related problem. Problems similar to parametric rolling, wherein a
30 portion of the cargo changes the shape or falls into the sea may happen.

The above described arrangement needs to be related only for preventing problems but can also be used for other purposes. For example, using the model
35 it is possible to determine the margins so that the crew may take decisions based on the collected information. Furthermore, the model may be used for

determining the most optimal cruising speed and direction, for example, in relation to the stability of the ship.

As explained above the controller 104
5 comprises a mass storage that can be used for storing the information collected during the journey. After the journey this information may be stored into a central service, cloud or similar so that the information can be analyzed later. Furthermore, the
10 collected information may be accumulated into statistics so that the accumulated statistics may be used in improving models and computations later when similar conditions occurred.

In an embodiment at least partially
15 autonomous cargo ship is provided. The information received from the loading computer together with the additional information received from the statistics collected earlier is used for route planning. The information is further supplemented with the weather
20 forecast. Based on the information the controller of the cargo ship is configured to determine a set of route points that can be followed using a dynamic positioning system. The controller is configured to determine a route that is economically sensible but
25 also safe. The initial route plan may and is typically updated during the journey as the weather forecasts may change and are not completely accurate. Furthermore, other incidents, such as traffic, may cause a need to change the heading. For example,
30 systems for preventing collisions will take control over the initial plan in case of threat of collision.

In figure 2 a method is disclosed. In the method a control system, such as the control system of figure 1, may be used for performing the steps of
35 the method. In the method first information is received from a loading computer, step 200. The loading computer comprises information from a loaded

cargo, for example, the weight and shape of the cargo, such as measures of the container.

Based on the received information a model of said the cargo ship is generated, step 201. The model
5 may be related to the whole ship or just cargo. For example, the model may include lateral and transversal projection areas, center of gravity and underwater transversal and lateral areas. In another configuration it is possible that the model includes
10 a grid of points being representative of stability of the cargo comprising container stacks. This model may include the weight and center of gravity for each container. Then, it is possible to compute how stable these stacks are and how much inclination and
15 acceleration the stacks tolerate without parametric rolling. It is possible to generate different models for different purposes the common nominator being that the model is based on the information on the cargo and received from a loading computer or a similar device
20 that includes information with regard the cargo. The model may be and typically is supplemented by cargo ship properties.

In figure 3 a method using the generated model is disclosed. The method may be performed during
25 the journey. During the journey the weather and operating environment changes continuously. For example, wind and the direction of the wind may have a significant effect with regard the operability and stability. Furthermore, when the cargo ship is on
30 journey the cargo is in constant move because of the waves as the inclination of the decks and the cargo changes continuously. The weather, such as wind, wind speed, wave height, and operating parameters, such as inclinations caused by rolling and accelerations, are
35 received, step 300.

The received information is then applied to to the model, step 301. From the model it is possible

to calculate or simulate, for example, an optimal direction in view of the weather conditions or if the container stacks are stable with the current rolling. For preventing problems the model may be used for
5 estimating if the current heading and speed is optimal or does not cause rolling problems. It is possible to compute safety margin and, for example, to reduce speed or even heading so that problems are prevented or in order to cruise more optimally. For example, it
10 is possible to compute what kind of inclination and acceleration is acceptable each container stack or other type of cargo. Then, it is possible to compute a heading and speed, step 302, that will keep inclination and acceleration at acceptable level.

15 Even if in the above only limited examples have been discussed the information may be used for other purposes. For example, the model may be used for improving fuel economy as it provides accurate information on the actual conditions on the cargo
20 ship.

The above mentioned method may be implemented as computer software which is executed in a computing device. When the software is executed in a computing device it is configured to perform the above described
25 method. The software is embodied on a computer readable medium so that it can be provided to the computing device, such as the controller 104 of figure 1.

As stated above, the components of the
30 exemplary embodiments can include computer readable medium or memories for holding instructions programmed according to the teachings of the present inventions and for holding data structures, tables, records, and/or other data described herein. Computer readable
35 medium can include any suitable medium that participates in providing instructions to a processor for execution. Common forms of computer-readable media

can include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, any other suitable magnetic medium, a CD-ROM, CD±R, CD±RW, DVD, DVD-RAM, DVD±RW, DVD±R, HD DVD, HD DVD-R, HD DVD-RW, HD DVD-RAM, Blu-ray Disc, any other suitable optical medium, a RAM, a PROM, an EPROM, a FLASH-EPROM, any other suitable memory chip or cartridge, a carrier wave or any other suitable medium from which a computer can read.

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the control system may be implemented in various ways. The control system and its embodiments are thus not limited to the examples described above; instead they may vary within the scope of the claims.

CLAIMS

1. A controller for a cargo ship (100), wherein said controller comprises:

at least one processor (107);

5 at least one network connection (105);

at least one memory (108);

wherein said at least one processor (107) is configured to:

receive information from at least one loading
10 computer (106) using said at least one network connection (105);

generate a model of said ship (100) based on said received information, wherein said model comprises at least one representative point of the
15 loaded cargo of said ship (100); and

receive additional information with regard said cargo ship (100) operation and current weather conditions; and

apply said additional information into said
20 generated model.

2. A controller according to the claim 1, wherein the processor (107) is further configured to determine, based on said model and received additional information, a route and speed for said cargo ship.

25 3. A controller according to the claim 2, wherein said controller is further connected to a dynamic positioning system (103), wherein said dynamic positioning system is configured to follow said determined route.

30 4. A controller according to the claim 3, wherein said controller (104) is configured to update said determined route and speed.

5. A cargo ship (100) comprising a controller (104) according to any preceding claims 1 - 4.

35 6. A cargo ship (100) according to claim 5, wherein said cargo ship further comprises a dynamic positioning system (103).

7. A method for operating a cargo ship comprising:

receiving information from at least one loading computer using a network connection; and

5 generating a model of said ship based on said received information, wherein said model comprises at least one representative point of the loaded cargo of said ship.

8. A method according to claim 7, wherein the
10 method further comprises receiving additional information with regard said cargo ship operation and current weather conditions.

9. A method according to claim 8, wherein the method further comprises applying said additional
15 information into said generated model.

10. A method according to claims 8 or 9 further comprising determining, based on said model and received additional information, a route and speed for said cargo ship.

20 11. A method to any claim 10, wherein the method comprises using a dynamic positioning system, for following said determined route.

12. A method according to claims 10 or 11, wherein the method further comprises updating said
25 determined route and speed.

13. A computer program comprising computer program code configured to perform the method according to any of claims 7 - 12 when said computer program is executed in a computing device.

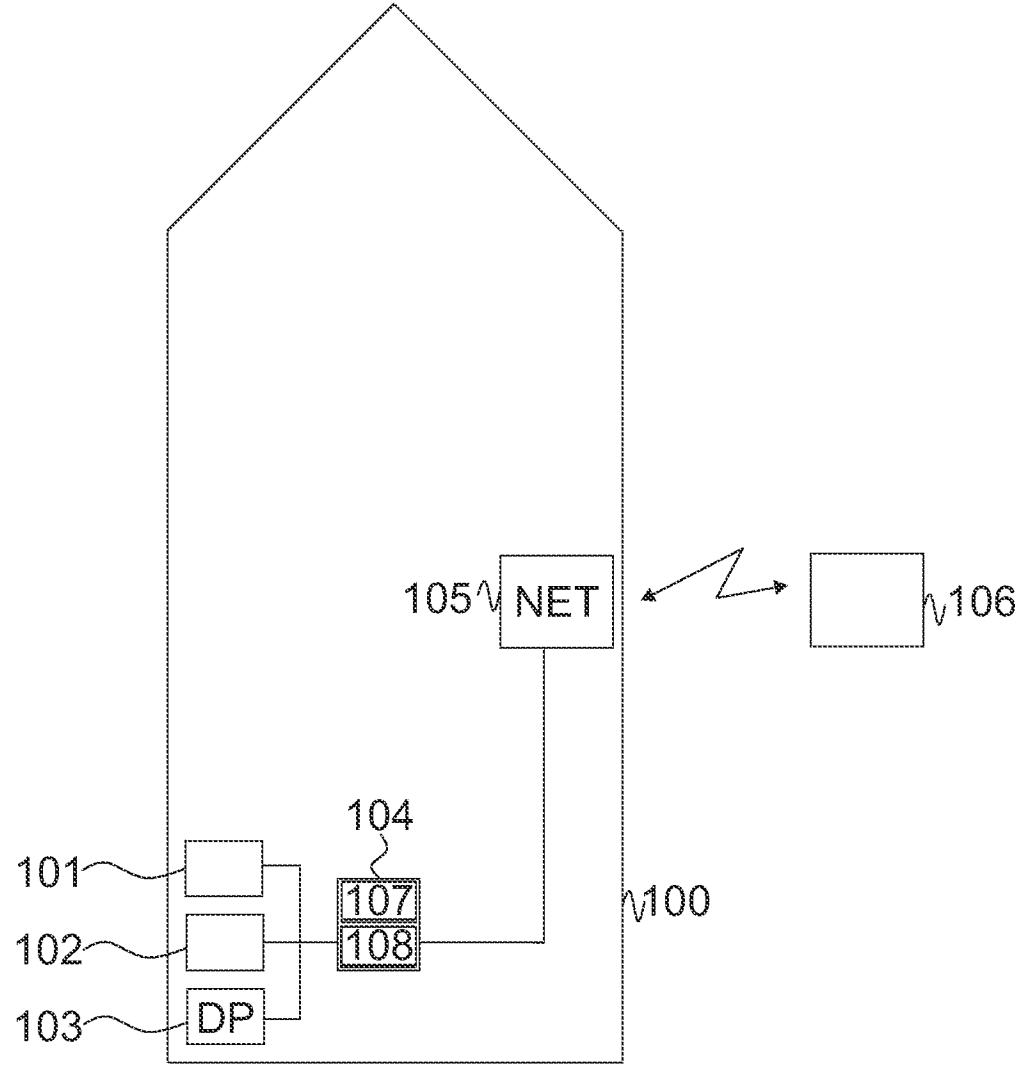


Figure 1

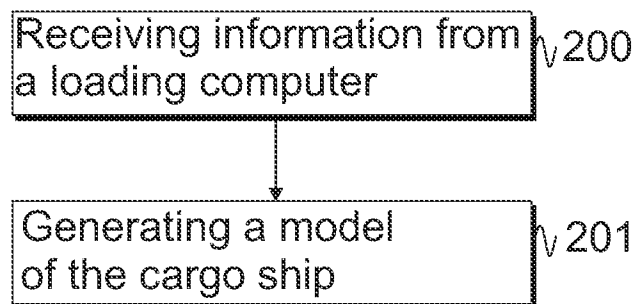


Figure 2

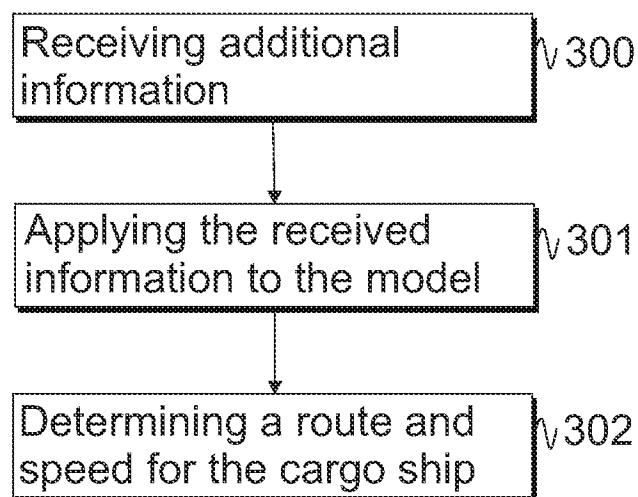


Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2018/050124

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05D1/02
ADD.

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)
G05D B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	RODSETH ORNULF JAN ET AL: "Communication architecture for an unmanned merchant ship", 2013 MTS/IEEE OCEANS - BERGEN, IEEE, 10 June 2013 (2013-06-10), pages 1-9, XP032487872, DOI: 10.1109/OCEANS-BERGEN.2013.6608075 [retrieved on 2013-09-24] Section II on pages 2 and 3 ----- -/-	1-13



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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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2018/050124

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WANG JIAN ET AL: "A modular designed dynamic positioning experiment system and its application on a ship model", OCEANS 2016 - SHANGHAI, IEEE, 10 April 2016 (2016-04-10), pages 1-6, XP032909455, DOI: 10.1109/OCEANSAP.2016.7485681 [retrieved on 2016-06-03] the abstract, figures 1 to 7, and sections I and II -----	1-13
X	US 2012/265380 A1 (KUWATA YOSHIAKI [US] ET AL) 18 October 2012 (2012-10-18) paragraphs [0008] - [0017], [0021], [0079], [0080], [0091]; claims 1,2,8-10,14,15; figures -----	1-13
X	EP 2 952 994 A1 (GE ENERGY POWER CONVERSION TECHNOLOGY LTD [GB]) 9 December 2015 (2015-12-09) paragraphs [0005] - [0007], [0010], [0028], [0030], [0037] - [0040], [0042] - [0045], [0047], [0048], [0052] - [0055]; claims 1-5,13-15; figures 1-3 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2018/050124

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012265380	A1	18-10-2012	NONE

EP 2952994	A1	09-12-2015	CA 2891245 A1 03-12-2015
			CN 105182969 A 23-12-2015
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			US 2015346730 A1 03-12-2015
