

PREDICTING EXTERNAL ENVIRONMENTAL DISTURBANCES ON A VESSEL TRAVELLING ALONG A ROUTE

TECHNICAL FIELD

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The invention relates to a method of predicting external environmental disturbances on vessels travelling along a route, a prediction handling device as well as a vessel comprising such a prediction handling device.

10 BACKGROUND

External environmental disturbances have a huge impact on modern vessels due to their large size. There exist a number of different types of disturbance, such as current. Another external disturbance is wind.

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It is known to make wind considerations in relation to the control of a vessel.

JP 2021-116011 does for instance disclose how a direction of disturbance is
20 estimated based on collected data such as ground vessel speed, water vessel speed, vessel position and vessel travelling direction, where the disturbance comprises a wind disturbance. However, actual disturbance measurements like wind speed and/or direction measurements do not seem to be made.

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Understanding the behaviour of a vessel under influence of external environmental disturbances is difficult and requires long experience by the crew of the vessel. Certain regions or routes might have particularly challenging conditions that are rapidly changing due to human built
30 structures or natural obstructions. For example, tall islands in archipelagos, buildings in harbours or bays in fjords blocking wind. Other examples are river mouths creating strong currents, tidal currents in

archipelago areas, or shallow waters and tight canals where the bank and squat effects will create severe disturbances to the vessel motions.

In situations with tight fairways or heavy traffic, it is important to not
5 wander from a planned path. Reacting to and compensating for
disturbances after they impact the vessel's position and velocity potentially
requires more energy and might introduce unwanted wear and tear of the
vessel's actuators. In manual control, experienced captains will manoeuvre
the vessel to compensate for the disturbances, for instance, by positioning
10 the vessel towards the wind direction or by positioning the vessel away
from an island in the direction of the wind to increase the safety margin if
there would be an engine failure. In closed loop control, such as autopilots
or dynamic positioning, disturbance feedforward from onboard sensors is
used to mitigate the impact of the disturbance before it has an impact.
15 However, rapid changes of disturbances are difficult to predict by only
using information from onboard sensors since the disturbance is not
measurable before it is also impacting the motion of the vessel.

There is therefore a need for improvement in the field.

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SUMMARY

One object of the invention is therefore to allow the handling of a vessel to
be improved when there are abrupt changes in external environmental
25 disturbances on the vessel as it travels along a route.

This object is according to a first aspect achieved through a method of
predicting external environmental disturbances on vessels travelling along
a route, the method being performed by a prediction handling device and
30 comprising:

obtaining at least one present measurement of a first type of external environmental disturbance on a first vessel at a present vessel position during a present passage of the first vessel along the route, and

- obtaining a prediction of the external environmental disturbance of
5 the first type on the present passage of the first vessel in a prediction range along the route, which prediction is based on the present disturbance measurement and previous disturbance measurements of the first type.

The object is according to a second aspect achieved through a prediction

- 10 handling device comprising a processor operative to:

obtain at least one present measurement of a first type of external environmental disturbance of a first vessel at a present vessel position during a present passage of the first vessel along a route, and

- obtain a prediction of the external environmental disturbance of the first
15 type on the present passage of the first vessel in a prediction range along the route, which prediction is based on the present disturbance measurement of the first type and previous disturbance measurements of the first type.

- 20 The object is according to a third aspect achieved through a vessel comprising the prediction handling device according to the second aspect. The vessel may additionally comprise a sensor operable to sense the first type of external environmental disturbance.

- 25 The vessel may additionally comprise a vessel control device operative to provide a vessel control function, which vessel control function is configured to receive and operate on the predicted external environmental disturbance of the first type.

- 30 The obtaining of a prediction may comprise predicting, in the prediction range, the external environmental disturbance of the first type on the first vessel.

Alternatively, the obtaining of a prediction may comprise sending the present disturbance measurement of the first type to a server in a request for a prediction and receiving the prediction as a response.

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According to one variation of the first aspect, the method may further comprise obtaining the present position, for instance from a position sensor or the vessel control device.

- 10 According to a corresponding variation of the second aspect the prediction handling device is further operative to obtain the present position, for instance from a position sensor or the vessel control device.

According to a further variation of the first aspect, the method may

- 15 comprise obtaining a present heading of the first vessel at the present position.

According to a corresponding variation of the second aspect, the prediction handling device is further operative obtain a present heading of the first

- 20 vessel at the present position.

The present heading may be received from the position sensor or the vessel control device. Alternatively, the present heading may be obtained via the present position and a preceding position of the first vessel or via the

- 25 present position and knowledge about the route.

When headings are used, the prediction may also be based on the present and previous headings.

- 30 An external environmental disturbance of a vessel is a disturbance coming from outside of the vessel and being caused by the environment around the vessel, such as by the air and/or water around the vessel.

The previous disturbances of the first type may have been collected on the previous passages along the route. In some instances they are also collected during the present passage along the route.

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When headings are used, the previous headings may have been obtained on the previous passages along the route. In some instances they may also be obtained during the present passage along the route.

- 10 The previous disturbance measurements on which the predicting may be based may comprise disturbances measurement in an interval of a selected previous passage, which interval corresponds to the prediction range and the selected previous passage is a passage in which the disturbances at a position corresponding to the present position and at previous positions of
- 15 the previous passage are similar to the disturbance measurements obtained at the present and previous positions of the present passage.

- The starting point of the prediction range may be the present vessel position. The end point of the prediction range may on the other hand be
- 20 provided a number of vessel positions from the present vessel position towards the end position of the route. Alternatively, the end point of the prediction range may be the end position of the route.

- The prediction may be made using a disturbance prediction model for the
- 25 route, which disturbance prediction model may additionally be based on disturbance information, where the disturbance information comprises the first type of external environmental disturbance. The disturbance information may also comprise further types of external environmental disturbance, such as a second type of external environmental disturbance.
- 30 The first type of external environmental disturbance may as an example be wind, while the second type of external environmental disturbance may be current.

Each passage along the route may additionally be a time-series to which the disturbance information is correlated and the disturbance prediction model may use at least a part of one previous time-series of at least one
5 previous passage to predict at least a part of a present time-series of the present passage.

A present first measurement of the first type of external environmental disturbance obtained at the present vessel position may be a measurement
10 made on the first vessel. A present second measurement of the first type of external environmental disturbance obtained at the present vessel position may be a measurement made at a point passed by the first vessel and distanced from the route.

15 The first type of external environmental disturbance may be provided as a first physical quantity in the environment of the first vessel.

In yet another variation of the first aspect the method further comprises obtaining a measurement of a second type of physical quantity in the
20 environment of the first vessel and estimating the first physical quantity based on the measurement of the second physical quantity.

According to a corresponding variation of the second aspect the prediction handling device is further operative to obtain a measurement of a second
25 type of physical quantity in the environment of the first vessel and estimate the first physical quantity based on the measurement of the second physical quantity.

The previous passages along the same route may comprise previous
30 passages of the first vessel and/or previous passages of one or more other vessels.

It should be emphasized that the term “comprises/comprising” when used in this specification is taken to specify the presence of stated features, steps or components, but does not preclude the presence or addition of one or more other features, steps, components or groups thereof.

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BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail in relation to the enclosed drawings, in which:

- 10 fig. 1 schematically shows a first way of realizing a prediction handling device,
fig. 2 shows a computer program product in the form of a CD ROM with computer program code used to implement the prediction handling device,
fig. 3 schematically shows a first vessel comprising the prediction handling
15 device,
fig. 4 schematically shows a chart with the first vessel travelling along a route and where external environmental disturbances of the first vessel are predicted,
fig. 5 shows a flow chart of a number of method steps in a first
20 embodiment of a method of predicting external environmental disturbances, and
fig. 6 shows a flow chart of a number of method steps in a second embodiment of the method of predicting external environmental disturbances.

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DETAILED DESCRIPTION

- In the following description, for purposes of explanation and not limitation, specific details are set forth such as particular architectures,
30 interfaces, techniques, etc. in order to provide a thorough understanding of the invention. However, it will be apparent to those skilled in the art that the invention may be practiced in other embodiments that depart

from these specific details. In other instances, detailed descriptions of well-known devices, circuits and methods are omitted so as not to obscure the description of the invention with unnecessary detail.

- 5 Fig. 1 schematically shows one realization of a prediction handling device PHD 10. In the present example, the prediction handling device 10 comprises a processor PR 12 and a data storage 14 with computer program instructions 16 that, when executed by the processor 12, implements a prediction handling function. There is also a communication interface CI
- 10 18. The communication interface 18 may have a computer communication section CCS 18A and/or a radio communication section RCS 18B, where the computer communication section 18A may be an Ethernet interface for connection to a local area network (LAN) for instance a LAN provided in the vessel and the radio communication section 18B may comprise a
- 15 transceiver for transmission and reception of radio signals. It should be realized that it is possible that the communication interface 18 only comprises the radio communication section 18B and not the computer communication section 18A or vice versa.
- 20 The prediction handling device 10 may thus comprise a processor 12 with associated program memory 14 including computer program code 16 for implementing the prediction handling function.

- A computer program may also be provided via a computer program
- 25 product, for instance in the form of a computer readable storage medium or data carrier, like a CD ROM or a memory stick, carrying such a computer program with the computer program code, which will implement the prediction handling function when being loaded into a processor. One such computer program product in the form of a CD ROM
- 30 20 with the above-mentioned computer program code 16 is schematically shown in fig. 2.

The prediction handling device 10 may with advantage be provided in a vessel.

Fig. 3 schematically shows a first vessel V1 22 comprising the prediction
5 handling device PHD 10. As can be seen in the figure the first vessel 22
also comprises a first sensor S1 24 as well as a vessel control device VCD
26 that implements a vessel control function VCF 28. The previously
described communication interface may here be used for communicating
10 with the vessel control device 26 and the first sensor 24. For this reason
these may all be connected to a LAN. The communication interface may
also communicate with external sensors, such as sensors on land as well as
perhaps with a server comprising a database with historical vessel data
and/or performing a prediction.

15 The first sensor 24 may be a sensor for sensing a first type of external
environmental disturbance on the first vessel. The first type of external
environmental disturbance may as an example be wind and therefore the
sensor may be a wind sensor that senses the speed and/or direction of the
wind.

20 Aspects of the present disclosure are directed towards predicting external
environmental disturbances on the first vessel travelling along a route. The
aspects are thus concerned with predicting disturbances coming from
outside the vessel and being caused by the environment around the vessel.

25 Understanding the behaviour of a vessel under the influence of external
environmental disturbances is difficult and requires an experienced crew.
Certain regions might have particularly challenging and rapidly changing
conditions. Reacting to disturbances after they had an impact on the vessel
30 potentially requires more energy and might introduce wear of the
actuators. Today, experienced captains will manoeuvre the vessel to
compensate for the disturbances and in closed loop control, feedforward

from onboard sensors may be used to mitigate the disturbance before it has an impact. However, rapid changes are difficult to predict by only using onboard sensors.

- 5 Aspects of the present disclosure are directed towards building up a position dependent disturbance prediction based on historic data from onboard sensors. In that way, rapid changes can be predicted and used for closed-loop control, route planning or in advisory systems for the crew of the first vessel 22. Thereby it may be possible to decrease energy
10 consumption as well as to increase operational performance of less experienced crews.

One aspect of the present disclosure is concerned with predicting a first type of external environmental disturbance on the first vessel 10.

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- How this can be done will now be described with further reference to fig. 4 and 5, where fig. 4 shows an exemplary chart in which the first vessel 22 travels along a route R from a point of origin P_0 to a destination point and fig. 5 shows a flow chart of a number of method steps in a method of
20 predicting external environmental disturbances on the first vessel and being performed by the prediction handling function of the prediction handling device.

- In the example given below, the first type of external environmental
25 disturbance is wind, which wind may have a speed and direction. However, it should be realized that in addition or instead also other types of external environmental disturbances can be handled in a similar way. One example of a second type of external environmental disturbance is current.

- 30 As can be seen in fig. 4, the first vessel 22 is travelling along the route R, which travelling is made in a present passage of the first vessel 22 along the route R. In this present passage, the first vessel 22 starts at the point of

origin P_O of the route R and then continues towards a point of destination (not shown). The point of origin P_O may with advantage be a point in a first harbour and the point of destination may be a point in a second harbour.

In the example in fig. 4, the first vessel 22, after leaving the first harbour,
5 passes through a strait between an island and a part of the mainland before it enters more open waters. Both the island and the mainland may have obstacles, such as buildings and high rocks that block the wind.

Furthermore, the first vessel 22 may additionally have travelled along the
10 route R several times before. The first vessel 22 may thus have travelled along the route R more than one time earlier, which may, for instance, be the case if the route R is more or less fixed. This can be the case when the first vessel 22 is a ferry or perhaps a cruise ship. During these previous trips, the disturbance determining device 10 may have collected
15 measurements of the first type of external environment disturbance, for instance, using the first sensor 24, where these measurements may have been collected at various positions along the route R . Also measurements of the position and possibly also of the heading at the position may have been collected. After each such trip, the disturbance determining device 10
20 stores the collected measurements in a database as historical data. The database may be provided on the vessel, such as in the memory of the prediction handling device or in an onboard server. Alternatively, the database may be provided in an external server, such as a server on the mainland or in the cloud.

25

The historic data may be accessed by the prediction handling device via the communication interface 18 in order to make predictions.

The prediction handling device 10 may thus have or have access to a
30 history of measurements of the first type of external environmental disturbance experienced along the route R , where these measurements are associated with corresponding positions along the route R and possibly

also with the points in time when they were obtained. The measurements may optionally also be associated with vessel headings used at these corresponding positions.

- 5 Alternatively, the prediction handling device may request a prediction from a server, for instance a server in the cloud, which server accesses the historic data, makes a prediction and returns the prediction to the prediction handling device as a response.
- 10 Over time, sufficiently much data may have been collected for obtaining a prediction of the first type of disturbance along the route R, which prediction may involve a prediction of the first type of disturbance given the present position of the first vessel 22 on the route R and the first type of disturbance at this present position. The prediction may also consider a
- 15 present heading of the first vessel 22 at the present position.

- As the first vessel 22 travels along the route R during a present passage of the route R, the disturbance determining device 10 may additionally continually obtain measurements of the first type of external
- 20 environmental disturbance at various positions along the route R. It may also obtain measurements of the positions and possibly also data about the headings at these positions.

- In the example given above, the prediction handling device 10 obtains at
- 25 least one present measurement DM_P of the first type of external environmental disturbance on the first vessel 22, where the disturbance is obtained at a present point in time and at a present vessel position P_P along the route R, S100. The measurement may with advantage be obtained from the first sensor 24. Thereby the measurement may be a
- 30 present first measurement of the first type of external environmental disturbance made on the first vessel 22. In the example of fig. 4, the present position P_P is a position when the first vessel 22 enters the

- previously mentioned strait. The prediction handling device 10 may also obtain data about the present position as well as possibly also the present heading of the first vessel 22 at the present vessel position P_P , which position and heading may be received from the vessel control device or
- 5 from a position sensor. It is possible to omit receiving of the heading as it can be determined based on the present and a preceding position. It is also possible to determine the heading based on the present position and knowledge about the route R.
- 10 Thereafter the prediction handling device 10 obtains a prediction of the external environmental disturbance of the first type on the present passage of the first vessel 22 along the route R, S_{110} , where the prediction has been made in a prediction range $PD_1 - PD_{10}$ and is based on the present disturbance measurement DM_P of the first type at the present position and
- 15 previous disturbance measurements of the first type. It is also possible that the present and previous headings are considered. When headings are used, the prediction may thus also be based on the present and previous headings.
- 20 The starting point of the prediction range may be the present vessel position P_P and the end point of the prediction range PR_{EP} may be provided a number of discrete vessel positions from the present vessel position P_P towards the end position of the route R. The end of the prediction range PR_{EP} may be provided a fixed number of such positions
- 25 from the present vessel position and these positions may additionally be provided at equal distances from each other along the route R. Alternatively, the end point of the prediction range PR_{EP} may be the end position of the route R.
- 30 In the example shown in fig. 4, the prediction range comprises ten discrete equidistant predictions along the route R starting with a first predicted disturbance PD_1 at a first predicted position after the present position at a

first predicted point in time and ending with a tenth predicted disturbance PD_{10} at a tenth predicted position after the present position at a tenth predicted point in time, which tenth prediction PD_{10} is in this example also the last prediction of the prediction range $PD_1 - PD_{10}$.

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The prediction may have been performed using a disturbance prediction model for the route, which can employ a number of prediction techniques. The prediction technique used can for instance be based on gaussian processes, neural networks, fitting of polynomials or lookup tables based on the recorded data, etc.

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The disturbance prediction model may additionally be based on disturbance information, where the disturbance information comprises the first type of external environmental disturbance.

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The positions of the predictions may correspond to the same or approximately the same positions along the route R of previous passages and the corresponding predicted points in time may be the points in time that these positions are being predicted to be reached. The predictions of when the positions can be reached may be based on vessel control data of the first vessel, such as vessel speed and vessel heading.

20

Furthermore, the predictions of the first type of external environmental disturbance may be based on previous disturbances of the first type associated with previous passages and especially of previous disturbances in intervals corresponding to the prediction range $PD_1 - PD_{10}$. The previous disturbances of the first type may thereby have been collected on previous passages along the route R.

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The prediction may involve considering measurements in an interval of the first type of external environmental disturbance of a previous passage along the route, which interval may correspond to the prediction range.

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The previous passage may additionally have a previous measurement value of the first type of disturbance obtained at a position along the route corresponding to the present position of the present passage. This previous measurement value is also close to the value of the present disturbance
5 measurement. It may in fact be the closest of all historical values at positions corresponding to the present position. Then special attentions may be given to the measurements in an interval of the previous historical passage that corresponds to the prediction interval.

10 It is additionally possible that also previously detected disturbances of the first type on the first vessel during the present passage along the route R have been used in the prediction. In some instances, previous disturbances of the first type are thus collected during the present passage along the route R.

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This means that it is possible to consider a previous passage in which the historical measurements between the point of origin P_O and the point corresponding to the present position P_P are close to the measurements of the present passage between the point of origin P_O and the present
20 position P_P .

In the example of fig. 4, it is thus possible that the predictions in the prediction range PD1 – PD10 are also based on disturbances of the first type measured between the point of origin P_O and the present position P_P .

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It is additionally possible that a previous passage is selected in which the historic measurements up to the measurement at the point corresponding to the present position are the historic measurements being the most similar to the measurements of the present passage up to the present
30 position. Historic measurements of this selected previous passage that appear in the interval corresponding to the prediction range may then be given special attention in the predictions of the prediction range. It is for

instance possible that these historical measurements are selected as the predictions of the prediction range of the present passage.

The prediction may be obtained through the prediction handling device
5 performing it, i.e. through the prediction handling device 10 predicting, in the prediction range, the external environmental disturbance of the first type on the first vessel.

However, the prediction may also be performed on some other entity, such
10 as a server like a server located in the cloud. In this case the prediction handling device may send the present position and present disturbance measurement to the server in a request for a prediction, possibly together with a present heading. The server in this case returns the prediction to the disturbance predicting device as a response to the request, where the
15 prediction has been made based on the present position, the present disturbance measurement and optionally also the present heading. Alternatively, the server might return a model or the parameters of a model that is used to predict the disturbances locally.

20 Through this type of prediction, it is possible to take pre-emptive action when there are abrupt changes in the first type of external environmental disturbance. This can be exemplified by fig. 4.

In fig. 4, the wind and the prediction of the wind are shown as vectors,
25 where the measured wind is shown as a solid vector and the predictions are shown as dashed vectors. The direction of the vector is the wind direction and the magnitude of the vector corresponds to the wind speed.

In the example of fig. 4, it can be seen that it is possible to predict the wind
30 strength and direction that influences the first vessel 22 during the passage through the strait as well as when it exits the strait and enters more open water. For instance, given the wind speed and direction at the present

position P_P along the island, the wind speed and direction can be predicted once the first vessel 22 clears the island. In this way, rapid changes of the disturbance can be predicted, and appropriate action can be taken before the disturbance impacts the motion of the vessel.

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The prediction handling device 10 can be considered to be a data-driven position dependent disturbance predictor, i.e. a device that predicts the disturbance at a position along the route or path other than the present position. The predictor is driven by the present position and a present

10 measurement of the environmental disturbance.

The idea is to collect data on the vessel's position and optionally also the heading together with various measurements of the environmental disturbances and perhaps other complementary information along the

15 route. This data is stored either in an onboard computer, in the memory 14 of the prediction handling device 10, in the cloud or similar. Once enough data has been collected a reliable prediction can be made, where the prediction can be made in the prediction handling device or in an external server, such as a server in the cloud.

20

The predictions provide information on the disturbance along the route R . For instance, given a simulation of the vessel position along the path, the disturbance information can be returned for the whole trajectory of the vessel. Alternatively, the predicted environmental disturbance is simply

25 displayed along the path in a graphical user interface (GUI) to help advise the crew on changes in the disturbance. The predictions could also be provided to the vessel control function 28, for instance together with disturbance feedforward of the present disturbance measurement DM_P . Thereby the control of the first vessel 10 can be improved.

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A second embodiment will now be described with reference being made to fig. 6, which shows a number of method steps in the method of predicting

external environmental disturbances on the first vessel 22 and being performed by the prediction handling device 10.

As the first vessel 22 travels along the route R during the present passage,
5 it may continually obtain measurements of disturbance information at various positions along the route R, where the disturbance information may comprise the first type of disturbance as well as possibly also at least one further type of external environmental disturbance, such as a second type of disturbance. As was mentioned earlier it may also obtain the
10 positions and headings of the first vessel 22 at these positions.

More particularly, the prediction handling device 10 obtains present disturbance information comprising present disturbance measurements at the present vessel position P_P along the route R, where the present
15 disturbance measurements comprise at least one present measurement DM_P of the first type of external environmental disturbance on the first vessel 22 and of any further types if they are used, such as at least one present measurement of the second type of external environmental disturbance. Also here, the disturbance information is obtained at a
20 present point in time and at a present position P_P along the route R.

The prediction handling device 10 may also obtain the present vessel position as well as a present heading of the first vessel 22 at the present vessel position P_P . The present vessel position and the present heading
25 may be received from the vessel control device 28. They may also be received from a position sensor on the first vessel. Alternatively, only the position may be received and the present heading may be determined based on the present position together with at least one other item of information such as a preceding position or knowledge about the route R.
30

It is also possible that the disturbance information comprises measurements of a physical quantity that does not in itself provide the

corresponding type of disturbance, but where the disturbance can be deduced from the measurements of the physical quantity, for instance using sensor fusion.

- 5 Put differently, the first type of external environmental disturbance may be provided as a first physical quantity in the environment of the first vessel. In this case it is possible to obtain a measurement of a second type of physical quantity in the environment of the first vessel and estimate the first physical quantity based on the measurement of the second physical
10 quantity.

After having obtained the current disturbance information at the present position P_P , the prediction handling device 10 obtains a prediction of the disturbance on the first vessel 22 during the present passage, S_{210} , which
15 prediction has been made using a disturbance predicting model.

As before, the prediction may be obtained through the prediction handling device 10 performing it or through receiving the prediction from another entity, such as a cloud server, where the present position, the present
20 disturbance information and optionally also the present heading are sent to the server in a request for a prediction and the prediction is returned as a response to the request. The prediction is also in this case made based on the present position, the present disturbance information and optionally also the present heading.

25 Also here the disturbance prediction model is based on disturbance information comprising the first type of external environmental disturbance. The disturbance information may in this case also comprise further types of external environmental disturbance, such as a second type
30 of external environmental disturbance. The first type of external environmental disturbance may as an example be wind, while the second type of external environmental disturbance may be current. The predicting

of external environmental disturbances may comprise predicting external environmental disturbances of the first type as well of all the additional types that are used, such as the second type.

- 5 It is again possible that the prediction has been performed in a prediction range associated with the present position P_P using the present disturbance information obtained at the present position P_P . The prediction range may be provided in the same way as in the first embodiment.

10

The prediction in this case employs a prediction model which considers each passage along the route R as a time-series, where the sensed disturbance information is linked or correlated to the time-series through being linked or correlated with a corresponding position along the route R and a corresponding point in time of the time series. For each passage, there may thus be a series of vessel positions. Each vessel position of the series is associated with a corresponding point in time and these positions are correlated with the disturbance information being obtained at them. Also a vessel heading may be associated with the position and point in

20 time.

Over time there will thereby be several time-series from the point of origin to the end point of the route. Every passage or journey gives more data and can be used to improve the model.

25

The disturbance prediction model may then use previous time-series of the previous passages to predict at least a part of a present time-series of the present passage.

- 30 Since it is difficult to separate the effect of different disturbances as well as model errors of a vessel model, it is preferable to fit a model to the output of the sensor measuring the environmental disturbance, for instance, it is

better to predict the wind direction and speed rather than the force on the first vessel 22. This also increases modularity. Moreover, the model is kept as simple as possible which decreases the amount of data (information) needed to fit a model and it should also decrease the computational load to
5 use the model.

It is here possible that the different types of external environmental disturbances are treated separately.

- 10 Thereby the predictions of the first type of external environmental disturbance may be based on previous disturbances of the first type associated with previous passages and especially of previous disturbances in intervals corresponding to the prediction range PD1 – PD10.
- 15 The prediction may involve considering measurements in the prediction interval of the first type of disturbance of a first previous passage along the route. The first previous passage may additionally have a previous measurement value of the first type disturbance obtained at a position along the route corresponding to the present position of the present
20 passage and where this previous measurement value is close to the value of the present disturbance measurement. Then special attentions may be given to the measurements in an interval of the first previous historical passage that corresponds to the prediction interval.
- 25 In case previously detected disturbances of the first type on the first vessel during the present passage along the route R are used in the prediction, it is possible to select a first previous passage in which the historical measurements of the first type between the point of origin and the point corresponding to the present position are close to the measurements of the
30 present passage between the point of origin and the present position. The historic measurements of the first type obtained between the point of origin and the point corresponding to the present position of the selected

first previous passage may be the historic measurements that are the most similar to the measurements in the present passage of all historic passages.

In the example of fig. 4, it is thus possible that the predictions in the
5 prediction range PD₁ – PD₁₀ are also based on disturbances of the first type measured between the point of origin P_O and the present position P_P.

Historic measurements of the selected first previous passage that appear in the interval corresponding to the prediction range may then be given
10 special attention in the predictions of the prediction range. It is for instance possible that these historical measurements are selected as the predictions of the prediction range of the present passage.

For any further type of disturbance, such as for the second type of
15 disturbance, it is then possible to select a second previous passage where in an analogous way there are similarities between the second type of disturbance sensed at the present and optionally also at previous vessel positions with the historic disturbances of the second type at the corresponding vessel positions.

20 Alternatively, the different types of external environmental disturbances may be treated together

In this case a first previous passage may be selected, where a combination
25 of the historical measurements of the first type and other types at a position corresponding to the present position is similar to the combination of the present disturbance measurements of the first and the other types at the present position of the present passage.

30 Alternatively, when also positions between the point of origin and the present position of the present passage are considered, it is possible to select a first previous passage when there is a similarity between the

combination of measurements of the first and other types at the present and previous positions of the present passage and a combination of the first and other types of historical measurements at the corresponding positions of the first previous passage.

5

The first and other types of historic measurements appearing in the interval corresponding to the prediction range of the selected previous first passage are then selected as the predicted disturbances of the first and other types in the prediction range of the present passage.

10

The predictions may then be used in existing algorithms for simulation, control or planning.

In the second embodiment, the prediction is used in the control of the first
15 vessel 22.

Therefore, the prediction handling device 10 provides the predicted disturbances of the prediction interval to the vessel control function 28 of the vessel control device 26, S220, where the vessel control function 28 is
20 used to control the first vessel 22 along the route R.

It is also here possible that the predictions are provided together with the actual measurements made at the present point in time. Thereby the vessel control function 28 of the vessel control device 26 receives and operates on
25 the predicted external environmental disturbances of the first and optional other types. It may also receive and operate on the measurements of the disturbances of the first and optional other types at the present point in time. This operation may involve the vessel control function 28 changing the control of the first vessel 22 based on the measured and predicted
30 disturbance, where the change of control may involve a change of heading and/or speed of the first vessel 22.

According to aspects of the present disclosure, it is possible to extended prediction to use data from several vessels to accelerate the learning of the prediction model, as well as to share the disturbance prediction models among vessels. This enables to use the disturbance prediction even for a
5 vessel which has never travelled the route R before.

It is thus possible that the historic passages used in the model have been made by more than one other vessel, such as by a second vessel and/or a third vessel. In fact, it is possible that all the historic passages are made by
10 other vessels than the first.

Put differently, the earlier mentioned previous passages along the same route may comprise previous passages of the first vessel and/or previous passages of one or more other vessels.

15

It is also possible that additional sensors are used for obtaining a type of disturbance. In the example in fig. 4, there is a second sensor S2 30 on the mainland adjacent the outlet of the strait and a third sensor S3 32 on the island also at the outlet of the strait. The model may also employ the
20 sensor measurements of these sensors 30 and 32 and link them to the associated time-series. Also the positions of these sensors may be used.

These sensor measurements as well as the sensor positions may then be linked to the measurements of the first sensor 24 that are collected at the
25 same point in time.

The present first measurement of the first type of external environmental disturbance obtained by the first sensor 24 at the present vessel position may thus be complemented by a present second measurement of the first
30 type of external environmental disturbance obtained by the second sensor 30 at a point passed by the first vessel 22 and distanced from the route a first distance and complemented by a present third measurement of the

first type of external environmental disturbance obtained by the third sensor 32 at a point passed by the first vessel 22 and distanced from the route a second distance.

- 5 The following example explains the advantages of the use of the further sensors. It is possible that the wind in the strait is in lee, but high at the exit from it. It is also possible that, depending on the direction of the wind and the placing of these additional sensors 30, 32, the measurement of at least one of the additional sensors 30, 32 improve the estimation of the
- 10 wind at the exit of the strait. It is for instance possible that the second sensor 30 is able to better detect southerly winds and the third sensor 32 winds from northeast. This may thus improve the predicting of the wind at the exit from the strait.
- 15 The invention may be varied in a number of ways. Therefore, while the invention has been described in connection with what is presently considered to be most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various
- 20 modifications and equivalent arrangements. Therefore, the invention is only to be limited by the following claims.

CLAIMS

1. A method for predicting external environmental disturbances on vessels travelling along a route (R), the method being performed by a
5 prediction handling device (10) and comprising:
obtaining (S100, S200) at least one present measurement (DM_P) of a first type of external environmental disturbance on a first vessel (22) at a present vessel position (P_P) during a present passage of the first vessel (22) along the route (R), and
10 obtaining (S110; S210) a prediction of the external environmental disturbance of the first type on the present passage of the first vessel (22) in a prediction range ($PD_1 - PD_{10}$) along the route (R), which prediction is based on the present disturbance measurement (DM_P) and previous disturbance measurements of the first type.
15
2. The method as claimed in claim 1, wherein the starting point of the prediction range is the present vessel position (P_P).
3. The method according to claim 1 or 2, wherein the prediction is
20 made using a disturbance prediction model for the route (R), which disturbance prediction model is based on disturbance information, said disturbance information comprising the first type of external environmental disturbance.
- 25 4. The method as claimed in claim 3, wherein each passage along the route (R) is a time-series to which the disturbance information is correlated and the disturbance prediction model uses at least a part of one previous time-series of one previous passage to predict at least a part of a present time-series of the present passage.
30
5. The method as claimed in any previous claim, wherein a present first measurement (DM_P) of the first type of external environmental

disturbance obtained at the present vessel position (P_P) is a measurement made on the first vessel (22).

6. The method according to claim 5, wherein a present second
5 measurement of the first type of external environmental disturbance obtained at the present vessel position (P_P) is a measurement made at a point (32) passed by the first vessel (22) and distanced from the route (R).
7. The method as claimed in any previous claim, wherein the first type
10 of external environmental disturbance is provided as a first physical quantity in the environment of the first vessel (22) and further comprising obtaining a measurement of a second type of physical quantity in the environment of the first vessel (22) and estimating the first physical quantity based on the measurement of the second physical quantity.
15
8. The method as claimed in any previous claim, wherein the previous passages along the same route comprise previous passages of the first vessel (22) and/or previous passages of one or more other vessels.
- 20 9. The method as claimed in any previous claim, further comprising providing (S220) the predicted external environmental disturbance to a vessel control function (28) used to control the first vessel (22) along the route (R).
- 25 10. A prediction handling device (10) comprising a processor (12) operative to:
obtain at least one present measurement (DM_P) of a first type of external environmental disturbance of a first vessel at a present vessel position (P_P) during a present passage of the first vessel (22) along a route (R), and
30 obtain a prediction of the external environmental disturbance of the first type on the present passage of the first vessel (22) in a prediction range ($PD_1 - PD_{10}$) along the route (R), which prediction is based on the present

disturbance measurement (DM_P) of the first type and previous disturbance measurements of the first type.

11. The prediction handling device (10) according to claim 10, wherein
5 the prediction has been made using a disturbance prediction model for the route (R), which disturbance prediction model is based on disturbance information, said disturbance information comprising the first type of external environmental disturbance.
- 10 12. The prediction handling device according to claim 11, wherein each passage along the route (R) is a time-series to which the disturbance information is correlated and the disturbance prediction model uses at least one previous time-series of at least one previous passage to predict at least a part of a present time-series of the present passage.
- 15 13. A vessel (22) comprising the prediction handling device (10) according to any of claims 10 – 12.
14. The vessel (22) according to claim 12 further comprising a sensor (24)
20 operable to sense the first type of external environmental disturbance.
15. The vessel according to claim 13 or 14, further comprising a vessel control device (26) operative to provide a vessel control function (28), which vessel control function (28) is configured to receive and operate on
25 the predicted external environmental disturbance of the first type.