

METHOD FOR AUTOMATED DRAFT SURVEY

TECHNICAL FIELD

[0001] The present disclosure relates to draft surveys of waterborne vessels. More particularly, the subject matter relates to an automated system/method for performing error-free draft survey of water-borne vessels.

BACKGROUND

[0002] The background description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

[0003] Vessels when they are in port for loading, unloading, bunkering activities require a draft survey.

[0004] A draft survey is a calculation of the weight of cargo loaded or unloaded to or from a ship from measurements of changes in its displacement. The draft survey is performed by reading the ship's draft on the draft markings at six standard points on the hull: forward, midships and aft on both port and starboard sides. Corrections for factors such as trim, water density and non-cargo weight changes are made before calculating the cargo weight change.

[0005] The current modes of draft survey which are in prevalent use currently include very risky methods such as climbing down the pilot ladder, deploying smaller boards for going around the vessel. There is a need to have an automated approach to draft survey for greater accuracy and better results.

[0006] Currently smaller vessels are used to go around the cargo vessel and visually inspect the drafts of the vessels or ascend down the pilot ladder to check and visually report the draft based on draft marks. These are both time consuming and risky and error prone. Since the observation is made from the survey boat which is smaller in size and will have motions and added to that there will be parallax error. When viewed from the pilot ladder the observer is not stationary as the pilot ladder is suspended. Also, the line of sight has an inherent parallax error. Added to this there are other idiosyncrasies such as the vessels list or trim or heel or combination of these which biases errors in the visual observation.

[0007] The existing models make use of Radar based techniques such as Chinese application CN205787119 that discloses instrument of radar-based detection apparatus that is for commercial measurement draft degree of depth.

adar-based systems that are commonly known require periodic inspection and require an operator to conduct regular maintenance. There is, therefore, a need in the art to provide a solution that obviates above-mentioned limitations, provides an automated efficient, ergonomic, and user-friendly approach to draft survey that delivers reliable
5 air draft values.

OBJECTS OF THE PRESENT DISCLOSURE

[0009] Some of the objects of the present disclosure, which at least one embodiment herein satisfies are as listed herein below.

[0010] It is an object of the present disclosure to provide an apparatus and a method for
10 automated draft surveying.

[0011] It is yet another object of the present disclosure to provide an apparatus that removes manual intervention from the process of draft survey.

[0012] It is another object of the present disclosure to eliminate the parallax error from the process of draft survey.

[0013] It is another object of the present disclosure to provide a simple, cost effective,
15 easy to implement method for surveying.

[0014] It is another object of the present disclosure to provide a simple automated method to capture time history data of the wave from an overhang and create a wave spectrum in real time.

[0015] It is another object of the present disclosure to use spectral analysis to eliminate
20 the error due to variation in the water mark because of the wave height.

[0016] These and other objects of the present invention will become readily apparent from the following detailed description taken in conjunction with the accompanying drawings.

SUMMARY

[0017] The present disclosure relates to modular and equipment draft surveys of
25 waterborne vessels. More particularly, the subject matter relates to an automated system/method for performing error-free draft survey of water-borne vessels.

[0018] Aspects of the present disclosure include an automated robotic arm that makes use of angular displacement & motion sensors for a precise/accurate draft survey without
30 human intervention.

[0019] In an aspect, a system for automated draft survey in a water borne vessel is disclosed. The system can consist if an adjustable frame, a retractable robotic arm that is

adjustable frame. The robotic arm is configured such that, on actuation of the retractable robotic arm, the arm is configured to extend outward away from the adjustable frame over surface of water to measure a true draft value. The retractable robotic arm is operatively coupled to a processor with the processor being configured to actuate the robotic arm on receipt of one or more remote instructions to measure a water level from the robotic arm, a distance between the adjustable frame and calculate a true draft value.

[0020] In an embodiment, the retractable robotic arm can comprise one or more level sensors at least at a distal end of the retractable robotic arm and at an intermediate point on the retractable robotic arm. The retractable robotic arm can include at least one sensor for measuring an angular displacement, and a motion sensor.

[0021] In another aspect, a method for automated draft survey of a vessel is disclosed. The method comprises mounting one or more non-contact sensors on a retractable robotic arm operatively mounted on an adjustable frame, installing at least one adjustable frame on an edge of the vessel. Actuating the robotic arm to begin a retraction of the retractable robotic arm in a plane of a deck of the vessel such that at least one non-contact sensor on a distal end of the retractable robotic arm measures a water level (D1) between the deck and waterline. The retractable robotic arm can be configured to automatically retract inboard to measure the distance to the deck D2. The robotic arm can then then measure a distance (D2) between the adjustable frame and the deck by at least one intermediate non-contact sensor on the retractable robotic arm. The processor then subtracts the water level D1 from the distance D2 to calculate an Air Draft value and the obtained Air Draft is subtracted from a known vessel depth value (D3) to obtain a true Draft value.

[0022] The method can further comprise performing corrections or calibration in the obtained true draft value based on measurements by at least one angular displacement sensor and at least one motion sensor, said angular displacement and motion sensors being mounted on the retractable robotic arm. The angular displacement sensors can be any or a combination of one or more of an accelerometer which can measure the three rotational degrees of freedom such as an azimuth, a declination and an altitude measuring device.

[0023] The adjustable frame can be removable and can be fastened upon to the deck of the vessel by one or more counter weights or using ISO locks or any other temporary mechanical fastener

[0024] Various objects, features, aspects and advantages of the inventive subject matter will become more apparent from the following detailed description of preferred embodiments,

ying drawing figures in which like numerals represent like components.

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0025] The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

[0026] FIG. 1A illustrates an exemplary diagram of the proposed system for draft survey implemented on a vessel, in accordance with an embodiment of the present disclosure.

10 [0027] FIG. 1B illustrates an exemplary diagram of a retractable robotic arm assembly in accordance with an embodiment of the present disclosure.

[0028] FIG. 2A illustrates a front view of the proposed system implemented on a vessel, in accordance with an embodiment of the present disclosure.

15 [0029] FIG. 2B illustrates a front view of the proposed system implemented on a vessel when the vessel is tilted by an angle of 10 degrees, in accordance with an embodiment of the present disclosure.

[0030] FIG. 3 illustrates an exemplary implementation of the system for draft apparatus in multiple locations on the vessel, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

20 [0031] In the following description, numerous specific details are set forth in order to provide a thorough understanding of embodiments of the present invention. It will be apparent to one skilled in the art that embodiments of the present invention may be practiced without some of these specific details.

25 [0032] The present disclosure relates to draft surveys of waterborne vessels. More particularly, the subject matter relates to an automated system/method for performing error-free draft survey of water-borne vessels.

[0033] While embodiments of the present invention have been illustrated and described, it will be clear that the invention is not limited to these embodiments only. Numerous modifications, changes, variations, substitutions, and equivalents will be apparent to those skilled in the art, without departing from the spirit and scope of the invention, as described in 30 the claim.

ing description, numerous details are set forth. It will be apparent, however, to one of ordinary skill in the art having the benefit of this disclosure, that the present invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form, rather than in detail, to avoid obscuring the present invention.

[0035] As used herein, and unless the context dictates otherwise, the term "coupled to" is intended to include both direct coupling (in which two elements that are coupled to each other contact each other) and indirect coupling (in which at least one additional element is located between the two elements). Therefore, the terms "coupled to" and "coupled with" are used synonymously.

[0036] Aspects of the present disclosure include an automated robotic arm that makes use of angular displacement & motion sensors for a precise/accurate draft survey without human intervention.

[0037] Referring now to FIG. 1A that illustrates an exemplary diagram of the proposed system for draft survey implemented on a vessel, in accordance with an embodiment of the present disclosure.

[0038] In an aspect, a system for automated draft survey in a water borne vessel is disclosed. The system can consist of an adjustable frame 1, a retractable robotic arm 2 that is removably coupled to the adjustable frame. The robotic arm 2 is configured such that, on actuation of the retractable robotic arm 2, the arm is configured to extend outward away from the adjustable frame over surface of water to measure a true draft value D3. The adjustable frame is placed on a main deck of the vessel. The retractable robotic arm 2 is operatively coupled to a processor with the processor being configured to actuate the robotic arm on receipt of one or more remote instructions to measure a water level from the robotic arm, a distance between the adjustable frame and calculate a true draft value.

[0039] FIG. 1B illustrates an exemplary diagram of a retractable robotic arm assembly in accordance with an embodiment of the present disclosure.

[0040] In an embodiment, the retractable robotic arm 2 can comprise one or more level sensors 5, 6, at least at a distal end 3 of the retractable robotic arm and at an intermediate point on the retractable robotic arm. The retractable robotic arm can include at least one sensor for measuring an angular displacement, and a motion sensor. The robotic arm may be configured with a hinge 4 to enable the robotic arm to accurately measure values even when the vessel is tilted. The sensors are housed within a wind and light shield 7, which may be made of any

ents the wind induced vibration to the sensors and any interference from external source of noise.

[0041] FIG. 2A illustrates a front view of the proposed system implemented on a vessel, in accordance with an embodiment of the present disclosure.

5 [0042] FIG. 2B illustrates a front view of the proposed system implemented on a vessel when the vessel is tilted by an angle of 10 degrees, in accordance with an embodiment of the present disclosure.

[0043] In another aspect, a method for automated draft survey of a vessel is disclosed. The method comprises mounting one or more non-contact sensors on a retractable robotic arm
10 operatively mounted on an adjustable frame, installing at least one adjustable frame on an edge of the vessel. Actuating the robotic arm to begin a retraction of the retractable robotic arm in a plane of a deck of the vessel such that at least one non-contact sensor on a distal end of the retractable robotic arm measures a water level (D1) between the deck and waterline. The retractable robotic arm can be configured to automatically retract inboard to measure the
15 distance to the deck D2. The robotic arm can then then measure a distance (D2) between the adjustable frame and the deck by at least one intermediate non-contact sensor on the retractable robotic arm. The processor then subtracts the water level D1 from the distance D2 to calculate an Air Draft value and the obtained Air Draft is subtracted from a known vessel depth value (D3) to obtain a true Draft value.

20 [0044] The method can further comprise performing corrections or calibration in the obtained true draft value based on measurements by at least one angular displacement sensor and at least one motion sensor, said angular displacement and motion sensors being mounted on the retractable robotic arm. The angular displacement sensors can be any or a combination of one or more of an accelerometer, an azimuth, a declination and an altitude measuring device.

25 [0045] The accelerometer is used to measure the accelerations different directions corresponding to the movements of the vessel on the water. The different accelerometer readings are collected and on processing the accelerometer readings, the exact instantaneous angular displacement may be evaluated. The relative motion of the sensors with respect to the waves may also be determined.

30 [0046] There are two types of corrections that may be required - one is due to list heel or trim of the vessel and the other is due to the relative motion of the sensor with respect to the vessel. This relative motion can be due to wind induced vibrations, motion of the vessel itself or any other source of mechanical disturbance. The sensors recalibrate the measured values to eliminate the error due to relative angular and linear motion of the sensor with respect to the

nominal offset in angular displacement due to the trim, list or heel of the vessel.

[0047] The adjustable frame can be removable and can be fastened upon to the deck of the vessel by one or more counter weights. In an embodiment, adjustable frame can be fastened upon to the deck of the vessel by or using ISO locks or any other temporary mechanical fastener.

[0048] FIG. 3 illustrates an exemplary implementation of the system for draft apparatus in multiple locations on the vessel, in accordance with an embodiment of the present disclosure. The system is installed in three positions on the surface of the deck in the illustrated embodiment.

[0049] A plurality of a non-contact level sensors may be mounted on an adjustable frame. There can be a plurality of adjustable frames with each frame having a retractable robotic arm. In an embodiment, a remote operation of the robotic arm can be triggered via a remote switch or a remote actuation device.

[0050] In an embodiment, the adjustable frame can be fastened using counter weights or a self-stabilizing stand /magnetic stand etc. On actuation, the retractable arm extends outboards and measures the water level D1 as illustrated by figures 2A and 2B. The retractable arm may be mounted with devices which can measure the angular displacement – these could be accelerometers, or any other azimuth, declination and altitude measuring device. After predefined time the retractable robotic arm retracts inboards and also measures the distance between the arm and the deck D2. The Air Draft value is obtained by subtracting the the distance between the arm and the deck D2 from the water level value D1. The air draft value is obtained as $D1-D2$. The processor then subtracts the air draft from the previously known vessel depth to get the draft $D3-(D1-D2)$.

[0051] The error due to angular displacement may be automatically corrected based on Pythagoras theory and knowledge of trigonometry and vectors. The correction logic/algorithms is pre-programmed into the PLC mounted on the sensors.

[0052] In an embodiment, one of the sensors may be configured to generate a high frequency wave. This sensor may use a high frequency sampling to generate a short-term wave spectrum. Using spectral statistics such as but not limited to zero up crossing, down zero crossing etc - a still water draft can be evaluated for more accurate results.

[0053] In yet another embodiment, sensors may be configured to measure a Line of Sight value at multiple locations. Using the sensor one can measure the LOS (line of sight distance) at multiple locations. This may enable the system to capture a more accurate short

ply the wave spectral analysis to more accurately evaluate the still water draft.

[0054] The sensors can be used to assess the sea state in real time and specific to the location of the vessel. This is much more reliable than relying on historical data which are generic representation of the wider nautical area. A real time spectral analysis can be used to more accurately perform voyage optimization.

[0055] The time history data of the wave is captured from an overhang and a wave spectrum is created in real time.

[0056] The spectrum analysis of the wave spectrum can be used to eliminate the error due to variation in the water mark because of the wave height.

[0057] It should be apparent to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refers to at least one of something selected from the group consisting of A, B, C ... N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc.

[0058] While the foregoing describes various embodiments of the invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. The scope of the invention is determined by the claims that follow. The invention is not limited to the described embodiments, versions or examples, which are included to enable a person having ordinary skill in the art to make and use the invention when combined with information and knowledge available to the person having ordinary skill in the art.

ADVANTAGES OF THE PRESENT DISCLOSURE

[0059] The present disclosure provides a system for draft survey that is automated and required no human interference during measurement.

[0060] The present disclosure provides a system for draft survey that eliminates human involvement and supervision.

disclosure provides a method for draft survey that is safer as an observer is not required to go to the edge of the vessel and any measurements can be taken remotely.

5 [0062] The system and method of the present disclosure eliminates need of reference to draft marks required for calibration.

[0063] The system and method of the present disclosure provide accurate results as no parallax error or error induced due to observer's motion or observers' measurements.

[0064] The system and method of the present disclosure take into account the heel trim list of the vessel using the accelerometer of any other such angular deviation measuring device.

10 [0065] The system and method of the present disclosure take into account any motion of the vessel by offsetting the motion sensed by the motion sensor or any other such device.

[0066] The system and method of the present disclosure will reduce port charges and allow for better route planning and voyage optimization thereby resulting in opex savings.

15 [0067] The system and method of the present disclosure provide a simple automated method to capture time history data of the wave from an overhang and create a wave spectrum in real time.

[0068] The system and method of the present disclosure use spectral analysis to eliminate the error due to variation in the water mark because of the wave height.

We Claim:

1. A system for automated draft survey in a water borne vessel, characterized in that the system comprising:
 - an adjustable frame (1);
 - 5 a retractable robotic arm (2) removably coupled to the adjustable frame such that, on actuation of the retractable robotic arm (2), the arm is configured to extend outward away from the adjustable frame (1) over surface of water,
 - wherein the retractable robotic arm (2) comprises one or more level sensors (5, 6) at least at a distal end (3) of the retractable robotic arm and at an intermediate point on the
 - 10 retractable robotic arm (2),
 - wherein the retractable robotic arm (2) is operatively coupled to a processor, the processor, on receipt of one or more remote instructions, is configured to:
 - actuate the robotic arm to measure a water level (D1) between the deck and
 - waterline;
 - 15 measure, by the one or more level sensors (5, 6) on the retractable robotic arm (2), a distance (D2) between the adjustable frame (1) and the deck;
 - subtract the water level (D1) from the distance (D2) to calculate an Air Draft value; and
 - subtract the obtained Air Draft value from a known vessel depth value (D3) to
 - 20 calculate a true Draft value.
2. The system as claimed in claim 1, wherein the retractable robotic arm (2) comprises at least one sensor for measuring an angular displacement, and a motion sensor.
3. The system as claimed in claim 1, wherein the adjustable frame (1) is removable and fastened upon to the deck of the vessel by one or more counter weights.
- 25 4. A method for automated draft survey of a water borne vessel, characterized in that the method comprising:
 - mounting one or more non-contact sensors (5, 6) on a retractable robotic arm (2) operatively mounted on an adjustable frame (1);
 - installing at least one adjustable frame (1) on an edge of the vessel;

actuating, a retraction of the retractable robotic arm (2) in a plane of a deck of the vessel such that at least one non-contact sensor (5, 6) on a distal end (3) of the retractable robotic arm measures a water level (D1) between the deck and waterline;

5 measuring a distance (D2) between the adjustable frame (1) and the deck by at least one intermediate non-contact sensor (5, 6) on the retractable robotic arm (2);

subtracting the water level (D1) from the distance (D2) to calculate an Air Draft value;

subtracting the obtained Air Draft value from a known vessel depth value (D3) to obtain a true Draft value.

- 10 5. The method for automated draft survey of a vessel as claimed in claim 4, wherein the method comprises performing corrections or calibration in the obtained true draft value based on measurements by at least one angular displacement sensor and at least one motion sensor, said angular displacement and motion sensors being mounted on the retractable robotic arm (2).
- 15 6. The method as claimed in claim 4, wherein the adjustable frame (1) is removable and fastened upon to the deck of the vessel by one or more counter weights.
7. The method as claimed in claim 4, wherein the angular displacement sensors being any or a combination of one or more of an accelerometer, an azimuth, a declination and an altitude measuring device.
- 20 8. The method as claimed in claim 4, wherein said retractable robotic arm (2) being configured to automatically retract inboard to measure the distance to the deck (D2).