APPARATUS AND METHOD FOR GUIDING OPERATOR TO SECURE SPREADER TO CONTAINER

TECHNICAL FIELD

[0001] This disclosure relates to an assisting apparatus, a spreader comprising the apparatus and a corresponding method for guiding an operator to secure a spreader to a container.

BACKGROUND

[0002] Quay cranes are used at container ports for loading containers to vessels and unloading containers from vessels. A quay crane operator is needed to secure the spreader to the container for loading the container to a vessel or unloading the container from a vessel by the quay crane. Remote operation has been introduced in some ports where the operator sits in an operation center on the port premises. The crane operation is not done on the crane but in the remote operation center.

[0003] In order to land the spreader to the container to secure the spreader to the container, an operator needs to identify four corner castings of the container and maneuver the twist lock pins of the spreader to within an accuracy of 5 centimeters from the corner castings of the container.

[0004] A prior art discloses a spreader frame comprising several electromagnets and permanent magnets which can magnetically act on the container to help to position the spreader frame to be in alignment with the container.

[0005] Another prior art discloses back-reach range scanning sensors located on a back-reach area of the crane or boom range scanning sensors located on the crane boom are used to capture scan data. The back-reach scan data and the boom scan data are aligned and combined to map the position of the crane spreader and the crane load target.

[0006] Over the years, the height of quay cranes has increased from 25 meters to 60 meters. At a height of 60 meters, it is very difficult for an operator to land the spreader to the container without any assistance. Moreover, vessels cannot act as reference static points because they are not standardized, which increases the complexity and decreases the accuracy of landing the spreader to the container.

[0007] A solution is needed to assist an operator in securing the spreader to the container, especially when the quay crane is at a height of more than 60 meters.

SUMMARY

[0008] This disclosure was conceptualized to assist in aligning a spreader with a container for securing the spreader to the container, for loading the container to a vessel and unloading the container from a vessel, and for transferring containers at ports, airports, warehouse and manufacturing plants, etc.

[0009] A technical solution is provided in the form of an apparatus suitable for use with a spreader, a spreader comprising the apparatus and a corresponding method for guiding an operator to align the spreader with a container for securing the spreader to a container. The apparatus comprises at least one sensor configured to capture data from the container; a graphic processing unit connected to the at least one sensor, wherein the graphic processing unit is configured to compute at least one position of the container and the spreader using the data captured by the at least one sensor, and send an output signal according to the computed position of the container and the spreader; a display unit connected to the graphic processing unit, wherein the display unit is configured to receive the output signal from the graphic processing unit, and send a visual light signal to the operator according to the output signal of the graphic processing unit, wherein the visual light signal guides the operator to move the spreader.

[0010] The dependent claims define some examples associated with the system and method, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present disclosure will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the accompanying drawings, in which:

- FIG. 1 shows a schematic illustration of an operator in a remote office operates a crane to align a spreader with a container to secure the spreader to the container with guidance from an assisting apparatus installed on the spreader;
- FIG.2 shows a schematic illustration of a front view of an assisting apparatus installed on the spreader for guiding an operator to secure the spreader to a container according to some embodiments;
- FIG.3 shows a schematic illustration of a top view of the assisting apparatus of FIG.2;

- FIG.4 shows a schematic illustration of an assisting apparatus comprising at least one sensor, a graphic processing unit and a display unit according to some embodiments;
- FIG. 5 shows a photo of a graphic processing unit and a display unit of an assisting apparatus, according to some embodiments;
- FIG. 6A to FIG. 6F shows a corresponding LED in the display unit illuminates to indicate the operator to move the spreader to left, right, forward, backward, up and down, respectively;
- FIG. 7A to FIG. 7K shows a schematic illustration of moving a spreader to align with a container for securing the spreader to the container, according to some embodiments.
- FIG. 8 is a flow chart depicting a method for guiding an operator to move the spreader to be in alignment with a container for securing the spreader to the container.

DETAILED DESCRIPTION

[0012] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure. Other embodiments may be utilized and structural, and logical changes may be made without departing from the scope of the disclosure. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0013] Embodiments described in the context of one of the systems or methods are analogously valid for the other systems or methods.

[0014] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0015] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

[0016] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0017] As used herein, the term “data” may be understood to include information in any suitable analog or digital form, for example, provided as a file, a portion of a file, a set of files, a signal or stream, a portion of a signal or stream, a set of signals or streams, and the like. The term data, however, is not limited to the aforementioned examples and may take various forms and represent any information as understood in the art.

[0018] As used herein, the term “connected” can refer to a wired or wireless connection. Preferably, the connection between the at least one sensor and the graphic processing unit and/or the connection between the graphic processing unit and the display unit is a wired connection.

[0019] FIG. 1 shows an operator 10 in a remote office operating a crane 20 to move a spreader 30 to align the spreader 30 with a container 40 for securing the spreader 30 to the container 40 with guidance from an assisting apparatus 100 suitable for use on the spreader 20, for example, installed on the spreader 30. The operator 10 may sit in the crane 20 to operate the crane 20 to move the spreader 30 to align the spreader 30 with the container 40 for securing the spreader 30 to the container 40 with guidance from the assisting apparatus 100 which is suitable for use with the spreader 30. With the guidance from the assisting apparatus 100, the operator 10 operates the crane 20 to align the spreader 30 with the container 40 to land the spreader 30 onto the container 40. For example, a twist lock pin 32 of the spreader 30 is moved to within an accuracy of 5 centimeters from the corner castings 42 of the container 40. The spreader 30 then interlocks with the container 40. Subsequently, the operator 10 operates the crane 20 to lift the interlocked spreader 30 and container 40 for loading the container 40 to a vessel, unloading the container 40 from a vessel, and transferring the container 40 at ports, airports, warehouse and manufacturing plants, etc.

[0020] According to an aspect of the disclosure, as shown in FIG.2 to FIG.3, there is an assisting apparatus 100 capable of being installed on the spreader 30 for guiding an operator 10 to move the spreader 30 to be in alignment with a container 40 for securing the spreader 30 to the container 40. As shown in FIG. 2 and FIG. 3, the container 40 and the spreader 30 are initially not aligned with each other. The assisting apparatus 100 identifies the position of the container 40 and the spreader 30, in particular the relative position between the container 40 and the spreader 30, and guides the operator 10 to move the spreader 30 to align the spreader 30 with the container 40. For example, the assisting apparatus 100 identifies the position of the spreader 30 and the four corner castings 42 of the container 40, and guides the operator 10 to

move the spreader 30 to align the twist lock pin 32 of the spreader 30 to within a desired accuracy, for example 5 centimeters from the corner castings 42.

[0021] As shown in FIG. 4, the assisting apparatus 100 comprises at least one sensor 120, a graphic processing unit 140 and a display unit 160, according to some embodiments of the present disclosure. The at least one sensor 120, the graphic processing unit 140 and the display unit 160 are installed on the spreader 30.

[0022] FIG. 5 shows a photo of a graphic processing 140 and a display unit 160 of an assisting apparatus 100, according to some embodiments of the present disclosure. The graphic processing 140 and the display unit 160 are both installed on the spreader 30.

[0023] The at least one sensor 120 is configured to capture data from the container 40 for computing position of the container 40 and the spreader 30. The at least one sensor 120 can include at least one light detection and ranging (LiDAR) sensor 122 and/or at least one image capturing device, for example a camera 124.

[0024] The at least one LiDAR sensor 122 may be armored with casings and mount to prevent or minimize electromagnetic interference and protect the LiDAR sensor 122 from the relatively harsh environmental conditions at the port.

[0025] The at least one LiDAR sensor 122 emits pulsed light waves which bounce off the container 40 and return to the at least one LiDAR sensor 122. The at least one LiDAR sensor 122 uses the time it takes for each pulsed light wave to return to the LiDAR sensor 122 to calculate the distance each pulsed light wave has traveled. The pulsed laser measurements carried out by the at least one LiDAR sensor 122 are then processed into a point cloud of the container 40. The point cloud of the container 40 is a set of data points in space representing the container 40. Each point position has a corresponding set of Cartesian coordinates (X, Y, Z). The point cloud of the container 40 measures a plurality of points on an external surface of the container 40.

[0026] The at least one image capturing device 124 may be protected from electromagnetic interference and the relatively harsh environmental conditions at the port using explosion proof, corrosion proof, salt resistant cover.

[0027] The at least one image capturing device 124 is configured to capture images of the container 40 to obtain metadata of the container 40.

[0028] The corner castings 42 of the container 40 and an identification number of the container 40 can be identified from the captured images of the container 40 using computer

vision. A feature selection method is used to identify the four corner castings 42 of the container 40 from the images of the container 40 captured by the at least one camera 124. Feature selection method uses only relevant data and gets rid of noise in data, thus reduces the input variable to the model. An Optical Character Recognition (OCR) is used to detect the identification number of each container 40. OCR extracts characters of the identification number from the images of the container 40, and turns the characters into machine-readable texts.

[0029] Installing the at least one sensor 120 on the spreader 30 helps to increase the accuracy. Traditionally, due to the electromagnetic interference, the sensors are mounted either on the outreach and back-reach of the crane or other infrastructure on the port premise. As the height of the crane increases, the height at which the sensors are mounted also increases. This decreases the precision and accuracy of the sensors. When the height at which the sensors are mounted increases, the spot separation also increases. Likewise, as the scan field of view/slope increases, the spot separation also increases, decreasing in accuracy. The scan field of view is the angle covered by the LiDAR sensor or the angle in which LiDAR signals are emitted. If the scan field of view is consistent, the at least one sensor 120 of the assisting apparatus 100 according to embodiments of the present disclosure installed on the spreader 30, which is closer to the source (i.e., the container), provides a more accurate result (i.e., the at least one sensor 120 can achieve a spot separation of less than 5 centimeters).

[0030] Installing the at least one sensor 120 on the spreader 30 also helps to reduce cost. If sensors are placed on the back-reach, outreach and other infrastructure around the crane, niche and high-performance sensors are required and consequently the cost is higher.

[0031] The graphic processing unit 140 is connected to the at least one sensor 120. The graphic processing unit 140 may be armored with casings and mount to prevent electromagnetic interference and the harsh conditions at the port.

[0032] The graphic processing unit 140 is configured to compute position of the container 40 and the spreader 30 using the data captured by the at least one sensor 120. The graphic processing unit 140 can compute the position of the container 40 and the spreader 30 using the point cloud formed from the at least one LiDAR sensor 122 and/or the metadata obtained from the at least one image capturing device 124. The graphic processing unit 140 can calibrate, combine, and/or align the point cloud formed from the at least one LiDAR sensor 122 and/or the metadata obtained from the at least one image capturing device 124, to obtain the location

of the container 40 and the spreader 30. The graphic processing unit 140 can further compute the direction in which the spreader 30 should be moved to align the spreader 30 with the container 40.

[0033] Installing the graphic processing unit 140 on the spreader 30 helps to avoid adding further latency to the existing system. If the computation and processing of data is carried out on a server and/or cloud, a further latency (> 500ms) would be added to the existing system of remote operation which already has a latency of 500ms. With a latency of more than 1s, a remote operator would make decisions and move a container based on a position it was a second ago. This would compromise safety and increase cases of stack collisions.

[0034] The display unit 160 is connected to the graphic processing unit 140. The graphic processing unit 140 sends an output signal to the display unit 160 according to the position of the container 40 and the spreader 30 computed by the graphic processing unit 140. The display unit 160 is configured to send a visual light signal to the operator 10 according to the output signal of the graphic processing unit. The visual light signal guides the operator 10 to operate the crane 20 to move the spreader 30.

[0035] According to an embodiment of the present disclosure, the display unit 160 can include a plurality of light emitting diodes (LEDs) 162. According to some embodiments, one or a combination of LEDs 162 can be illuminated or blinked corresponding to different output signal received from the graphic processing unit 140.

[0036] According to some embodiments, if the output signal from the graphic processing unit 140 is for the operator 10 to move the spreader 30 in a guiding direction, e.g., to left, at least one corresponding LED 162 (e.g., at least one LED 162 on the left side of the display unit 160) can illuminate to indicate the operator 10 to move the spreader 30 in the respective guiding direction. In this case, the visual light signal is the at least one LED on the left side of the display unit 160 illuminating. In another example, as shown in FIG. 6A to FIG. 6F, LEDs 162a, 162b, 162c, 162d, 162e, 162f in the display unit 160 illuminates to indicate the operator 10 to move the spreader 30 to left, right, forward, backward, up and down, respectively. The visual light signal in this example is the LEDs 162a, 162b, 162c, 162d, 162e, 162f illuminating.

[0037] The visual light signal can also be LEDs 162 illuminating in different colors to guide the operator 10 to move the spreader 30. According to some embodiments, at least one LED 162 of the display unit 160 can be illuminated in different colors according to different output signal received from the graphic processing unit 140. For example, the at least one LED 162 is

illuminated in different colors such as red, orange, yellow, green, blue, purple to indicate the operator 10 to move the spreader 30 to left, right, forward, backward, up and down, respectively.

[0038] If an error occurs, the at least one LED 162 may blink to indicate an error to the operator 10. In this scenario, the visual light signal is the at least one LED 162 blinking. The operator 10 can stop the spreader 30 and/or take necessary measures after viewing the visual light signal. In a non-limiting example, a display unit 160 of an assisting apparatus 100 sends visual light signal to the operator 10 to guide the operator 10 to move the spreader 30 towards the container 40 in a first direction, and the operator 10 operates the crane 20 to move the spreader 30 towards the container 40 in the first direction. However, through the position of the container 40 and the spreader 30 computed by its graphic processing unit 140, the assisting apparatus 100 detects that the spreader 30 is not moving towards the container 40 in the first direction. The graphic processing unit 140 then sends an output signal to the display unit 160. The display unit 160 sends a visual light signal to the operator 10 according to the output signal of the graphic processing unit 140 to indicate an error to the operator 10, for example, via a visual notification, such as by blinking at least one LED 162 of the display unit 160.

[0039] In some embodiments, the visual light signals can be set according to users' preference for guiding the operator 10 to move the spreader 30.

[0040] The operator 10 in remote office may view the visual light signals through viewing screens 12 which show videos of the display unit 160. Videos of the display unit 160 can be recorded by a recording camera 14 (not shown) and transmitted to the screens 12 for the operator 10 to view. The operator 10 can be guided by the visual light signals to operate a joystick 16 to move the spreader 30 in a certain direction or to stop moving the spreader 30. Therefore, it is not required to add new screens, monitor or system in the remote office.

[0041] When operators sit in a crane, they are used to observing various factors to move the spreader, e.g. the movement of rope, vessel's hull or containers, etc., to gauge the position and direction of the spreader. When the operators move to remote offices, some of these factors are unavailable to them. They move the spreader using a joystick and by viewing the videos of the spreader on multiple monitors. Given that the operators mainly use cues and indicators on the spreader, if other forms of indicators, e.g., text data on screen or augmented visual screen, are used, it would cause a steep learning curve.

[0042] The spreader 30 has power source and copper cables to provide power supply. As the apparatus 100 is installed on the spreader 30, it will be subjected to electromagnetic interference. As such, the graphic processing unit 140 only sends limited and vital data to remote office using Long-range Wide Area Network (LoRaWan), e.g. via radio waves at a frequency of 900MHz in the case of backup measures. This would reduce the data loss due to electromagnetic interference.

[0043] FIG. 7A to FIG 7K shows a spreader 30, which is initially not in alignment with a container 40, is moved by an operator 10 who is guided by an assisting apparatus 100 installed on the spreader 30, to align the spreader 30 with the container 40. The assisting apparatus 100 guides the operator 10 to move the spreader 30 from a first position (shown in FIG. 7A and FIG. 7B) to a second position (shown in FIG. 7D and FIG. 7E), and subsequently to a third position (shown in FIG. 7G and FIG. 7H), and subsequently to a fourth position (shown in FIG. 7J and FIG. 7K) for securing the spreader 30 to the container 40.

[0044] The spreader 30 is not in alignment with the container 40 until the spreader 30 arrives at the fourth position (shown in FIG. 7J and FIG. 7K). When the spreader 30 is being moved from the first position to the fourth position, at least one sensor 120 of the assisting apparatus 100 captures data from the container 40, and a graphic processing unit 140 of the assisting apparatus 100 computes the position of the container 40 and the spreader 30 using the data captured by the at least one sensor 120. The graphic processing unit 140 sends an output signal according to the computed position of the container 40 and the spreader 30 to a display unit 160 of the assisting apparatus 100. The display unit 160 sends a visual light signal to the operator 10 according to the output signal of the graphic processing unit 140. The display unit 160 sends a visual light signal, e.g., by illuminating at least one LED of the display unit 160 to indicate the operator 10 to move the spreader 30.

[0045] When the spreader 30 is at the first position as shown in FIG. 7A and FIG. 7B, where the spreader 30 and the container 40 do not align with each other in either X direction or Y' direction, the display unit 160 sends a visual light signal, e.g., by illuminating LED 162b of the display unit 160 (see FIG. 7C), to indicate the operator 10 to move the spreader 30 in the X direction. The operator 10 views the visual light signal and operates the crane 20 to move the spreader 30 in the X direction.

[0046] The display unit 160 continues to send a visual light signal to indicate the operator 10 to move the spreader 30 in the X direction, until the spreader 30 arrives at the second

position as shown in FIG. 7D and FIG. 7E, where the spreader 30 and the container 40 align with each other in the X direction but not align with each other in the Y' direction. Upon the spreader 30 and the container 40 align with each other in the X direction, the display unit 160 sends a visual light signal, e.g., by illuminating LED 162c of the display unit 160 (see FIG. 7F), to indicate the operator 10 to move the spreader 30 in the Y' direction. The operator 10 views the visual light signal and operates the crane 20 to move spreader 30 in the Y' direction.

[0047] The display unit 160 continues to send a visual light signal to indicate the operator 10 to move the spreader 30 in the Y' direction, until the spreader 30 arrives at the third position as shown in FIG. 7G and FIG. 7H, where the spreader 30 and the container 40 align with each other in both the X direction and the Y' direction. Upon the spreader 30 and the container 40 align with each other in both the X direction and the Y' direction, the display unit 160 sends a visual light signal, e.g., by illuminating LED 162f of the display unit 160 (see FIG. 7I), to indicate the operator 10 to move the spreader 30 in the Z' direction. The operator 10 views the visual light signal and operates the crane 20 to move spreader 30 in the Z' direction.

[0048] The display unit 160 continues to send a visual light signal to indicate the operator 10 to move the spreader 30 in the Z' direction, until the spreader 30 arrives at the fourth position as shown in FIG. 7J and FIG. 7K, where the spreader 30 and the container 40 interlock with each other. Upon the spreader 30 and the container 40 interlock with each other, the display unit 160 may send a visual light signal, e.g., by illuminating none of the LEDs of the display unit 160, to indicate the operator 10 to stop moving the spreader 30 in the Z' direction. The operator 10 views the visual light signal and stops moving spreader 30 in the Z' direction.

[0049] FIG. 8 is a flow chart depicting a method 800 for guiding an operator 10 to move a spreader 30 to be in alignment with a container 40 for securing a spreader 30 to a container 40. The method 800 comprises:

- a step 802 of capturing data from the container 40 by at least one sensor 120;
- a step 804 of computing at least one position of the container 40 and the spreader 30 by a graphic processing unit 140 using the data captured by the at least one sensor 120;
- a step 806 of sending an output signal by the graphic processing unit 140 according to the computed position of the container 40 and the spreader 30;
- a step 808 of sending a visual light signal to the operator 10 by a display unit 160 according to the output signal received from the graphic processing unit 140, wherein the visual light signal guides the operator 10 to move the spreader 30.

[0050] The at least one sensor 120 may include at least one LiDAR sensor 122 and at least one image capturing device 124, for example a camera 124.

[0051] The method 100 can further include the graphic processing unit 140 calibrating, combining, and/or aligning data captured from the at least one LiDAR sensor 122 and/or the data captured from the at least one image capturing device 124.

[0052] The sending a visual light signal to the operator 10 may include illuminating at least one LEDs 162 to indicate the operator 10 to move the spreader 30 in a respective direction.

[0053] The sending a visual light signal to the operator 10 may include blinking at least one LEDs 162 to indicate an error to the operator 10. The operator 10 may stop the spreader 30 and/or take necessary measures after viewing the visual light signal.

[0054] Furthermore, one or more of the steps of a method described herein may be performed in parallel rather than sequentially.

[0055] While the disclosure has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the present disclosure as defined by the appended claims. The scope of the present disclosure is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

1. An assisting apparatus suitable for use with a spreader for guiding an operator to secure the spreader onto a container comprising:

at least one sensor configured to capture data from the container;

a graphic processing unit connected to the at least one sensor, wherein the graphic processing unit is configured to compute at least one position of the container and the spreader using the data captured by the at least one sensor, and send an output signal according to the computed position of the container and the spreader;

a display unit connected to the graphic processing unit, wherein the display unit is configured to receive the output signal from the graphic processing unit, and send a visual light signal to the operator according to the output signal of the graphic processing unit, wherein the visual light signal guides the operator to move the spreader.

2. The assisting apparatus of claim 1, wherein the at least one sensor comprises at least one LiDAR sensor and at least one image capturing device for capturing data from the container.

3. The assisting apparatus of claim 2, wherein the graphic processing unit is configured to calibrate, combine, and/or align data captured from the at least one LiDAR sensor and/or the data captured from the at least one image capturing device.

4. The assisting apparatus of claim 1, wherein the display unit comprises at least one LED arranged to indicate a direction for the operator to move the spreader.

5. The assisting apparatus of claim 1, wherein the display unit comprises at least one LED arranged to indicate an error to the operator.

6. A spreader comprising an assisting apparatus according to one of claims 1 to 5, wherein the assisting apparatus is installed on the spreader.

7. A method for guiding an operator to secure a spreader to a container comprising:
capturing data from the container by at least one sensor;
computing at least one position of the container and the spreader by a graphic processing unit using the data captured by the at least one sensor;
sending an output signal by the graphic processing unit according to the computed position of the container and the spreader;
sending a visual light signal to the operator by a display unit according to the output signal received from the graphic processing unit, wherein the visual light signal guides the operator to move the spreader.

8. The method of claim 7, wherein the at least one sensor comprises at least one LiDAR sensor and at least one image capturing device.

9. The method of claim 8, further comprising the graphic processing unit calibrating, combining, and/or aligning data captured from the at least one LiDAR sensor and/or the data captured from the at least one image capturing device.

10. The method of claim 7, wherein the sending a visual light signal to the operator comprises illuminating at least one LED to indicate the operator to move the spreader in a respective direction.

11. The method of claim 7, wherein the sending a visual light signal to the operator comprises blinking at least one LED to indicate an error to the operator.