ANTI-HOISTING MONITORING METHOD, APPARATUS, AND SYSTEM FOR CONTAINER TRUCK

TECHNICAL FIELD

[0001] The present application relates to the field of engineering machinery detection technologies, and in particular, to an anti-hoisting monitoring method, an apparatus, and a system for a container truck.

BACKGROUND

[0002] A container truck is often loaded with a container, and in an operation process, the container is generally unloaded from the container truck by using a hoisting mechanism. In practical application, due to a fact that a lock catch between the container and the container truck is not completely unfastened, the container truck is also driven to be hoisted together in a hoisting process of the container, and thus a hoisting operation of the container truck is affected, and it is easy to cause safety accidents. In a conventional technology, when a container is hoisted, an anti-hoisting monitoring system for a container truck is generally used to monitor whether the container truck is hoisted together, and if the container truck is hoisted together, a corresponding alarm signal may be sent out.

[0003] However, in the conventional technology, a fixed monitoring area is generally set for the anti-hoisting monitoring system for the container truck, and when the container is hoisted by a specific height, whether the container truck is hoisted is determined depending on whether an obstacle exists in the monitoring area. In this way, an false alarm possibly occurs when a rope or another object is suspended in the monitoring area. In other words, in the conventional technology, when the container is hoisted by a specific height for the anti-hoisting monitoring system for the container truck, a manner of determining whether the container truck is hoisted depending on whether an obstacle exists in the monitoring area has relatively low detection accuracy and cause a relatively large probability of a false alarm.

SUMMARY

[0004] In view of this, the present application provides an anti-hoisting monitoring method, apparatus, and system for a container truck, which may improve detection accuracy and reduce an occurrence probability of false alarms.

[0005] According to an aspect of the present application, an anti-hoisting monitoring method for a container truck is provided, including: acquiring a first point cloud set of a container, where the first point cloud set represents a set of a plurality of points that are emitted by a laser transmitter to a side surface, close to the laser transmitter, of the container; obtaining an anti-hoisting monitoring area based on the first point cloud set; acquiring a second point cloud set of a target object, where the target object represents a part of the container truck or represents an object other than the container or the container truck, and the second point cloud set represents a set of a plurality of points emitted by the laser transmitter to the target object; and outputting, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted, where the container truck is configured to load the container.

[0006] According to an aspect of the present application, before the obtaining an anti-hoisting monitoring area based on the first point cloud set, the anti-hoisting monitoring method for the container truck further includes: acquiring an opening size of a spreader, where the spreader is configured to hoist the container; and obtaining a type of the container based on the opening size of the spreader~~; and~~.

~~[0006]~~[0007] According to an aspect of the present application, the obtaining an anti-hoisting monitoring area based on the first point cloud set includes: obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container.

~~[0007]~~[0008] According to an aspect of the present application, the obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container includes: obtaining the type of the container based on the first point cloud set and the opening size of the spreader; and acquiring the anti-hoisting monitoring area corresponding to the type of the container.

~~[0008]~~[0009] According to an aspect of the present application, the type of the container includes any one of a single twenty foot container, a single forty foot container, a single forty-five foot container, and a double twenty foot container.

~~[0009]~~[0010] According to an aspect of the present application, the obtaining an anti-hoisting monitoring area based on the first point cloud set includes: obtaining coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set; and obtaining the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area.

[0011] According to an aspect of the present application, the boundary points of the anti-hoisting monitoring area include a first point, a second point, a third point, and a fourth point, where the first point and the second point are two endpoints of an intersection line of a surface of laser emitted

by the laser transmitter and the side surface, close to the laser transmitter, of the container; and the third point and the fourth point are two endpoints of an intersection line of the surface of laser emitted by the laser transmitter and a side surface, away from the laser transmitter, of the container. ~~The~~

[0012] According to an aspect of the present application, the obtaining coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set includes: obtaining, based on the first point cloud set, a slope of an intersection line of a top surface and the side surface, close to the laser transmitter, of the container, coordinates of the first point, and coordinates of the second point; and obtaining coordinates of the third point and coordinates of the fourth point based on the slope of the intersection line, the coordinates of the first point, and the coordinates of the second point.

~~[0010]~~[0013] According to an aspect of the present application, ~~T~~the obtaining the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area includes: obtaining the anti-hoisting monitoring area based on the coordinates of the first point, the coordinates of the second point, the coordinates of the third point, and the coordinates of the fourth point.

~~[0011]~~[0014] According to an aspect of the present application, the outputting, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted includes: obtaining coordinates of all points in the second point cloud set based on the second point cloud set; obtaining, based on coordinates of the boundary points of the anti-hoisting monitoring area and the coordinates of the all points in the second point cloud set, a position relationship between each point in the second point cloud set and the anti-hoisting monitoring area, where the position relationship represents that a point in the second point cloud set is located in the anti-hoisting monitoring area or the point in the second point cloud set is located outside the anti-hoisting monitoring area; and outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted.

~~[0012]~~[0015] According to an aspect of the present application, the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted includes: if the all points in the second point cloud set are located outside the anti-hoisting monitoring area, outputting the signal representing that the container truck is not hoisted.

~~[0013]~~[0016] According to an aspect of the present application, the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted includes: if there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, selecting a plurality of points, located in the anti-hoisting monitoring area, in the second point

cloud set to form a third point cloud set; and if there exist a preset quantity of points in the third point cloud set that meet a preset condition, outputting the signal representing that the container truck is hoisted, where the preset condition represents that a distance between any two adjacent points is less than a preset value.

~~[0014]~~[0017] According to an aspect of the present application, after the selecting a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set to form a third point cloud set, the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted further includes: if there does not exist the preset quantity of points in the third point cloud set that meet the preset condition, outputting the signal representing that the container truck is not hoisted.

~~[0015]~~[0018] According to an aspect of the present application, the acquiring a first point cloud set of a container includes: acquiring a fourth point cloud set in an emission range of the laser transmitter, where the fourth point cloud set represents a set of all points emitted on the object in the emission range; and performing clustering on the points in the fourth point cloud set to obtain point cloud sets of different parts through division, and selecting, based on a quantity of points in the point cloud sets of different parts and a distance between two adjacent points, the first point cloud set representing the side surface, close to the laser transmitter, of the container.

~~[0016]~~[0019] According to another aspect of the present application, an anti-hoisting monitoring apparatus for a container truck is provided, including: a first acquisition module, configured to acquire a first point cloud set of a container, where the first point cloud set represents a set of a plurality of points that are emitted by a laser transmitter to a side surface, close to the laser transmitter, of the container; a first calculation module, configured to obtain an anti-hoisting monitoring area based on the first point cloud set; a second acquisition module, configured to acquire a second point cloud set of a target object, where the target object represents a part of the container truck or represents an object other than the container or the container truck, and the second point cloud set represents a set of a plurality of points emitted by the laser transmitter to the target object; and a first output module, configured to output, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted, where the container truck is configured to load the container.

~~[0017]~~[0020] According to another aspect of the present application, an anti-hoisting monitoring system for a container truck is provided, including: a container; a container truck configured to load the container; a laser transmitter configured to emit laser toward a side, close to the laser transmitter, of the container; and an electronic device, configured to perform the foregoing anti-hoisting monitoring methods for a container truck.

[0018][0021] According to another aspect of the present application, an electronic device is provided, including: a processor, and a memory configured to store an instruction executable by the processor. The processor is configured to perform the foregoing anti-hoisting monitoring methods for a container truck.

[0019][0022] According to the anti-hoisting monitoring method, apparatus, and system for a container truck provided in the present application, the first point cloud set on the side surface, close to the laser transmitter, of the container is acquired, then the anti-hoisting monitoring area is obtained based on the first point cloud set, and next the position relationship between the target object and the anti-hoisting monitoring area is confirmed based on the second point cloud set of the target object and the anti-hoisting monitoring area. In addition, in a case that the target object is located in the anti-hoisting monitoring area, whether the target object belongs to a part of the container truck or belongs to the object other than the container or the container truck is confirmed again based on a characteristic of the second point cloud set. In this way, the detection accuracy is improved, and the occurrence probability of the false alarms caused when a rope or another object is suspended in the anti-hoisting monitoring area is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020][0023] To describe the technical solutions in the embodiments of the present application or the conventional technology more clearly, the drawings for describing the embodiments or the conventional technology are briefly described below. Apparently, the drawings described below show only the embodiments of the present application, and those of ordinary skill in the art may further derive other drawings from these drawings without creative efforts.

[0021][0024] FIG. 1 is a schematic structural diagram showing when an object intrudes into an anti-hoisting monitoring area in the conventional technology.

[0022][0025] FIG. 2 is a schematic flowchart of an anti-hoisting monitoring method for a container truck according to an exemplary embodiment of the present application.

[0023][0026] FIG. 3 is a schematic diagram of an anti-hoisting monitoring area according to an exemplary embodiment of the present application.

[0024][0027] FIG. 4 is a schematic structural diagram showing when a double twenty foot container is hoisted in the conventional technology.

[0025][0028] FIG. 5 is a schematic flowchart of an anti-hoisting monitoring method for a container truck according to another exemplary embodiment of the present application.

[0026][0029] FIG. 6 is a schematic flowchart of acquiring a first point cloud set on a side surface, close to a laser transmitter, of a container according to an exemplary embodiment of the present application.

[0027][0030] FIG. 7 is a schematic flowchart of obtaining an anti-hoisting monitoring area based on a first point cloud set according to an exemplary embodiment of the present application.

[0028][0031] FIG. 8 is a schematic flowchart of obtaining an anti-hoisting monitoring area based on a first point cloud set according to another exemplary embodiment of the present application.

[0029][0032] FIG. 9 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to an exemplary embodiment of the present application.

[0030][0033] FIG. 10 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to another embodiment of the present application.

[0031][0034] FIG. 11 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to another exemplary embodiment of the present application.

[0032][0035] FIG. 12 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to another exemplary embodiment of the present application.

[0033][0036] FIG. 13 is a structural block diagram of an anti-hoisting monitoring apparatus for a container truck according to an exemplary embodiment of the present application.

[0034][0037] FIG. 14 is a structural block diagram of an anti-hoisting monitoring apparatus for a container truck according to another exemplary embodiment of the present application.

[0035][0038] FIG. 15 is a structural block diagram of an anti-hoisting monitoring system for a container truck according to an exemplary embodiment of the present application.

[0036][0039] FIG. 16 is a structural block diagram of an electronic device according to an exemplary embodiment of the present application.

DETAILED DESCRIPTIONS OF THE EMBODIMENTS

[0037][0040] The following clearly and completely describes the technical solutions in the embodiments of the present application with reference to the accompanying drawings in the embodiments of the present application. Apparently, the described embodiments are only some rather than all of the embodiments of the present application. All other embodiments obtained by

a person of ordinary skill in the art based on the embodiments of the present application without creative efforts shall fall within the protection scope of the present application.

[0038][0041] FIG. 1 shows that, in a conventional technology, a fixed monitoring area is generally set for an anti-hoisting monitoring system for a container truck, and when a container is hoisted by a specific height, whether the container truck is hoisted is determined depending on whether an obstacle exists in a monitoring area. In this way, an false alarm possibly occurs when a rope or another object is suspended in the monitoring area. FIG. 1 is a schematic structural diagram showing when an object intrudes into an anti-hoisting monitoring area in the conventional technology. As shown in FIG. 1, a laser transmitter 530 emits a laser surface towards a container 600 to form the monitoring area, and an object (the part indicated by arrow A in FIG. 1) intrudes into the monitoring area. When detecting that an intruding object exists in the monitoring area, the anti-hoisting monitoring system of the container truck in the conventional technology sends the false alarm that the container truck is hoisted. However, according to an anti-hoisting monitoring method, apparatus, and system for a container provided in the present application, whether an object intruding into an anti-hoisting monitoring area is a part of the container truck may be identified, so that an occurrence probability of the false alarm is reduced.

[0039][0042] Specifically, FIG. 2 is a schematic flowchart of an anti-hoisting monitoring method for a container truck according to an exemplary embodiment of the present application. As shown in FIG. 2, the anti-hoisting monitoring method for the container truck provided in the embodiment of the present application may include the following steps.

[0040][0043] S310: acquiring a first point cloud set of a container.

[0041][0044] In an embodiment, a laser transmitter is disposed on a side of the container, and the laser transmitter may emit a plurality of laser points towards a side surface, close to the laser transmitter, of the container. The plurality of laser points are distributed on the side surface of the container, and the plurality of points distributed on the side surface, close to the laser transmitter, of the container may form the first point cloud set.

[0042][0045] In an embodiment, the first point cloud set may include spatial coordinates of a plurality of points, and after the laser transmitter emits laser to the container, spatial coordinates of each point distributed on the side surface of the container may be obtained, so that a signal representing the spatial coordinates of the plurality of points is transmitted to the controller.

[0043][0046] S320: obtaining an anti-hoisting monitoring area based on the first point cloud set.

[0044][0047] In an embodiment, the laser transmitter and the container are arranged in the horizontal direction, and the laser transmitter emits laser in the horizontal direction. FIG. 3 is a

schematic diagram of an anti-hoisting monitoring area according to an exemplary embodiment of the present application. The anti-hoisting monitoring area may be understood as an area defined when a surface of laser emitted by the laser transmitter intersects with the container at the top view angle. A lower edge of the anti-hoisting monitoring area may be understood as a straight line integrated by the side surface, close to the laser transmitter, of the container at the top view angle.

~~[0045]~~[0048] In an embodiment, the spatial coordinates of each point in the first point cloud set may be obtained based on the first point cloud set, so that a linear expression of the lower edge of the anti-hoisting monitoring area may be obtained, and then coordinates of another boundary point of the anti-hoisting monitoring area may be obtained based on the linear expression of the lower edge of the anti-hoisting monitoring area. A specific derivation process will be described below in detail.

~~[0046]~~[0049] S330: acquiring a second point cloud set of a target object.

~~[0047]~~[0050] In an embodiment, the target object may represent a part of the container truck or represent an object other than the container or the container truck.

~~[0048]~~[0051] In an embodiment, the target object enters an emission range of the laser transmitter, a plurality of laser points emitted by the laser transmitter may also be distributed on a surface of the target object, and the plurality of laser points distributed on the surface of the target object may form the second point cloud set.

~~[0049]~~[0052] S340: outputting, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted.

~~[0050]~~[0053] In an embodiment, the container truck is configured to load the container, and if a lock catch between the container and the container truck is not completely unlocked, the container truck may be hoisted during hoisting of the container. After Step S340 is performed, whether the container truck is hoisted may be monitored, and the signal representing that the container truck is hoisted or not hoisted is output to inform an operation in time, thereby reducing an occurrence probability of a safety accident.

~~[0051]~~[0054] In an embodiment, after the anti-hoisting monitoring area and the second point cloud set are obtained, whether a point in the second point cloud set is located in the anti-hoisting monitoring area may be determined based on a position relationship between the second point cloud set and the anti-hoisting monitoring area, and then whether the container truck is hoisted is determined based on a characteristic of the second point cloud set, thereby outputting the signal representing that the container truck is hoisted or not hoisted.

~~[0052]~~[0055] It should be understood that, a characteristic of the second point cloud set obtained when the target object is a part of the container is different from a characteristic of the

second point cloud set obtained when the target object is the object other than the container truck or the container. Therefore, whether the target object is a part of the container truck may be identified based on the characteristic of the second point cloud set, so that a signal representing whether the container truck is hoisted together with the container is output. A specific identification process is described below in detail.

~~[0053]~~[0056] According to the anti-hoisting monitoring method for a container truck provided in the embodiment of the present application, the first point cloud set on the side surface, close to the laser transmitter, of the container is acquired, then the anti-hoisting monitoring area is obtained based on the first point cloud set, and next the position relationship between the target object and the anti-hoisting monitoring area is confirmed based on the second point cloud set of the target object and the anti-hoisting monitoring area. In addition, in a case that the target object is located in the anti-hoisting monitoring area, whether the target object belongs to the part of the container truck or the object other than the container or the container truck is confirmed again based on the characteristic of the second point cloud set. In this way, the detection accuracy is improved, and the occurrence probability of the false alarm caused when a rope or another object is suspended in the anti-hoisting monitoring area is reduced.

~~[0054]~~[0057] FIG. 4 is a schematic structural diagram showing when a double twenty foot container is hoisted in the conventional technology. As shown in FIG. 4, in the conventional technology, laser emitted by a laser transmitter 530 forms a fixed monitoring area 700, a double twenty foot container 800 represents that two twenty foot containers 600 are arranged side by side, and the two twenty foot containers 600 are connected to each other. In a process that the double twenty foot container 800 enters a lane, if an entering direction is relatively inclined with a direction of the lane, as shown in FIG. 4, the fixed monitoring area 700 and the rear container 600 are partially overlapped (an area indicated by the arrow B in FIG. 4), and thus an false alarm occurs in an anti-hoisting monitoring system of the container truck. In view of this, FIG. 5 is a schematic flowchart of an anti-hoisting monitoring method for a container truck according to another exemplary embodiment of the present application. As shown in FIG. 5, before Step S320, the anti-hoisting monitoring method for the container truck further includes the following steps.

~~[0055]~~[0058] S350: acquiring an opening size of a spreader.

~~[0056]~~[0059] In an embodiment, the spreader is configured to hoist a container, types of the container are different, and opening sizes of the spreader are also different.

~~[0057]~~[0060] In an embodiment, the opening size of the spreader may be obtained through a scheduling system. In other words, when the container truck loaded with a container enters a lane, the opening size of the spreader may be obtained through the scheduling system.

~~[0058]~~[0061] S360: obtaining a type of the container based on the opening size of the spreader.

~~[0059]~~[0062] In an embodiment, the type of the container may include any one of a single twenty foot container, a double twenty foot container, a single forty foot container, and a single forty-five foot container. Specifically, the type of the container may be the single twenty foot container, a single forty foot container, the single forty-five foot container, or a double twenty foot container, and the type of the container is not limited in the embodiment of the present application. It should be noted that, the type of the container may also be referred to as a container dimension of the container.

~~[0060]~~[0063] In an embodiment, after the first point cloud set on the side surface, close to the laser transmitter, of the container is obtained, an overall size of the container may be confirmed to be twenty foot, forty foot, or forty-five foot based on the first point cloud set. Specifically, the overall size of the container may be confirmed based on a distance between the head point and the tail point in the first point cloud set in a transverse direction.

~~[0061]~~[0064] Due to a fact that first point cloud set features obtained by the double twenty foot container and the single forty foot container are similar, in a case that the overall size of the container is confirmed to be forty foot based on the first point cloud set, it needs to further confirm whether the type of the container is the double twenty foot container or the single forty foot container.

~~[0062]~~[0065] Specifically, in an embodiment, when the size of the container is confirmed to be twenty foot based on the first point cloud set, and a size of the spreader is also twenty foot, it may be determined that the container is the single twenty foot container. In a case that the size of the container is confirmed to be forty foot based on the first point cloud set, and the size of the acquired spreader is also forty foot, it may be determined that the container is the single forty foot container. In a case that the size of the container is confirmed to be forty foot based on the first point cloud set, and the size of the acquired spreader is twenty foot, it may be determined that the container is the double twenty foot container. In a case that the size of the container is confirmed to be forty-five foot based on the first point cloud set, and the size of the acquired spreader is also forty-five foot, it may be determined that the container is the single forty-five foot container.

~~[0063]~~[0066] In another embodiment, the type of container may be determined based on a container dimension identification system. In other words, after the container truck loaded with the container enters the lane, the type of the container may be directly acquired through the container dimension identification system.

~~[0064]~~[0067] In yet another embodiment, the type of container may be determined based on an entrance vehicle detection system. In other words, after the container truck loaded with the

container enters the lane, the container loaded on the container truck may be detected by the entrance vehicle detection system disposed at an entrance of the lane, so as to acquire the type of the container.

[~~0065~~][0068] As shown in FIG. 5, Step S320 may include the following steps.

[~~0066~~][0069] S323: obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container.

[~~0067~~][0070] In an embodiment, the anti-hoisting monitoring area corresponding to the type of the container may be obtained based on the first point cloud set and the type of the container.

[~~0068~~][0071] In an embodiment, the obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container includes: obtaining the type of the container based on the first point cloud set and the opening size of the spreader; and acquiring the anti-hoisting monitoring area corresponding to the type of the container.

[~~0069~~][0072] Specifically, based on the distance between the head point and the tail point in the first point cloud set in the transverse direction, it may be confirmed that the overall size of the container is twenty foot, forty foot or forty-five foot. It should be noted that, since the first point cloud set features obtained by the double twenty foot container and the single forty foot container are similar, that is, distances between the head point and tail point in the transverse direction are similar, the type of the container may be determined based on the opening size of the spreader in the embodiment of the present application.

[~~0070~~][0073] For example, in a case that the overall size of the container is confirmed to be forty foot based on the first point cloud set, and the opening size of the spreader is also forty foot, it may be determined that the container is the single forty foot container; and in a case that the overall size of the container is confirmed to be forty foot based on the first point cloud set, and the opening size of the spreader is twenty foot, it may be determined that the container is the double twenty foot container.

[~~0071~~][0074] In an embodiment, the anti-hoisting monitoring area corresponding to the type of the container may be obtained based on the type of the container. For example, if the container is the single twenty foot container, an anti-hoisting monitoring area corresponding to the single twenty foot container may be obtained; if the container is the single forty foot container, an anti-hoisting monitoring area corresponding to the single forty foot container may be obtained; if the container is the double twenty foot container, an anti-hoisting monitoring area corresponding to the double twenty foot container may be obtained; and if the container is a forty-five foot container, an anti-hoisting monitoring area corresponding to the forty-five foot container may be obtained.

~~[0072]~~[0075] Therefore, according to the embodiment of the present application, the anti-hoisting monitoring area corresponding to the type of the container is obtained based on the first point cloud set and the opening size of the spreader so that a corresponding anti-hoisting monitoring area may be flexibly set based on the type of the container in a lane in the embodiment of the present application, thereby avoiding a case of occurrence of the false alarm caused by inaccurate setting of the anti-hoisting monitoring area.

~~[0073]~~[0076] Compared with a monitoring area with a fixed position in the conventional technology, even in a case that the entering direction is relatively inclined with a direction of the lane in a process that the double twenty foot container enters the lane shown in FIG. 4, in the present application, in the process of obtaining the anti-hoisting monitoring area, the anti-hoisting monitoring area may be corrected in real-time in combination with the type of the container, so that the anti-hoisting monitoring area does not deviate from the container, and a case that the anti-hoisting monitoring area is partially overlapped with the rear container is avoided, and the occurrence probability of the false alarm is reduced. FIG. 6 is a schematic flowchart of acquiring a first point cloud set on a side surface, close to a laser transmitter, of a container according to an exemplary embodiment of the present application. As shown in FIG. 6, in an embodiment, Step S310 may include the following steps.

~~[0074]~~[0077] S311: acquiring a fourth point cloud set in an emission range of the laser transmitter.

~~[0075]~~[0078] In an embodiment, the laser transmitter may emit laser in the emission range of the laser transmitter, and after the laser is emitted to an object in the emission range, laser points distributed on surfaces of all objects in the emission range may form the fourth point cloud set.

~~[0076]~~[0079] In an embodiment, the fourth point cloud set may include spatial coordinates of the laser points distributed on the surfaces of all objects.

~~[0077]~~[0080] S312: performing clustering on the points in the fourth point cloud set to obtain point cloud sets of different parts through division, and selecting, based on a quantity of points in the point cloud sets of different parts and a distance between two adjacent points, the first point cloud set representing the side surface, close to the laser transmitter, of the container.

~~[0078]~~[0081] In an embodiment, the clustering is a data segmentation method, according to which the fourth point cloud set may be segmented into point cloud sets of different parts based on a specific standard. For example, in a clustering process, a clustering distance threshold between adjacent points may be set, and if an actual distance between two adjacent points does not exceed a set clustering distance threshold, the two adjacent points may be considered to be located on a same unsegmented object; otherwise, if the actual distance between the two adjacent points

exceeds the set clustering distance threshold, the two adjacent points may be considered to be located on two separated objects, so that point cloud sets of different objects may correspond to different objects.

~~[0079]~~[0082] In an embodiment, after point cloud sets corresponding to different objects are obtained, whether a corresponding object is the side surface, close to the laser transmitter, of the container may be determined based on a quantity of points contained in a point cloud set corresponding to each object so that the first point cloud set is obtained.

~~[0080]~~[0083] In an embodiment, after the point cloud sets corresponding to different objects are obtained, whether the corresponding object is the side surface, close to the laser emission, of the container may alternatively be determined based on a transverse distance between a head point and a tail point in the point cloud set corresponding to each object, so that the first point cloud set is obtained.

~~[0081]~~[0084] FIG. 7 is a schematic flowchart of obtaining an anti-hoisting monitoring area based on a first point cloud set according to an exemplary embodiment of the present application. As shown in FIG. 2 and FIG. 7, in an embodiment, Step S320 may include the following steps.

~~[0082]~~[0085] S321: obtaining coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set.

~~[0083]~~[0086] As shown in FIG. 2, in an embodiment, the boundary points of the anti-hoisting monitoring area include endpoint coordinates of an upper boundary and endpoint coordinates of a lower boundary.

~~[0084]~~[0087] In an embodiment, the first point cloud set may include spatial coordinates of a plurality of points on the side surface, close to the laser transmitter, of the container, the lower boundary of the anti-hoisting monitoring area in FIG. 2 may be understood as a set of the side surface, close to the laser transmitter, of the container. Endpoint coordinates of the lower boundary of the anti-hoisting monitoring area and a linear expression of the lower boundary may be obtained based on the first point cloud set, and then endpoint coordinates of the upper boundary of the anti-hoisting monitoring area may be obtained.

~~[0085]~~[0088] S322: obtaining the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area.

~~[0086]~~[0089] In an embodiment, after Step S321 is performed, the coordinates of the boundary points of the anti-hoisting monitoring area may be obtained, a plurality of boundary points are sequentially connected based on coordinates of the plurality of boundary points, and an area formed by enclosing is the anti-hoisting monitoring area.

[0087][0090] Specifically, the anti-hoisting monitoring area shown in FIG. 2 is used as an example. In an embodiment, the boundary points of the anti-hoisting monitoring area may include a first point, a second point, a third point, and a fourth point, where the first point and the second point are two endpoints of an intersection line of a surface of laser emitted by the laser transmitter and the side surface, close to the laser transmitter, of the container, that is, in FIG. 2, the first point and the second point are lower boundary endpoints of the anti-hoisting monitoring area; and the third point and the fourth point are two endpoints of an intersection line of the surface of laser emitted by the laser transmitter and a side surface, away from the laser transmitter, of the container, that is, in FIG. 2, the third point and the fourth point are upper boundary endpoints of the anti-hoisting monitoring area.

[0088][0091] FIG. 8 is a schematic flowchart of obtaining an anti-hoisting monitoring area based on a first point cloud set according to another exemplary embodiment of the present application. As shown in FIG. 8, Step S321 may include the following steps.

[0089][0092] S3211: obtaining, based on the first point cloud set, a slope of an intersection line of a top surface and the side surface, close to the laser transmitter, of the container, coordinates of the first point, and coordinates of the second point.

[0090][0093] In an embodiment, the first point cloud set includes spatial coordinates of a plurality of points on the side surface, close to the laser transmitter, of the container, and the coordinates of the first point and the coordinates of the second point may be directly obtained based on the first point cloud set.

[0091][0094] As shown in FIG. 2, in an embodiment, the intersection line of the top surface and the side surface, close to the laser transmitter, of the container may be understood as a lower boundary of the anti-hoisting monitoring area in FIG. 2. The slope of the intersection line may be obtained according to a least square fitting method by selecting coordinates of any multiple points on the intersection line of the top surface and the side surface, close to the laser transmitter, of the container, and the least square fitting method is recorded in the related technology and not described in the present application again.

[0092][0095] S3212: obtaining coordinates of the third point and coordinates of the fourth point based on the slope of the intersection line, the coordinates of the first point, and the coordinates of the second point.

[0093][0096] As shown in FIG. 4, in an embodiment, the boundary of the anti-hoisting monitoring area is enclosed to form a rectangle, and an upper boundary of the anti-hoisting monitoring area is parallel to the lower boundary of the anti-hoisting monitoring area. In a case that a slope of the lower boundary of the anti-hoisting monitoring area is known, a slope of the

upper boundary of the anti-hoisting monitoring area may be obtained, and in combination with the coordinates of the first point and the coordinates of the second point, endpoint coordinates of the upper boundary of the anti-hoisting monitoring area may be obtained, so that the coordinates of the third point and the coordinates of the fourth point may be obtained.

~~[0094]~~[0097] As shown in FIG. 8, correspondingly, Step S322 may include the following steps.

~~[0095]~~[0098] S3221: obtaining the anti-hoisting monitoring area based on the coordinates of the first point, the coordinates of the second point, the coordinates of the third point, and the coordinates of the fourth point.

~~[0096]~~[0099] In an embodiment, a boundary line of the anti-hoisting monitoring area may be obtained based on the coordinates of the first point, the coordinates of the second point, the coordinates of the third point, and the coordinates of the fourth point, so that the corresponding anti-hoisting monitoring area is defined.

~~[0097]~~[0100] FIG. 9 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to an exemplary embodiment of the present application. As shown in FIG. 9, in an embodiment, Step S340 may include the following steps.

~~[0098]~~[0101] S341: obtaining coordinates of all points in the second point cloud set based on the second point cloud set.

~~[0099]~~[0102] In an embodiment, the second point cloud set may include coordinates of all points distributed on a surface of the target object, and the coordinates of all points in the second point cloud set may be obtained based on the second point cloud set.

~~[0100]~~[0103] S342: obtaining, based on coordinates of the boundary points of the anti-hoisting monitoring area and the coordinates of the all points in the second point cloud set, a position relationship between each point in the second point cloud set and the anti-hoisting monitoring area.

~~[0101]~~[0104] In an embodiment, coordinates of each point in the second point cloud set are separately subjected to vector operation with the coordinates of the boundary points of the anti-hoisting monitoring area, so that the position relationship between each point in the second point cloud set and the anti-hoisting monitoring area may be obtained, that is, each point in the second point cloud set may be confirmed to be located in the anti-hoisting monitoring area or outside the anti-hoisting monitoring area.

~~[0102]~~[0105] As shown in FIG. 3, whether any point P in the second point cloud set is located in the anti-hoisting monitoring area may be determined based on an operation result of the vector operation equation $((\overrightarrow{P1Pn})\times(\overrightarrow{P1P}))\bullet((\overrightarrow{PjPi})\times(\overrightarrow{PjP}))$, where P represents any point in the second

point cloud set, P1 represents the first point, Pn represents the second point, Pi represents the third point, and Pj represents the fourth point; a cross-multiplication result of $(\overrightarrow{P1Pn})\times(\overrightarrow{P1P})$ represents a normal vector perpendicular to vector $(\overrightarrow{P1Pn})$ and vector $(\overrightarrow{P1P})$ according to a right hand rule; and a cross-multiplication result of $(\overrightarrow{PjPi})\times(\overrightarrow{PjP})$ represents a normal vector perpendicular to vector $(\overrightarrow{PjPi})$ and vector $(\overrightarrow{PjP})$ according to the right hand rule. The two normal vectors are on a same straight line, then a direction relationship between the two normal vectors may be determined by comparing a result of mutual multiplication of the two normal vectors with zero, and based on the direction relationship between the two normal vectors, whether any point P in the second point cloud set is located in the anti-hoisting monitoring area or not may be determined.

~~[0103]~~[0106] Specifically, if $((\overrightarrow{P1Pn})\times(\overrightarrow{P1P}))\bullet((\overrightarrow{PjPi})\times(\overrightarrow{PjP}))>0$, it indicates that calculated directions of the two normal vectors are the same, and then the point P is located in the anti-hoisting monitoring area. If $((\overrightarrow{P1Pn})\times(\overrightarrow{P1P}))\bullet((\overrightarrow{PjPi})\times(\overrightarrow{PjP}))<0$, it indicates that the calculated directions of the two normal vectors are opposite, then the point P is located outside the anti-hoisting monitoring area.

~~[0104]~~[0107] S343: outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted.

~~[0105]~~[0108] In an embodiment, after the position relationship between each point in the second point cloud set and the anti-hoisting monitoring area is determined, whether the target object is located in the anti-hoisting monitoring area may be determined, and then whether the target object belongs to a part of the container truck may be determined based on a characteristic of the second point cloud set of the target object, so that the signal that the container truck is hoisted or not hoisted may be output.

~~[0106]~~[0109] FIG. 10 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to another exemplary embodiment of the present application. As shown in FIG. 10, in an embodiment, Step S343 may include the following steps.

~~[0107]~~[0110] S3431: if all points in the second point cloud set are located outside the anti-hoisting monitoring area, outputting the signal representing that the container truck is not hoisted.

~~[0108]~~[0111] After Step S342 is executed, position relationships between all points in the second point cloud set and the anti-hoisting monitoring area may be obtained. If an execution result indicates that all points in the second point cloud set are located outside the anti-hoisting

monitoring area, it may be considered that a target object detected in this case is completely located outside the anti-hoisting monitoring area. Regardless of whether the target object is a part of the container truck or is an object other than the container truck or the container, since the target object is located outside the anti-hoisting monitoring area, the signal representing that the container truck is not hoisted may be correspondingly output.

~~[0109]~~[0112] In addition, FIG. 11 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to an exemplary embodiment of the present application. As shown in FIG. 11, in an embodiment, Step S343 may further include the following steps.

~~[0110]~~[0113] S3432: if there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, selecting a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set to form a third point cloud set.

~~[0111]~~[0114] If the execution result of Step S342 indicates that there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, it indicates that at least part of the target object is located in the anti-hoisting monitoring area, so that whether the part, located in the anti-hoisting monitoring area, of the target object belongs to a part of the container truck needs to be confirmed again. Therefore, in a case that there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set may be selected to form the third point cloud set, and then whether the container truck is hoisted is confirmed again based on the third point cloud set.

~~[0112]~~[0115] S3433: if there exist a preset quantity of points in the third point cloud set that meet a preset condition, outputting the signal representing that the container truck is hoisted.

~~[0113]~~[0116] In an embodiment, after the third point cloud set is formed, if there exist the preset quantity of points in the third point cloud set that meet the preset condition, and the preset condition represents that a distance between any two adjacent points is less than a preset value, it may be determined that more points on a same object are in the anti-hanging monitoring area. In addition, when points that meet a preset quantity are all located on a same object, it indicates that a surface area of the object is large, and small-volume objects such as a rope and a hook may be excluded, so that it may be determined that the target object located in the anti-hanging monitoring area in this case belongs to a part of the container truck, and therefore, the signal that representing that the container truck is hoisted may be output.

[0114][0117] In an embodiment, the preset quantity may be set to be five, six, seven, or the like according to actual conditions, and a numerical value of the preset quantity is not specifically limited in the present application.

[0115][0118] In an embodiment, the preset value may also be set according to actual conditions, and the preset value is not specifically limited in the present application.

[0116][0119] FIG. 12 is a schematic flowchart of outputting, based on an anti-hoisting monitoring area and a second point cloud set, a signal representing that a container truck is hoisted or not hoisted according to another exemplary embodiment of the present application. As shown in FIG. 12, in an embodiment, after Step S3432, Step S343 may further include:

[0117][0120] S3435: if there does not exist the preset quantity of points in the third point cloud set that meet the preset condition, outputting the signal representing that the container truck is not hoisted.

[0118][0121] In an embodiment, after the third point cloud set is formed, if there does not exist the preset quantity of points in the third point cloud set that meet the preset condition, it may be determined that only fewer points on a same object are located in the anti-hoisting monitoring area, indicating that a surface area of the object is small, and it may be considered that the target object located in the anti-hoisting monitoring area is a small-size object such as a rope or a hook instead of a part of the container truck. Therefore, the signal representing that the container truck is not hoisted may be output.

[0119][0122] FIG. 13 is a structural block diagram of an anti-hoisting monitoring apparatus for a container truck according to an exemplary embodiment of the present application. As shown in FIG. 13, an anti-hoisting monitoring apparatus for a container truck 400 provided in the embodiment of the present application may include: a first acquisition module 410, configured to acquire a first point cloud set of a container, where the first point cloud set represents a set of a plurality of points that are emitted by a laser transmitter to a side surface, close to laser transmitter, of the container; a first calculation module 420, configured to obtain an anti-hoisting monitoring area based on the first point cloud set; a second acquisition module 430, configured to acquire a second point cloud set of a target object, where the target object represents a part of the container truck or represents an object other than the container or the container truck, and the second point cloud set represents a set of a plurality of points emitted by the laser transmitter to the target object; and a first output module 440, configured to output, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted, where the container truck is configured to load the container.

[0120][0123] According to the anti-hoisting monitoring apparatus for a container truck provided in the embodiment of the present application, the first point cloud set on the side surface, close to the laser transmitter, of the container is acquired, then the anti-hoisting monitoring area is obtained based on the first point cloud set, and next the position relationship between the target object and the anti-hoisting monitoring area is confirmed based on the second point cloud set of the target object and the anti-hoisting monitoring area. In addition, in a case that the target object is located in the anti-hoisting monitoring area, whether the target object belongs to a part of the container truck or belongs to the object other than the container or the container truck is confirmed again based on a characteristic of the second point cloud set. In this way, the detection accuracy is improved, and the occurrence probability of a false alarm caused when a rope or another object is suspended in the anti-hoisting monitoring area is reduced.

[0121][0124] FIG. 14 is a structural block diagram of an anti-hoisting monitoring apparatus for a container truck according to another exemplary embodiment of the present application. As shown in FIG. 14, in an embodiment, the first calculation module 420 may include: a second calculation module 421, configured to obtain coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set; and a third calculation module 422, configured to obtain the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area.

[0125] As shown in FIG. 14, in an embodiment, the anti-hoisting monitoring apparatus for a container truck 400 may further include: a fourth acquisition module 450, configured to acquire an opening size of a spreader; and a fifth acquisition module 460, configured to obtain a type of the container based on the opening size of the spreader. ~~Correspondingly~~

[0122][0126] As shown in FIG. 14, in an embodiment, the first calculation module 420 may include an eighth calculation module 423 configured to obtain the anti-hoisting monitoring area based on the first point cloud set and the type of the container.

[0123][0127] As shown in FIG. 14, in an embodiment, the eighth calculation module 423 is configured to: obtain the type of the container based on the first point cloud set and the opening size of the spreader; and obtain the anti-hoisting monitoring area corresponding to the type of the container.

[0124][0128] As shown in FIG. 14, in an embodiment, the type of the container includes any one of a single twenty foot container, a single forty foot container, a single forty-five foot container, and a double twenty foot container.

[0129] As shown in FIG. 14, in an embodiment, the second calculation module 421 may include: a fourth calculation module 4211, configured to obtain, based on the first point cloud set, a slope

of an intersection line of a top surface and a side surface, close to the laser transmitter, of the container, coordinates of a first point, and coordinates of a second point; and a fifth calculation module 4212, configured to obtain coordinates of a third point and coordinates of a fourth point based on the slope of the intersection line, the coordinates of the first point, and the coordinates of the second point.

~~[0125]~~[0130] As shown in FIG. 14, in an embodiment, ~~Correspondingly,~~ the third calculation module 422 may be further configured to obtain the anti-hoisting monitoring area based on the coordinates of the first point, the coordinates of the second point, the coordinates of the third point, and the coordinates of the fourth point.

~~[0126]~~[0131] As shown in FIG. 14, in an embodiment, a first output module 440 may include: a sixth calculation module 441, configured to obtain coordinates of all points in the second point cloud set based on the second point cloud set; a seventh calculation module 442, configured to obtain a position relationship between each point in the second point cloud set and the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area and the coordinates of all points in the second point cloud set, where the position relationship represents that a point in the second point cloud set is located in the anti-hoisting monitoring area or a point in the second point cloud set is located outside the anti-hoisting monitoring area; and a second output module 443, configured to output, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted.

~~[0127]~~[0132] As shown in FIG. 14, in an embodiment, the second output module 443 may include a third output module 4431 configured to: if all points in the second point cloud set are located outside the anti-hoisting monitoring area, output the signal representing that the container truck is not hoisted.

~~[0128]~~[0133] As shown in FIG. 14, in an embodiment, the second output module 443 may include: a first selection module 4432, configured to, if there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, select a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set to form a third point cloud set; and a third output module 4433, configured to if there exist a preset quantity of points in the third point cloud set that meets a preset condition, output a signal representing that the container truck is hoisted, where the preset condition represents that a distance between any two adjacent points is less than a preset value.

~~[0129]~~[0134] As shown in FIG. 14, in an embodiment, the second output module 443 may include a fourth output module 4434 configured to: if there does not exist the preset quantity of

points in the third point cloud set that meet the preset condition, output a signal representing that the container truck is not hoisted.

[0130][0135] As shown in FIG. 14, in an embodiment, the first acquisition module 410 may include: a third acquisition module 411, configured to acquire a fourth point cloud set in an emission range of the laser transmitter; where the fourth point cloud set represents a set of all points emitted on an object in the emission range; and a second selection module 412, configured to perform clustering on the points in the fourth point cloud set to obtain point cloud sets of different parts through division, and select, based on a quantity of points in the point cloud sets of different parts and a distance between two adjacent points, the first point cloud set representing the side surface, close to the laser transmitter, of the container.

[0131][0136] FIG. 15 is a structural block diagram of an anti-hoisting monitoring system for a container truck according to an exemplary embodiment of the present application. As shown in FIG. 15, in an embodiment, an anti-hoisting monitoring system of a container truck 500 may include a container 510; a container truck 520 configured to load the container 510; a laser transmitter 530 configured to emit laser toward a side, close to the laser transmitter 530, of the container 510; and an electronic device 540, configured to perform the foregoing anti-hoisting monitoring methods for a container truck.

[0132][0137] According to the anti-hoisting monitoring system for a container truck provided in the embodiment of the present application, a first point cloud set on a side surface, close to the laser transmitter, of the container is acquired, then an anti-hoisting monitoring area is obtained based on the first point cloud set, and next a position relationship between a target object and the anti-hoisting monitoring area is confirmed based on a second point cloud set of the target object and the anti-hoisting monitoring area. In addition, in a case that the target object is located in the anti-hoisting monitoring area, whether the target object belongs to a part of the container truck or belongs to an object other than the container or the container truck is confirmed again based on a characteristic of the second point cloud set. In this way, detection accuracy is improved, and the occurrence probability of a false alarm caused when a rope or another object is suspended in the anti-hoisting monitoring area is reduced.

[0133][0138] FIG. 16 is a structural block diagram of an electronic device according to an exemplary embodiment of the present application. As shown in FIG. 16, an electronic device 540 may be any one or both of a first device and a second device, or may be a single unit equipment independent of the first device and the second device. The single unit equipment may communicate with the first device and the second device, so as to receive collected input signals from the first device and the second device.

[0134][0139] As shown in FIG. 16, the electronic device 540 includes one or more processors 541 and a memory 542.

[0135][0140] The processor 541 may be a Central Processing Unit (CPU) or a processing unit in another form that has a data handling capacity and/or instruction execution capacity, and may control another component in the electronic device 540 to perform a desired function.

[0136][0141] The memory 542 may include one or more computer program products. The computer program products may include various forms of computer-readable storage media, for example, a volatile memory and/or a non-volatile memory. The volatile memory may include, for example, a random access memory (RAM) and/or a cache memory (cache). The non-volatile memory may include, for example, a read-only memory (ROM), a hard disk, a flash memory, and the like. One or more computer program instructions may be stored in the computer-readable storage medium. The processor 541 may run the program instructions to implement the methods in the foregoing embodiments of the present application and/or another desired function. The computer-readable storage medium may further store various content such as an input signal, a signal component, and a noise component.

[0137][0142] In an example, the electronic device 540 may further include an input apparatus 543 and an output apparatus 544. These components are interconnected by using a bus system and/or another form of connection mechanism (not shown).

[0138][0143] When the electronic device is single unit equipment, the input apparatus 543 may be a communication network connector configured to receive collected input signals from the first device and the second device.

[0139][0144] In addition, the input apparatus 543 may further include, for example, a keyboard, a mouse, and the like.

[0140][0145] The output apparatus 544 may output various information, including determined distance information, direction information, and the like. The output apparatus 544 may include, for example, a display, a loudspeaker, a printer, a communication network, and a remote output device connected to the communication network.

[0141][0146] Certainly, for simplicity, FIG. 16 only shows some of components in the electronic device 540 that are related to the present application, and does not show components such as a bus, an input/output interface, and the like. In addition, according to a specific application situation, the electronic device 540 may further include any other proper components.

[0142][0147] The computer program product may use any combination of one or more programming languages to write a program code for performing operations in the embodiments of the present application. The programming languages include an object-oriented programming

language, such as Java, C++, and conventional procedural programming language, such as the “C” language or a similar programming language. The program code may be entirely executed on a user’s computing device, partially on a user’s computing device, executed as an independent software package, partially executed on a user’s computing device and partially executed on a remote computing device, or entirely executed on a remote computing device or a server.

~~[0143]~~[0148] The computer-readable storage medium may employ any combination of one or more readable media. The readable medium may be a readable signal medium or a readable storage medium. The readable storage medium may include, but not limited to, electronic, magnetic, optical, electromagnetic, infrared, or semiconductor systems, apparatuses, or devices, or any combination thereof. A more specific example (a non-exhaustive list) of the readable storage medium includes an electrical connection based on one or more conducting wires, a portable disk, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or flash memory), an optical fiber, a portable compact disk read-only memory (CD-ROM), an optical storage component, a magnetic storage component, or any proper combination of the foregoing content.

~~[0144]~~[0149] The foregoing description has been given for the purposes of illustration and description. In addition, the description is not intended to limit the embodiments of the present application to the form disclosed herein. Although a quantity of exemplary aspects and embodiments have been discussed above, those skilled in the art will recognize some variations, modifications, changes, additions, and sub-combinations thereof.

CLAIMS

What is claimed is:

1. An anti-hoisting monitoring method for a container truck, comprising:

acquiring a first point cloud set of a container, wherein the first point cloud set represents a set of a plurality of points that are emitted by a laser transmitter to a side surface, close to the laser transmitter, of the container;

obtaining an anti-hoisting monitoring area based on the first point cloud set;

acquiring a second point cloud set of a target object, wherein the target object represents a part of the container truck or represents an object other than the container or the container truck, and the second point cloud set represents a set of a plurality of points emitted by the laser transmitter to the target object; and

outputting, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted, wherein the container truck is configured to load the container.

2. The anti-hoisting monitoring method for a container truck according to claim 1, wherein before the obtaining an anti-hoisting monitoring area based on the first point cloud set, the anti-hoisting monitoring method for the container truck further comprises:

acquiring an opening size of a spreader, wherein the spreader is configured to hoist the container; and

obtaining a type of the container based on the opening size of the spreader~~; and~~.

3. The anti-hoisting monitoring method for a container truck according to claim 1, wherein the obtaining an anti-hoisting monitoring area based on the first point cloud set comprises:

obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container.

~~3~~4. The anti-hoisting monitoring method for a container truck according to claim 2, wherein the obtaining the anti-hoisting monitoring area based on the first point cloud set and the type of the container comprises:

obtaining the type of the container based on the first point cloud set and the opening size of the spreader; and

acquiring the anti-hoisting monitoring area corresponding to the type of the container.

45. The anti-hoisting monitoring method for a container truck according to any one of claims 2 ~~or 3~~to 4, wherein the type of the container comprises any one of a single twenty foot container, a single forty foot container, a single forty-five foot container, and a double twenty foot container.

56. The anti-hoisting monitoring method for a container truck according to claim 1, wherein the obtaining an anti-hoisting monitoring area based on the first point cloud set comprises:

obtaining coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set; and

obtaining the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area.

67. The anti-hoisting monitoring method for a container truck according to claim 56, wherein the boundary points of the anti-hoisting monitoring area comprise a first point, a second point, a third point, and a fourth point, wherein the first point and the second point are two endpoints of an intersection line of a surface of laser emitted by the laser transmitter and the side surface, close to the laser transmitter, of the container; and the third point and the fourth point are two endpoints of an intersection line of the surface of laser emitted by the laser transmitter and a side surface, away from the laser transmitter, of the container~~;~~.

8. The anti-hoisting monitoring method for a container truck according to claim 7, wherein the obtaining coordinates of boundary points of the anti-hoisting monitoring area based on the first point cloud set comprises:

obtaining, based on the first point cloud set, a slope of an intersection line of a top surface and the side surface, close to the laser transmitter, of the container, coordinates of the first point, and coordinates of the second point; and

obtaining coordinates of the third point and coordinates of the fourth point based on the slope of the intersection line, the coordinates of the first point, and the coordinates of the second point~~; and~~.

9. The anti-hoisting monitoring method for a container truck according to claim 8, wherein the obtaining the anti-hoisting monitoring area based on the coordinates of the boundary points of the anti-hoisting monitoring area comprises:

obtaining the anti-hoisting monitoring area based on the coordinates of the first point, the coordinates of the second point, the coordinates of the third point, and the coordinates of the fourth point.

~~7~~10. The anti-hoisting monitoring method for a container truck according to claim 1, wherein the outputting, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted comprises:

obtaining coordinates of all points in the second point cloud set based on the second point cloud set;

obtaining, based on coordinates of boundary points of the anti-hoisting monitoring area and the coordinates of the all points in the second point cloud set, a position relationship between each point in the second point cloud set and the anti-hoisting monitoring area, wherein the position relationship represents that a point in the second point cloud set is located in the anti-hoisting monitoring area or the point in the second point cloud set is located outside the anti-hoisting monitoring area; and

outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted.

~~8~~11. The anti-hoisting monitoring method for a container truck according to claim ~~7~~10, wherein the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted comprises:

if the all points in the second point cloud set are located outside the anti-hoisting monitoring area, outputting the signal representing that the container truck is not hoisted.

~~9~~12. The anti-hoisting monitoring method for a container truck according to claim 10~~7~~, wherein the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted comprises:

if there exists a point, located in the anti-hoisting monitoring area, in the second point cloud set, selecting a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set to form a third point cloud set; and

if there exist a preset quantity of points in the third point cloud set that meet a preset condition, outputting the signal representing that the container truck is hoisted, wherein the preset condition represents that a distance between any two adjacent points is less than a preset value.

~~10~~13. The anti-hoisting monitoring method for a container truck according to claim ~~12~~9, wherein after the selecting a plurality of points, located in the anti-hoisting monitoring area, in the second point cloud set to form a third point cloud set, the outputting, based on the position relationship, a signal representing that the container truck is hoisted or not hoisted further comprises:

if there does not exist the preset quantity of points in the third point cloud set that meet the preset condition, outputting the signal representing that the container truck is not hoisted.

~~11~~14. The anti-hoisting monitoring method for a container truck according to any one of claims 1 to ~~10~~13, wherein the acquiring a first point cloud set of a container comprises:

acquiring a fourth point cloud set in an emission range of the laser transmitter, wherein the fourth point cloud set represents a set of all points emitted on the object in the emission range; and

performing clustering on the points in the fourth point cloud set to obtain point cloud sets of different parts through division, and selecting, based on a quantity of points in the point cloud sets of different parts and a distance between two adjacent points, the first point cloud set representing the side surface, close to the laser transmitter, of the container.

~~12~~15. An anti-hoisting monitoring apparatus for a container truck, comprising:

a first acquisition module, configured to acquire a first point cloud set of a container, wherein the first point cloud set represents a set of a plurality of points that are emitted by a laser transmitter to a side surface, close to the laser transmitter, of the container;

a first calculation module, configured to obtain an anti-hoisting monitoring area based on the first point cloud set;

a second acquisition module, configured to acquire a second point cloud set of a target object, wherein the target object represents a part of the container truck or represents an object other than the container or the container truck, and the second point cloud set represents a set of a plurality of points emitted by the laser transmitter to the target object; and

a first output module, configured to output, based on the anti-hoisting monitoring area and the second point cloud set, a signal representing that the container truck is hoisted or not hoisted, wherein the container truck is configured to load the container.

~~13~~16. An anti-hoisting monitoring system for a container truck, comprising:

a container;

a container truck, configured to load the container;

a laser transmitter, configured to emit laser towards a side surface, close to the laser transmitter, of the container; and

an electronic device, configured to perform the anti-hoisting monitoring method for the container truck according to any one of claims 1 to 14~~11~~.

~~14~~17. An electronic device, comprising:

a processor; and

a memory, configured to store executable instructions of the processor, wherein

the processor is configured to perform the anti-hoisting monitoring method for the container truck according to any one of claims 1 to 14~~11~~.