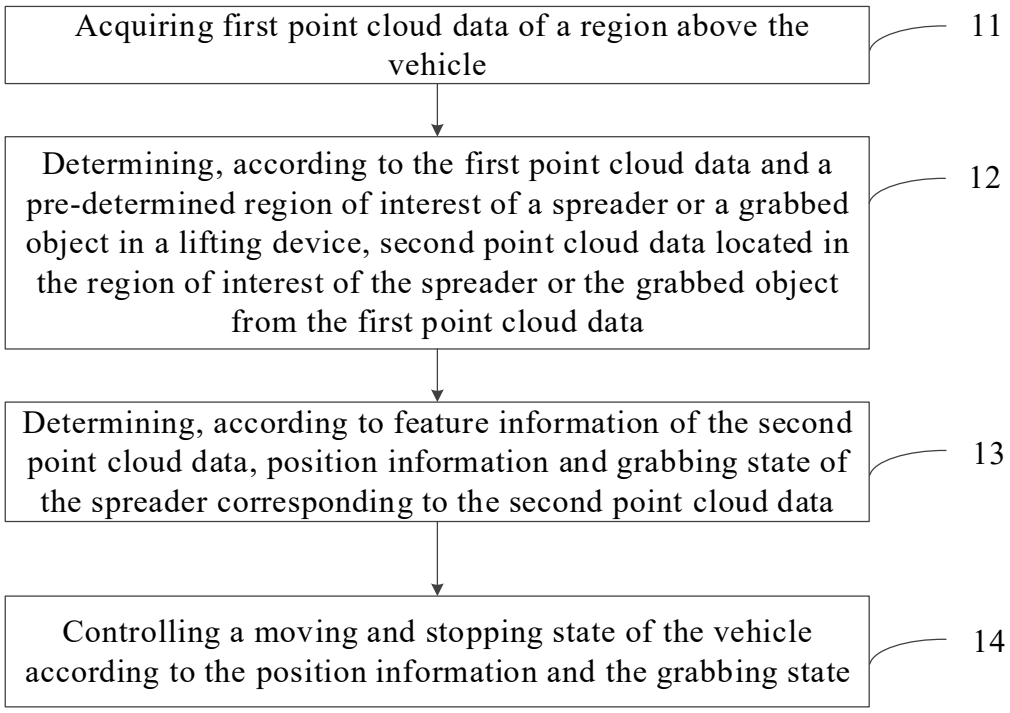

Acquiring first point cloud data of a region above the vehicle
11
Determining, according to the first point cloud data and a pre-determined region of interest of a spreader or a grabbed object in a lifting device, second point cloud data located in the region of interest of the spreader or the grabbed object from the first point cloud data
12
Determining, according to feature information of the second point cloud data, position information and grabbing state of the spreader corresponding to the second point cloud data
13
Controlling a moving and stopping state of the vehicle according to the position information and the grabbing state
14

FIG. 1

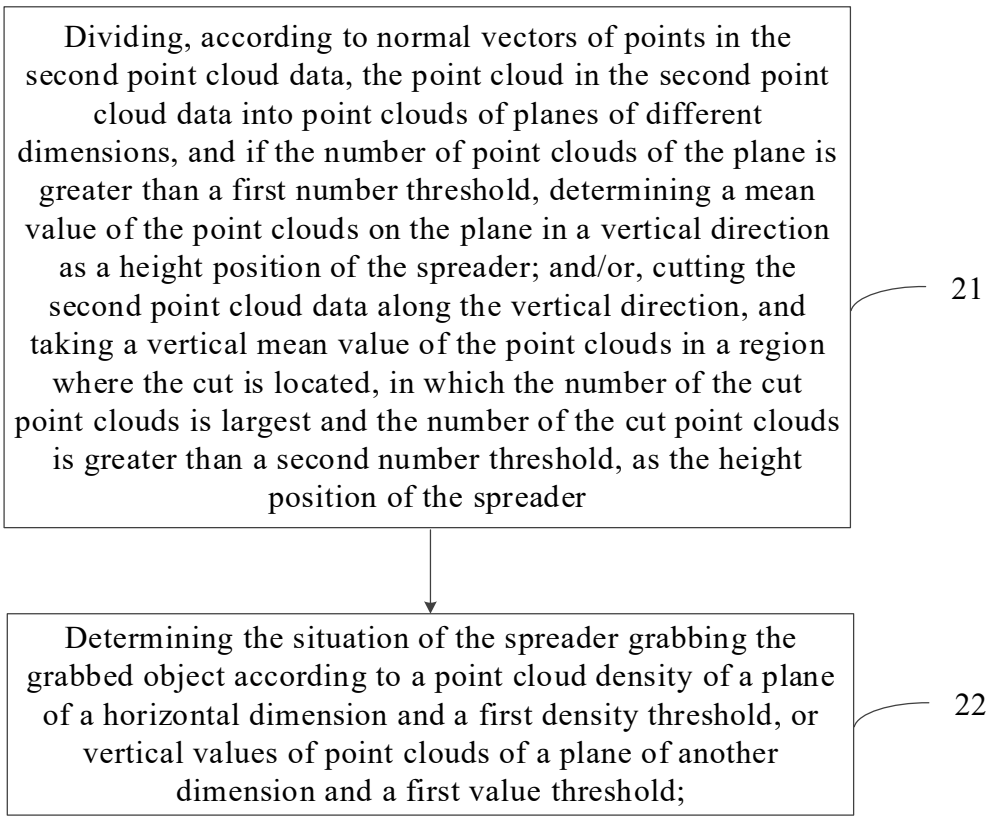

Dividing, according to normal vectors of points in the second point cloud data, the point cloud in the second point cloud data into point clouds of planes of different dimensions, and if the number of point clouds of the plane is greater than a first number threshold, determining a mean value of the point clouds on the plane in a vertical direction as a height position of the spreader; and/or, cutting the second point cloud data along the vertical direction, and taking a vertical mean value of the point clouds in a region where the cut is located, in which the number of the cut point clouds is largest and the number of the cut point clouds is greater than a second number threshold, as the height position of the spreader
21
Determining the situation of the spreader grabbing the grabbed object according to a point cloud density of a plane of a horizontal dimension and a first density threshold, or vertical values of point clouds of a plane of another dimension and a first value threshold;
22

FIG. 2

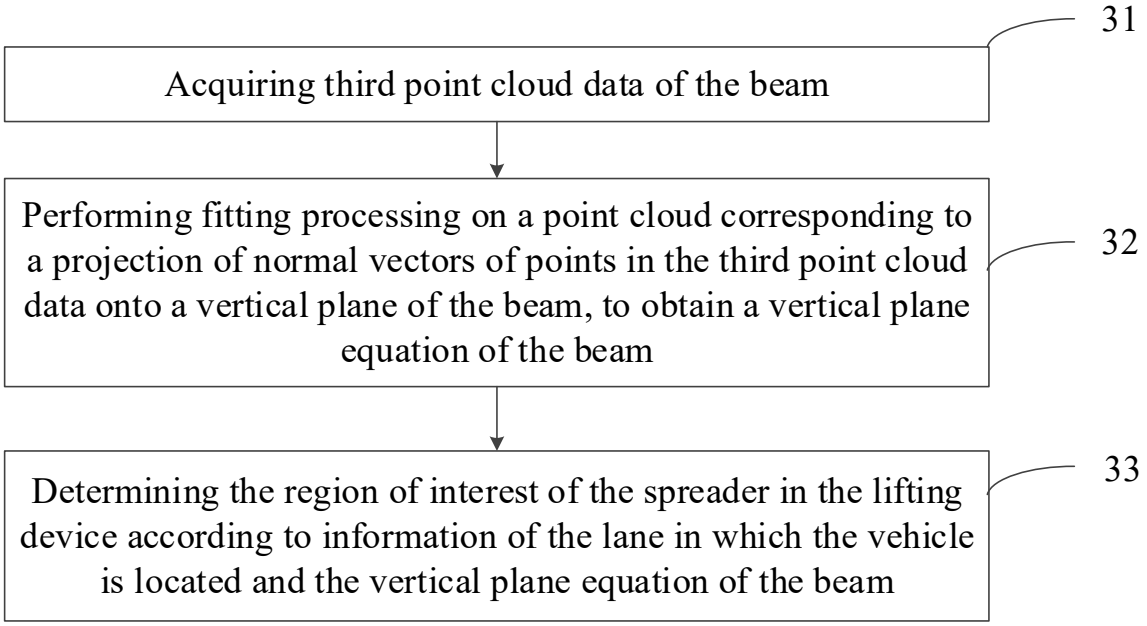

31
Acquiring third point cloud data of the beam
Performing fitting processing on a point cloud corresponding to a projection of normal vectors of points in the third point cloud data onto a vertical plane of the beam, to obtain a vertical plane equation of the beam
32
Determining the region of interest of the spreader in the lifting device according to information of the lane in which the vehicle is located and the vertical plane equation of the beam
33

FIG. 3

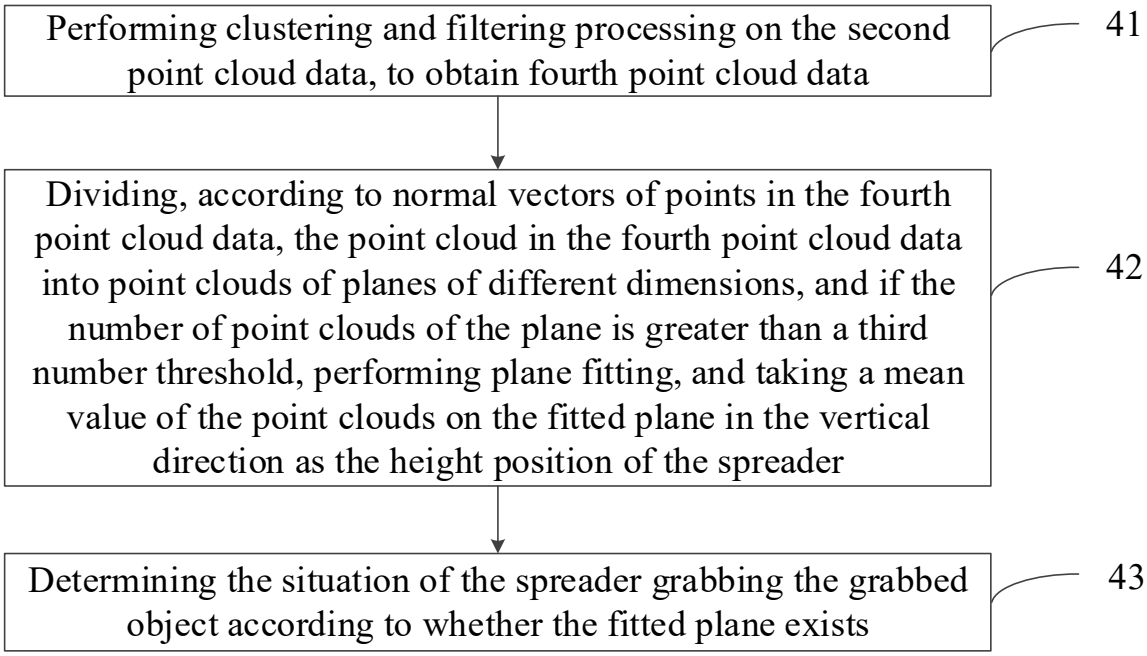

Performing clustering and filtering processing on the second point cloud data, to obtain fourth point cloud data
41
Dividing, according to normal vectors of points in the fourth point cloud data, the point cloud in the fourth point cloud data into point clouds of planes of different dimensions, and if the number of point clouds of the plane is greater than a third number threshold, performing plane fitting, and taking a mean value of the point clouds on the fitted plane in the vertical direction as the height position of the spreader
42
Determining the situation of the spreader grabbing the grabbed object according to whether the fitted plane exists
43

FIG. 4

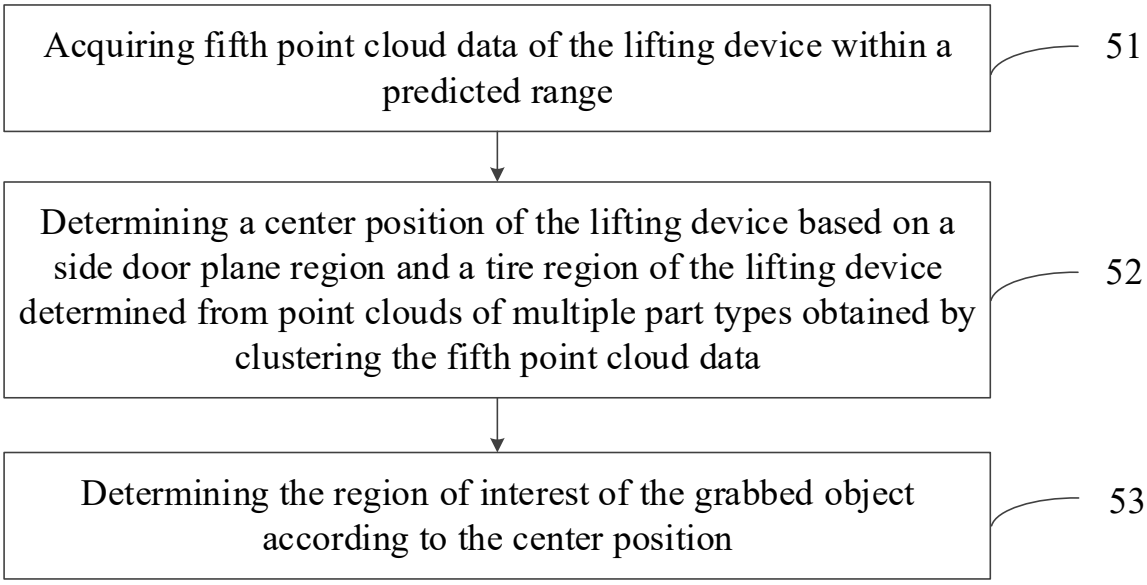

Acquiring fifth point cloud data of the lifting device within a predicted range
51
Determining a center position of the lifting device based on a side door plane region and a tire region of the lifting device determined from point clouds of multiple part types obtained by clustering the fifth point cloud data
52
Determining the region of interest of the grabbed object according to the center position
53

FIG. 5


Installing sensors, usually cameras and/or laser radars, where the installation position and angle need to cover the region above the vehicle body
611
Coordinate transformation, transforming the sensor data into a coordinate system fixed to the own vehicle, where the front of the own vehicle is the positive direction of the x-axis of the coordinate system, the left side of the own vehicle is the positive direction of the y-axis, and the directly above of the own vehicle is the positive direction of the z-axis
612
Determining the region of interest of the beam of the crane according to information such as the position of the beam in the crane, the size of the beam, and the approximate position of the crane determined by other methods, and each of two beams has a region of interest. The point cloud is filtered by using these two regions of interest, to respectively obtain point clouds falling in different beam regions
613
Estimating normal vectors of each point for the point cloud of the beam region. Then the normal vectors are projected onto the parallel plane, to obtain two-dimensional vectors, and the relationship is used to filter out points in the point cloud whose normal vectors are approximately parallel to the parallel plane, i.e., points falling on the vertical plane of the beam
614
Performing plane fitting on the points falling on the vertical plane of the beam obtained in step 614 by using a random sample consensus method, where the fitted vertical plane equation of the beam is obtained, and the interior points in the fitting process, that is, the points finally used for determining the vertical plane equation in the fitting process, are also obtained
615
Obtaining the precise position of the crane through the two vertical plane equations of the beam in step 615, and determining the region of interest of the spreader of the crane in combination with information of the lane in which the vehicle is located, to obtain the point cloud of the region of interest of the spreader
616
Estimating the normal vector of each point for the point cloud of the beam region. Through the directions of the normal vectors, the points are divided into three types
617
Checking the number of point clouds of each type of plane, respectively. When the number threshold is reached, a random sample consensus method is used for plane fitting, and the z-mean value of the point clouds of each plane can represent the spreader height calculated by this feature
618
Uniformly dividing the region of interest of the spreader of the crane in the z direction, to obtain the divided region with the largest number of point clouds. When the number of point clouds in this region exceeds the threshold, the z-mean value of the point clouds in this region represents the spreader height calculated by this feature
619
Comparing and voting the spreader height calculated by the respective features obtained in step 618 and step 619 with each other, to obtain the detected height z value of the spreader
620
Obtaining the detected position values of the spreader according to the crane position x obtained in step 616 and the information of the lane y in which the vehicle is located
621
According to the respective feature planes obtained in step 618, when the point cloud density of the x-y plane is greater than the threshold, it is considered that the spreader grabs a container; when the z-range of the point cloud of the x-z plane is greater than the threshold, it is considered that the spreader grabs a container; when the z-range of the point cloud of the y-z plane is greater than the threshold, it is considered that the spreader grabs a container
622
Comparing and voting the results of whether the spreader grabs a container obtained from the respective features in step 620 with each other, to obtain the container-grabbing state of the spreader
623
Estimating the spreader height of the next frame by using a least squares method based on the currently calculated spreader height and the spreader heights of the historically stored n frames, to obtain the current spreader speed and direction
624

FIG. 6

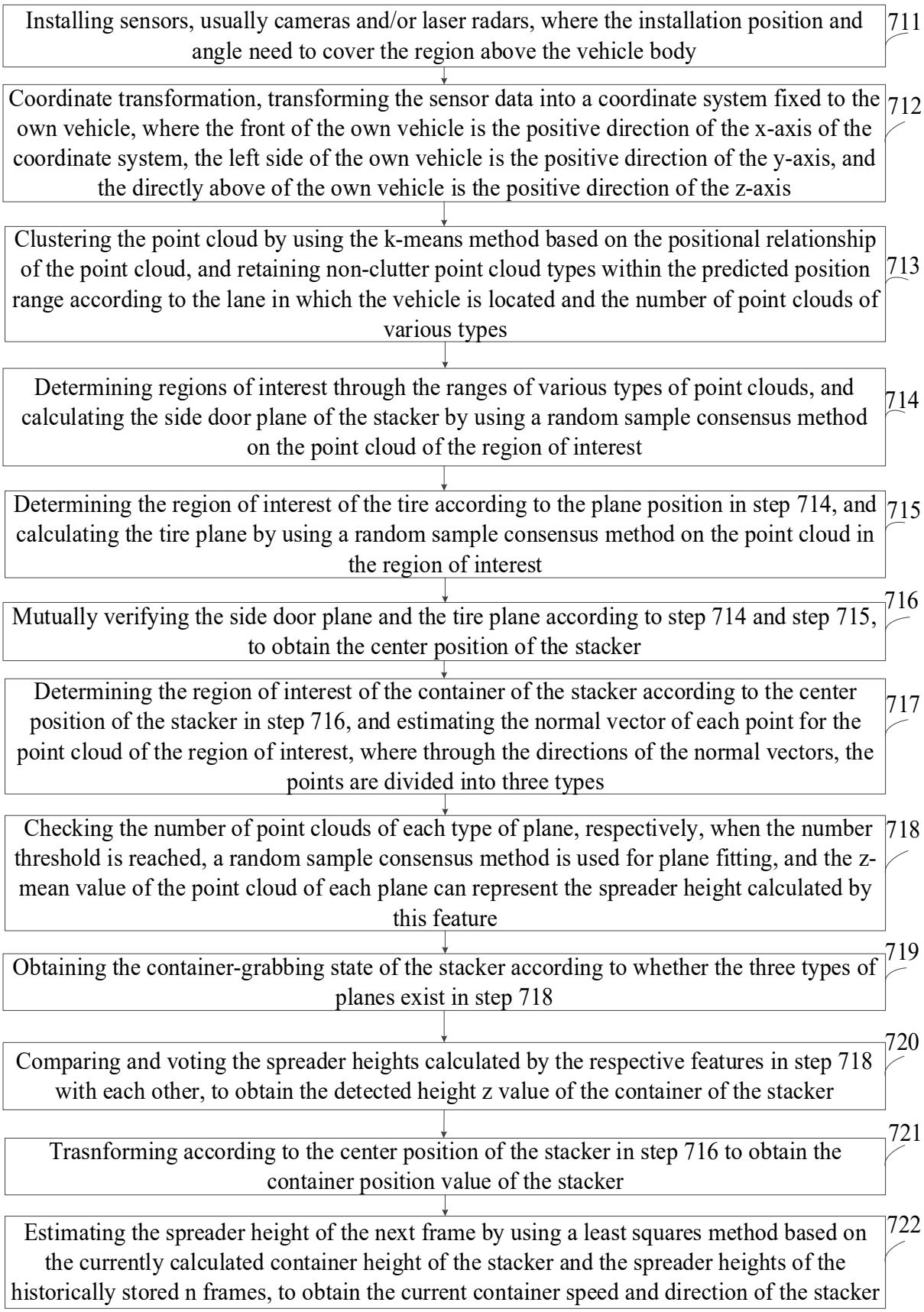

Installing sensors, usually cameras and/or laser radars, where the installation position and angle need to cover the region above the vehicle body
711
Coordinate transformation, transforming the sensor data into a coordinate system fixed to the own vehicle, where the front of the own vehicle is the positive direction of the x-axis of the coordinate system, the left side of the own vehicle is the positive direction of the y-axis, and the directly above of the own vehicle is the positive direction of the z-axis
712
Clustering the point cloud by using the k-means method based on the positional relationship of the point cloud, and retaining non-clutter point cloud types within the predicted position range according to the lane in which the vehicle is located and the number of point clouds of various types
713
Determining regions of interest through the ranges of various types of point clouds, and calculating the side door plane of the stacker by using a random sample consensus method on the point cloud of the region of interest
714
Determining the region of interest of the tire according to the plane position in step 714, and calculating the tire plane by using a random sample consensus method on the point cloud in the region of interest
715
Mutually verifying the side door plane and the tire plane according to step 714 and step 715, to obtain the center position of the stacker
716
Determining the region of interest of the container of the stacker according to the center position of the stacker in step 716, and estimating the normal vector of each point for the point cloud of the region of interest, where through the directions of the normal vectors, the points are divided into three types
717
Checking the number of point clouds of each type of plane, respectively, when the number threshold is reached, a random sample consensus method is used for plane fitting, and the z-mean value of the point cloud of each plane can represent the spreader height calculated by this feature
718
Obtaining the container-grabbing state of the stacker according to whether the three types of planes exist in step 718
719
Comparing and voting the spreader heights calculated by the respective features in step 718 with each other, to obtain the detected height z value of the container of the stacker
720
Trasnforming according to the center position of the stacker in step 716 to obtain the container position value of the stacker
721
Estimating the spreader height of the next frame by using a least squares method based on the currently calculated container height of the stacker and the spreader heights of the historically stored n frames, to obtain the current container speed and direction of the stacker
722

FIG. 7

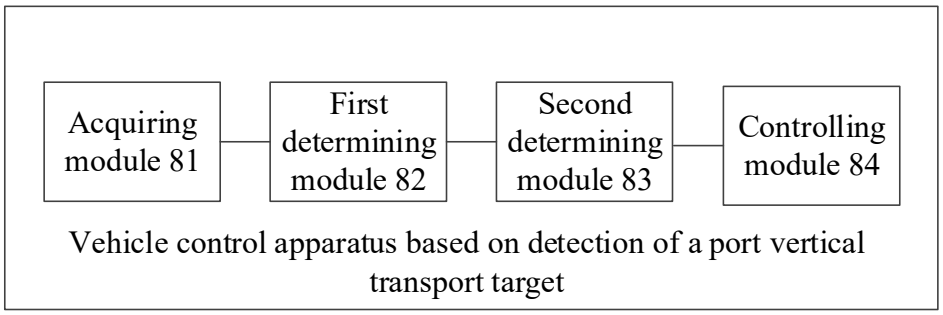

Acquiring module 81
First determining module 82
Second determining module 83
Controlling module 84
Vehicle control apparatus based on detection of a port vertical transport target

FIG. 8

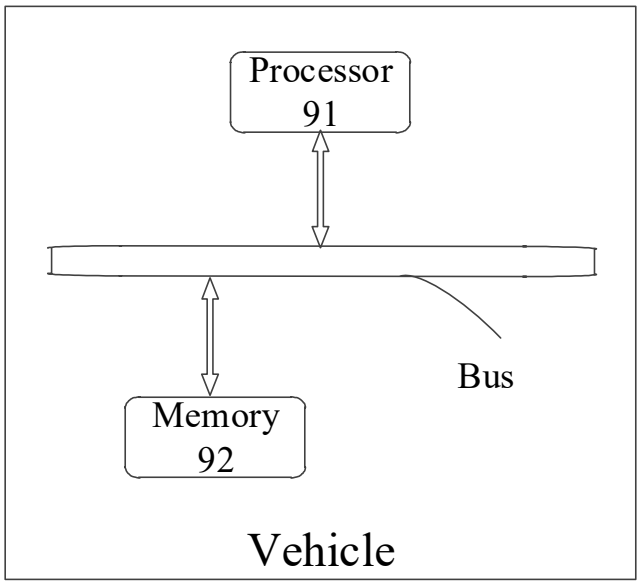

Processor 91
Bus
Memory 92
Vehicle

FIG. 9