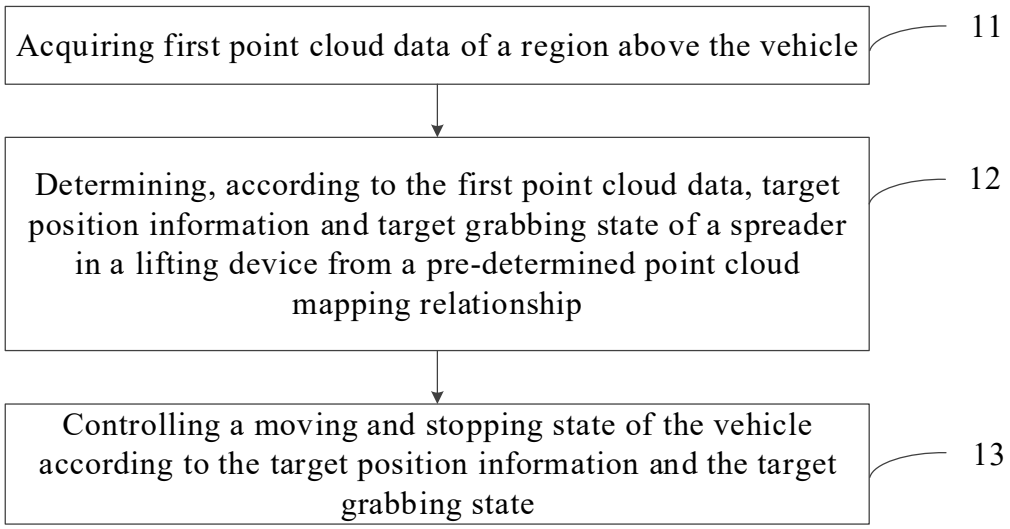


FIG. 1

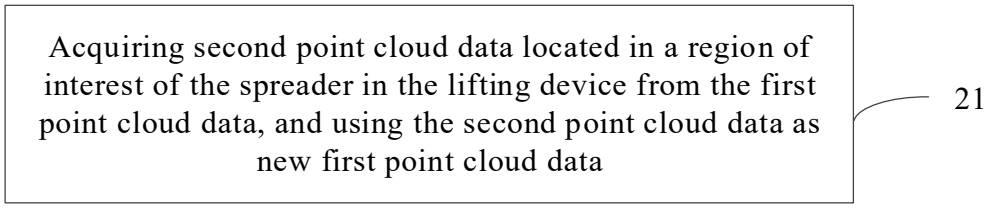


FIG. 2

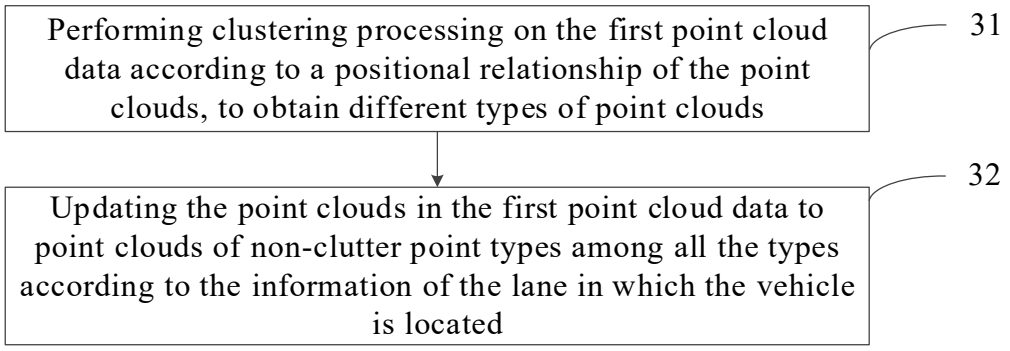


FIG. 3

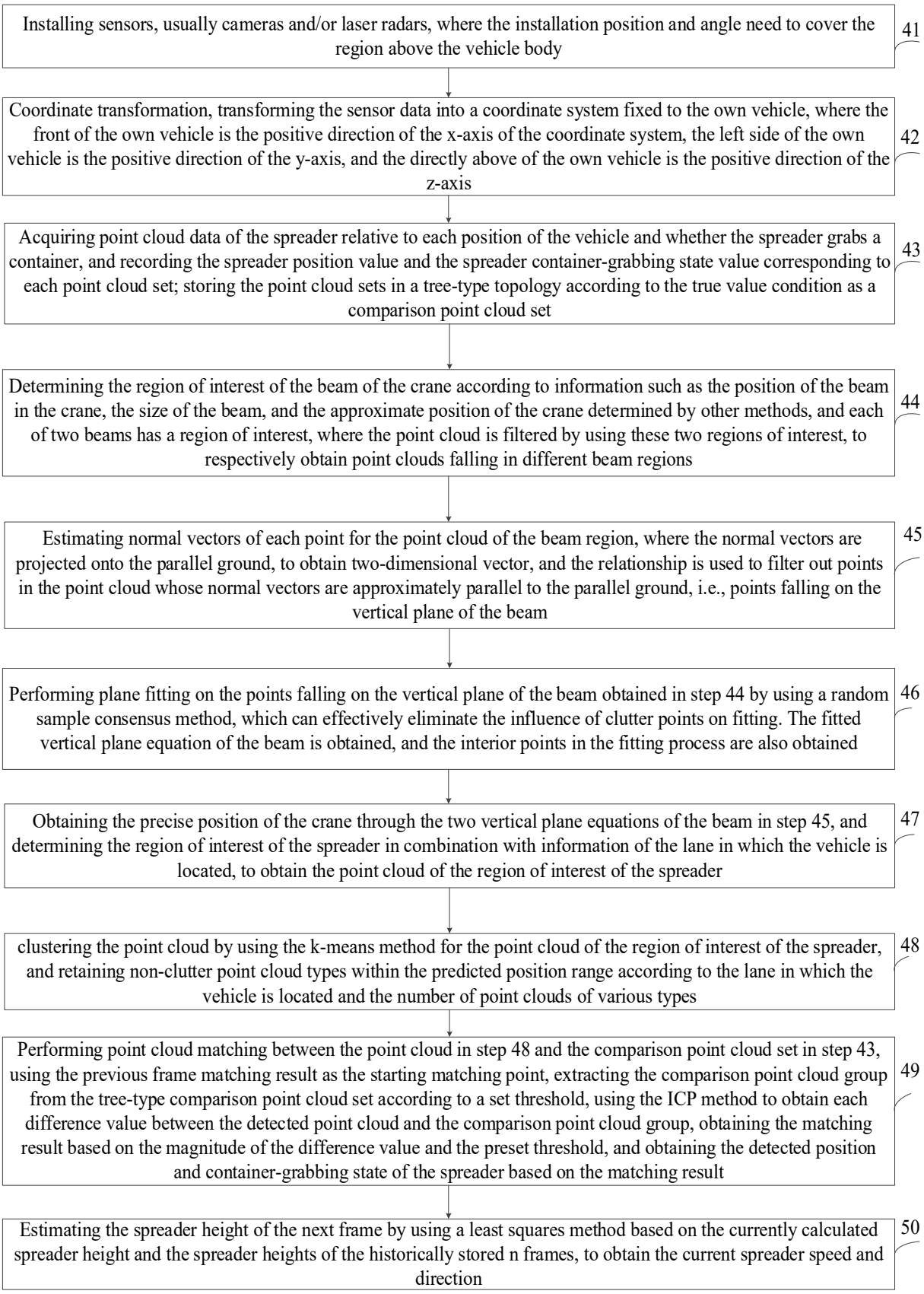

Installing sensors, usually cameras and/or laser radars, where the installation position and angle need to cover the region above the vehicle body
41
Coordinate transformation, transforming the sensor data into a coordinate system fixed to the own vehicle, where the front of the own vehicle is the positive 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
42
Acquiring point cloud data of the spreader relative to each position of the vehicle and whether the spreader grabs a container, and recording the spreader position value and the spreader container-grabbing state value corresponding to each point cloud set; storing the point cloud sets in a tree-type topology according to the true value condition as a comparison point cloud set
43
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, where the point cloud is filtered by using these two regions of interest, to respectively obtain point clouds falling in different beam regions
44
Estimating normal vectors of each point for the point cloud of the beam region, where the normal vectors are projected onto the parallel ground, to obtain two-dimensional vector, and the relationship is used to filter out points in the point cloud whose normal vectors are approximately parallel to the parallel ground, i.e., points falling on the vertical plane of the beam
45
Performing plane fitting on the points falling on the vertical plane of the beam obtained in step 44 by using a random sample consensus method, which can effectively eliminate the influence of clutter points on fitting. The fitted vertical plane equation of the beam is obtained, and the interior points in the fitting process are also obtained
46
Obtaining the precise position of the crane through the two vertical plane equations of the beam in step 45, and determining the region of interest of the spreader 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
47
clustering the point cloud by using the k-means method for the point cloud of the region of interest of the spreader, 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
48
Performing point cloud matching between the point cloud in step 48 and the comparison point cloud set in step 43, using the previous frame matching result as the starting matching point, extracting the comparison point cloud group from the tree-type comparison point cloud set according to a set threshold, using the ICP method to obtain each difference value between the detected point cloud and the comparison point cloud group, obtaining the matching result based on the magnitude of the difference value and the preset threshold, and obtaining the detected position and container-grabbing state of the spreader based on the matching result
49
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
50

FIG. 4

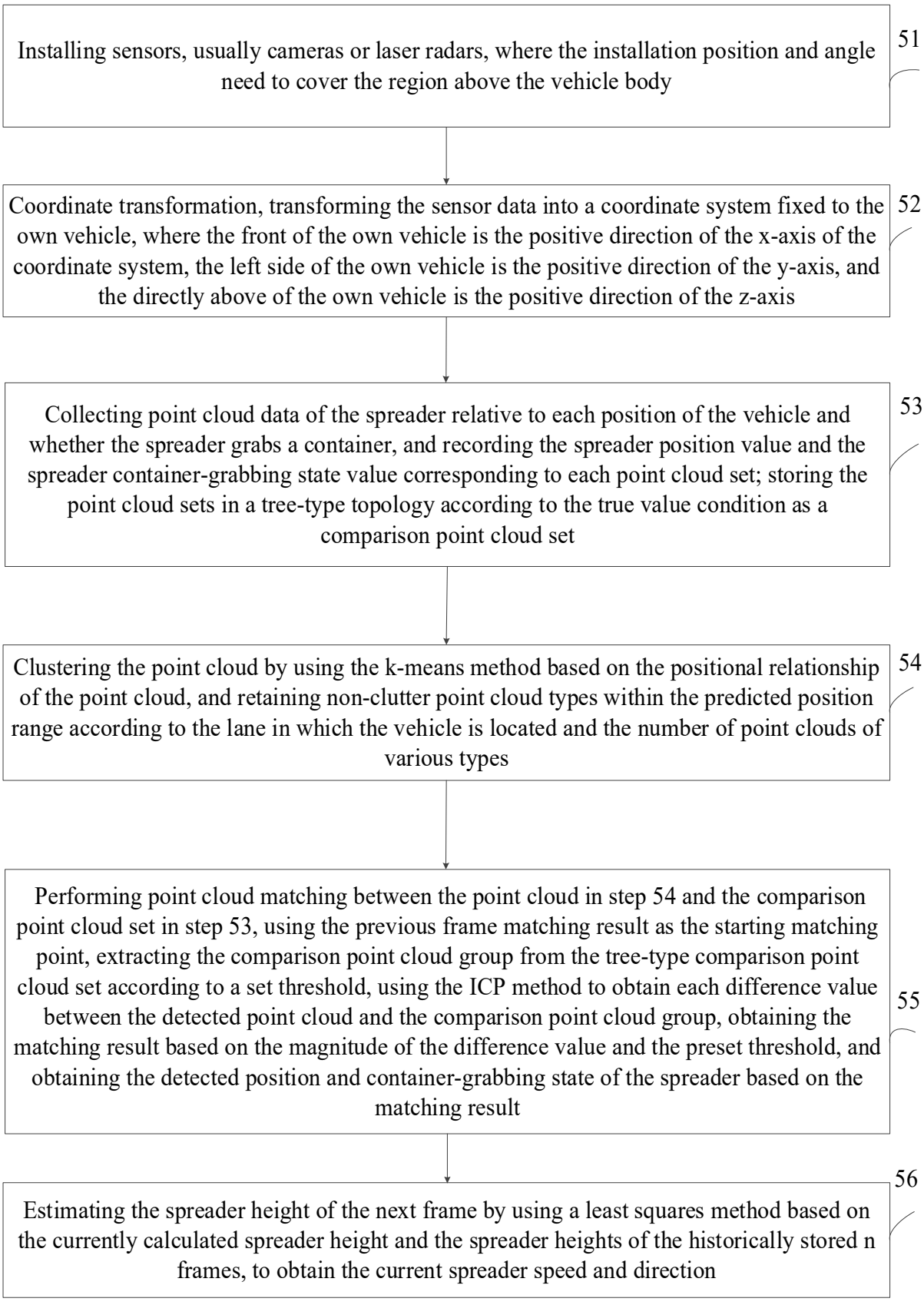

Installing sensors, usually cameras or laser radars, where the installation position and angle need to cover the region above the vehicle body
51
Coordinate transformation, transforming the sensor data into a coordinate system fixed to the own vehicle, where the front of the own vehicle is the positive 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
52
Collecting point cloud data of the spreader relative to each position of the vehicle and whether the spreader grabs a container, and recording the spreader position value and the spreader container-grabbing state value corresponding to each point cloud set; storing the point cloud sets in a tree-type topology according to the true value condition as a comparison point cloud set
53
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
54
Performing point cloud matching between the point cloud in step 54 and the comparison point cloud set in step 53, using the previous frame matching result as the starting matching point, extracting the comparison point cloud group from the tree-type comparison point cloud set according to a set threshold, using the ICP method to obtain each difference value between the detected point cloud and the comparison point cloud group, obtaining the matching result based on the magnitude of the difference value and the preset threshold, and obtaining the detected position and container-grabbing state of the spreader based on the matching result
55
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
56

FIG. 5

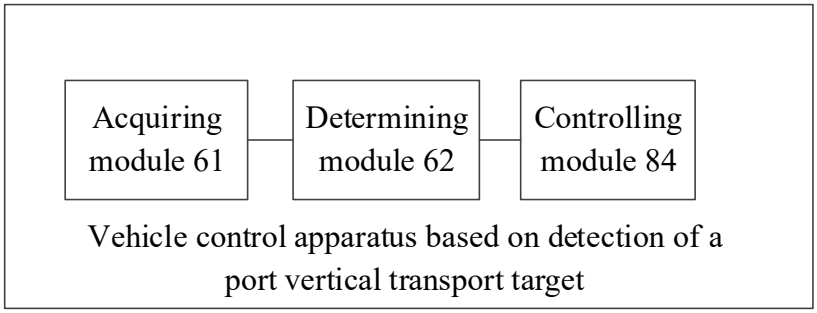

Acquiring module 61
Determining module 62
Controlling module 84
Vehicle control apparatus based on detection of a port vertical transport target

FIG. 6

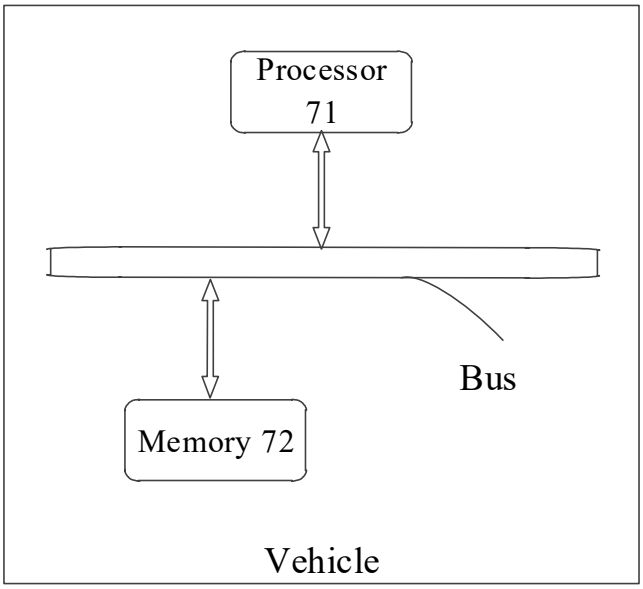

Processor 71
Bus
Memory 72
Vehicle

FIG. 7