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(54) **VEHICLE**

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(57) **ABSTRACT**

A vehicle comprising: a rotary reference LiDAR; a plurality of fixed LiDARs; and a processing unit configured to execute aiming processing of the plurality of fixed LiDARs using the reference LiDAR. For example, the reference LiDAR has a view angle range of 360 degrees in a yaw direction; each of the plurality of fixed LiDARs has a predetermined view angle range in the yaw direction; and the view angle range of the reference LiDAR and the view angle range of each fixed LiDAR at least partially overlap.

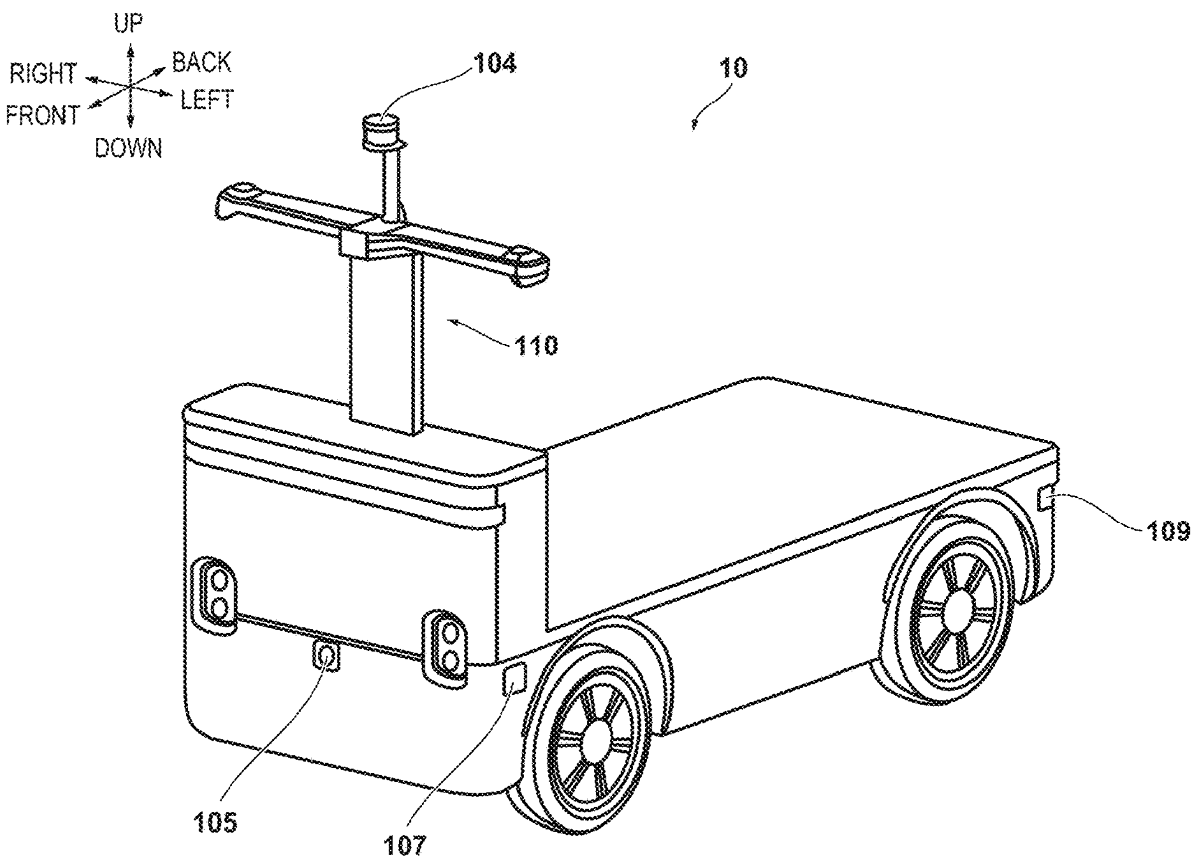


FIG. 1

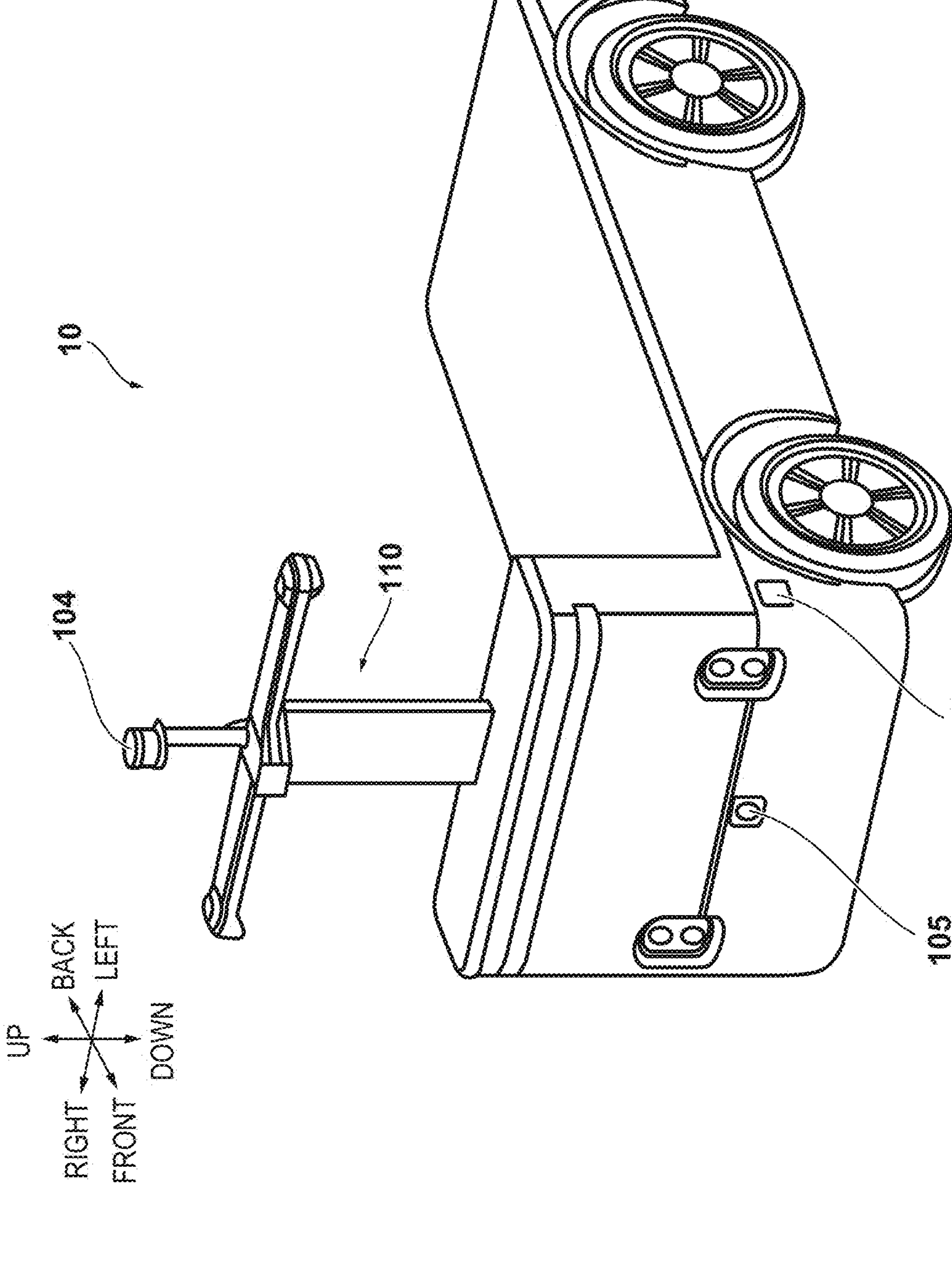


FIG. 2

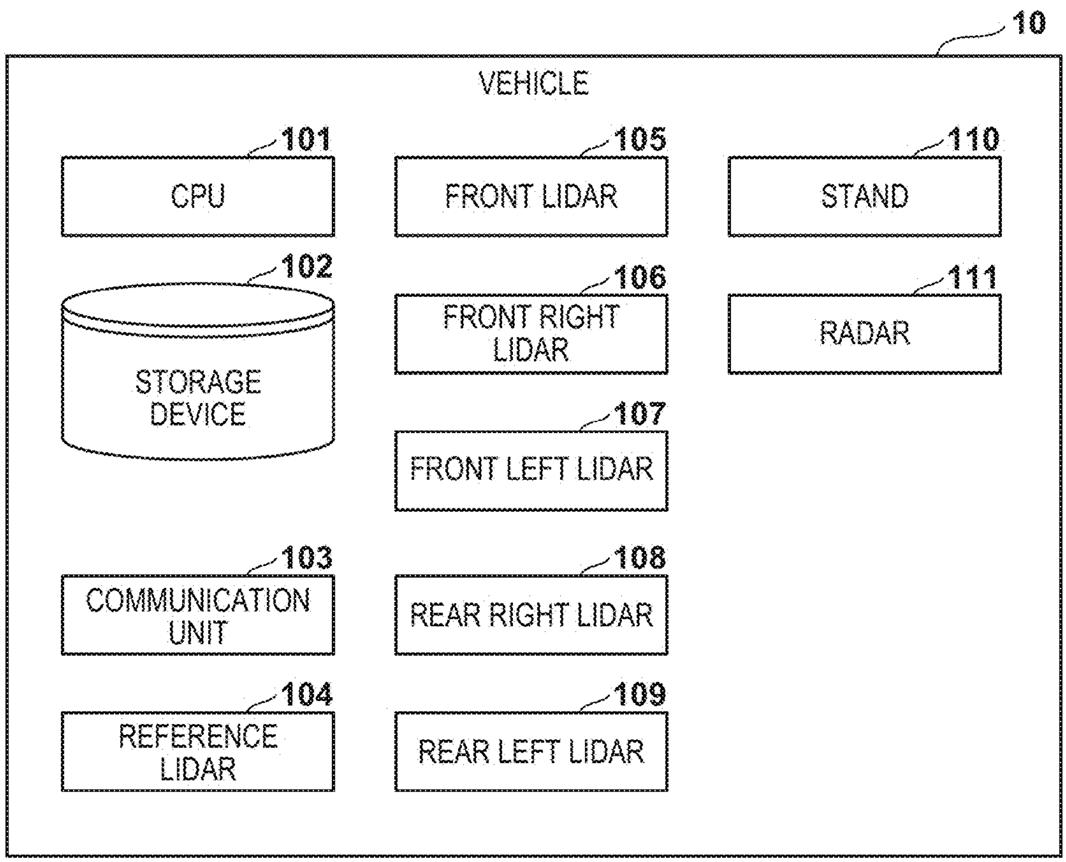

10
VEHICLE
101
CPU
102
STORAGE DEVICE
103
COMMUNICATION UNIT
104
REFERENCE LIDAR
105
FRONT LIDAR
106
FRONT RIGHT LIDAR
107
FRONT LEFT LIDAR
108
REAR RIGHT LIDAR
109
REAR LEFT LIDAR
110
STAND
111
RADAR

FIG. 3

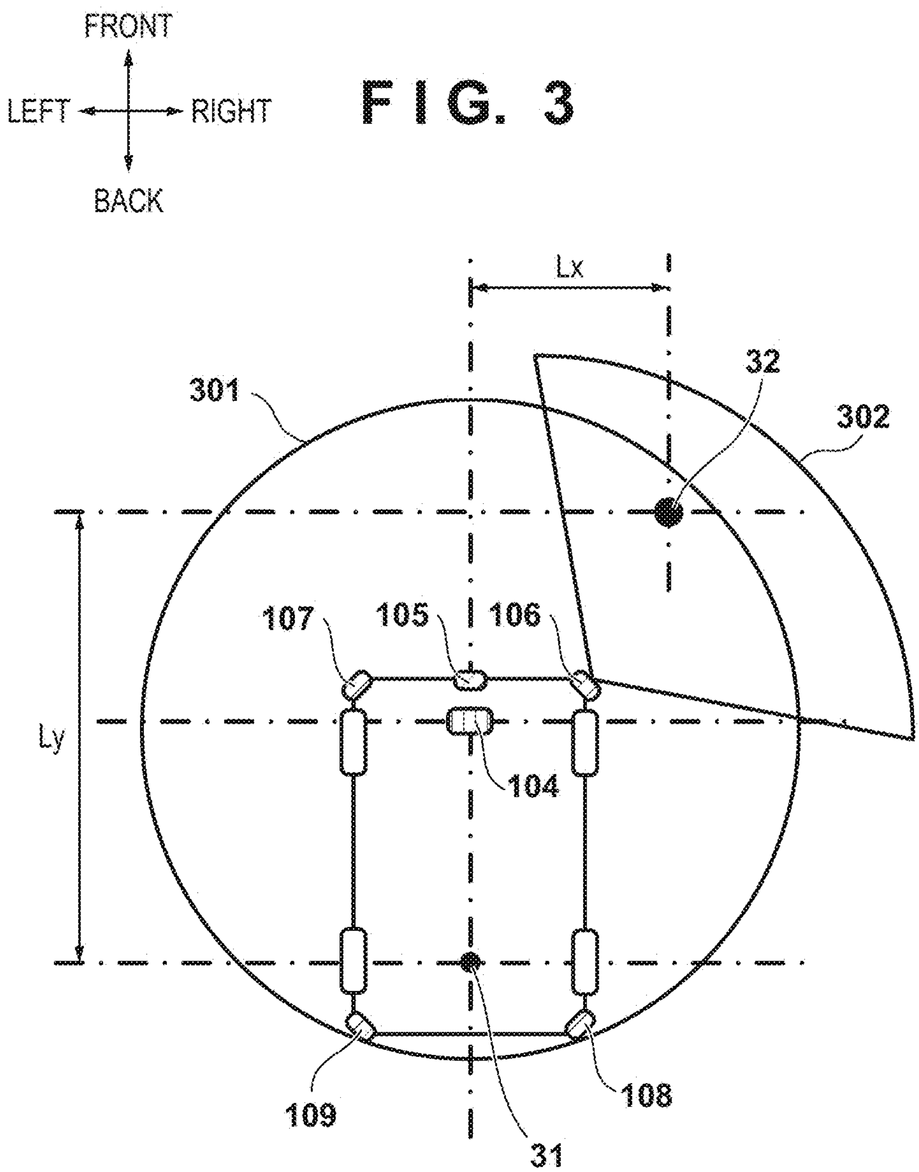

FRONT
LEFT
RIGHT
BACK
Lx
Ly
301
302
32
107
105
106
104
109
108
31

FIG. 4

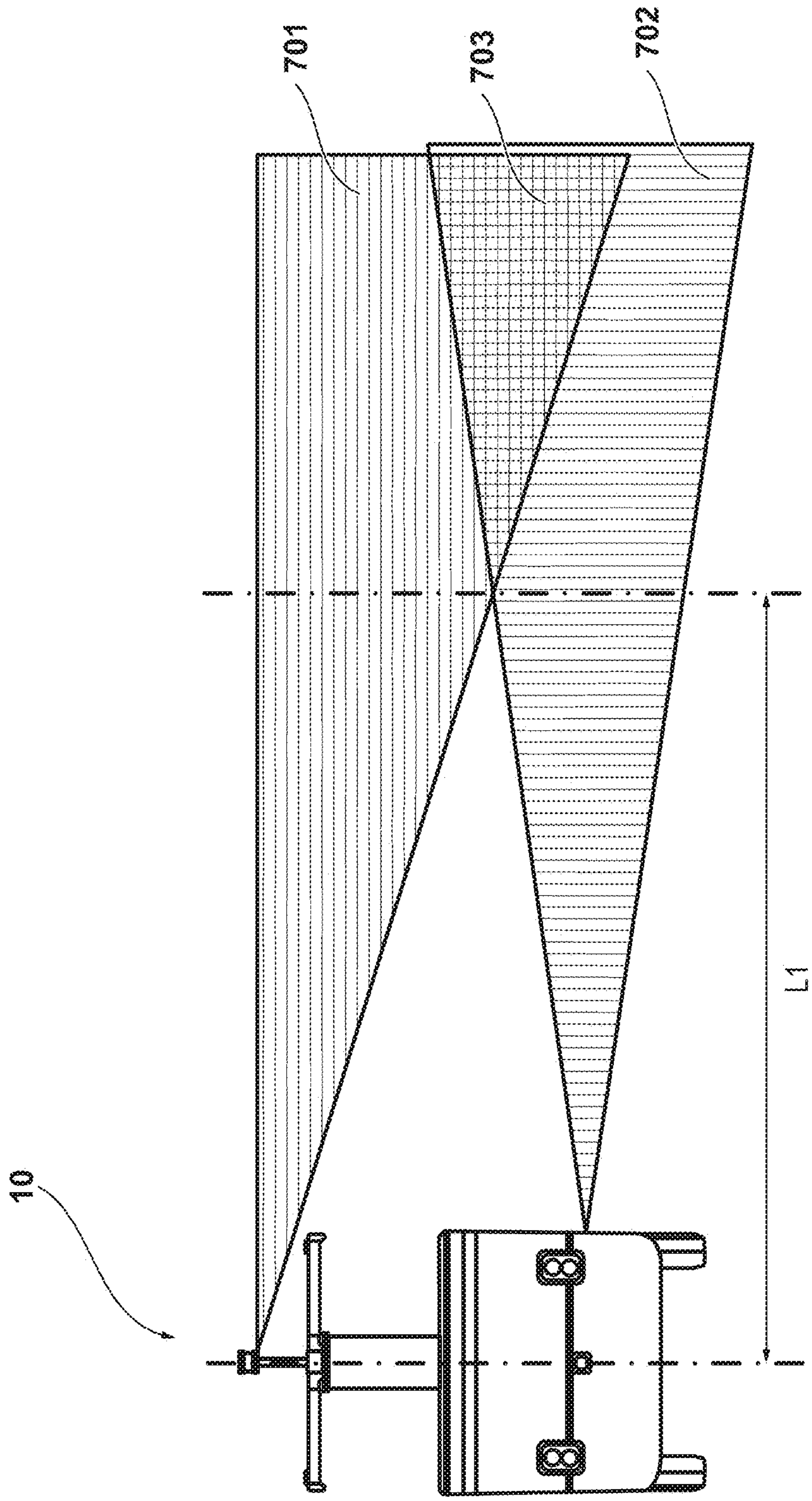


FIG. 5

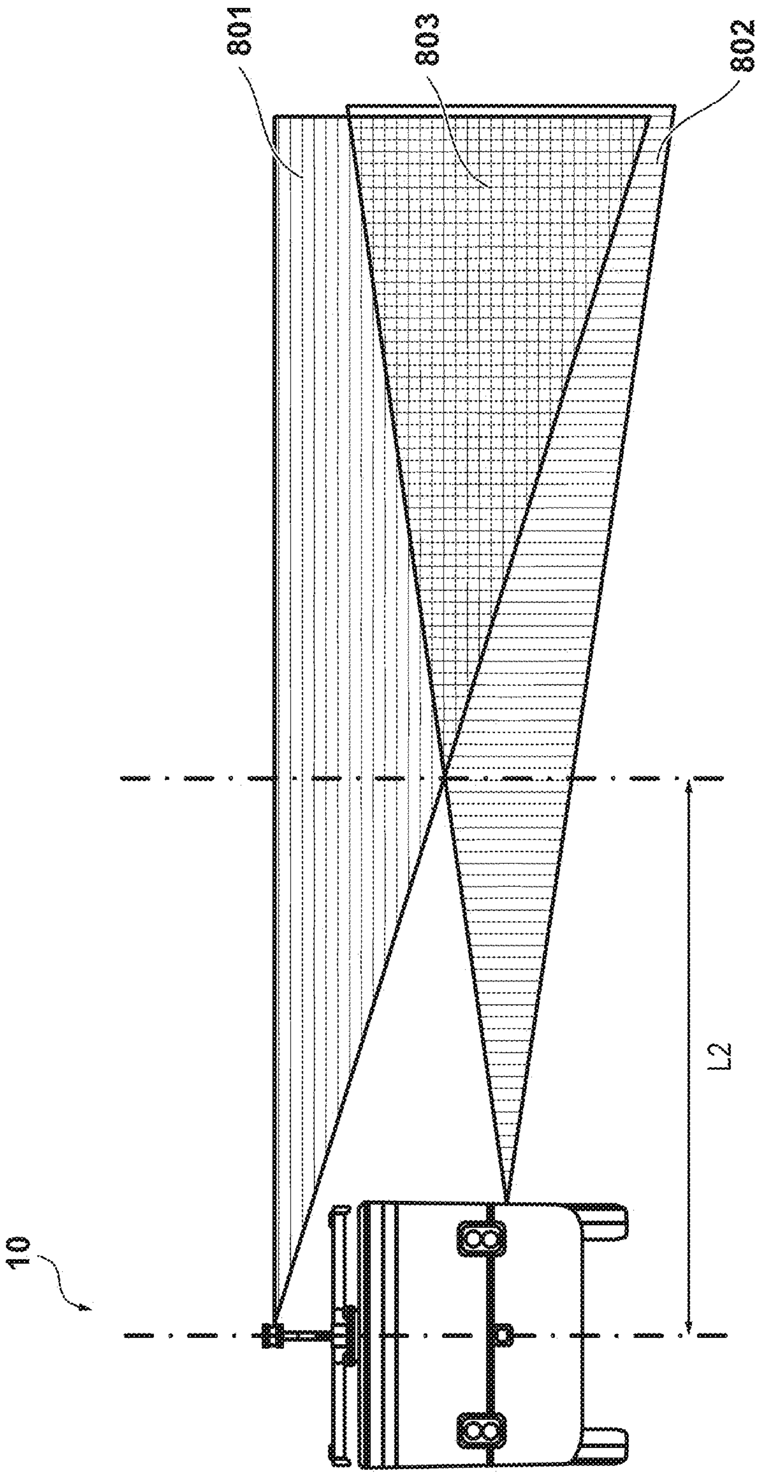


FIG. 6

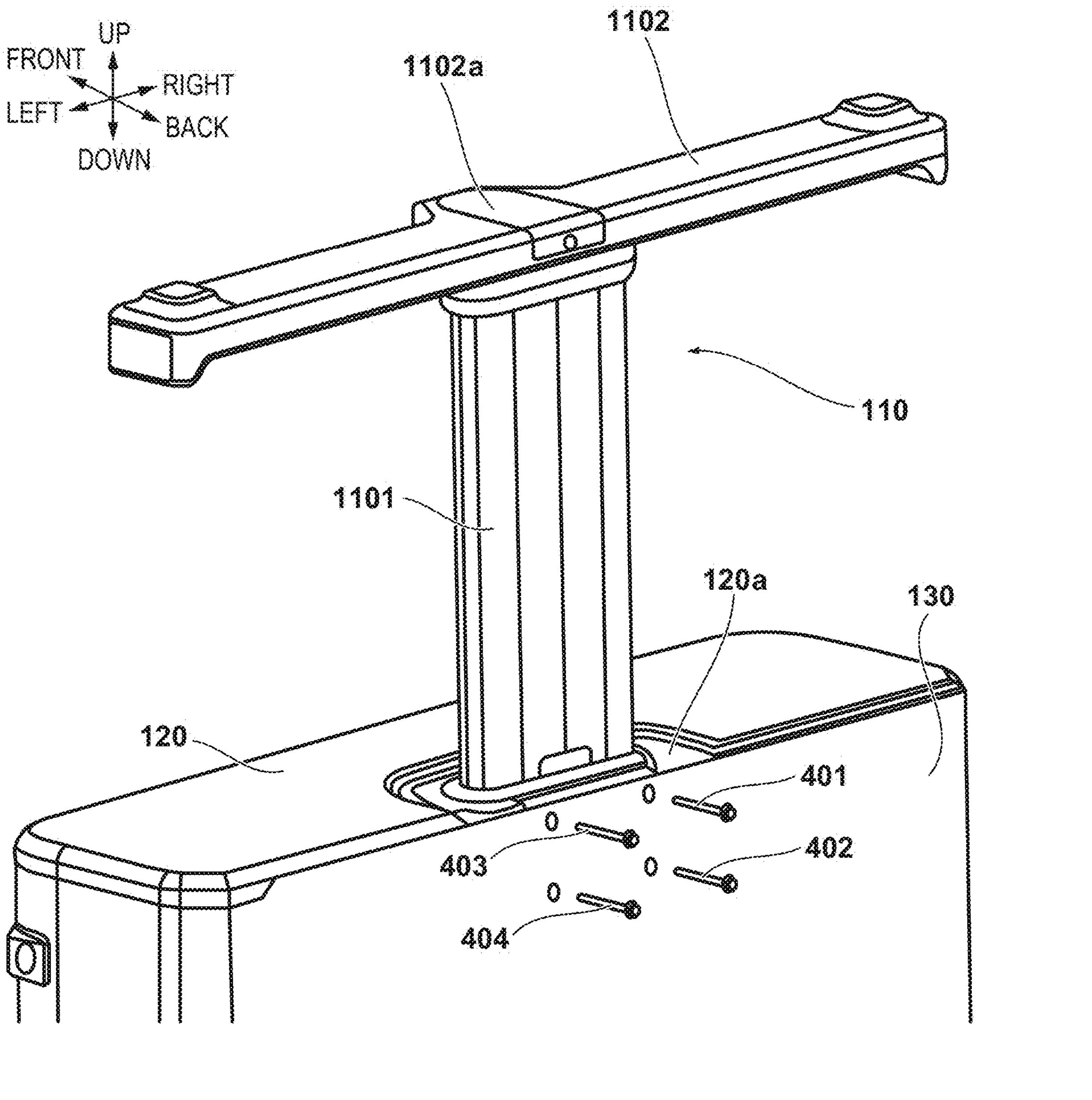

UP
FRONT
RIGHT
LEFT
BACK
DOWN
1102
1102a
110
1101
120a
130
120
401
403
402
404

FIG. 7

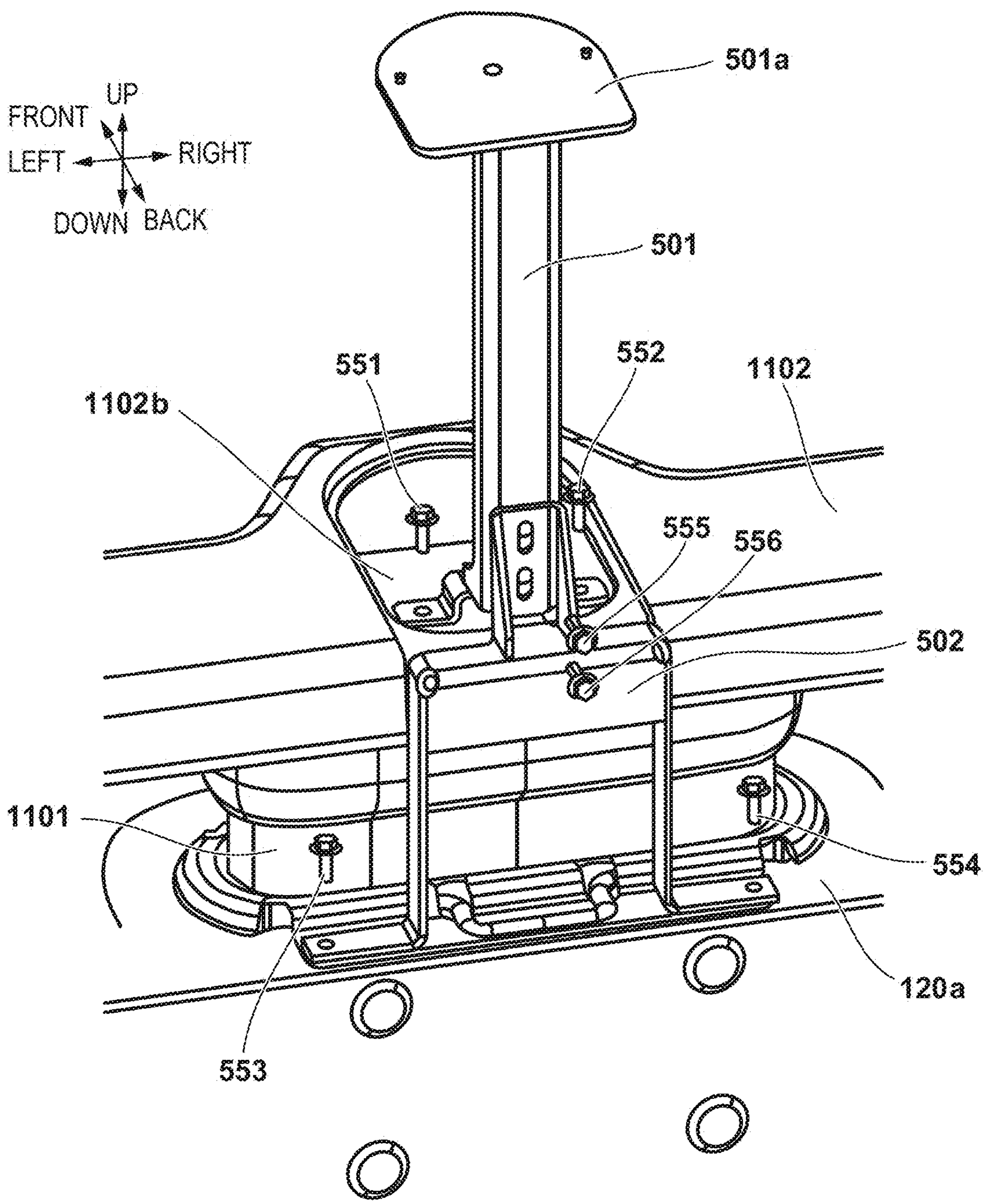
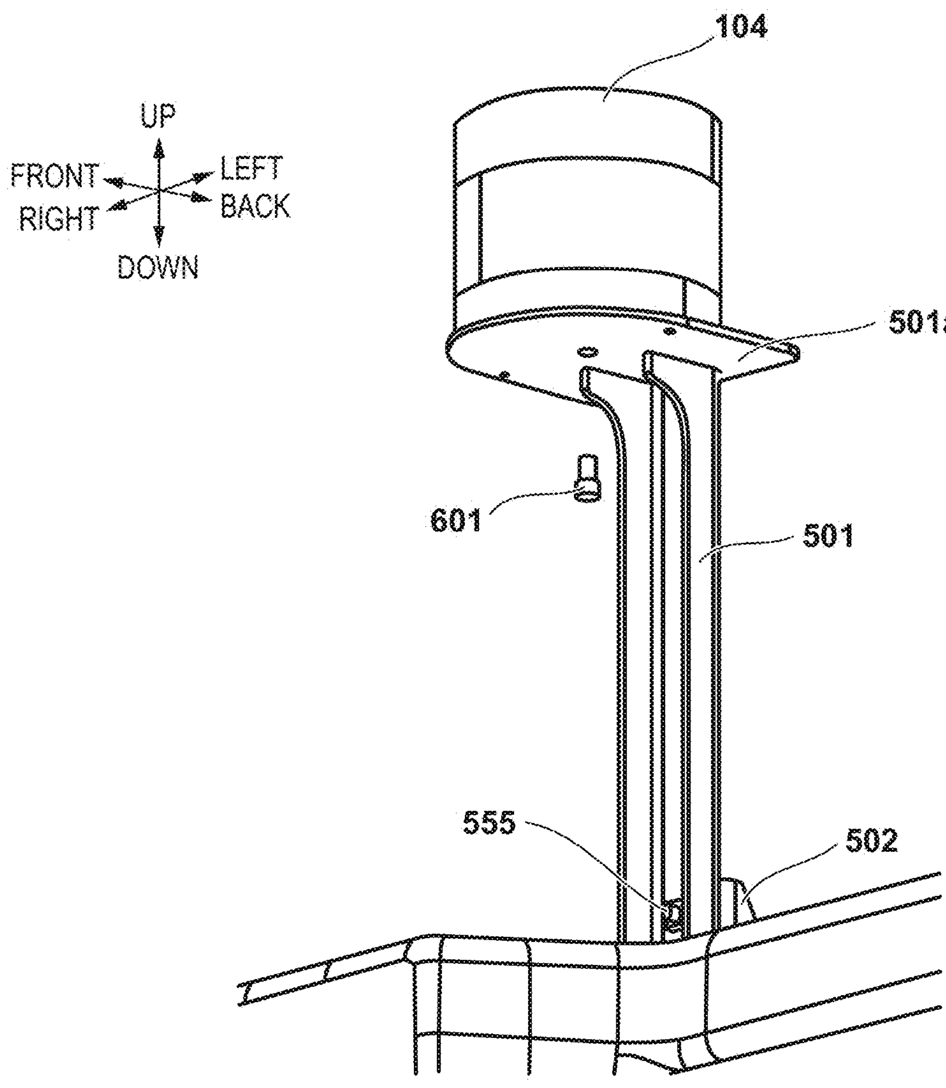

501a
UP
FRONT
LEFT
RIGHT
DOWN
BACK
501
551
552
1102
1102b
555
556
502
1101
554
120a
553

FIG. 8



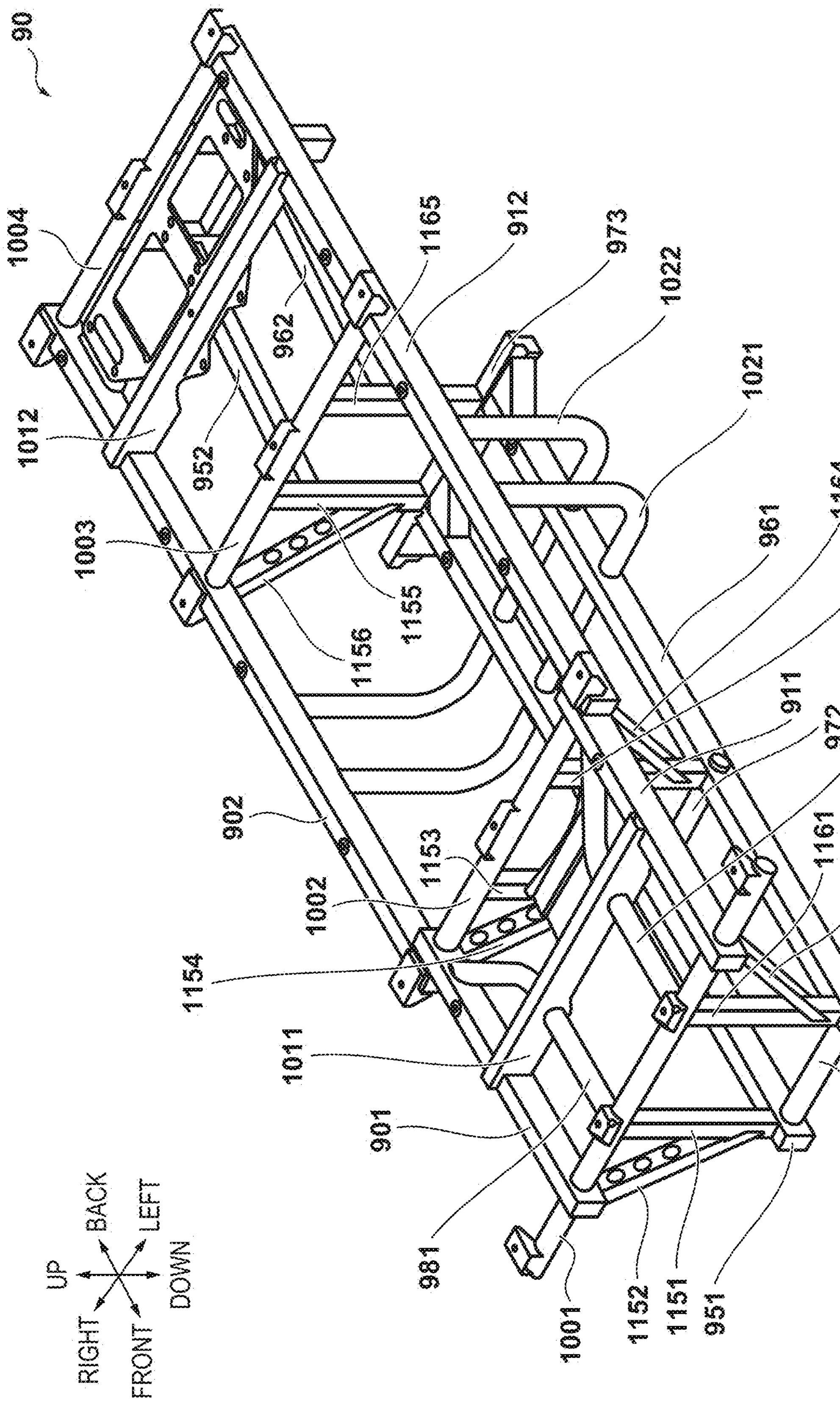

90
1004
1012
1003
952
962
1165
912
973
1022
1021
1156
1155
961
1164
1163
911
972
991
902
1153
1002
1154
1011
901
981
1161
1162
971
1001
1152
1151
951
UP
BACK
LEFT
RIGHT
FRONT
DOWN

FIG. 9

FIG. 10

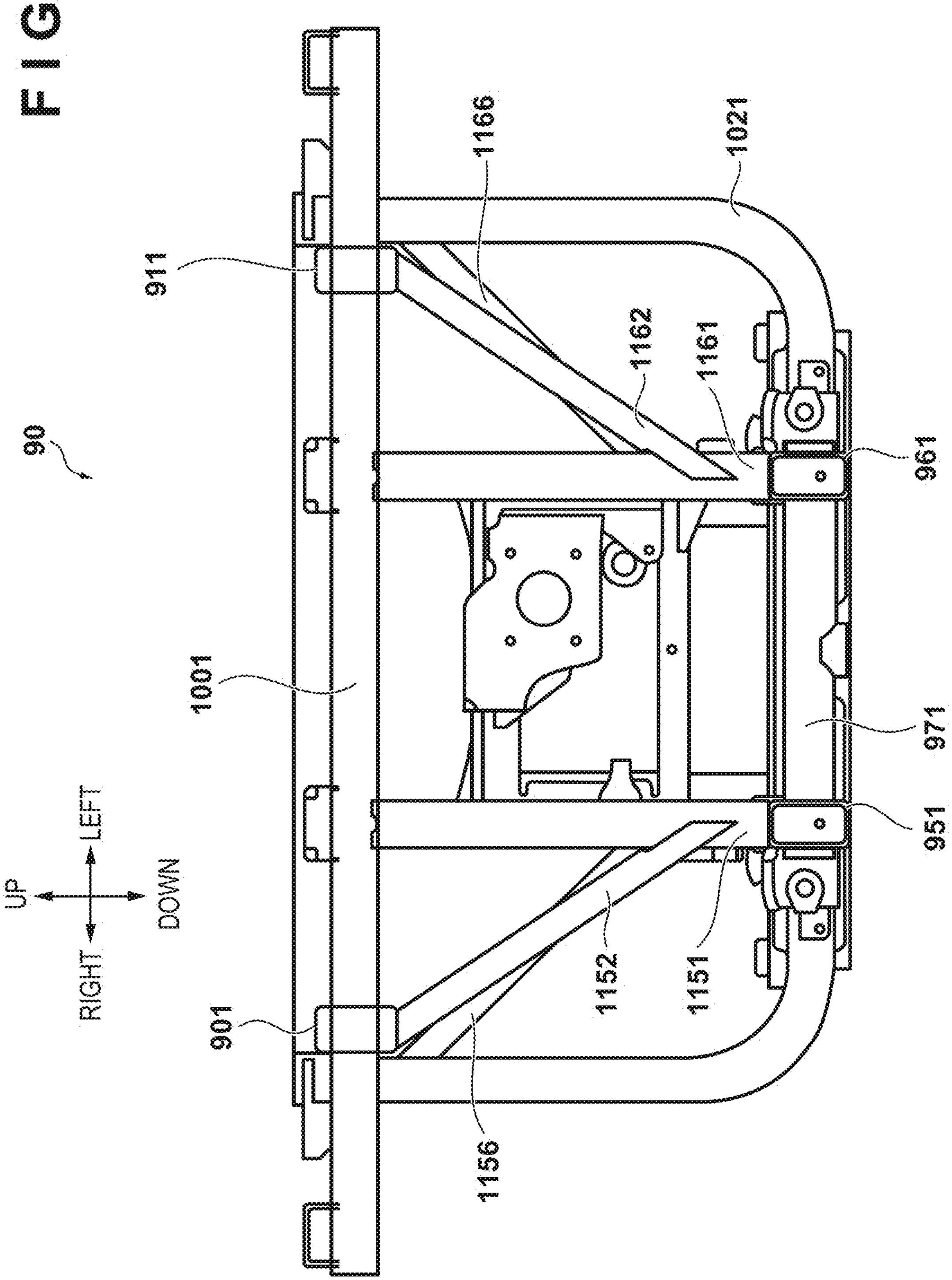
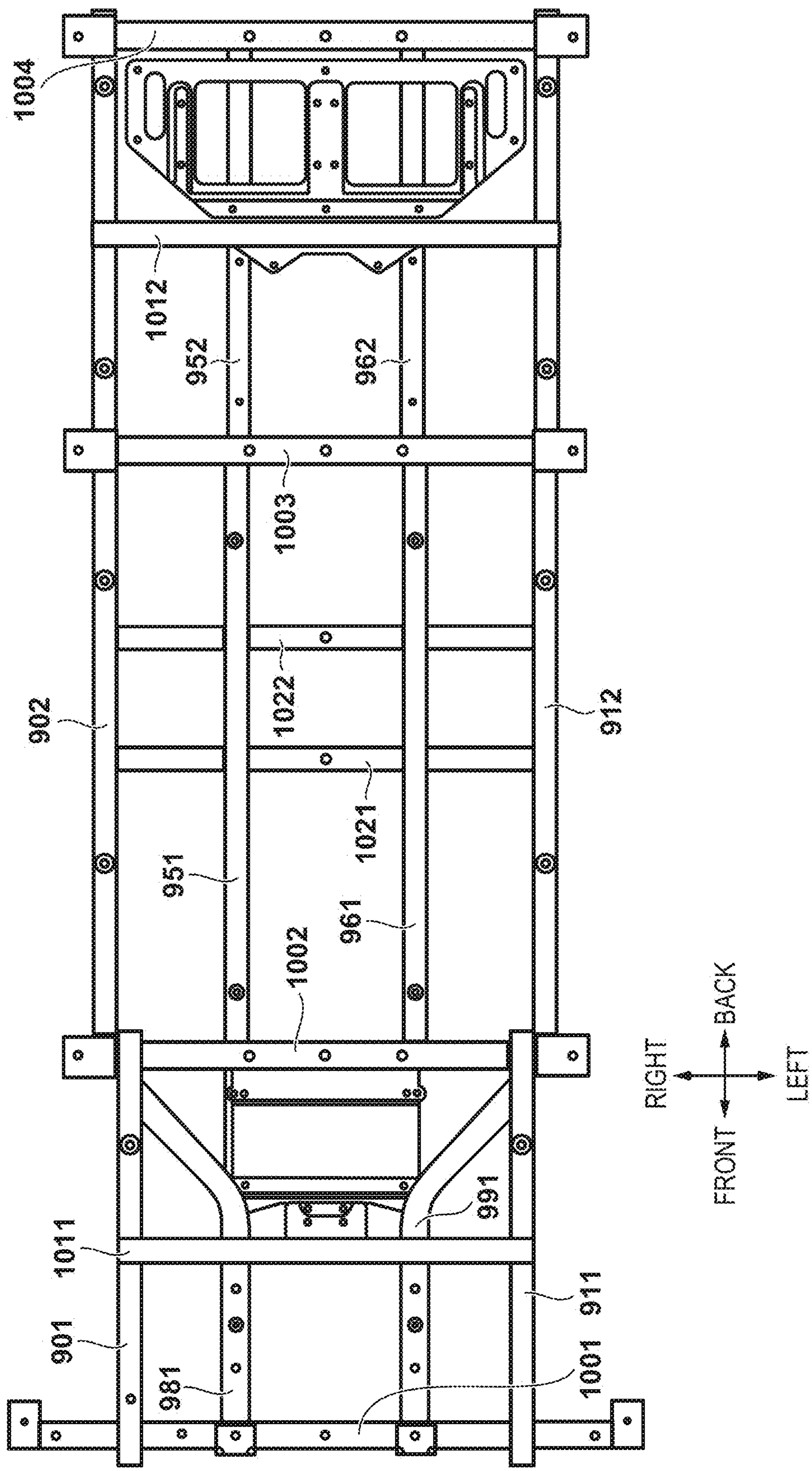

90
911
1166
1021
1162
1161
961
1001
971
951
UP
LEFT
RIGHT
DOWN
901
1152
1151
1156

FIG. 11


1004
1012
952
962
1003
902
1022
912
1021
951
961
1002
RIGHT
BACK
LEFT
FRONT
991
1011
911
901
1001
981

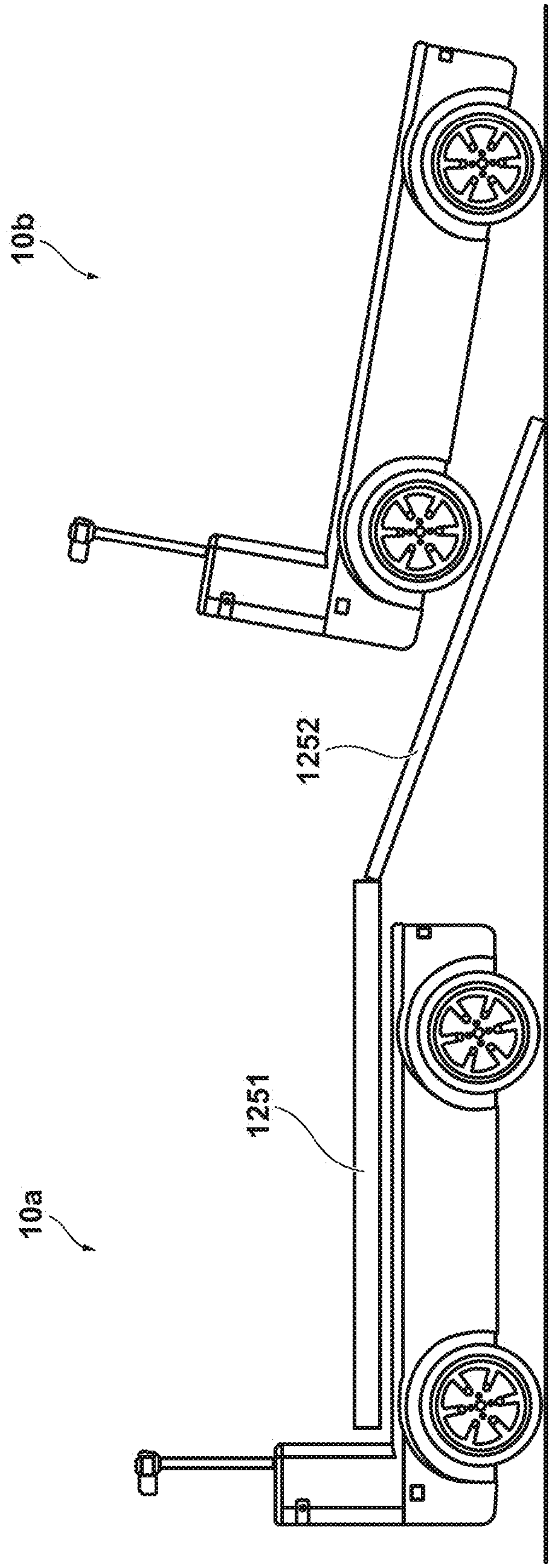
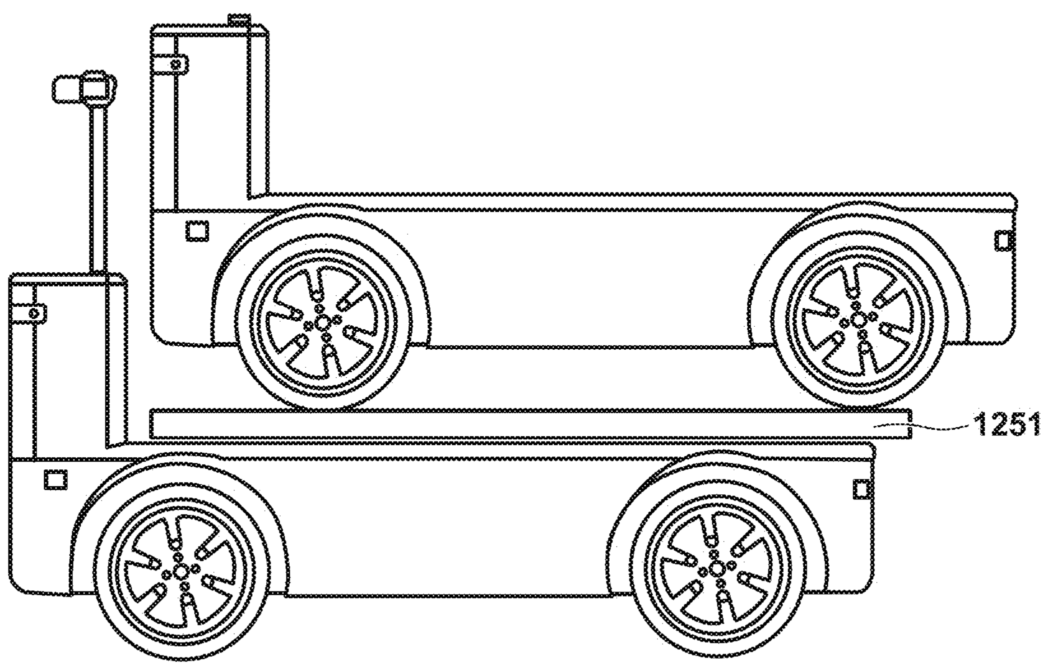


FIG. 12

FIG. 13



VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority to and the benefit of Japanese Patent Application No. 2024-023905 filed on Feb. 20, 2024, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a vehicle.

Description of the Related Art

[0003] Aiming (optical axis adjustment) processing of an object detection device such as a radar or a light detection and ranging (LiDAR) mounted on a vehicle is known. Japanese Patent Laid-Open No. 2002-131434 discloses that an aiming jig is installed at a predetermined distance forward of a vehicle on a longitudinal axis of the vehicle, and a reference reflector of the aiming jig is detected to perform aiming in the vertical direction.

[0004] However, the technique described in Japanese Patent Laid-Open No. 2002-131434 requires a large-scale aiming jig, and thus has a problem that it is difficult to efficiently perform aiming of a plurality of sensors installed in a vehicle.

SUMMARY OF THE INVENTION

[0005] The present invention has been made in view of the above problem, and provides a technique for achieving efficient aiming.

[0006] According to one aspect of the present invention, there is provided a vehicle comprising: a rotary reference LiDAR; a plurality of fixed LiDARs; and a processing unit configured to execute aiming processing of the plurality of fixed LiDARs using the reference LiDAR.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a diagram illustrating an example of an external configuration of a vehicle according to an embodiment;

[0008] FIG. **2** is a diagram illustrating a configuration example of the vehicle according to the embodiment;

[0009] FIG. **3** is an explanatory diagram of aiming processing according to the embodiment;

[0010] FIG. **4** is a diagram illustrating a relationship between detection ranges of a reference LiDAR and a fixed LiDAR when a stand is lifted according to the embodiment;

[0011] FIG. **5** is a diagram illustrating a relationship between detection ranges of the reference LiDAR and the fixed LiDAR when the stand is lowered according to the embodiment;

[0012] FIG. **6** is a partially enlarged view of a vehicle according to an embodiment;

[0013] FIG. **7** is a diagram illustrating an exemplary structure for mounting a reference LiDAR to a stand according to the embodiment;

[0014] FIG. **8** is a diagram illustrating an exemplary structure for mounting the reference LiDAR to the stand according to the embodiment;

[0015] FIG. **9** is a perspective view of an internal structure of a vehicle according to an embodiment;

[0016] FIG. **10** is a front view of the internal structure of the vehicle according to the embodiment;

[0017] FIG. **11** is a top view of the internal structure of the vehicle according to the embodiment;

[0018] FIG. **12** is an explanatory diagram of an example of vehicle superimposition according to an embodiment (before superimposition); and

[0019] FIG. **13** is an explanatory diagram of an example of vehicle superimposition according to the embodiment (after superimposition).

DESCRIPTION OF THE EMBODIMENTS

[0020] Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the scope of the claimed invention, and limitation is not made to an invention that requires a combination of all features described in the embodiments. Two or more of the multiple features described in the embodiments may be combined as appropriate. Furthermore, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.

[0021] The vertical direction, the horizontal direction, and the front-and-rear direction in the drawings indicate directions defined with respect to the vehicle.

First Embodiment

<Configuration>

[0022] FIG. **1** is a diagram illustrating an example of an external configuration of a vehicle according to an embodiment. FIG. **2** is a diagram illustrating a configuration example of the vehicle according to the embodiment. A vehicle **10** is, for example, an automatic guided vehicle, and is an autonomous work vehicle capable of conveying a mounted object such as a cargo.

[0023] The vehicle **10** includes a CPU **101**, a storage device **102**, and a communication unit **103**. A control operation of the vehicle **10** is achieved by the CPU **101** reading and executing a computer program stored in the storage device **102**. The CPU **101** may be one or more CPUs. The storage device **102** is one or more memories that store several types of information. For example, information that has been received from another device, a computer program to be read and executed by the CPU **101**, and the like are stored. The communication unit **103** has a function of communicating with another device in a wired or wireless manner through a network.

[0024] In addition, the vehicle **10** includes a reference LiDAR **104**, a front LiDAR **105**, a front right LiDAR **106**, a front left LiDAR **107**, a rear right LiDAR **108**, a rear left LiDAR **109**, a stand **110**, and a radar **111**. By arranging the fixed LiDAR at the four corners and the front portion in a lower part of the vehicle, it is possible to obtain a required visual field necessary for automated driving. Note that in the present embodiment, an example will be described in which a total of five fixed LiDARs of the front LiDAR **105** to the rear left LiDAR **109** are provided as a plurality of fixed LiDARs (LiDARs fixedly installed in vehicle), but the number of fixed LiDARs is not limited to five, and may be a larger number or a smaller number.

[0025] The reference LiDAR **104** is, for example, a rotary light detection and ranging (LiDAR) detachable from the vehicle **10**. The reference LiDAR **104** is a LiDAR for detecting a target around the vehicle **10**, and can rotate. This makes it possible to have a view angle range of **360** degrees in the yaw direction.

[0026] The front LiDAR **105** is a fixed LiDAR that detects the front direction of the vehicle **10**, and is arranged in a front portion of the vehicle **10**. The front right LiDAR **106** is a fixed LiDAR that detects the front right direction of the vehicle **10**, and is arranged in a front right portion of the vehicle **10**. The front left LiDAR **107** is a fixed LiDAR that detects the front left direction of the vehicle **10**, and is arranged in a front left portion of the vehicle **10**. The rear right LiDAR **108** is a fixed LiDAR that detects the rear right direction of the vehicle **10**, and is arranged in a rear right portion of the vehicle **10**. The rear left LiDAR **109** is a fixed LiDAR that detects the rear left direction of the vehicle **10**, and is arranged in a rear left portion of the vehicle **10**. Each fixed LiDAR has a predetermined view angle range in the yaw direction.

[0027] The stand **110** is a global navigation satellite system (GNSS) stand provided in a front portion of vehicle **10**. A GNSS sensor is installed in the GNSS stand, and it is possible to receive GNSS data and grasp position information of the vehicle **10** by using the sensor. In addition, the reference LiDAR **104** can be detachably installed in the stand **110**. The stand **110** according to the present embodiment has a T-shape, but is not limited to this shape. The radar **111** is, for example, a millimeter wave radar, detects a target around the vehicle **10** using radio waves, and detects (measures) a distance to the target and a direction (orientation) of the target with respect to the vehicle **10**.

<Aiming Processing>

[0028] FIG. **3** is an explanatory diagram of aiming processing according to the embodiment. Aiming processing is calibration processing for ensuring correct operation of an electronic control device. In the present embodiment, aiming processing of the fixed LiDAR is performed using the reference LiDAR **104**.

[0029] In FIG. **3**, a control origin **31** is, for example, an axle center point of a rear tire. A target **32** is an object arranged in an arbitrary position around the vehicle **10** for aiming. A view angle range **301** is a view angle range of the reference LiDAR **104** and indicates an angle range of 360 degrees. A view angle range **302** is a view angle range of the front right LiDAR **106**. The view angle range **301** of the reference LiDAR **104** and the view angle range **302** of the front right LiDAR **106** overlap.

[0030] Note that although the view angle ranges of the front LiDAR **105**, the front left LiDAR **107**, the rear right LiDAR **108**, and the rear left LiDAR **109** are omitted, the view angle range **301** of the reference LiDAR **104** and the view angle range of each fixed LiDAR overlap.

[0031] First, the reference LiDAR **104** detects the target **32** and acquires information of coordinates (Lx, Ly) of the target **32** with respect to the control origin **31**. It is assumed that the reference LiDAR **104** is calibrated (subjected to aiming processing) in advance with respect to the vehicle **10**. Specifically, the reference LiDAR **104** is calibrated (subjected to aiming processing) in advance by performing the aiming processing on one target accurately arranged with respect to the vehicle **10** within the view angle range of the reference LiDAR **104** in advance.

[0032] Since the target **32** present within the view angle range **301** of the reference LiDAR **104** calibrated in advance with respect to the vehicle **10** is known to have a relationship with the vehicle **10**, if the target **32** is included within the view angle range **302** of the front right LiDAR **106**, the relationship with the vehicle **10** can be given to the front right LiDAR **106**. That is, the front right LiDAR **106** can acquire the relationship with (=can be aimed) the vehicle **10** via the reference LiDAR **104**.

[0033] Similarly, for each of the fixed LiDARs other than the front right LiDAR **106**, another target is arranged in a position where the view angle ranges of each fixed LiDAR and the reference LiDAR **104** overlap, and similar operation is performed, whereby the aiming processing can be performed.

[0034] As described above, the rotary reference LiDAR serving as the master is aimed with respect to the vehicle **10** in advance with high accuracy, and each fixed LiDAR serving as the slave performs its own correction on the basis of a value calculated by the reference LiDAR, whereby aiming of the fixed LiDAR can be easily performed.

<Stand Lifting and Lowering Operation and Change in Visual Field Overlapping Range>

[0035] The stand **110** according to the present embodiment may be configured to be movable up and down with respect to the vehicle front structure. Here, FIG. **4** is a diagram illustrating a relationship between detection ranges of the reference LiDAR and a fixed LiDAR when the stand is lifted according to the embodiment. FIG. **5** is a diagram illustrating a relationship between detection ranges of the reference LiDAR and a fixed LiDAR when the stand is lowered according to the embodiment.

[0036] As illustrated in FIG. **4**, in a state where the stand **110** is lifted with respect to the vehicle front structure (when lifted), the distance from the center of the vehicle **10** to an overlapping position where the visual field range **701** in the vertical direction of the reference LiDAR **104** and the visual field range **702** in the vertical direction of the fixed LiDAR start overlapping is L**1**. An overlapping range in the vertical direction is indicated by **703**. On the other hand, as illustrated in FIG. **5**, in a state where the stand **110** is lowered with respect to the vehicle front structure (when lowered), the distance from the center of the vehicle **10** to the overlapping position where the visual field range **801** in the vertical direction of the reference LiDAR **104** and the visual field range **802** in the vertical direction of the fixed LiDAR start overlapping is L**2**. An overlapping range in the vertical direction is indicated by **803**.

[0037] As is clear from FIGS. **4** and **5**, L2<L1. That is, by lowering the reference LiDAR **104**, the target can be arranged at a position closer to the vehicle **10**, and the aiming processing can be performed in a narrow space. Therefore, the peripheral space can be efficiently utilized.

[0038] In this manner, execution of the processing is facilitated by executing the aiming processing of the plurality of fixed LiDARs in a state where the reference LiDAR **104** is lowered.

[0039] As described above, according to the present embodiment, as long as the target is arranged within the view angle range of the reference LiDAR and the fixed LiDAR, the aiming processing of the fixed LiDAR can be executed without requiring accuracy of the position of the target with respect to the vehicle. In addition, by using the rotary reference LiDAR, it is possible to execute the aiming processing of the plurality of fixed LiDARs in a short time since data is acquired by rotating the reference LiDAR once in a state where the targets are arranged for the fixed LiDARs.

[0040] As described above, use of the rotary reference LiDAR facilitates aiming of the fixed LiDAR not only at the time of shipment from the factory but also at the time of maintenance at the work site of the vehicle.

Second Embodiment

[0041] Next, an example of a mounting structure for mounting a reference LiDAR **104** to a stand **110** will be described with reference to FIGS. **6** to **8**. FIG. **6** is a partially enlarged view of a vehicle according to an embodiment. FIG. **7** is a diagram illustrating an exemplary structure for mounting the reference LiDAR to the stand according to the embodiment. FIG. **8** is a diagram illustrating an exemplary structure for mounting the reference LiDAR to the stand according to the embodiment.

[0042] In FIG. **6**, the stand **110** is a T-shaped stand including a vertical member **1101** extending in the vertical direction and a horizontal member **1102** extending in the horizontal direction in an upper portion of the vertical member **1101**. The horizontal member **1102** includes a removable lid **1102***a*. The stand **110** is fixed to the vehicle front structure with a plurality of screws **401** to **404** via a back surface **130** of the vehicle front structure in a state of being lifted in the vertical direction from an upper surface **120** of the vehicle front structure. By removing the plurality of screws **401** to **404**, the vertical member **1101** of the stand **110** can be lowered as illustrated in FIG. **7**. The state of FIG. **7** illustrates the lowest state, and the vertical member **1101** is not fixed to the vehicle front structure in this state. Therefore, the stand **110** can be lifted by gripping and lifting the stand **110** upward.

[0043] As illustrated in FIG. **7**, with the lid **1102***a* removed, a fixing member **501** for mounting the reference LiDAR **104** is mounted to a placement surface **1102***b* via a plurality of screws **551** and **552**. The fixing member **501** includes a placement plate **501***a* for placing the reference LiDAR **104** thereon.

[0044] Then, a bracket **502** is mounted to a surface **120***a* of the upper surface **120** of the vehicle front structure via a plurality of screws **553** and **554**, and is mounted to the fixing member **501** via a plurality of screws **555** and **556**. By mounting the bracket **502**, the fixing member **501** can be more stably fixed to the stand **110**. As illustrated in FIG. **8**, the reference LiDAR **104** can be placed on the placement plate **501***a* of the fixing member **501** and attached via a screw **601**.

[0045] As described above, according to the present embodiment, the reference LiDAR can be easily detached from the vehicle, and the reference LiDAR can be accurately mounted to the vehicle.

Third Embodiment

[0046] Next, an example of an internal structure of a vehicle according to an embodiment will be described with reference to FIGS. **9** to **11**. FIG. **9** is a perspective view of the internal structure of the vehicle according to the embodiment. FIG. **10** is a front view of the internal structure of the vehicle according to the embodiment. FIG. **11** is a top view of the internal structure of the vehicle according to the embodiment. An internal structure **90** is a structure inside the vehicle that extends from a lower portion of the vehicle front structure of the vehicle **10** to a vehicle rear structure corresponding to a cargo bed portion extending from the lower portion toward the vehicle rear.

[0047] Reference numerals **901** and **911** denote a pair of upper frame members extending in the longitudinal direction of the vehicle in the vehicle front structure. The upper frame member **901** and the upper frame member **911** are arranged in parallel. Reference numerals **902** and **912** denote a pair of upper frame members extending in the longitudinal direction of the vehicle in the vehicle rear structure. An upper frame member **902** and an upper frame member **912** are arranged in parallel.

[0048] Reference numerals **1001** and **1002** denote cylindrical members that connect the upper frame member **901** and the upper frame member **911** and extend in the horizontal direction of the vehicle. The cylindrical member **1001** and the cylindrical member **1002** are arranged in parallel. In the present embodiment, the cylindrical members **1001** and **1002** perpendicularly cross the upper frame members **901** and **911**. The cylindrical member **1002** is also connected to the upper frame member **902** and the upper frame member **912**.

[0049] Reference numerals **1003** and **1004** denote cylindrical members that connect the upper frame member **902** and the upper frame member **912** and extend in the horizontal direction of the vehicle. The cylindrical member **1003** and the cylindrical member **1004** are arranged in parallel. In the present embodiment, the cylindrical members **1003** and **1004** perpendicularly cross the upper frame members **902** and **912**. Reference numerals **1011** and **1012** denote reinforcing members extending in the horizontal direction of the vehicle.

[0050] Reference numerals **981** and **991** denote cylindrical members partially extending in the longitudinal direction of the vehicle and partially extending in a direction diagonally crossing the longitudinal direction of the vehicle. One end of the cylindrical member **981** is connected to the cylindrical member **1001** and extends through the reinforcing member **1011**, and the other end is connected to the upper frame member **901**. One end of the cylindrical member **991** is connected to the cylindrical member **1001** and extends through the reinforcing member **1011**, and the other end is connected to the upper frame member **911**.

[0051] Reference numerals **951** and **961** denote a pair of lower frame members extending in the longitudinal direction of the vehicle. The lower frame members **951** and **961** are parallel to the upper frame members **901**, **902**, **911**, and **912**. Reference numerals **971** and **972** denote cylindrical members that connect the lower frame member **951** and the lower frame member **961** and extend in the horizontal direction of the vehicle. Reference numerals **1021** and **1022** denote cylindrical members that connect the upper frame member **902**, the lower frame member **951**, the lower frame member **961**, and the upper frame member **912**. The cylindrical member **1021** and the cylindrical member **1022** are partially bent and have an L shape. Reference numeral **973** denotes a reinforcing member extending in the horizontal direction of the vehicle and connected to the lower frame member **951** and the lower frame member **961**.

[0052] Reference numerals **1151** and **1161** denote a pair of vertical frame members extending in the vertical direction of the vehicle. The vertical frame member **1151** and the vertical frame member **1161** are parallel to each other. The vertical frame member **1151** connects the cylindrical member **1001** and the lower frame member **951**. The vertical frame member **1161** connects the cylindrical member **1001** and the lower frame member **961**.

[0053] Reference numerals **1153** and **1163** denote a pair of vertical frame members extending in the vertical direction of the vehicle. The vertical frame member **1153** and the vertical frame member **1163** are parallel to each other. The vertical frame member **1153** connects the cylindrical member **1002** and the lower frame member **951**. The vertical frame member **1163** connects the cylindrical member **1002** and the lower frame member **961**.

[0054] Reference numerals **1155** and **1165** denote a pair of vertical frame members extending in the vertical direction of the vehicle. The vertical frame member **1155** and the vertical frame member **1165** are parallel to each other. The vertical frame member **1155** connects the cylindrical member **1003** and the reinforcing member **973**. The vertical frame member **1165** connects the cylindrical member **1003** and the reinforcing member **973**.

[0055] Reference numerals **952** and **962** denote a pair of middle frame members extending in the longitudinal direction of the vehicle. The middle frame members **952** and **962** are positioned between the upper frame member and the lower frame member in the vertical direction of the vehicle. One end of the middle frame member **952** is connected to the vertical frame member **1155**. One end of the middle frame member **962** is connected to the vertical frame member **1165**.

[0056] Reference numeral **1152** denotes a reinforcing member that connects the upper frame member **901** and the vertical frame member **1151** and extends obliquely with respect to both members. Reference numeral **1162** denotes a reinforcing member that connects the upper frame member **911** and the vertical frame member **1161** and extends obliquely with respect to both members. Reference numeral **1154** denotes a reinforcing member that connects the upper frame member **901** and the vertical frame member **1153** and extends obliquely with respect to both members. Reference numeral **1164** denotes a reinforcing member that connects the upper frame member **911** and the vertical frame member **1163** and extends obliquely with respect to both members.

[0057] Reference numeral **1156** denotes a reinforcing member that connects the upper frame member **902** and the vertical frame member **1155** and extends obliquely with respect to both members. Note that a reinforcing member **1166** is also arranged on the left side of the vehicle so as to be symmetric with the reinforcing member **1156**, and the reinforcing member **1166** is a reinforcing member that connects the upper frame member **912** and the vertical frame member **1165** and extends obliquely with respect to both members.

[0058] A battery (not illustrated) can be housed in a central space of the internal structure **90**. More specifically, the battery (not illustrated) is housed in an internal space defined by the upper frame members **902** and **912**, the lower frame members **951** and **961**, the cylindrical members **1002** and **1003**, the cylindrical members **1021** and **1022**, and the vertical frame members **1153**, **1163**, **1155**, and **1165**. The battery can be placed or lowered from above the vehicle through an opening defined by the upper frame members **902** and **912** and the cylindrical members **1002** and **1003**. Accordingly, the battery can be loaded and unloaded without lifting up the vehicle **10**.

[0059] In addition, by providing the L-shaped cylindrical members **1021** and **1022** on the side of the battery (not illustrated), the vehicle body rigidity can be secured, and the battery can be protected from the impact of a side collision.

[0060] When the vehicle **10** is viewed from the front, the internal structure **90** has a trapezoidal shape with a narrow lower portion and a wide upper portion. As a result, the load of the cargo placed on the cargo bed at the vehicle rear can be efficiently supported, and internal components such as a battery can be arranged on the lower frame members **951** and **961** having high strength. Therefore, it is possible to protect the battery in the case where the vehicle **10** goes over an obstacle etc. or the vehicle is bumped up on a rough road.

Fourth Embodiment

[0061] Furthermore, an example of superimposition of vehicles according to an embodiment will be described with reference to FIGS. **12** and **13**. FIG. **12** is an explanatory diagram before superimposition of vehicles according to the embodiment. FIG. **13** is an explanatory diagram after superimposition of vehicles according to the embodiment.

[0062] As illustrated in FIG. **12**, a rack **1251** is placed on a cargo bed of a vehicle **10***a*, and a ladder rail **1252** is connected to the rack **1251**. In this state, a vehicle **10***b* rides on the ladder rail **1252** and moves forward, and after the superimposition, the ladder rail **1252** is removed. As a result, a superimposed state is obtained as illustrated in FIG. **13**. Further, the vehicle **10***b* may be fixed to the rack **1251** after the superimposition.

[0063] In this manner, a rack on which another vehicle of the same model can be loaded and fixed is used on the cargo bed of the vehicle. As a result, since two vehicles can be arranged with respect to the footprint of one vehicle, the storage cost and the transportation cost can be reduced. In addition, in a case where a certain vehicle cannot travel due to a failure, a power failure, or the like, another vehicle can provide assistance. Therefore, it is possible to efficiently operate at low cost while not operating as a work vehicle (during non-operation).

SUMMARY OF EMBODIMENTS

[0064] 1. The vehicle (**10**) according to the above embodiments is a vehicle comprising:

[0065] a rotary reference LiDAR (**104**);

[0066] a plurality of fixed LiDARs (**105~109**); and

[0067] a processing unit (**102**) configured to execute aiming processing of the plurality of fixed LiDARs using the reference LiDAR.

[0068] Thus, aiming of a fixed LiDAR can be easily performed. Therefore, efficient aiming can be achieved.

[0069] 2. In the vehicle (**10**) according to the above embodiments,

[0070] the reference LiDAR has a view angle range (**301**) of 360 degrees in a yaw direction;

[0071] each of the plurality of fixed LiDARs has a predetermined view angle range (**302**) in the yaw direction; and

[0072] the view angle range of the reference LiDAR and the view angle range of each fixed LiDAR at least partially overlap.

[0073] Thus, by arranging the target in an arbitrary position in the overlapping range and acquiring data, it is possible to aim the fixed LiDAR using the data of the reference LiDAR.

[0074] 3. The vehicle (**10**) according to the above embodiments, further comprising a stand (**110**) that is movable up and down, wherein

[0075] the reference LiDAR is fixed to the stand, and

[0076] the reference LiDAR is movable up and down in accordance with a lifting and lowering operation of the stand.

[0077] Thus, by performing the aiming processing in a state where the stand is lowered, the aiming processing can be performed at a position closer to the vehicle, and the aiming can be performed even in a narrow space.

[0078] 4. In the vehicle (**10**) according to the above embodiments, the stand is installed at a front upper portion of the vehicle.

[0079] Thus, it is possible to prevent the vehicle itself from creating a blind spot when detecting the reference LiDAR.

[0080] 5. In the vehicle (**10**) according to the above embodiments, the processing unit executes aiming processing of the plurality of fixed LiDARs in a state where the reference LiDAR is lowered.

[0081] Thus, by performing the aiming processing in a state where the reference LiDAR is lowered, the aiming processing can be performed at a position closer to the vehicle, and the aiming can be performed even in a narrow space.

[0082] 6. In the vehicle (**10**) according to the above embodiments, a position (L**2**) of an overlapping region (**803**) between the view angle range (**801**) of the reference LiDAR and the view angle range (**802**) of each fixed LiDAR in a state where the reference LiDAR is lowered is closer to the reference LiDAR than a position (L**1**) of an overlapping region (**703**) between the view angle range (**701**) of the reference LiDAR and the view angle range (**702**) of each fixed LiDAR in a state where the reference LiDAR is lifted.

[0083] Thus, in a state where the reference LiDAR is lowered, the aiming processing can be performed at a position closer to the vehicle, and the aiming can be performed even in a narrow space.

[0084] 7. In the vehicle (**10**) according to the above embodiments, the plurality of fixed LiDARs include:

[0085] a front LiDAR (**105**) arranged at a front of the vehicle and having a predetermined view angle range around the front,

[0086] a front right LiDAR (**106**) arranged on a front right side of the vehicle and having a predetermined view angle range around a front right direction,

[0087] a front left LiDAR (**107**) arranged on a front left side of the vehicle and having a predetermined view angle range around a front left direction,

[0088] a rear right LiDAR (**108**) arranged on a rear right side of the vehicle and having a predetermined view angle range around a rear right direction, and

[0089] a rear left LiDAR (**109**) arranged on a rear left side of the vehicle and having a predetermined view angle range around a rear left direction.

[0090] Thus, it is possible to secure sufficient detection accuracy for performing automated driving of the vehicle by autonomous control.

[0091] 8. In the vehicle (**10**) according to the above embodiments, the reference LiDAR is detachable from the vehicle.

[0092] Thus, the reference LiDAR can be removed at the time of work by the vehicle, and the reference LiDAR can be attached at the time of aiming of the fixed LiDAR. By using a reference LiDAR that is generally expensive and less likely to satisfy durability requirements for adjustment of other fixed LiDARs and removing the reference LiDAR during actual operation of the vehicle, it is possible to use one reference LiDAR for aiming of fixed LiDARs of a plurality of vehicles.

[0093] According to the present invention, efficient aiming can be achieved.

Other Embodiments

[0094] In addition, a program for implementing one or more functions that have been described in each of the embodiments is supplied to a system or a device through a network or a storage medium, and one or more processors on a computer of the system or the device are capable of reading and executing the program. The present invention can also be implemented in such an aspect.

[0095] The invention is not limited to the foregoing embodiments, and various variations/changes are possible within the spirit of the invention.

What is claimed is:

1. A vehicle comprising:

a rotary reference LiDAR;

a plurality of fixed LiDARs; and

a processing unit configured to execute aiming processing of the plurality of fixed LiDARs using the reference LiDAR.

2. The vehicle according to claim **1**, wherein:

the reference LiDAR has a view angle range of 360 degrees in a yaw direction;

each of the plurality of fixed LiDARs has a predetermined view angle range in the yaw direction; and

the view angle range of the reference LiDAR and the view angle range of each fixed LiDAR at least partially overlap.

3. The vehicle according to claim **2** further comprising a stand that is movable up and down, wherein

the reference LiDAR is fixed to the stand, and

the reference LiDAR is movable up and down in accordance with a lifting and lowering operation of the stand.

4. The vehicle according to claim **3**, wherein the stand is installed at a front upper portion of the vehicle.

5. The vehicle according to claim **3**, wherein the processing unit executes aiming processing of the plurality of fixed LiDARs in a state where the reference LiDAR is lowered.

6. The vehicle according to claim **3**, wherein a position of an overlapping region between the view angle range of the reference LiDAR and the view angle range of each fixed LiDAR in a state where the reference LiDAR is lowered is closer to the reference LiDAR than a position of an overlapping region between the view angle range of the reference LiDAR and the view angle range of each fixed LiDAR in a state where the reference LiDAR is lifted.

7. The vehicle according to claim **1**, wherein
the plurality of fixed LiDARs include:
a front LiDAR arranged at a front of the vehicle and having a predetermined view angle range around the front,
a front right LiDAR arranged on a front right side of the vehicle and having a predetermined view angle range around a front right direction,
a front left LiDAR arranged on a front left side of the vehicle and having a predetermined view angle range around a front left direction,
a rear right LiDAR arranged on a rear right side of the vehicle and having a predetermined view angle range around a rear right direction, and
a rear left LiDAR arranged on a rear left side of the vehicle and having a predetermined view angle range around a rear left direction.

8. The vehicle according to claim **1**, wherein the reference LiDAR is detachable from the vehicle.

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