US 20250256793A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2025/0256793 A1
(43) Pub. Date: Aug. 14, 2025
IWAHORI et al.

(54) SYSTEM, ASSEMBLY DEVICE, AND MOVING OBJECT

(71) Applicant: TOYOTA JIDOSHA KABUSHIKI KAISHA, Toyota-sh (JP)

(72) Inventors: Kento IWAHORI, Nagoya-shi (JP); Daiki YOKOYAMA, Miyoshi-shi (JP); Yasuhiro SAITO, Toyoake-shi (JP)

(73) Assignee: TOYOTA JIDOSHA KABUSHIKI KAISHA, Toyota-shi (JP)

(21) Appl. No.: 19/037,418

(22) Filed: Jan. 27, 2025

(30) Foreign Application Priority Data

Feb. 14, 2024 (JP) ................................ 2024-020294

Publication Classification

(51) Int. Cl.
B62D 65/18 (2006.01)
B62D 65/02 (2006.01)

(52) U.S. Cl.
CPC .......... B62D 65/18 (2013.01); B62D 65/024 (2013.01)

(57) ABSTRACT

The system includes a control command unit configured to transmit to a moving object running by unmanned driving a first control command for stopping the moving object at a first position, and a determination unit configured to determine whether a first stop position at which the moving object has been stopped according to the first control command is a work position suitable for the assembly of the part. When the determination unit determines that the first stop position is not the work position, the control command unit transmits to the moving object a second control command for moving the moving object to a second position where the assembly of the part is performed.

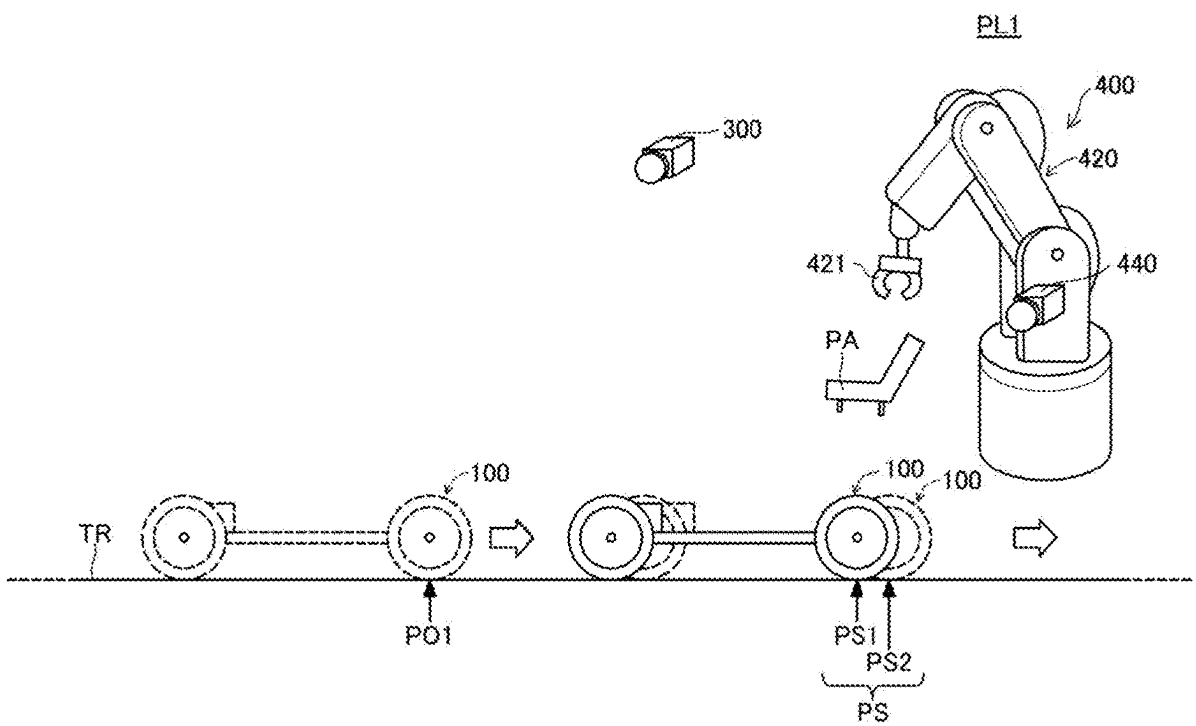


Fig.1

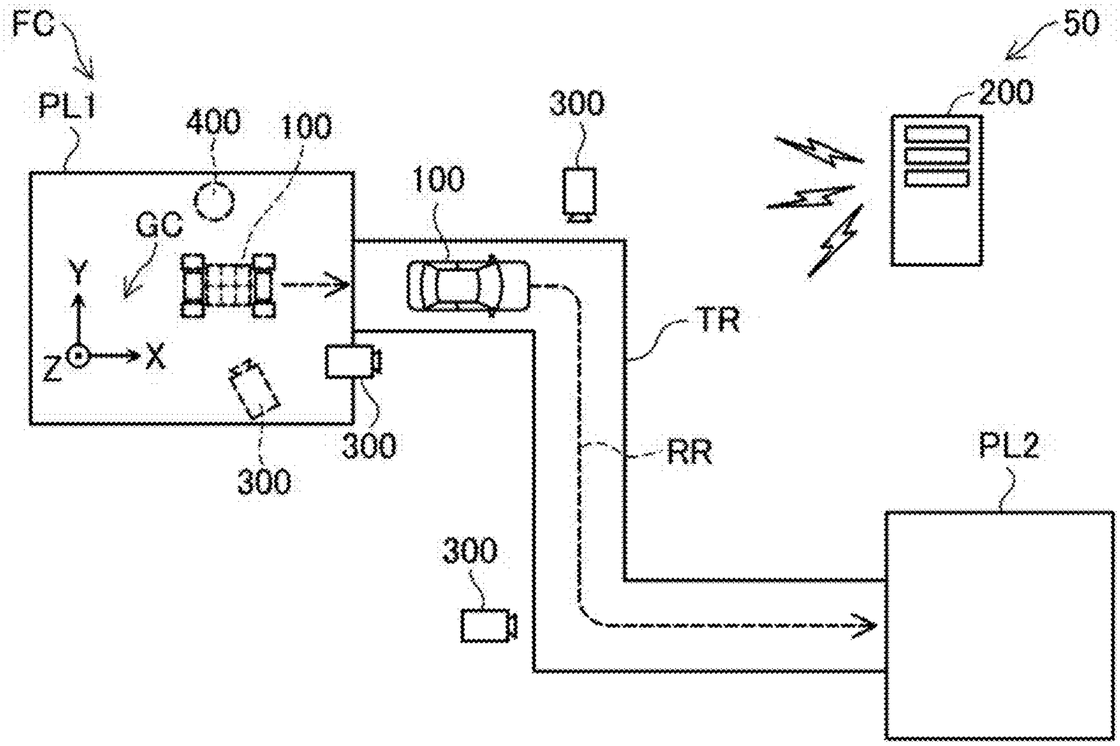


Fig.2

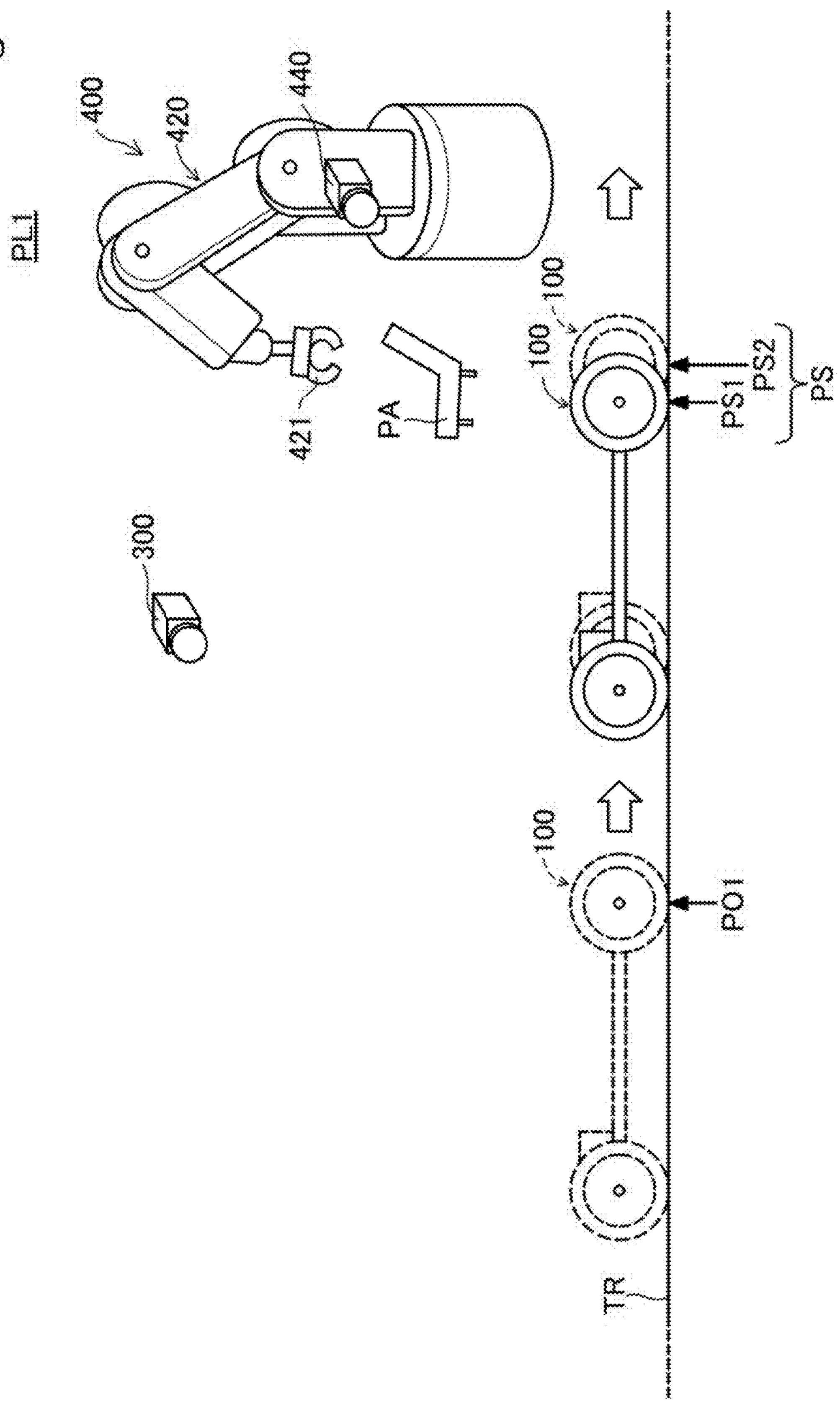
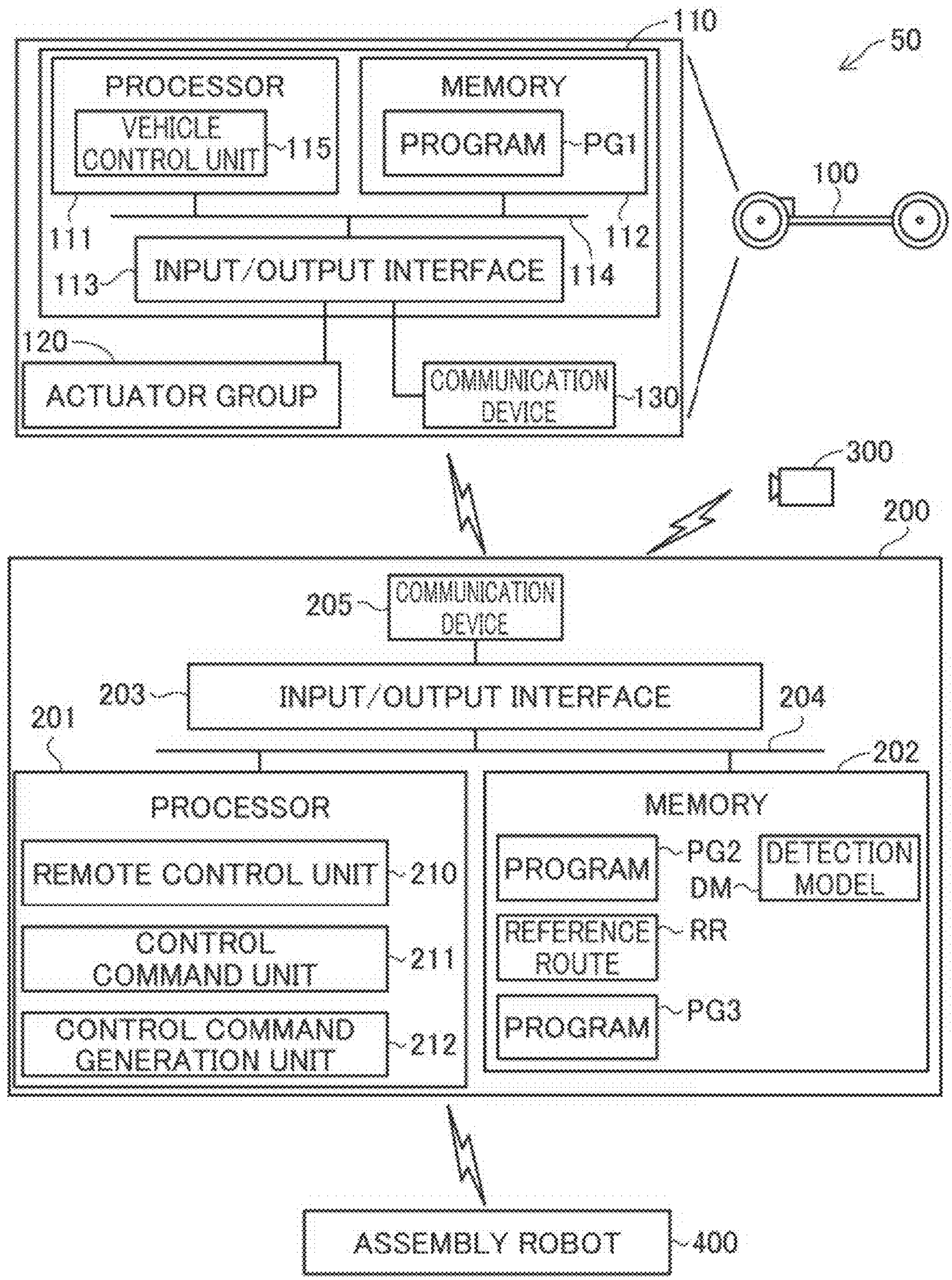


Fig.3



110
50
PROCESSOR
VEHICLE CONTROL UNIT
115
MEMORY
PROGRAM
PG1
100
111
112
114
113
INPUT/OUTPUT INTERFACE
120
ACTUATOR GROUP
COMMUNICATION DEVICE
130
300
200
205
COMMUNICATION DEVICE
203
INPUT/OUTPUT INTERFACE
204
201
202
PROCESSOR
REMOTE CONTROL UNIT
210
CONTROL COMMAND UNIT
211
CONTROL COMMAND GENERATION UNIT
212
MEMORY
PROGRAM
PG2
DM
DETECTION MODEL
REFERENCE ROUTE
RR
PROGRAM
PG3
ASSEMBLY ROBOT
400

Fig.4

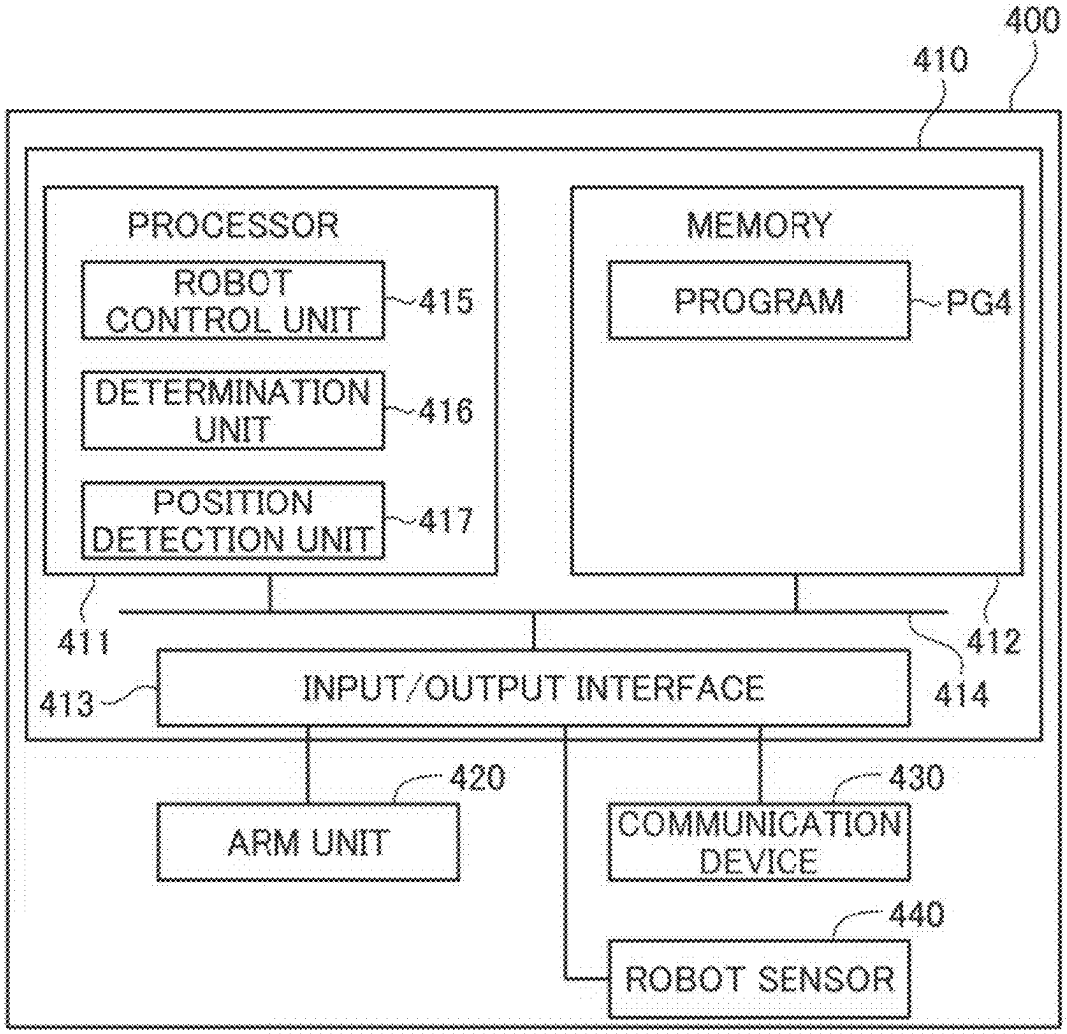

400
410
PROCESSOR
ROBOT CONTROL UNIT
415
DETERMINATION UNIT
416
POSITION DETECTION UNIT
417
MEMORY
PROGRAM
PG4
411
412
413
INPUT/OUTPUT INTERFACE
414
420
ARM UNIT
430
COMMUNICATION DEVICE
440
ROBOT SENSOR

Fig.5

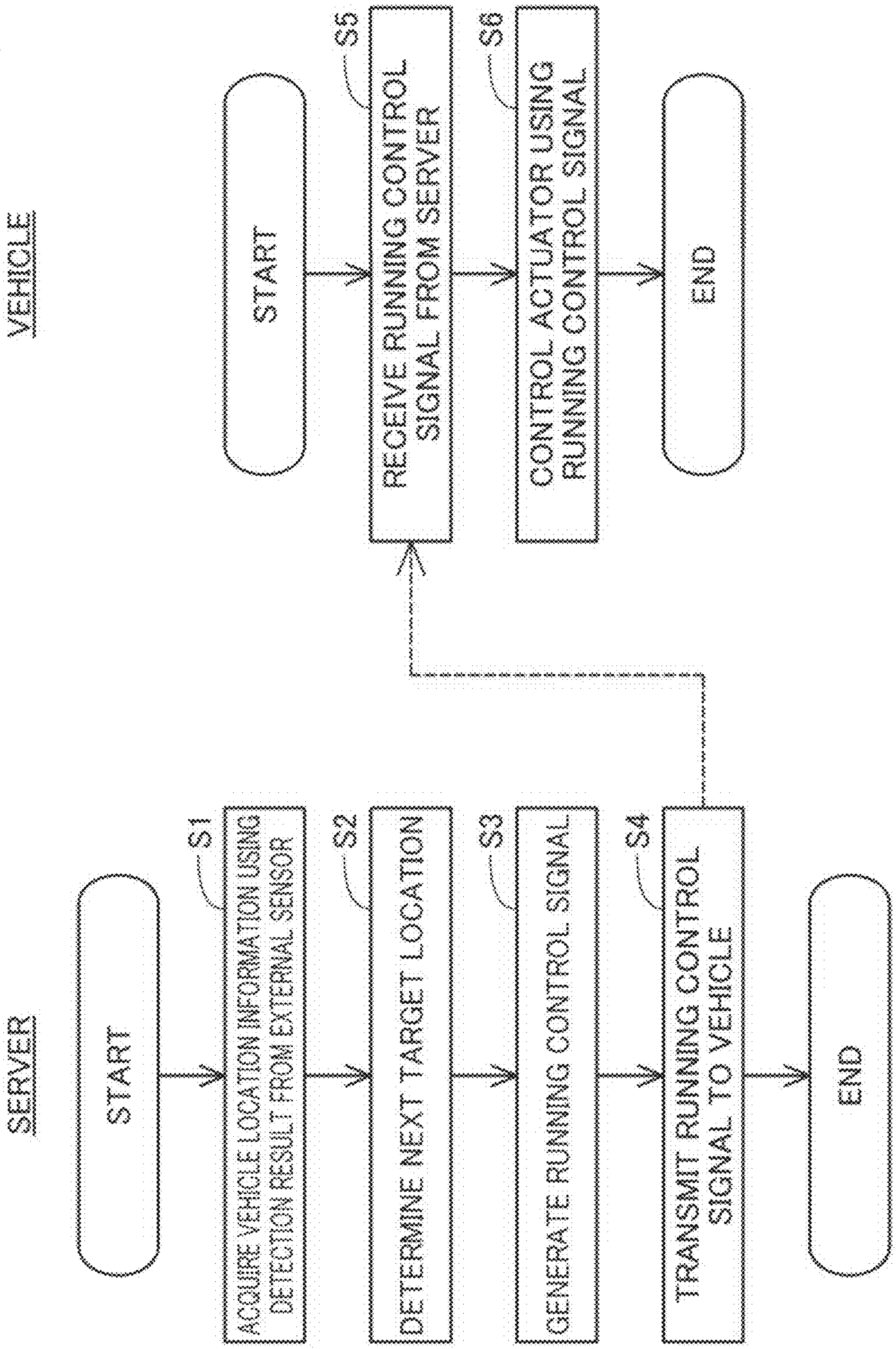
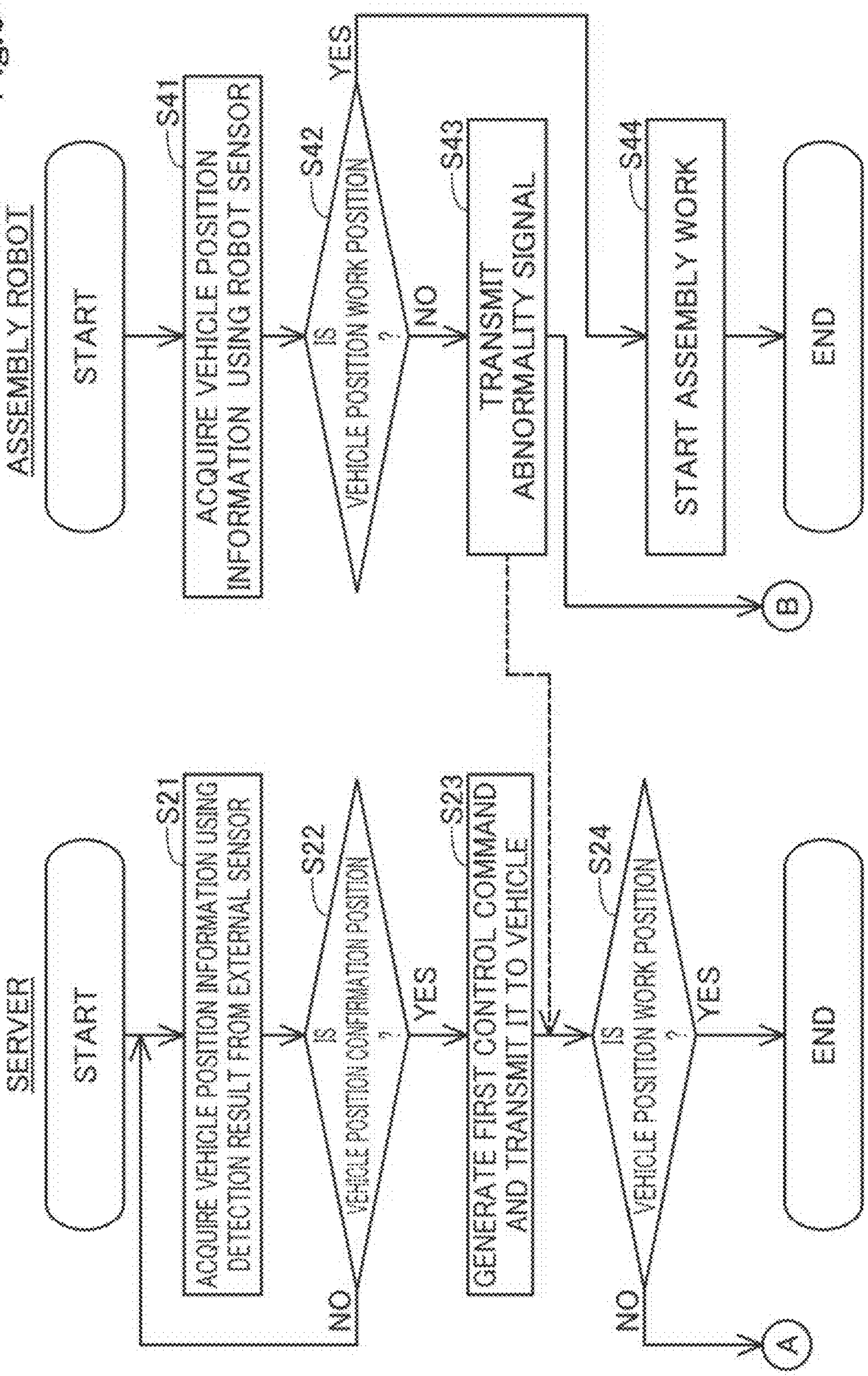

SERVER
START
S1
ACQUIRE VEHICLE LOCATION INFORMATION USING DETECTION RESULT FROM EXTERNAL SENSOR
S2
DETERMINE NEXT TARGET LOCATION
S3
GENERATE RUNNING CONTROL SIGNAL
S4
TRANSMIT RUNNING CONTROL SIGNAL TO VEHICLE
END
VEHICLE
START
S5
RECEIVE RUNNING CONTROL SIGNAL FROM SERVER
S6
CONTROL ACTUATOR USING RUNNING CONTROL SIGNAL
END

Fig.6


ASSEMBLY ROBOT
START
S41
ACQUIRE VEHICLE POSITION INFORMATION USING ROBOT SENSOR
S42
IS VEHICLE POSITION WORK POSITION ?
YES
NO
S43
TRANSMIT ABNORMALITY SIGNAL
S44
START ASSEMBLY WORK
END
B
SERVER
START
S21
ACQUIRE VEHICLE POSITION INFORMATION USING DETECTION RESULT FROM EXTERNAL SENSOR
S22
IS VEHICLE POSITION CONFIRMATION POSITION ?
YES
NO
S23
GENERATE FIRST CONTROL COMMAND AND TRANSMIT IT TO VEHICLE
S24
IS VEHICLE POSITION WORK POSITION ?
YES
NO
END
A

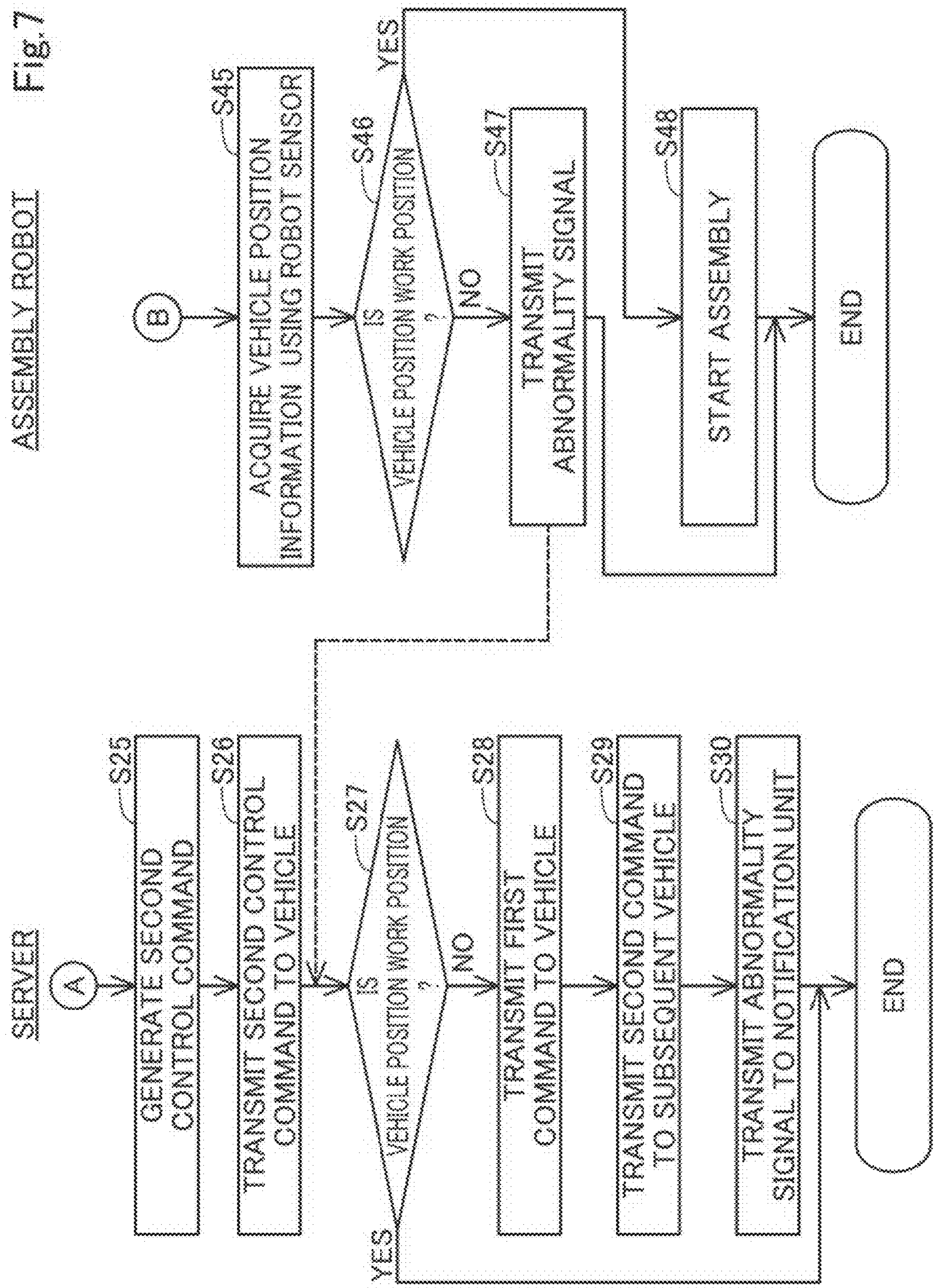

SERVER
A
GENERATE SECOND CONTROL COMMAND
S25
TRANSMIT SECOND CONTROL COMMAND TO VEHICLE
S26
IS VEHICLE POSITION WORK POSITION ?
S27
YES
NO
TRANSMIT FIRST COMMAND TO VEHICLE
S28
TRANSMIT SECOND COMMAND TO SUBSEQUENT VEHICLE
S29
TRANSMIT ABNORMALITY SIGNAL TO NOTIFICATION UNIT
S30
END
ASSEMBLY ROBOT
B
ACQUIRE VEHICLE POSITION INFORMATION USING ROBOT SENSOR
S45
IS VEHICLE POSITION WORK POSITION ?
S46
YES
NO
TRANSMIT ABNORMALITY SIGNAL
S47
START ASSEMBLY
S48
END
Fig. 7

Fig.8

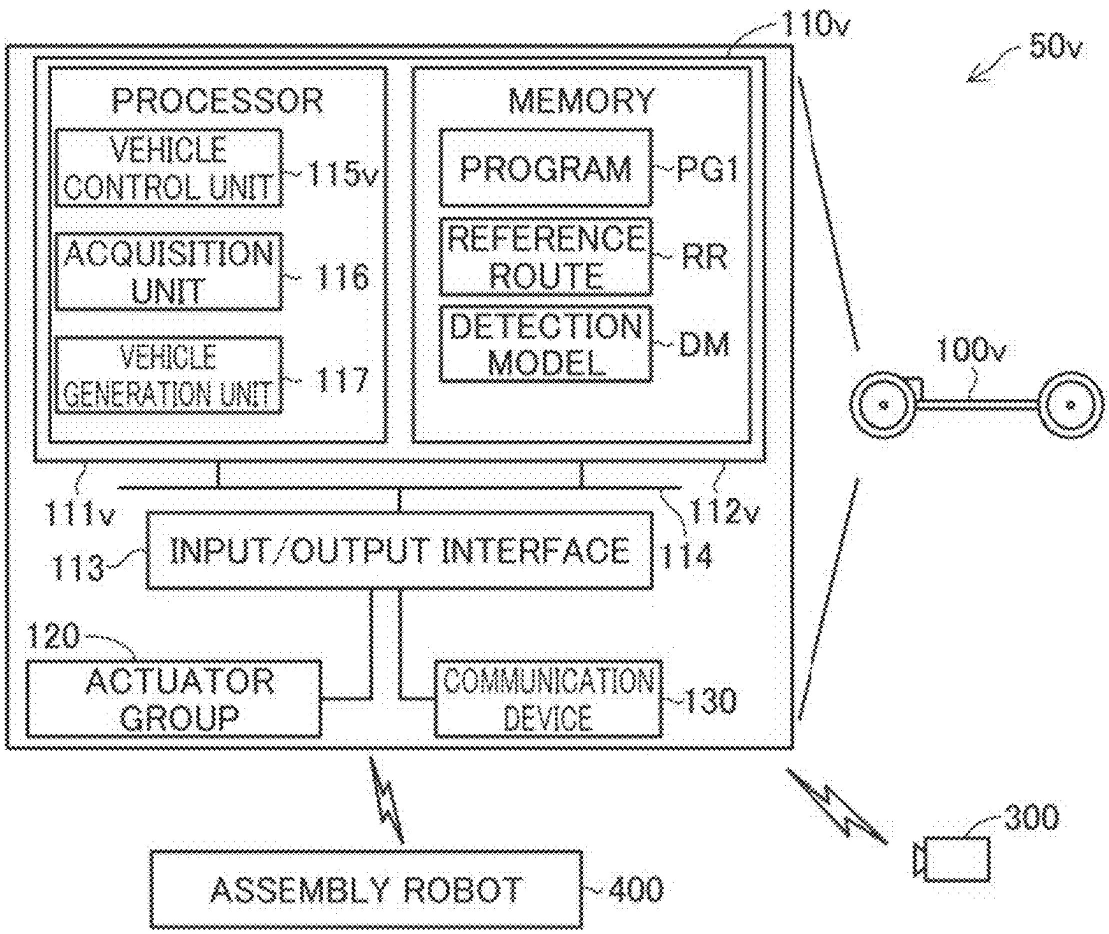
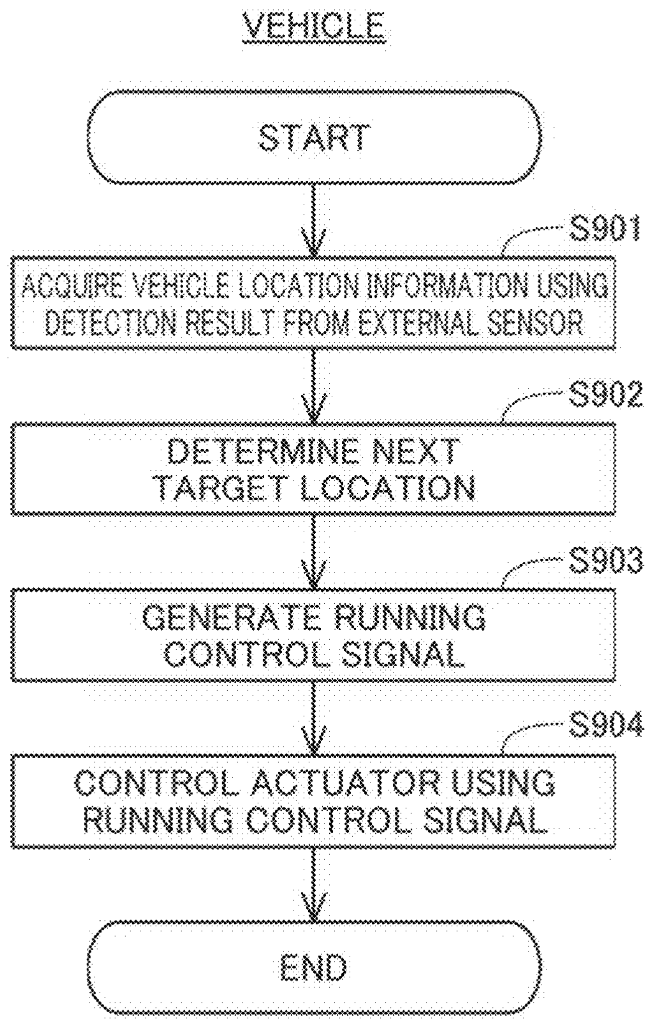

110v
50v
PROCESSOR
VEHICLE CONTROL UNIT
115v
ACQUISITION UNIT
116
VEHICLE GENERATION UNIT
117
MEMORY
PROGRAM
PG1
REFERENCE ROUTE
RR
DETECTION MODEL
DM
100v
111v
112v
114
113
INPUT/OUTPUT INTERFACE
120
ACTUATOR GROUP
COMMUNICATION DEVICE
130
300
ASSEMBLY ROBOT
400

Fig.9


VEHICLE
START
S901
ACQUIRE VEHICLE LOCATION INFORMATION USING DETECTION RESULT FROM EXTERNAL SENSOR
S902
DETERMINE NEXT TARGET LOCATION
S903
GENERATE RUNNING CONTROL SIGNAL
S904
CONTROL ACTUATOR USING RUNNING CONTROL SIGNAL
END

# SYSTEM, ASSEMBLY DEVICE, AND MOVING OBJECT

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims priority to Japanese Patent Application No. 2024-20294 filed on Feb. 14, 2024, which is incorporated herein by reference in its entirety.

## BACKGROUND

### Field

**[0002]** The present disclosure relates to a system, an assembly device, and a moving object.

### Related Art

**[0003]** Japanese Translation of PCT International Application Publication No. 2017-538619 discloses a method for operating a vehicle running in a production system by remote control.

**[0004]** In a vehicle production step, as a method for producing a vehicle by assembling parts onto an uncompleted vehicle that is capable of running by unmanned driving, a method of stopping a running vehicle at a stop position to perform assembly may be performed. In this method, the vehicle may stop at a position displaced from the stop position. In this case, the assembly may not be performed properly. This problem is common to both vehicles and moving objects.

## SUMMARY

**[0005]** According to one aspect of the present disclosure, a system is provided. This system includes a control command unit that transmits to a moving object running by unmanned driving a first control command for stopping the moving object at a first position where assembly of a part is scheduled to be performed, and a determination unit that determines whether a first stop position at which the moving object has been stopped according to the first control command is a work position suitable for the assembly of the part. When the determination unit determines that the first stop position is not the work position, the control command unit transmits to the moving object a second control command for moving the moving object to a second position where the assembly of the part is performed.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** FIG. **1** is a conceptual diagram showing a structure of a system;

**[0007]** FIG. **2** is a diagram describing stationary assembly;

**[0008]** FIG. **3** is a block diagram showing a structure of the system;

**[0009]** FIG. **4** is a block diagram showing a structure of an assembly robot;

**[0010]** FIG. **5** is a flowchart showing procedures in the process of running control of a vehicle;

**[0011]** FIG. **6** is a first flowchart showing procedures of stationary assembly control;

**[0012]** FIG. **7** is a second flowchart showing procedures of the stationary assembly control;

**[0013]** FIG. **8** is an explanatory view showing a schematic structure of a system according to a second embodiment; and

**[0014]** FIG. **9** is a flowchart showing procedures in the process of running control of a vehicle in the second embodiment.

## DETAILED DESCRIPTION

### A. First Embodiment

**[0015]** FIG. **1** is a conceptual diagram showing a structure of a system **50** in a first embodiment. The system **50** includes one or more vehicles **100** as moving objects, a server **200**, one or more external sensors **300**, and an assembly robot **400**.

**[0016]** In the present disclosure, the "moving object" means an object capable of moving, and is a vehicle or an electric vertical takeoff and landing aircraft (so-called flying-automobile), for example. The vehicle may be a vehicle to run with a wheel or may be a vehicle to run with a continuous track, and may be a passenger car, a truck, a bus, a two-wheel vehicle, a four-wheel vehicle, a combat vehicle, or a construction vehicle, for example. The vehicle includes a battery electric vehicle (BEV), a gasoline automobile, a hybrid automobile, and a fuel cell automobile. When the moving object is other than a vehicle, the term "vehicle" or "car" in the present disclosure is replaceable with a "moving object" as appropriate, and the term "run" is replaceable with "move" as appropriate.

**[0017]** The vehicle **100** is configured to be capable of running by unmanned driving. The "unmanned driving" means driving independent of running operation by a passenger. The running operation means operation relating to at least one of "run," "turn," and "stop" of the vehicle **100**. The unmanned driving is realized by automatic remote control or manual remote control using a device provided outside the vehicle **100** or by autonomous control by the vehicle **100**. A passenger not involved in running operation may be on-board a vehicle running by the unmanned driving. The passenger not involved in running operation includes a person simply sitting in a seat of the vehicle **100** and a person doing work such as assembly, inspection, or operation of switches different from running operation while on-board the vehicle **100**. Driving by running operation by a passenger may also be called "manned driving."

**[0018]** In the present specification, the "remote control" includes "complete remote control" by which all motions of the vehicle **100** are completely determined from outside the vehicle **100**, and "partial remote control" by which some of the motions of the vehicle **100** are determined from outside the vehicle **100**. The "autonomous control" includes "complete autonomous control" by which the vehicle **100** controls a motion of the vehicle **100** autonomously without receiving any information from a device outside the vehicle **100**, and "partial autonomous control" by which the vehicle **100** controls a motion of the vehicle **100** autonomously using information received from a device outside the vehicle **100**.

**[0019]** In this embodiment, the system **50** is used in a factory FC that manufactures the vehicle **100**. The reference coordinate system of the factory FC is a global coordinate system and a location in the factory can be expressed by X, Y, and Z coordinates in the global coordinate system GC. The factory FC has a first place PL**1** and a second place PL**2**. The first place PL**1** and the second place PL**2** are connected by a runway TR on which the vehicle **100** can travel. The factory FC, along the runway TR, a plurality of external sensors **300** are installed. The position of the external sensors **300** in the shop FC is adjusted in advance. The vehicle **100** travel through the runway TR from the first place PL**1** to the second place PL**2** by unmanned operation.

**[0020]** In the present embodiment, at a first place PL**1**, an assembly step of a part PA is performed on the vehicle **100**, which is in the form of a platform. Then, the vehicle **100** that has completed the assembly moves to a second place PL**2** where the next step is performed. The vehicle **100**, which is in the form of a platform, includes at least a vehicle control device **110**, an actuator group **120**, and a communication device **130**, in order to perform the three functions, "running," "turning," and "stopping," through unmanned driving.

**[0021]** FIG. **2** is a diagram describing assembly of the part PA onto the vehicle **100** at the first place PL**1**. As shown in FIG. **2**, an assembly robot **400** serving as an assembly device is disposed at the first place PL**1** along a track TR of the vehicle **100**. In the present disclosure, the track on which the vehicle **100** runs within the first place PL**1** is also referred to as the track TR.

**[0022]** In the present embodiment, the assembly robot **400** is a vertical articulated robot. The assembly robot **400** includes an arm unit **420** and a robot sensor **440**. An end effector **421** for gripping the part PA is attached to the top end portion of the arm unit **420**.

**[0023]** The vehicle **100** runs by unmanned driving in the direction shown by the arrow in FIG. **2**, and stops in the vicinity of the assembly robot **400**. Then, the part PA is assembled by the assembly robot **400** onto the vehicle **100** which is in a stationary state. Such a method of assembling the part PA onto the vehicle **100** in the form of a stationary platform is also referred to as "stationary assembly". In contrast, a method of assembling the part PA onto the vehicle **100** in the form of a moving platform, which is different from the present embodiment, is also referred to as "moving assembly". The "stationary assembly" has an advantage that the accuracy required for the control of the vehicle **100** and the robot sensor **440** is often lower than the accuracy required in the "moving assembly."

**[0024]** In the "stationary assembly," a stop position PS of the vehicle **100** may deviate from the proper position. According to the present embodiment described below, the part PA can be assembled even when the stop position of the vehicle **100** deviates from the proper position.

**[0025]** FIG. **3** is a block diagram showing the configuration of the system **50**. The vehicle **100** includes a vehicle control device **110** for controlling the various parts of the vehicle **100**, an actuator group **120** including one or more actuators driven under the control of the vehicle control device **110**, and a communication device **130** for communicating by wireless communication with an external device such as a server **200**. The actuator group **120** includes an actuator of a drive for accelerating the vehicle **100**, an actuator of a steering system for changing the direction of travel of the vehicle **100**, and an actuator of a braking system for decelerating the vehicle **100**.

**[0026]** The vehicle control device **110** is constituted by a computer including a processor **111**, a memory **112**, I/O interface **113**, and an internal bus **114**. The processor **111**, memory **112**, and the I/O interface **113** are bidirectionally communicatively connected via an internal bus **114**. An actuator group **120** and a communication device **130** are connected to the I/O interface **113**. The processor **111** implements various functions, including functions as Vehicle control unit **115**, by executing program PG**1** stored in the memories **112**.

**[0027]** Vehicle control unit **115**, by controlling the actuator group **120**, to run the vehicle **100**. Vehicle control unit **115** by controlling the actuator group **120** using the travel control signal received from the server **200**, it is possible to travel the vehicle **100**. The travel control signal is a control signal for traveling the vehicle **100**. In this embodiment, the travel control signal includes the acceleration and steering angle of the vehicle **100** as parameters. In other embodiments, the travel control signal may include the speed of the vehicle **100** as a parameter in lieu of or in addition to the acceleration of the vehicle **100**.

**[0028]** The server **200** is comprised of a computer including a processor **201**, a memory **202**, an input/output interface **203**, and an internal bus **204**. The processor **201**, memory **202**, and I/O interface **203** are bidirectionally communicatively connected via an internal bus **204**. The I/O interface **203** is connected to a communication device **205** for communicating with various devices external to the server **200**. Communication device **205** may communicate with vehicle **100** via wireless communication and may communicate with each external sensor **300** via wired or wireless communication. The processor **201** executes the program PG**2** stored in the memory **202** to realize various functions including functions as the remote control unit **210**.

**[0029]** The remote control unit **210** acquires a detection result by the sensor, generates a travel control signal for controlling the actuator group **120** of the vehicle **100** using the detection result, and transmits a travel control signal to the vehicle **100**, thereby causing the vehicle **100** to travel by remote control. The remote control unit **210** may generate and output not only a travel control signal but also a control signal for controlling various accessories provided in the vehicle **100** and actuators for operating various equipments such as a wiper, a power window, and a lamp. That is, the remote control unit **210** may operate such various equipments and various accessories by remote control.

**[0030]** In addition to the above structure, the processor **201** includes a control command unit **211** and a control command generation unit **212**. In addition to the above structure, the memory **202** stores a program PG**3**. The control command unit **211** and the control command generation unit **212** are functional units implemented by executing the program PG**3**. The server **200** functions as a control device for controlling the vehicle **100** in the assembly step.

**[0031]** The external sensor **300** is a sensor located outside the vehicle **100**. The external sensor **300** in this embodiment is a sensor for capturing the vehicle **100** from the outside of the vehicle **100**. The external sensor **300** includes a communication device (not shown) and can communicate with other devices, such as the server **200**, via wired or wireless communication.

**[0032]** Specifically, the external sensor **300** includes a camera. The camera as the external sensor **300** captures images of the vehicle **100** and outputs the captured images as detection results.

**[0033]** FIG. **4** is a block diagram showing a structure of the assembly robot **400**. In addition to the above structure, the assembly robot **400** includes a robot control device **410** and a communication device **430**.

**[0034]** The robot control device **410** includes a computer with a processor **411**, a memory **412**, an input/output interface **413**, and an internal bus **414**. The processor **411**, the memory **412**, and the input/output interface **413** are connected via the internal bus **414** to enable bidirectional communication. The arm unit **420**, the communication device **430**, and the robot sensor **440** are connected to the input/output interface **413**.

**[0035]** In the present embodiment, the processor **411** functions as a robot control unit **415**, a determination unit **416**, and a position detection unit **417** by executing a program PG**4** stored in advance in the memory **412**. The robot control unit **415** controls each unit of the assembly robot **400**, including the arm unit **420**. The communication device **430** serving as the transmission unit and the reception unit is capable of communication with the server **200** and the assembly robot **400** via wired or wireless communication. The robot sensor **440** is a sensor that captures the vehicle **100** from outside of the vehicle **100**. Specifically, the robot sensor **440** includes a camera. The camera as the robot sensor **440** captures images of the vehicle **100** and outputs the captured images as detection results.

**[0036]** As described above, in the first place PL**1**, the vehicle **100** in the form of a platform runs by unmanned driving under the control of the server **200**. The part PA is assembled onto the vehicle **100** stopped at the stop position PS. To describe this, running control by the server **200** is first described below with reference to FIG. **5**.

**[0037]** FIG. **5** is a flowchart showing procedures in the process of running control of the vehicle **100**. In the procedures of the process in FIG. **5**, the processor **201** of the server **200** functions as a remote control unit **210** by executing a program PG**2**. Further, the processor **111** of the vehicle **100** functions as a vehicle control unit **115** by executing a program PG**1**.

**[0038]** In step S**1**, the processor **201** of the server **200** acquires the vehicle-position data using the detection data outputted from the external sensor **300**. Vehicle position information is the underlying position information that generates a travel control signal. In the present embodiment, the vehicle position information includes the position and orientation of the vehicle **100** in the global coordinate system GC of the factory FC. Specifically, in step S**1**, the processor **201** acquires the vehicle position data using the captured images acquired from the cameras that are the external sensors **300**.

**[0039]** More specifically, in step S**1**, the server **200** for example, determines the outer shape of the vehicle **100** from the captured image, calculates the coordinates of a positioning point of the vehicle **100** in a coordinate system of the captured image, namely, in a local coordinate system, and converts the calculated coordinates to coordinates in the global coordinate system, thereby acquiring the location of the vehicle **100**. The outer shape of the vehicle **100** in the captured image may be detected by inputting the captured image to a detection model using artificial intelligence, for example. The detection model is prepared in the system **50** or outside the system **50**. The detection model is stored in advance in a memory of the server **200**, for example. An example of the detection model is a learned machine learning model that was learned so as to realize either semantic segmentation or instance segmentation. For example, a convolution neural network (CNN) learned through supervised learning using a learning dataset is applicable as this machine learning model. The learning dataset contains a plurality of training images including the vehicle **100**, and a label showing whether each region in the training image is a region indicating the vehicle **100** or a region indicating a subject other than the vehicle **100**, for example. In training the CNN, a parameter for the CNN is preferably updated through backpropagation in such a manner as to reduce error between output result obtained by the detection model and the label. The server **200** can acquire the orientation of the vehicle **100** through estimation based on the direction of a motion vector of the vehicle **100** detected from change in location of a feature point of the vehicle **100** between frames of the captured images using optical flow process, for example.

**[0040]** In step S**2**, the server **200** determines a target location to which the vehicle **100** is to move next. In the present embodiment, the target location is expressed by X, Y, and Z coordinates in the global coordinate system. The memory of the server **200** contains a reference route stored in advance as a route along which the vehicle **100** is to run. The route is expressed by a node indicating a departure place, a node indicating a way point, a node indicating a destination, and a link connecting nodes to each other. The server **200** determines the target location to which the vehicle **100** is to move next using the vehicle location information and the reference route. The server **200** determines the target location on the reference route ahead of a current location of the vehicle **100**.

**[0041]** In step S**3**, the server **200** generates a running control signal for causing the vehicle **100** to run toward the determined target location. In the present embodiment, the running control signal includes an acceleration and a steering angle of the vehicle **100** as parameters. The server **200** calculates a running speed of the vehicle **100** from transition of the location of the vehicle **100** and makes comparison between the calculated running speed and a target speed of the vehicle **100** determined in advance. If the running speed is lower than the target speed, the server **200** generally determines an acceleration in such a manner as to accelerate the vehicle **100**. If the running speed is higher than the target speed as, the server **200** generally determines an acceleration in such a manner as to decelerate the vehicle **100**. If the vehicle **100** is on the reference route, server **200** determines a steering angle and an acceleration in such a manner as to prevent the vehicle **100** from deviating from the reference route. If the vehicle **100** is not on the reference route, in other words, if the vehicle **100** deviates from the reference route, the server **200** determines a steering angle and an acceleration in such a manner as to return the vehicle **100** to the reference route. In other embodiments, the running control signal may include the speed of the vehicle **100** as a parameter instead of or in addition to the acceleration of the vehicle **100**.

**[0042]** In step S**4**, the server **200** transmits the generated running control signal to the vehicle **100**. The server **200** repeats the acquisition of vehicle location information, the determination of a target location, the generation of a running control signal, the transmission of the running control signal, and others in a predetermined cycle.

**[0043]** In step S**5**, the vehicle **100** receives the running control signal transmitted from the server **200**. In step S**6**, the vehicle **100** controls an actuator of the vehicle **100** using the received running control signal, thereby causing the vehicle **100** to run at the acceleration and the steering angle indicated by the running control signal. The vehicle **100** repeats the reception of a running control signal and the control over the actuator in a predetermined cycle. According to the system **50** in the present embodiment, it becomes possible to move the vehicle **100** without using a transport unit such as a crane or a conveyor.

**[0044]** Next, the "stationary assembly" is described below with reference to FIG. **6** and FIG. **7**. FIG. **6** is a first flowchart showing procedures of stationary assembly control. FIG. **7** is a second flowchart showing procedures of the stationary assembly control. The server **200** performs the running control shown in FIG. **5**, and also performs the stationary assembly control. The stationary assembly control is used when the current position of the vehicle **100** reaches a confirmation position PO**1**, which is described later. During the "stationary assembly" control, the communication device **205** of the server **200** functions as a reception unit that receives first information, which is described later. During the "stationary assembly" control, the communication device **430** of the assembly robot **400** functions as the transmission unit.

**[0045]** In the step S**21** of FIG. **6**, as in the step S**1**, the control command unit **211** of the server **200** acquires vehicle position information using the detection results output from the external sensor **300**. The vehicle position information includes the position and orientation of the vehicle **100** in a global coordinate system GC of a factory FC.

**[0046]** In the step S**22**, it is determined whether the vehicle position of the vehicle **100** indicated by the vehicle position information is the confirmation position PO**1**. As shown in FIG. **2**, the confirmation position PO**1** is an upstream position in the track TR relative to the stop position PS where the assembly by the assembly robot **400** is performed.

**[0047]** If it is determined in the step S**22** of FIG. **6** that the vehicle position of the vehicle **100** is not the confirmation position PO**1**, the control command unit **211** returns the process to the step S**21** after a predetermined time has elapsed. The predetermined time is, for example, several milliseconds. Here, the confirmation position PO**1** designates position information used to determine whether the vehicle **100** is approaching the stop position PS. For this reason, the confirmation position PO**1** may not be a point in the global coordinate system GC but may be defined including a position range.

**[0048]** If it is determined in the step S**22** that the vehicle position is the confirmation position PO**1**, in the step S**23**, the control command unit **211** generates a first control command and transmits the first control command to the vehicle **100**. The first control command is a signal that directs the vehicle **100** to stop at a first position PS**1**. In the present embodiment, the first control command is more specifically a running control signal set to stop the vehicle **100** at the first position PS**1**. The first position PS**1** is the position where assembly of the part PA by the assembly robot **400** is scheduled. In the present embodiment, the first position PS**1** is expressed in the form of X, Y, Z coordinates in the global coordinate system GC. As in the confirmation position PO**1**, the first position PS**1** may not be a point in the global coordinate system GC but may be defined including a position range. This is because, even if the stop position PS of the vehicle **100** deviates from the optimal position for assembly work, the movement of the arm unit **420** of the assembly robot **400** enables the assembly work while compensating for the positional deviation.

**[0049]** Upon reception of the first control command, as in the step S**6**, the vehicle control unit **115** of the vehicle **100** controls the actuator group **120** so that the vehicle **100** stops at the first position PS**1**.

**[0050]** The assembly robot **400**, when performing assembly work, first confirms whether the position of the stopped vehicle **100** is the proper work position for assembly. Specifically, first, in the step S**41**, the position detection unit **417** of the assembly robot **400** detects a first stop position, which is the stop position PS of the vehicle **100**, using the robot sensor **440**. In the present embodiment, the position acquired in the step S**41** is the position of the vehicle **100** relative to the assembly robot **400**. Since the step S**41** is performed in the same manner as the step S**1** performed by the server **200**, the explanation of the step S**41** is omitted.

**[0051]** Next, in the step S**42**, the determination unit **416** of the assembly robot **400** determines whether the first stop position at which the vehicle **100** has been stopped according to the first control command is the proper work position for the assembly of the part PA. If it is determined in the step S**42** that the first stop position is not the work position, in the step S**43**, the robot control unit **415** transmits an abnormality signal as the first information to the server **200** via the communication device **430**. The abnormality signal includes information indicating that the first stop position is not the work position. In the present embodiment, the first information further includes second information regarding positional deviation between the first stop position and the work position. In the present embodiment, the second information indicates whether the position of the vehicle **100** is behind or ahead of the work position. The abnormality signal is received by the communication device **205** of the server **200**.

**[0052]** There are multiple causes why the first stop position is not the work position. Examples of the causes include the case where the vehicle position of the vehicle **100** calculated by the processor **201** of the server **200** using captured images, i.e., the estimation position, is deviated from the real position. Since the vehicle **100** runs according to the running control signal generated by the server **200**, if the vehicle position as the starting point is deviated from the real position, the first stop position as the ending point will deviate from the first position PS**1**. Another cause why the first stop position is not the work position may be an error in the coordinates of the first position PS**1** as the target position to which the vehicle **100** should go next.

**[0053]** The assembly robot **400**, when far from the vehicle **100**, has a posture that makes the assembly difficult due to the joint mechanism. Therefore, as described above, before the assembly work is performed, the assembly robot **400** determines whether the position of the vehicle **100** is the proper work position for the work using the robot sensor **440**. For the same reason as that for the first position PS**1**, the work position may not be a point in the global coordinate system GC but may be defined including a position range.

**[0054]** If it is determined that the first stop position is the work position, in the step S**44**, the robot control unit **415** starts assembly work with respect to the vehicle **100** stopped at the first stop position. The robot control unit **415** performs the assembly work as a separate process routine.

**[0055]** In the step S**24**, the control command unit **211** determines whether the first stop position at which the vehicle **100** is stopped according to the first control command is the work position. If the abnormality signal transmitted in the step S**43** has been received, the control command unit **211** determines that the first stop position is not the work position. On the other hand, if the abnormality signal transmitted in the step S**43** has not been received, the control command unit **211** determines that the first stop position is the work position.

**[0056]** If it is determined in the step S**24** that the first stop position is the work position, it is not necessary to further move the vehicle **100**, and thus the control command unit **211** ends this process routine.

**[0057]** If it is determined in the step S**24** that the first stop position is not the work position, in the step S**25** of FIG. **7**, the control command generation unit **212** generates a second control command. The second control command is a command for moving the vehicle **100** to a second position PS**2** where assembly of the part PA is performed. In the present embodiment, the second control command includes control quantity information for remote control to the second position PS**2**. The control quantity information is information regarding control quantity, such as the steering angle and the acceleration, and serves as a command to be given to the vehicle **100** to enable the vehicle **100** to reach the second position PS**2** from the first stop position.

**[0058]** In the step S**26**, the control command unit **211** transmits the generated second control command to the vehicle **100** via the communication device **205**. In addition, in the step S**26**, the control command unit **211** transmits at least one of a deceleration command and a stop command to the subsequent vehicle **100** in the track TR of the vehicle **100** that has transmitted the second control command.

**[0059]** The second position PS**2** is different from the first stop position. In the present embodiment, the second position PS**2** is defined relative to the first stop position. In the present embodiment, the second position PS**2** is away from the first position PS**1** by a predetermined distance to the front or the back of the vehicle **100**. In the present embodiment, the abnormality signal includes information regarding positional deviation as to whether the first stop position is behind or ahead of the work position. Therefore, the control command generation unit **212** determines the movement direction of the vehicle **100** in the second control command using the information regarding positional deviation included in the abnormality signal. In other words, if information indicating that the first stop position is behind the work position is included in the abnormality signal, the movement direction directed by the second control command is frontward. The second control command directs a control of moving, for example, 50 cm forward.

**[0060]** After the vehicle **100** moves according to the second control command, the assembly robot **400** attempts to assemble the part PA again. Specifically, first, in the step S**45**, as in the step S**41**, the position detection unit **417** of the assembly robot **400** detects the stop position PS of the vehicle **100** using the robot sensor **440**.

**[0061]** The step S**45** is a process step for determining whether the second stop position, which is the position of the vehicle **100** that has moved according to the second control command, is the work position. Therefore, in the step S**25**, the server **200** may transmit to the assembly robot **400** a signal indicating that the second control command has been transmitted to the vehicle **100**. Then, the process may proceed such that the robot control unit **415** performs the step S**45** after the signal indicating that the second control command has been transmitted to the vehicle **100** is received.

**[0062]** In the step S**46**, the determination unit **416** of the assembly robot **400** determines whether the second stop position at which the vehicle **100** has been stopped according to the second control command is the proper work position for assembling the part PA. If the determination unit **416** determines in the step S**46** that the vehicle position is the work position, in the step S**48**, the robot control unit **415** starts the assembly work and ends this process routine.

**[0063]** If the determination unit **416** determines in the step S**46** that the second stop position is not the work position, in the step S**47**, as in the step S**45**, the robot control unit **415** transmits an abnormality signal to the server **200** and ends this process routine.

**[0064]** In the step S**27**, as in the step S**24**, the control command unit **211** determines whether the second stop position is the work position. If the abnormality signal transmitted in the step S**47** has been received, the control command unit **211** determines that the second stop position is not the work position. On the other hand, if the abnormality signal transmitted in the step S**47** has not been received, the control command unit **211** determines that the second stop position is the work position.

**[0065]** If it is determined in the step S**27** that the second stop position is the work position, it is not necessary to further move the vehicle **100**, and thus the control command unit **211** ends this process routine.

**[0066]** If it is determined in the step S**27** that the second stop position is not the work position, in the step S**28**, the control command unit **211** generates a first command that keeps the vehicle **100** stopped at the second stop position and transmits the first command to the vehicle **100** stopped at the second stop position.

**[0067]** In the step S**29**, the control command unit **211** performs a process of transmitting a second command for decelerating or stopping the subsequent vehicle **100**, which is a vehicle subsequent to the vehicle **100** stopped at the second stop vehicle position.

**[0068]** In the step S**30**, the control command unit **211** performs a transmission process of transmitting an abnormality signal to a notification unit (not shown) that reports an abnormality. Specifically, the notification unit is, for example, a warning device for sounding alarms located at the first place PL**1**, or an information terminal device used by the administrator. If the notification unit is a warning device, the warning device sounds an alarm upon reception of the abnormality signal. Further, if the notification unit is an information terminal, the information terminal shows a message informing the abnormality on a display screen upon reception of the abnormality signal.

**[0069]** The case where it is determined that the second stop position is not the work position in the step S**27** described above is a case where the vehicle **100** stopped at the first stop position has moved further, but the assembly work cannot be started. In this case, it is often more efficient if a worker addresses the abnormality. Therefore, in the present embodiment, the abnormality can be quickly resolved by performing the steps S**28**, S**29**, and S**30**. The order of performing the process steps of the steps S**28**, S**29**, and S**30** is not limited to the order shown in FIG. **7**. Further, as an alternative embodiment, at least one of the steps S**28**, S**29**, and S**30** may be performed.

**[0070]** Further, in addition to the timing before the assembly robot **400** starts the assembly, an abnormality may also occur after the assembly has started in the steps S**44** and S**48**.

In this case as well, the control command unit **211** can perform the steps S**27**, S**28**, and S**29**. This allows for quick resolution of the abnormality. More specifically, the robot control unit **415** grips the part PA with the end effector **421** during the assembly work, and assembles the part PA onto the stopped vehicle **100**. Examples of the abnormalities during the assembly work include an inability to grip the part PA and an inability to assemble the gripped part PA. Examples of the causes of the inability to assemble the gripped part PA include an abnormality in the orientation of the part PA before the part PA is gripped, an abnormality in the orientation of the gripped part PA, and an abnormality in the relative position between the vehicle **100** and the assembly robot **400**. In this embodiment, the robot control unit **415** transmits an abnormality signal to the server **200** if an abnormality occurs during the assembly work. Upon reception of the abnormality signal, the control command unit **211** performs the steps S**27**, S**28**, and S**29**.

**[0071]** According to the first embodiment described above, the system **50** includes the control command unit **211** and the determination unit **416**. If the determination unit **416** determines that the first stop position is not the proper work position for the assembly, in the step S**26**, the control command unit **211** transmits to the vehicle **100** the second control command to move the vehicle **100** to the second position PS**2**. This allows the control command unit **211** to move the vehicle **100** to the second position PS**2**, thereby enabling the assembly of the part PA at the second position PS**2**, even when the vehicle **100** stops at a position that is not the proper work position for the assembly of the part PA.

**[0072]** Further, the server **200** includes the control command unit **211**. The assembly robot **400** includes the determination unit **416**. This allows the assembly robot **400** to determine whether the position at which the vehicle **100** has been stopped is the work position, thereby allowing the server **200** to transmit the second control command to the vehicle **100**.

**[0073]** Further, the assembly robot **400** includes the communication device **430** that transmits to the server **200** an abnormality signal indicating that the first stop position is not the work position. If the communication device **205** receives an abnormality signal, the control command unit **211** transmits the second control command in the step S**26**. This allows the server **200** to transmit the second control command when the assembly robot **400** transmits an abnormality signal.

**[0074]** Further, the abnormality signal indicating that the first stop position is not the work position includes information regarding positional deviation. This allows the control command generation unit **212** to generate the second control command by reflecting the information regarding positional deviation. This makes it possible to move the vehicle **100** to the suitable position for assembly of the part.

**[0075]** Further, the server **200** has the control command generation unit **212** that generates the second control command including the control quantity information for remote control to the second position PS**2**. This allows the control command generation unit **212** to generate the second control command that includes the control quantity information.

**[0076]** Further, the assembly robot **400** performs assembly of the part PA onto the vehicle **100** that has been stopped according to the second control command. This allows the assembly robot **400** to perform assembly of the part PA onto the vehicle **100** that has been stopped according to the second control command. Further, the assembly robot **400** performs assembly of the part PA onto the vehicle **100** stopped at the first position PS**1**. This allows the assembly robot **400** to perform assembly of the part PA onto the vehicle **100** that has been stopped according to the first control command.

**[0077]** Further, if the determination unit **416** determines that the first stop position is not the work position, in the step S**26**, the control command unit **211** transmits at least one of the deceleration command and the stop command to the vehicle **100** subsequent to the stopped vehicle **100**. This allows to maintain an appropriate distance between the stopped vehicle **100** and the subsequent vehicle **100**.

**[0078]** Further, if the determination unit **416** determines that the second stop position at which the vehicle **100** has been stopped according to the second control command is not the work position, the control command unit **211** performs the steps S**28**, S**29**, and S**30**. This allows the steps S**28**, S**29**, and S**30** to be performed when the assembly cannot be properly performed onto the vehicle **100** stopped at the second stop position. This allows to maintain an appropriate distance between the stopped vehicle **100** and the subsequent vehicle **100**. In addition, the abnormality can be resolved quickly by workers.

## B. Second Embodiment

**[0079]** FIG. **8** is an explanatory diagram illustrating a schematic configuration of a system **50***v* according to a second embodiment. In this embodiment, **50***v* differs from that of the first embodiment in that it does not include the servers **200**. Further, the vehicle **100***v* in the present embodiment can be traveled by autonomous control of the vehicle **100***v*. For other configurations, unless otherwise described, it is the same as the first embodiment.

**[0080]** In the present embodiment, the processor **111***v* of the vehicle controller **110***v* functions as the vehicle controller **115***v* by executing the programmed PG**1** stored in the memorized **112***v*. The vehicle control unit **115***v* acquires an output result by the sensor, generates a travel control signal using the output result, and outputs the generated travel control signal to operate the actuator group **120**, thereby allowing the vehicle **100***v* to travel by autonomous control. In the present embodiment, in addition to the programming PG**1**, the detection-model DM and the reference-path RR are stored in the memory **112***v* in advance.

**[0081]** The processor **111***v* further includes an acquiring unit **116** and a vehicle creating unit **117** serving as a moving object creating unit. The processor **111***v* of the vehicle control device **110***v* functions as the acquiring unit **116** and the vehicle creating unit **117** by executing the program PG**1** stored in the memory **112***v*.

**[0082]** FIG. **9** is a flow chart showing a process sequence of the traveling control of the vehicular **100***v* in the second embodiment. In the process of FIG. **9**, the processor **111***v* of the vehicle **100***v* functions as a vehicle controller **115***v* by executing a programmed PG**1**.

**[0083]** In step S**901**, the processor **111***v* of the vehicle controller **110***v* acquires vehicle location information using detection result output from the camera as an external sensor. In step S**902**, the processor **111***v* determines a target location to which the vehicle **100***v* is to move next. In step S**903**, the processor **111***v* generates a running control signal for causing the vehicle **100***v* to run to the determined target location. In step S**904**, the processor **111***v* controls an actuator using the generated running control signal, thereby causing the vehicle **100**$v$ to run by following a parameter indicated by the running control signal. the processor **111**$v$ repeats the acquisition of vehicle location information, the determination of a target location, the generation of a running control signal, and the control over the actuator in a predetermined cycle. According to the running control in the present embodiment, it is possible to cause the vehicle **100**$v$ to run by autonomous control without controlling the vehicle **100**$v$ remotely using the server **200**.

**[0084]** The procedures of "stationary assembly" according to the present embodiment is described below in terms of the differences from those in the first embodiment. In the first embodiment, when the first stop position is not the work position, the vehicle **100** moves to the second position PS**2** according to the second control command transmitted from the server **200**. In contrast, in the present embodiment, the vehicle **100** generates a control signal to move itself to the second position PS**2**.

**[0085]** More specifically, if the stop position at which the vehicle **100** has been stopped for assembly is not the work position, the acquisition unit **116** acquires information regarding the positional deviation between the stop position and the work position. Specifically, for example, the acquisition unit **116** acquires information regarding the positional deviation between the stop position and the work position from the assembly robot **400**.

**[0086]** In the present embodiment, examples of the causes why the stop position is not the work position include the case where the vehicle position information acquired by a processor **111**$v$ of a vehicle control device **110**$v$ is deviated from the real position.

**[0087]** A vehicle generation unit **117** generates control information for stopping the vehicle at the work position using information acquired by the acquisition unit **116**. The control information includes the same information as that included in the running control signal described above. A vehicle control unit **115**$v$ as the control unit controls the actuator included in the actuator group **120** according to the control information. This allows a vehicle **100**$v$ to move to the second position PS**2** without the second control command from the server **200**.

## C. Alternative Embodiments (Alternative Embodiments With Regard to Assembly)

**[0088]** (C1) In the first embodiment described above, the second control command transmitted in the step S**26** directs movement by a predetermined distance to the front or the back of the vehicle **100**. In an alternative embodiment, information regarding the distance between the first stop position and the work position may be included as the second information. In this embodiment, the determination unit **416** of the assembly robot **400** generates the information regarding the distance between the first stop position and the work position as the second information. Then, the control command generation unit **212** generates a second control command including the movement direction and movement distance using the second information. Further, the second control command may include the movement direction, which also includes the left/right direction calculated from the second information, and the movement distance. As the quantity of information directed by the second control command increases, the vehicle **100** can be more accurately guided to the work position. As the quantity of information directed by the second control command decreases, the load of calculation performed by the determination unit **416** of the assembly robot **400** and the load of calculation performed by the control command generation unit **212** can be reduced.

**[0089]** (C2) In the first embodiment described above, the second control command transmitted in the step S**26** directs movement by a predetermined distance to the front or the back of the vehicle **100**. In an alternative embodiment, the second control command may include, instead of the predetermined distance, a distance calculated from the distance between the first stop position and the work position included in the second information. In this case, the control command generation unit **212** may generate the second control command on the premise that the assembly robot **400** addresses the positional deviation in the left/right direction of the vehicle **100** and that the vehicle **100** is moved only in the front/back direction. The vehicle **100** is difficult to move in the left/right direction. Therefore, generating the second control command that causes the vehicle **100** to move only in the front/back direction can reduce the movement time of the vehicle **100** from the first stop position to the second position.

**[0090]** (C3) In the first embodiment described above, in the step S**25**, the second control command generated by the control command generation unit **212** includes control information for remote control to the second position PS**2**. In an alternative embodiment, the second control command generated by the control command generation unit **212** may include route information regarding the route to the second position PS**2**. Further, the second control command may include both the route information and the control quantity information. In the case where the second control command includes the route information, the vehicle control unit **115** uses the route information to control the actuator group **120** so that the vehicle **100** runs along the route.

**[0091]** (C4) In the first embodiment described above, the assembly robot **400** is a vertical articulated robot. The assembly robot **400** is not limited to vertical articulated robots, but may be another kind of robot, for example, a horizontal articulated robot.

**[0092]** (C5) In the first embodiment described above, the robot sensor **440** is a camera. The robot sensor **440** is not limited to cameras, but may be, for example, a distance measuring device. The distance measuring device is, for example, a LIDAR (Light Detection And Ranging). In this case, the detection result output by the robot sensor **440** may be 3D point cloud data representing the vehicle **100**. In this case, the position detection unit **417** may acquire the vehicle position information by template matching using the 3D point cloud data as the detection result and the reference point cloud data prepared in advance.

**[0093]** (C6) In the step S**42** of the first embodiment described above, if the cause why the position of the vehicle **100** is not the work position is because of an error in the coordinates of the first position PS**1** directed by the control command unit **211**, it is assumed that the transmission of abnormality signals in the step S**43** will occur frequently. Therefore, the server **200**

may be configured to count the frequency of the execution of the step S**43**, and perform the steps S**28**, S**29**, and S**30** if the frequency exceeds a predetermined reference value. This allows for quick resolution of the abnormality.

**[0094]** (C7) In the first embodiment described above, the determination unit **416** is included in the assembly robot **400**. In an alternative embodiment, the server **200** may include a determination unit. In this case, the determination unit of the server **200** may perform the determination using a detection signal from the external sensor **300** or an abnormality signal transmitted from the assembly robot **400**. Further, in the first embodiment described above, the control command unit **211** includes the server **200**. In an alternative embodiment, the assembly robot **400** may include the control command unit **211**.

**[0095]** (C8) In the first embodiment described above, in the step S**26**, at least one of the deceleration command and the stop command is performed. In an alternative embodiment, neither the deceleration command nor the stop command may be performed in the step S**26**. Further, in the first embodiment described above, if it is determined in the step S**27** that the second stop position is not the work position, the steps S**28**, S**29**, and S**30** are performed. In an alternative embodiment, none of the steps S**28**, S**29**, and S**30** may be performed.

**[0096]** (C9) In the first embodiment described above, the abnormality signal as the first information includes information regarding positional deviation as the second information. In an alternative embodiment, the abnormality signal may not include the information regarding positional deviation. As described above, the cases where the first stop position is not the work position include a case where there is an error in the coordinates of the first position PS**1** directed by the control command unit **211**. In this case, the robot sensor **440** may fail to detect the vehicle **100**. In this case, it may be configured such that the abnormality signal does not include the information regarding positional deviation, but includes the information indicating that the first stop position is not the work position. Further, it may be configured such that the abnormality signal includes the information regarding positional deviation if the vehicle **100** can be detected by the robot sensor **440**, and that the abnormality signal does not include the information regarding positional deviation if the vehicle **100** cannot be detected by the robot sensor **440**.

**[0097]** (C10) In the first embodiment described above, the second control command includes a command that directs the forward or backward movement direction determined based on the information regarding positional deviation. In an alternative embodiment, the second control command may direct movement in a predetermined direction. Depending on the orientation of the arm unit **420** of the assembly robot **400**, the assembly work may become possible by moving the vehicle **100** neither frontward nor backward. In this case, transmitting a predetermined second control command without calculation by the control command generation unit **212** can reduce the load of calculation on the control command generation unit **212**.

**[0098]** (C11) In the first embodiment described above, the position acquired in the step S**41** is the position of the vehicle **100** relative to the assembly robot **400**. This relative position is not limited to a precise position convertible into coordinates in the global coordinate system GC, but may be approximate position information. The approximate information is, for example, information indicating whether the stop position PS of the vehicle **100** is ahead or behind the work position. Further, the position acquired in the step S**41** may not be the relative position but may be coordinates in the global coordinate system GC.

**[0099]** (C12) In the first embodiment described above, the second position PS**2** is defined based on the relative position with respect to the first stop position. In an alternative embodiment, the second position PS**2** may be coordinates in the global coordinate system GC.

D. Alternative Embodiments (Alternative Embodiments With Regard to Remote Control auto Driving System)

**[0100]** (D1) In each of the above-described embodiments, the external sensor is not limited to the camera but may be the distance measuring device, for example. The distance measuring device is a light detection and ranging (LiDAR) device, for example. In this case, detection result output from the external sensor may be three-dimensional point cloud data representing the vehicle **100**. The server **200** and the vehicle **100** may acquire the vehicle location information through template matching using the three-dimensional point cloud data as the detection result and reference point cloud data, for example.

**[0101]** (D2) In the above-described first embodiment, the server **200** performs the processing from acquisition of vehicle location information to generation of a running control signal. By contrast, the vehicle **100** may perform at least part of the processing from acquisition of vehicle location information to generation of a running control signal. For example, embodiments (1) to (3) described below are applicable, for example.

**[0102]** (1) The server **200** may acquire vehicle location information, determine a target location to which the vehicle **100** is to move next, and generate a route from a current location of the vehicle **100** indicated by the acquired vehicle location information to the target location. The server **200** may generate a route to the target location between the current location and a destination or generate a route to the destination. The server **200** may transmit the generated route to the vehicle **100**. The vehicle **100** may generate a running control signal in such a manner as to cause the vehicle **100** to run along the route received from the server **200** and control an actuator using the generated running control signal.

**[0103]** (2) The server **200** may acquire vehicle location information and transmit the acquired vehicle location information to the vehicle **100**. The vehicle **100** may determine a target location to which the vehicle **100** is to move next, generate a route from a current location of the vehicle **100** indicated by the received vehicle location information to the target location, generate a running control signal in such a manner as to cause the vehicle **100** to run along the generated route, and control an actuator using the generated running control signal.

**[0104]** (3) In the foregoing embodiments (1) and (2), an internal sensor may be mounted on the vehicle **100**, and detection result output from the internal sensor may be used in at least one of the generation of the route and the generation of the running control signal. The internal sensor is a sensor mounted on the vehicle **100**. More specifically, the internal sensor might include a camera, LiDAR, a millimeter wave radar, an ultrasonic wave sensor, a GPS sensor, an acceleration sensor, and a gyroscopic sensor, for example. For example, in the foregoing embodiment (1), the server **200** may acquire detection result from the internal sensor, and in generating the route, may reflect the detection result from the internal sensor in the route. In the foregoing embodiment (1), the vehicle **100** may acquire detection result from the internal sensor, and in generating the running control signal, may reflect the detection result from the internal sensor in the running control signal. In the foregoing embodiment (2), the vehicle **100** may acquire detection result from the internal sensor, and in generating the route, may reflect the detection result from the internal sensor in the route. In the foregoing embodiment (2), the vehicle **100** may acquire detection result from the internal sensor, and in generating the running control signal, may reflect the detection result from the internal sensor in the running control signal.

**[0105]** (D3) In the above-described embodiment in which the vehicle **100*v*** can be running by autonomous control, the vehicle **100*v*** may be equipped with an internal sensor, and detection result output from the internal sensor may be used in at least one of generation of a route and generation of a running control signal. For example, the vehicle **100*v*** may acquire detection result from the internal sensor, and in generating the route, may reflect the detection result from the internal sensor in the route. The vehicle **100*v*** may acquire detection result from the internal sensor, and in generating the running control signal, may reflect the detection result from the internal sensor in the running control signal.

**[0106]** (D4) In the above-described embodiment in which the vehicle **100*v*** can be running by autonomous control, the vehicle **100*v*** acquires vehicle location information using detection result from the external sensor. By contrast, the vehicle **100*v*** may be equipped with an internal sensor, the vehicle **100*v*** may acquire vehicle location information using detection result from the internal sensor, determine a target location to which the vehicle **100*v*** is to move next, generate a route from a current location of the vehicle **100*v*** indicated by the acquired vehicle location information to the target location, generate a running control signal for running along the generated route, and control an actuator of the vehicle **100*v*** using the generated running control signal. In this case, the vehicle **100*v*** is capable of running without using any detection result from an external sensor. The vehicle **100*v*** may acquire target arrival time or traffic congestion information from outside the vehicle **100*v*** and reflect the target arrival time or traffic congestion information in at least one of the route and the running control signal. The functional configuration of the system **50*v*** may be entirely provided at the vehicle **100*v***. Specifically, the processes realized by the system **50*v*** in the present disclosure may be realized by the vehicle **100*v*** alone.

**[0107]** (D5) In the above-described first embodiment, the server **200** automatically generates a running control signal to be transmitted to the vehicle **100**. By contrast, the server **200** may generate a running control signal to be transmitted to the vehicle **100** in response to operation by an external operator existing outside the vehicle **100**. For example, the external operator may operate an operating device including a display on which a captured image output from the external sensor is displayed, steering, an accelerator pedal, and a brake pedal for operating the vehicle **100** remotely, and a communication device for making communication with the server **200** through wire communication or wireless communication, for example, and the server **200** may generate a running control signal responsive to the operation on the operating device.

**[0108]** (D6) In each of the above-described embodiments, the vehicle **100** is simply required to have a configuration to become movable by unmanned driving. The vehicle **100** may embodied as a platform having the following configuration, for example. The vehicle **100** is simply required to include at least actuators and a controller. More specifically, in order to fulfill three functions including "run," "turn," and "stop" by unmanned driving, the actuators may include a driving device, a steering device and a braking device. The actuators are controlled by the controller that controls running of the vehicle **100**. In order for the vehicle **100** to acquire information from outside for unmanned driving, the vehicle **100** is simply required to include the communication device further. Specifically, the vehicle **100** to become movable by unmanned driving is not required to be equipped with at least some of interior components such as a driver's seat and a dashboard, is not required to be equipped with at least some of exterior components such as a bumper and a fender or is not required to be equipped with a bodyshell. In such cases, a remaining component such as a bodyshell may be mounted on the vehicle **100** before the vehicle **100** is shipped from a factory, or a remaining component such as a bodyshell may be mounted on the vehicle **100** after the vehicle **100** is shipped from a factory while the remaining component such as a bodyshell is not mounted on the vehicle **100**. Each of components may be mounted on the vehicle **100** from any direction such as from above, from below, from the front, from the back, from the right, or from the left. Alternatively, these components may be mounted from the same direction or from respective different directions. The location determination for the platform may be performed in the same way as for the vehicle **100** in the first embodiments.

**[0109]** (D7) The vehicle **100** may be manufactured by combining a plurality of modules. The module means a unit composed of one or more components grouped according to a configuration or function of the vehicle **100**. For example, a platform of the vehicle **100** may be manufactured by combining a front module, a center module and a rear module. The front module constitutes a front part of the platform, the center module constitutes a center part of the platform, and the rear module constitutes a rear part of the platform. The number of the modules constituting the platform is not limited to three but may be equal to or less than two, or equal to or greater than four. In addition to or instead of the platform, any parts of the vehicle **100** different from the platform may be modularized. Various modules may include an arbitrary exterior component such as a bumper or a grill, or an arbitrary interior component such as a seat or a console. Not only the vehicle **100** but also any types of moving object may be manufactured by combining a plurality of modules. Such a module may be manufactured by joining a plurality of components by welding or using a fixture, for example, or may be manufactured by forming at least part of the module integrally as a single component by casting. A process of forming at least part of a module as a single component is also called Giga-casting or Mega-casting. Giga-casting can form each part conventionally formed by joining multiple parts in a moving object as a single component. The front module, the center module, or the rear module described above may be manufactured using Giga-casting, for example.

**[0110]** (D8) A configuration for realizing running of a vehicle by unmanned driving is also called a "Remote Control auto Driving system". Conveying a vehicle using Remote Control Auto Driving system is also called "self-running conveyance". Producing the vehicle using self-running conveyance is also called "self-running production". In self-running production, for example, at least part of the conveyance of vehicles is realized by self-running conveyance in a factory where the vehicle is manufactured.

**[0111]** (D9) In each of the above embodiments, some or all of the functions and processing implemented in software may be implemented in hardware. In addition, some or all of the functions and processes implemented in hardware may be implemented in software. As hardware for realizing various functions in the above embodiments, for example, it may be used various circuits such as integrated circuits and discrete circuits.

**[0112]** The present disclosure is not limited to the embodiments described above, but can be realized in various configurations without departing from the spirit thereof. Further, if the technical feature is not described as essential in this specification, the technical feature may be deleted as appropriate. For example, the present disclosure may be implemented by the aspects described below.

**[0113]** (1) According to a first aspect of the present disclosure, a system is provided. This system includes a control command unit configured to transmit to a moving object running by unmanned driving a first control command for stopping the moving object at a first position where assembly of a part is scheduled to be performed, and a determination unit configured to determine whether a first stop position at which the moving object has been stopped according to the first control command is a work position suitable for the assembly of the part. When the determination unit determines that the first stop position is not the work position, the control command unit transmits to the moving object a second control command for moving the moving object to a second position where the assembly of the part is performed. According to the above aspect, even when the moving object stops at a position that is not the proper work position for the assembly of the part, it is possible to enable the assembly of the part at the second position by moving the moving object to the second position by the control command unit.

**[0114]** (2) The system according to the above aspect may include a control device including the control command unit, and an assembly device that performs the assembly of the part. The assembly device includes the determination unit. According to the above aspect, the assembly device can determine whether the position where the moving object has been stopped is the work position, and the control device can transmit the second control command to the moving object.

**[0115]** (3) In the system according to the above aspect, the assembly device may further include a transmission unit configured to transmit to the control device first information indicating that the first stop position is not the work position when the determination unit determines that the first stop position is not the work position, the control device may further include a reception unit configured to receive the first information, and the control command unit may transmit the second control command when the reception unit receives the first information. According to the above aspect, the control device can transmit the second control command when the assembly device transmits the first information.

**[0116]** (4) In the system according to the above aspect, the first information may include second information regarding positional deviation between the first stop position and the work position. According to the above aspect, the assembly device can transmit the information regarding positional deviation to the control device. This allows the moving object to move to the position suitable for the assembly of the part.

**[0117]** (5) In the system according to the above aspect, the control device may further include a control command generation unit configured to generate, using the second information, the second control command that includes at least one of route information regarding a route to the second position and control quantity information for remote control to the second position. According to the above aspect, it is possible to generate the second control command that includes either the route information or the control quantity information generated by the control command generation unit.

**[0118]** (6) The system according to the above aspect may further include an assembly device that performs the assembly of the part. The assembly device may perform the assembly of the part on the moving object that has been moved according to the second control command. According to the above aspect, the assembly device can perform the assembly of the part onto the moving object that has been stopped according to the second control command.

**[0119]** (7) The system according to the above aspect may further include an assembly device that performs the assembly of the part. When the determination unit determines that the first stop position is the work position, the assembly device may perform the assembly of the part on the moving object stopped at the first stop position. According to the above aspect, the assembly device can perform the assembly of the part onto the moving object stopped at the moving object stop position.

**[0120]** (8) In the system according to the above aspect, when the determination unit determines that the first stop position is not the work position, at least one of a deceleration command and a stop command may be transmitted to a moving object subsequent to the moving object stopped at the first stop position. According to the above aspect, it is possible to keep an appropriate distance between the moving object stopped at the moving object stop position and the subsequent moving object.

**[0121]** (9) In the system according to the above aspect, the determination unit may determine whether a second stop position where the moving object has been stopped according to the second control command is the work position, and, when the determination unit determines that the second stop position is not the work position, the control command unit may perform at least one of a process of transmitting a first command for keeping the moving object stopped at the second stop position, a process of transmitting a second command for deceleration or stopping to a moving object subsequent to the moving object stopped at the second stop position, and a process of transmitting an abnormality signal to a notification unit that notifies an abnormality. According to the above aspect, when the second stop position is not the work position, that is, when the assembly cannot be properly performed onto the moving object stopped at the second stop position, one of the process of transmitting the first command, the process of transmitting the second command, and the process of transmitting the abnormality signal may be performed.

**[0122]** (10) According to a second aspect of the present disclosure, an assembly device that performs assembly of a part onto a moving object is provided. The assembly device includes a transmission unit configured to communicate with at least one of the moving object and a control device that performs remote control with respect to the moving object, a position detection unit configured to detect a stop position of the moving object, and a determination unit configured to determine whether the stop position is a work position suitable for the assembly of the part. The transmission unit transmits information regarding positional deviation between the stop position and the work position to at least one of the control device and the moving object when the determination unit determines that the stop position is not the work position. According to the above aspect, it is possible to provide an assembly device that transmits information regarding positional deviation between the stop position and the work position when it is determined that the position where the moving object is stopped is not the proper work position for the assembly.

**[0123]** (11) According to a third aspect of the present disclosure, a moving object is provided. The moving object includes an acquisition unit configured to acquire information regarding positional deviation between a stop position of the moving object and a work position suitable for assembly of a part onto the moving object, a moving object generation unit configured to generate control information for stopping the moving object at the work position using the acquired information, and a control unit configured to control an actuator for causing the moving object to run using the control information. According to the above aspect, it is possible to provide a moving object that moves to a proper work position for assembly when the position where the moving object is stopped is not the proper work position for the assembly.

**[0124]** The present disclosure may also be implemented in various aspects other than the aspects described above. For example, the present disclosure may also be implemented in aspects including an assembly method, a program for assembly method, a non-transitory tangible computer-readable storage medium storing the program for assembly.

What is claimed is:

**1**. A system comprising:

a control command unit configured to transmit to a moving object running by unmanned driving a first control command for stopping the moving object at a first position where assembly of a part is scheduled to be performed; and

a determination unit configured to determine whether a first stop position at which the moving object has been stopped according to the first control command is a work position suitable for the assembly of the part,

wherein, when the determination unit determines that the first stop position is not the work position, the control command unit transmits to the moving object a second control command for moving the moving object to a second position where the assembly of the part is performed.

**2**. The system according to claim **1**, comprising:

a control device comprising the control command unit; and

an assembly device that performs the assembly of the part, the assembly device comprising the determination unit.

**3**. The system according to claim **2**, wherein

the assembly device further comprises a transmission unit configured to transmit to the control device first information indicating that the first stop position is not the work position when the determination unit determines that the first stop position is not the work position,

the control device further comprises a reception unit configured to receive the first information, and

the control command unit transmits the second control command when the reception unit receives the first information.

**4**. The system according to claim **3**, wherein

the first information includes second information regarding positional deviation between the first stop position and the work position.

**5**. The system according to claim **4**, wherein

the control device further comprises a control command generation unit configured to generate, using the second information, the second control command that includes at least one of route information regarding a route to the second position and control quantity information for remote control to the second position.

**6**. The system according to claim **1**, further comprising

an assembly device that performs the assembly of the part,

wherein the assembly device performs the assembly of the part on the moving object that has been moved according to the second control command.

**7**. The system according to claim **1**, further comprising an assembly device that performs the assembly of the part,

wherein, when the determination unit determines that the first stop position is the work position, the assembly device performs the assembly of the part on the moving object stopped at the first stop position.

**8**. The system according to claim **1**, wherein

when the determination unit determines that the first stop position is not the work position, at least one of a deceleration command and a stop command is transmitted to a moving object subsequent to the moving object stopped at the first stop position.

**9**. The system according to claim **1**, wherein

the determination unit determines whether a second stop position where the moving object has been stopped according to the second control command is the work position, and

when the determination unit determines that the second stop position is not the work position, the control command unit performs at least one of a process of transmitting a first command for keeping the moving object stopped at the second stop position, a process of transmitting a second command for deceleration or stopping to a moving object subsequent to the moving object stopped at the second stop position, and a process of transmitting an abnormality signal to a notification unit that notifies an abnormality.

**10**. An assembly device that performs assembly of a part onto a moving object, comprising:

a transmission unit configured to communicate with at least one of the moving object and a control device that performs remote control with respect to the moving object;

a position detection unit configured to detect a stop position of the moving object; and

a determination unit configured to determine whether the stop position is a work position suitable for the assembly of the part,

wherein the transmission unit transmits information regarding positional deviation between the stop position and the work position to at least one of the control device and the moving object when the determination unit determines that the stop position is not the work position.

**11**. A moving object, comprising:

an acquisition unit configured to acquire information regarding positional deviation between a stop position of the moving object and a work position suitable for assembly of a part onto the moving object;

a moving object generation unit configured to generate control information for stopping the moving object at the work position using the acquired information; and

a control unit configured to control an actuator for causing the moving object to run using the control information.

* * * * *