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VEHICLE MANUFACTURING SYSTEM, VEHICLE MANUFACTURING METHOD, AND NONTRANSITORY COMPUTER READABLE MEDIUM

Abstract

A vehicle manufacturing system includes: a first information acquisition unit configured to acquire first information indicating positions and attitudes of a plurality of vehicles from outside of the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; a second information acquisition unit configured to acquire second information, provided in at least one of the vehicles, the second information indicating a position and an attitude of a vehicle in front of or behind the vehicle; and an abnormality occurrence detection unit configured to switch control of the plurality of vehicles or notify someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS
[0001] This application is based upon and claims the benefit of priority from Japanese patent application No. 2024-024429, filed on Feb. 21, 2024, the disclosure of which is incorporated herein in its entirety by reference.
BACKGROUND
[0002] The present disclosure relates to a vehicle manufacturing system, a vehicle manufacturing method, and a program.
[0003] Patent Literature 1 discloses that vehicles travel autonomously or under remote control in a manufacturing system for manufacturing vehicles. [0004] Patent Literature 1: Published Japanese Translation of PCT International Publication for Patent Application, No. 2017-538619
SUMMARY
[0005] However, Patent Literature 1 discloses merely that vehicles are remotely controlled by using information obtained outside the vehicles. Therefore, an object of the present disclosure is to provide a vehicle manufacturing system for detecting the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.
[0006] A vehicle manufacturing system according to the present disclosure includes: [0007] first information acquisition means for acquiring first information indicating positions and attitudes of a plurality of vehicles from outside of the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; [0008] second information acquisition means for acquiring second information, provided in at least one of the vehicles, the second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition means is provided; and [0009] abnormality occurrence detection means for switching control of the plurality of vehicles or notifying someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value.
[0010] By the above-described configuration, it is possible to provide a system for detecting the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.
[0011] In the vehicle manufacturing system according to the present disclosure, [0012] the first information is an image or a distance, [0013] the second information is an image or a distance, [0014] the first information acquisition means is a photographing apparatus, a LiDAR, a radar, a GPS, or an ultrasonic sensor, and [0015] the second information acquisition means is a photographing apparatus, a LiDAR, a radar, a GPS, or an ultrasonic sensor.
[0016] The above-described configuration is an example of the first information, the second information, the first information acquisition means, and the second information acquisition means.

[0017] In the vehicle manufacturing system according to the present disclosure, the switching of control of the plurality of vehicles is to stop or decelerate the plurality of vehicles.
[0018] The above-described configuration is an example of the switching of control of vehicles.
[0019] In the vehicle manufacturing system according to the present disclosure, the notification to the outside is to notify a manager, an operator, or a production management system of an abnormality.
[0020] The above-described configuration is an example of the notification to the outside.
[0021] In the vehicle manufacturing system according to the present disclosure, the predetermined value is changed according to a specific section.
[0022] By the above-described configuration, a threshold for the difference, which is the predetermined value, can be changed according to the specific section.
[0023] In the vehicle manufacturing system according to the present disclosure, the specific section is a section in which a vehicle makes a U-turn, a section having a large turning curvature, or a slope.
[0024] The above-described configuration is an example of the specific section.
[0025] A method for manufacturing vehicles according to the present disclosure includes: [0026] acquiring first information indicating positions and attitudes of a plurality of vehicles by using first information acquisition means provided outside the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; [0027] acquiring, by using second information acquisition means provided in at least one of the vehicles, second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition means is provided; and [0028] switching control of the plurality of vehicles or notifying someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information acquisition means and the positions and attitudes of the plurality of vehicles acquired from the second information acquisition means is larger than a predetermined value.
[0029] By the above-described configuration, it is possible to provide a method for detecting the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.
[0030] A program according to the present disclosure causes an information processing apparatus to: [0031] acquire first information indicating positions and attitudes of a plurality of vehicles by using first information acquisition means provided outside the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; [0032] acquire, by using second information acquisition means provided in at least one of the vehicles, second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition means is provided; and [0033] switch control of the plurality of vehicles or notify the outside of the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information acquisition means and the positions and attitudes of the plurality of vehicles acquired from the second information acquisition means is larger than a predetermined value.
[0034] By the above-described configuration, it is possible to provide a program for causing an information processing apparatus to detect the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.
[0035] According to the present disclosure, it is possible to provide a vehicle manufacturing system and the like capable of detecting the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.
[0036] The above and other objects, features, and advantages of the present disclosure will become

more fully understood from the detailed description given hereinbelow and the accompanying drawings.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0037] FIG. **1** is a schematic diagram showing an overview of a vehicle manufacturing system according to an embodiment;

[0038] FIG. **2** is a block diagram showing a configuration of a vehicle manufacturing system according to an embodiment;

[0039] FIG. **3** is a flowchart of a vehicle manufacturing method according to an embodiment;

[0040] FIG. **4** is a diagram for explaining control of the traveling of a vehicle;

[0041] FIG. **5** is a control block diagram for explaining Travel Control Example 1;

[0042] FIG. **6** is a flowchart for explaining Travel Control Example 1;

[0043] FIG. **7** is a control block diagram for explaining Travel Control Example 2; and

[0044] FIG. **8** is a flowchart for explaining Travel Control Example 2.

DESCRIPTION OF EMBODIMENTS

Embodiments

[0045] Embodiments according to the present disclosure will be described hereinafter with reference to the drawings. However, the invention specified in the claims is not limited to the below-shown embodiments. Further, all the components/structures described in the embodiments are not necessarily indispensable as means for solving the problem. For clarifying the explanation, the following description and drawings are partially omitted and simplified as appropriate. The same reference numerals (or symbols) are assigned to the same elements throughout the drawings and redundant descriptions thereof are omitted as appropriate.

Description of Overview of Vehicle Manufacturing System According to Embodiment

[0046] FIG. **1** is a schematic diagram showing an overview of a vehicle manufacturing system according to an embodiment. An overview of a vehicle manufacturing system **50** according to an embodiment will be described with reference to FIG. **1**. The vehicle manufacturing system **50** is used in a vehicle manufacturing factory.

[0047] As shown in FIG. **1**, the vehicle manufacturing system **50** includes a server **200**, a first information acquisition unit **1111**, second information acquisition units **1113** and **1115**, a first vehicle **1117**, a second vehicle **1119**, and radio communication terminals **1121** and **1123**. A manager **1101** and a production management system **1103** are present outside the vehicle manufacturing system.

[0048] The manager **1101** is a person who works in the factory. For example, the manager **1101** is a manager or an operator for the production management system **1103** or a process performed therein. The manager **1101** manages the vehicle manufacturing system **50**.

[0049] The production management system **1103** is a manufacturing execution system, and is a system for monitoring and managing equipment in the factory and work performed therein by workers by linking with each part of the production line of the factory. The production management system **1103** acquires information from BOP (Bill Of Process)/BOE (Bill Of Equipment). Further, the production management system **1103** also includes a production instruction database for providing information about instructions in regard to the production to the vehicle manufacturing system. The instructions in regard to the production are instructions for people and equipment, such as instructions in regard to parts to be used or procedures to be followed, in addition to types and specifications of individual products according to a production plan.

[0050] The first and second vehicles **1117** and **1119** are a plurality of vehicles which are manufactured step by step while they are continuously moving. Hereinafter, the first and second vehicles **1117** and **1119** are also referred to as vehicles **100**. The vehicle **100**, i.e., each of vehicles **100**, includes an ECU (Electronic Control Unit), and also includes a battery and a motor mounted on the body of the vehicle. Further, tires are attached to the vehicle, so that the vehicle can autonomously travel.

[0051] More specifically, the vehicle **100** is a battery electric vehicle (BEV: Battery Electric Vehicle). Note that the vehicle **100** is not limited to electric vehicles, and may be, for example, an electric motorcycle, an electric bicycle, an electric kickboard, a hybrid vehicle, or a fuel cell vehicle. Further, the vehicle **100** may be a vehicle equipped with wheels or endless tracks, e.g., caterpillars, and may be, for example, a passenger car, a truck, a bus, a two-wheeled vehicle, a four-wheeled vehicle, a tank, a construction vehicle, or any of other types of vehicles. Further, the vehicle **100** is not limited to vehicles, and may be an electric vertical takeoff and landing aircraft (so-called a flying car). The vehicle **100** becomes a completed vehicle step by step as parts are assembled into the vehicle **100** while it is traveling by itself.

[0052] In the vehicle **100**, first information indicating its position and attitude (e.g., orientation and the like) is acquired by the first information acquisition unit **1111**, so that the vehicle **100** moves while being controlled by the server **200**. For the first information acquisition unit **1111**, for example, a LiDAR (Light Detection And Ranging) or a photographing apparatus can be used. The photographing apparatus may be an RGB camera, an RGBD camera, an infrared camera, or the like. Further, the first information acquisition unit **1111** may be a radar, a GPS (Global Positioning System), or an ultrasonic sensor. The first information is an image or a distance. The first information acquisition unit **1111** acquires the distance and the image of the vehicle **100**, and the server **200** calculates the relative position and the relative attitude of the vehicle **100**. The server **200** may perform an image analysis by using AI (Artificial Intelligence) in order to acquire the position and attitude of the vehicle from the image. The position indicates a distance between the vehicle and another vehicle, and the attitude indicates the orientation or steering angle of the vehicle.

[0053] The second information acquisition unit **1113** is provided in the first vehicle **1117**. The second information acquisition unit **1115** is provided in the second vehicle **1119**. Each of the second information acquisition units **1113** and **1115** acquires second information indicating the position and attitude of a vehicle in front of or behind the vehicle in which the second information acquisition unit is provided. Although FIG. **1** shows that the second information acquisition unit acquires only second information in regard to the vehicle in front of the vehicle in which the second information acquisition unit is provided, it may acquire second information in regard to the vehicle behind the vehicle in which the second information acquisition unit is provided. Each of the second information acquisition units **1113** and **1115** is, for example, a radar or a photographing apparatus. The second information acquisition unit may be a LiDAR, a GPS, or an ultrasonic sensor. The second information is an image or a distance. The second information acquisition units **1113** and **1115** acquire distances to the vehicles in front of or behind the first and second vehicles **1117** and **1119**, respectively, in which the second information acquisition units are provided and images thereof. Then, the server **200** calculates relative positions and relative attitudes of the vehicles in front of or behind the first and second vehicles **1117** and **1119** in which the second information acquisition units are provided. The server **200** may perform image analyses by using AI (Artificial Intelligence) in order to acquire positions and attitudes of the vehicles from the images.

[0054] The radio communication terminal **1121** is provided in the first vehicle **1117**. The radio communication terminal **1123** is provided in the second vehicle **1119**. The radio communication terminal **1121** transmits the second information acquired by the second information acquisition unit **1113** of the first vehicle **1117** to the server **200** through CAN (Controller Area Network) communication. Similarly, the radio communication terminal **1123** transmits the second information acquired by the second information acquisition unit **1115** of the second vehicle **1119** to the server **200** through CAN communication.

[0055] The server **200** is an information processing apparatus including a memory and a processor, and functions as a vehicle manufacturing control apparatus for controlling the vehicle manufacturing system. For example, the server **200** receives results of detections by the first information acquisition unit **1111** and the second information acquisition units **1113** and **1115**. The server **200** controls the vehicles according to the detection results and the like. The server **200** may be composed of one apparatus or a plurality of apparatuses. The server **200** may be a cloud server that processes some or all of its functions in a distributed manner.

[0056] The server **200** processes, for example, signals received from the first information acquisition unit **1111**. The server **200** acquires positions and attitudes of a plurality of vehicles **100** including the first and second vehicles **1117** and **1119** by using the first information acquired from the first information acquisition unit **1111**.

[0057] The server **200** processes, for example, signals received from the second information acquisition units **1113** and **1115**. The server **200** acquires positions and attitudes of a plurality of vehicles **100** including the first and second vehicles **1117** and **1119** by using the second information acquired from the second information acquisition units **1113** and **1115**.

[0058] The server **200** switches the control of the plurality of vehicles or notifies the outside of the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value. When the difference between the first information and the second information is larger than a predetermined value, e.g., when there is an error in the measurement of the distance between vehicles, it is dangerous for the vehicle **100** to continue traveling. Therefore, the server **200** switches the control of the vehicles or notifies the outside when an abnormality occurs in the manufacturing of vehicles.

[0059] Switching the control of a plurality of vehicles is to stop or decelerate the plurality of vehicles, which are traveling in line. Further, notifying the outside is to notify the manager **1101** or the production management system **1103** of the abnormality.

[0060] The predetermined value, which is used as the threshold for the difference between the first information and the second information, may be changed according to the section. For a section in which vehicles are traveling in line in an ordinary manner, the predetermined value for the distance between vehicles is about 10 cm with the steering angle being about 3°. In contrast, for a section in which vehicles make a U-turn, a section in which the turning curvature is large, or in a slope, the predetermined value may be increased from the aforementioned distance. For example, in a specific section such as a section in which vehicles make a U-turn or a section in which the turning curvature is large, or a slope, the predetermined value for the distance between vehicles may be about 20 cm with the steering angle being about 5°. This is because in such a specific section, there is a possibility that each of the second information acquisition units **1113** and **1115** may determine, as the distance and the steering angle, values larger than the actual distance and the actual steering angle.

Description of Configuration of Vehicle Manufacturing System According to Embodiment

[0061] FIG. **2** is a block diagram showing a configuration of a vehicle manufacturing system according to an embodiment. The configuration of the vehicle manufacturing system according to the embodiment will be described with reference to FIG. **2**.

[0062] As shown in FIG. **2**, the vehicle manufacturing system **50** includes the first information acquisition unit **1111**, the second information acquisition units **1113** and **1115**, and an abnormality occurrence detection unit **1125**. The abnormality occurrence detection unit **1125** is a part of the function of the server **200**.

[0063] The first information acquisition unit **1111** acquires first information indicating the positions and attitudes of a plurality of vehicles, which are manufactured step by step while they are continuously moving, from the outside of the plurality of the vehicles. The first information acquisition unit **1111** is preferably, for example, an infrared camera or a LiDAR. The first information acquisition unit **1111** acquires distances between a plurality of vehicles and steering-angle directions thereof.

[0064] At least one of the second information acquisition units **1113** and **1115** is provided in at least one vehicle, and acquires second information indicating the position and attitude of a vehicle in front of or behind the vehicle in which the second information acquisition unit is provided. Each of the second information acquisition units **1113** and **1115** can acquire a distance to the vehicle in front of or behind the vehicle in which the second information acquisition unit is provided and a steering-angle direction thereof.

[0065] The abnormality occurrence detection unit **1125** switches the control of the plurality of vehicles or notifying someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value.

[0066] The first information acquisition unit **1111**, the second information acquisition units **1113** and **1115**, and the abnormality occurrence detection unit **1125** may also be referred to as first information acquisition means, second information acquisition means, and abnormality occurrence detection means, respectively.

[0067] By the above-described configuration, it is possible to provide a vehicle manufacturing system capable of detecting the occurrence of an abnormality when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.

Description of Vehicle Manufacturing Method According to Embodiment

[0068] FIG. **3** is a flowchart of a vehicle manufacturing method according to an embodiment. The vehicle manufacturing method according to the embodiment will be described with reference to FIG. **3**.

[0069] As shown in FIG. **3**, the first information acquisition unit **1111** acquires first information (Step S**301**). The first information acquisition unit **1111** acquires first information indicating the positions and attitudes of a plurality of vehicles, which are manufactured step by step while they are continuously moving, from the outside of the plurality of vehicles.

[0070] Next, the second information acquisition units **1113** and **1115** acquire second information (Step S**302**). At least one of the second information acquisition units **1113** and **1115** is provided in at least one vehicle, and acquires second information indicating the position and attitude of a vehicle in front of or behind the vehicle in which the second information acquisition unit is provided.

[0071] Next, the abnormality occurrence detection unit **1125** switches the control of the vehicles or notifies the outside when the difference is large (Step S**303**). The abnormality occurrence detection unit **1125** switches the control of the plurality of vehicles or notifying someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value.

[0072] By the above-described configuration, it is possible to provide a method for manufacturing vehicles in which the occurrence of an abnormality is detected when a difference between first information acquired from the outside of a vehicle and second information acquired from the inside of the vehicle is larger than a predetermined value.

A. Traveling Control Example 1

[0073] FIG. **4** is a conceptual diagram showing a configuration of a system **50** in Traveling Control Example 1. The system **50** includes at least one vehicle **100** as a mobile object, a server **200**, and at least one external sensor **300**.

[0074] Note that when the mobile object is an object other than the vehicle, each of the terms "vehicle" and "car" in the present disclosure can be replaced with a "mobile object" as appropriate, and the term "traveling" can be replaced with a "movement" as appropriate.

[0075] The vehicle **100** is configured to be able to travel by an unattended operation. The "unattended operation" means an operation (e.g., driving) that does not rely on a traveling operation performed by an occupant (e.g., a driver). The traveling operation means an operation related to at least one of "running", "turning", and "stopping" of the vehicle **100**. The unattended operation is carried out by automatic or manual remote control using an apparatus located outside the vehicle **100**, or by autonomous control of the vehicle **100**. An occupant (e.g., a driver or a passenger) who does not perform a traveling operation may be on board the vehicle **100** which is traveling by an unattended operation. Examples of occupants who do not perform a traveling operation includes a person simply sitting on a seat of the vehicle **100** and a person who performs an operation other than the traveling operation, such as assembling, inspecting, and operating switches while being on board the vehicle **100**. Note that the operation (e.g., driving) by a traveling operation performed by an occupant may be referred to as a "manned operation (or piloted operation)".

[0076] In this specification, the "remote control" includes "full remote control" in which all the operations of the vehicle **100** are completely determined from the outside of the vehicle **100**, and "partial remote control" in which some of the operations of the vehicle **100** are determined from the outside of the vehicle **100**. Further, the "autonomous control" includes "full autonomous control" in which the vehicle **100** autonomously controls its own operations without receiving any information from an apparatus located outside the vehicle **100**, and "partial autonomous control" in which the vehicle **100** autonomously controls its own operations by using information received from an apparatus located outside the vehicle **100**.

[0077] In this embodiment, the system **50** is used in a factory FC in which vehicles **100** are manufactured. The reference coordinate system of the factory FC is a global coordinate system GC. That is, any position in the factory FC is represented by X, Y and Z-coordinates in the global coordinate system GC. The factory FC includes a first place PL**1** and a second place PL**2**. The first and second places PL**1** and PL**2** are connected to each other by a track TR (e.g., passageway) on which a vehicle **100** can travel. The factory FC includes a plurality of external sensors **300** along the track TR. The positions of the external sensors **300** in the factory FC are adjusted in advance. The vehicle **100** moves from the first place PL**1** to the second place PL**2** through the track TR by an unattended operation.

[0078] FIG. **5** is a block diagram showing a configuration of the system **50**. The vehicle **100** includes a vehicle control apparatus **110** for controlling various units of the vehicle **100**, an actuator group **120** including at least one actuator driven under the control of the vehicle control apparatus **110**, and a communication apparatus **130** for communicating with an external apparatus such as the server **200** through wireless communication. The actuator group **120** includes an actuator of a driving unit for accelerating the vehicle **100**, an actuator of a steering unit for changing the traveling direction of the vehicle **100**, and an actuator of a braking unit for decelerating the vehicle **100**.

[0079] The vehicle control apparatus **110** is composed of a computer including a processor **111**, a memory **112**, an input/output interface **113**, and an internal bus **114**. The processor **111**, the memory **112**, and the input/output interface **113** are connected to each other through the internal bus **114** so that they can bidirectionally communicate with each other. The actuator group **120** and the communication apparatus **130** are connected to the input/output interface **113**. The processor **111** implements various functions including the function as the vehicle control unit **115** by executing a program PG**1** stored in the memory **112**.

[0080] The vehicle control unit **115** drives the vehicle **100** by controlling the actuator group **120**. The vehicle control unit **115** can drive the vehicle **100** by controlling the actuator group **120** by using a driving control signal received from the server **200**. The driving control signal is a control

signal for driving the vehicle **100**. In this embodiment, the driving control signal includes an acceleration and a steering angle of the vehicle **100** as parameters. In other embodiments, the driving control signal may include a speed of the vehicle **100** as a parameter instead of or in addition to the acceleration of the vehicle **100**.
[0081] The server **200** is composed of a computer including a processor **201**, a memory **202**, an input/output interface **203**, and an internal bus **204**. The processor **201**, the memory **202**, and the input/output interface **203** are connected through the internal bus **204** so that they can bidirectionally communicate with each other. A communication apparatus **205** for communicating with various apparatuses located outside the server **200** is connected to the input/output interface **203**. The communication apparatus **205** can communicate with the vehicle **100** through wireless communication, and can communicate with each of the external sensors **300** through wired communication or wireless communication. The processor **201** implements various functions including the function as the remote-control unit **210** by executing a program PG**2** stored in the memory **202**.
[0082] The remote-control unit **210** acquires a detection result obtained by a sensor, generates a driving control signal for controlling the actuator group **120** of the vehicle **100** by using the detection result, and transmits the generated driving control signal to the vehicle **100**. In this way, the remote-control unit **210** drives the vehicle **100** by remote control. The remote-control unit **210** may generate and output, in addition to the driving control signal, control signals for controlling various auxiliary apparatuses provided in the vehicle **100** and actuators for operating various types of equipment such as wipers, power windows, and lamps. That is, the remote-control unit **210** may operate these various types of equipment and various auxiliary apparatuses by remote control.
[0083] The external sensor **300** is a sensor located outside the vehicle **100**. The external sensor **300** in this embodiment is a sensor for capturing (e.g., finding and keeping track of) the vehicle **100** from outside the vehicle **100**. The external sensor **300** includes a communication apparatus (not shown) and can communicate with other apparatuses such as the server **200** through wired communication or wireless communication.
[0084] Specifically, the external sensor **300** is formed by a camera (e.g., a still camera or a video camera). A camera, which functions as the external sensor **300**, takes an image (e.g., a still image or a moving image) including (i.e., showing therein) the vehicle **100** and outputs the taken image as a detection result.
[0085] FIG. **6** shows a flowchart showing a procedure of processes for controlling the traveling of a vehicle **100** in a traveling control example. In the procedure of processes shown in FIG. **6**, the processor **201** of the server **200** functions as the remote-control unit **210** by executing the program PG**2**. Further, the processor **111** of the vehicle **100** functions as the vehicle control unit **115** by executing the program PG**1**.
[0086] In a step S**110**, the processor **201** of the server **200** acquires vehicle position information of the vehicle **100** by using a detection result output from the external sensor **300**. The vehicle position information is position information based on which a driving control signal is generated. In this 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 a step S**110**, the processor **201** acquires vehicle position information by using the photographed image acquired from the camera serving as the external sensor **300**.
[0087] Specifically, in the step S**110**, the processor **201** acquires the position of the vehicle **100** by, for example, detecting the external shape of the vehicle **100** from the photographed image, calculating the coordinates of the positioning point of the vehicle **100** in the coordinate system of the photographed image, i.e., in the local coordinate system, and converting the calculated coordinates into coordinates in the global coordinate system GC. The external shape of the vehicle **100** included (i.e., shown) in the photographed image can be detected by, for example, inputting the photographed image into a detection model DM using artificial intelligence. The detection model

DM is prepared, for example, in the system **50** or outside the system **50**, and stored in the memory **202** of the server **200** in advance. Examples of the detection model DM include a trained machine-learning model that has been trained to perform either semantic segmentation or instance segmentation. As this machine-learning model, for example, a convolutional neural network (hereinafter also referred to as a CNN) trained through supervised learning using a learning data set can be used. The learning data set includes, for example, a plurality of training images each including the vehicle **100** and labels each indicating whether a respective area in the training image is an area indicating the vehicle **100** or an area that does not indicate a mobile object. When the CNN is trained, it is preferred that parameters of the CNN are updated by backpropagation (error backpropagation method) so that errors between output results by the detection model DM and labels are reduced. Further, the processor **201** can acquire the orientation of the vehicle **100** by, for example, estimating it based on the orientation of the moving vector of the vehicle **100** calculated from changes in the positions of the feature points of the vehicle **100** between frames of the photographed images by using an optical flow method.

[0088] In a step S**120**, the processor **201** of the server **200** determines a target position to which the vehicle **100** should go next. In this embodiment, the target position is represented by X, Y and Z-coordinates in the global coordinate system GC. In the memory **202** of the server **200**, a reference route RR, which is a route along which the vehicle **100** should travel, is stored in advance. A route is represented by a node indicating a starting point, a node(s) indicating a passing point(s), a node indicating a destination, and links connecting these nodes with one another. The processor **201** determines a target position to which the vehicle **100** should go next by using the vehicle position information and the reference route RR. The processor **201** determines the target position of the vehicle **100** ahead of the current position thereof on the reference route RR.

[0089] In a step S**130**, the processor **201** of the server **200** generates a driving control signal for driving the vehicle **100** toward the determined target position. The processor **201** calculates the traveling speed of the vehicle **100** based on the changes in the position of the vehicle **100**, and compares the calculated traveling speed with the target speed. When the traveling speed is lower than the target speed, the processor **201** determines, as a whole, the acceleration of the vehicle **100** so that the vehicle **100** accelerates, whereas when the traveling speed is higher than the target speed, the processor **201** determines the acceleration so that the vehicle **100** decelerates. Further, when the vehicle **100** is positioned on the reference route RR, the processor **201** determines the steering angle and the acceleration of the vehicle **100** so that the vehicle **100** does not deviate from the reference route RR, whereas when the vehicle **100** is not positioned on the reference route RR, i.e., the vehicle **100** has deviated from the reference route RR, the processor **201** determines the steering angle and the acceleration so that the vehicle **100** returns to the reference route RR.

[0090] In a step S**140**, the processor **201** of the server **200** transmits the generated driving control signal to the vehicle **100**. The processor **201** repeats the acquisition of the position of the vehicle **100**, the determination of a target position, the generation of a driving control signal, the transmission of the driving control signal, and the like in a predetermined cycle.

[0091] In a step S**150**, the processor **111** of the vehicle **100** receives the driving control signal transmitted from the server **200**. In a step S**160**, the processor **111** of the vehicle **100** controls the actuator group **120** by using the received driving control signal, and thereby drives the vehicle **100** so as to travel at the acceleration and the steering angle indicated by the driving control signal. The processor **111** repeats the reception of a driving control signal and the control of the actuator group **120** at a predetermined cycle. According to the system **50** in this example, it is possible to drive the vehicle **100** by remote control, and thereby move the vehicle **100** without using conveyance equipment such as a crane or a conveyor.

B: Traveling Control Example 2

[0092] FIG. **7** is an explanatory diagram showing a schematic configuration of a system **50***v* in Traveling Control Example 2. This example differs from Traveling Control Example 1 because the system **50***v* does not includes the server **200**. Further, a vehicle **100***v* in the configuration can travel by autonomous control performed by the vehicle **100***v* itself. The rest of the configuration is the same as that described above unless otherwise specified.

[0093] In this example, a processor **111***v* of a vehicle control apparatus **110***v* functions as a vehicle control unit **115***v* by executing a program PG**1** stored in a memory **112***v*. The vehicle control unit **115***v* acquires an output result obtained by a sensor, generates a driving control signal by using the output result, and outputs the generated driving control signal and thereby operates the actuator group **120**. By doing so, the vehicle control unit **115***v* can make the vehicle **100***v* travel by autonomous control performed by the vehicle **100** itself. In this example, in addition to the program PG**1**, a detection model DM and a reference route RR are stored in the memory **112***v* in advance.

[0094] FIG. **8** shows a flowchart showing a procedure of processes for controlling the traveling of the vehicle **100***v* in Traveling Control Example 2. In the processing procedure shown in FIG. **8**, the processor **111***v* of the vehicle **100***v* functions as the vehicle control unit **115***v* by executing the program PG**1**.

[0095] In a step S**210**, the processor lily of the vehicle control apparatus **110***v* acquires vehicle position information by using a detection result output from a camera which is an external sensor **300**. In a step S**220**, the processor lily determines a target position to which the vehicle **100***v* should go next. In a step S**230**, the processor **111***v* generates a driving control signal for making the vehicle **100***v* travel toward the determined target position. In a step S**240**, the processor **111***v* controls the actuator group **120** by using the generated driving control signal, and thereby makes the vehicle **100***v* travel according to parameters indicated by the driving control signal. The processor **111***v* repeats the acquisition of vehicle position information, the determination of a target position, the generation of a driving control signal, and the control of actuators in a predetermined cycle. According to the system **50***v* in this example, it is possible to make the vehicle **100***v* travel by autonomous control performed by the vehicle **100***v* itself without having the server **200** remotely control the vehicle **100***v*.

YY: Other Traveling Control Examples

[0096] (YY1) In the above-described examples, the external sensor **300** is a camera. However, the external sensor **300** may not be a camera and may be, for example, LiDAR (Light Detection And Ranging). In this case, the detection result output from the external sensor **300** may be 3D (three-dimensional) point cloud data representing the vehicle **100**. In this case, the server **200** and the vehicle **100** may acquire vehicle position information by template matching between the 3D point cloud data, which is the detection result, and reference point cloud data prepared in advance.

[0097] (YY2) In Traveling Control Example 1, a series of processes from the acquisition of vehicle position information to the generation of a driving control signal are performed by the server **200**. However, at least some of the processes from the acquisition of vehicle position information to the generation of a driving control signal may be performed by the vehicle **100**. For example, the below-shown Embodiments (1) to (3) may be adopted.

[0098] (1) The server **200** may acquire vehicle position information, determine a target position to which the vehicle **100** should go next, and generate a route from the current position of the vehicle **100** indicated by the acquired vehicle position information to the target position. The server **200** may generate a route to a target position which is located between the current position and the 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 driving control signal so as to travel along the route received from the server **200**, and control the actuator group **120** by using the generated driving control signal.

[0099] (2) The server **200** may acquire vehicle position information and transmit the acquired vehicle position information to the vehicle **100**. The vehicle **100** may determine a target position to which the vehicle **100** should go next, generate a route from the current position of the vehicle **100** indicated by the received vehicle position information to the target position, generate a driving control signal so as to travel along the generated route, and control the actuator group **120** by using the generated driving control signal.

[0100] (3) In the above-described Embodiments (1) and (2), the vehicle **100** may be equipped with an internal sensor, and a detection result output from the internal sensor may be used for at least either the generation of a route or the generation of a driving control signal. The internal sensor is a sensor provided in the vehicle **100**. Examples of internal sensors may include a sensor for detecting the motion state of the vehicle **100**, a sensor for detecting the operation state of each unit of the vehicle **100**, and a sensor for detecting the environment around the vehicle **100**. Specifically, examples of internal sensors include a camera, LiDAR, a millimeter-wave radar, an ultrasonic sensor, a GPS sensor, an acceleration sensor, and a gyro sensor. For example, in the above-described Embodiment (1), the server **200** may acquire a detection result obtained by the internal sensor, and when generating a route, take the detection result of the internal sensor into consideration in the generation of the route. In the above-described Embodiment (1), the vehicle **100** may acquire a detection result obtained by the internal sensor, and when generating a driving control signal, take the detection result of the internal sensor into consideration in the generation of the driving control signal. In the above-described Embodiment (2), the vehicle **100** may acquire a detection result obtained by the internal sensor, and when generating a route, take the detection result of the internal sensor into consideration in the generation of the route. In the above-described Embodiment (2), the vehicle **100** may acquire a detection result obtained by the internal sensor, and when generating a driving control signal, take the detection result of the internal sensor into consideration in the generation of the driving control signal.

[0101] (YY3) In Traveling Control Example 2, the vehicle **100***v* may be equipped with an internal sensor, and a detection result output from the internal sensor may be used for at least either the generation of a route or the generation of a driving control signal. For example, the vehicle **100***v* may acquire a detection result obtained by the internal sensor, and when generating a route, take the detection result of the internal sensor into consideration in the generation of the route. The vehicle **100***v* may acquire a detection result obtained by the internal sensor, and when generating a driving control signal, take the detection result of the internal sensor into consideration in the generation of the driving control signal.

[0102] (YY4) In Traveling Control Example 2, the vehicle **100***v* acquires vehicle position information by using a detection result obtained by an external sensor **300**. However, the vehicle **100***v* may be equipped with an internal sensor, and the vehicle **100***v* may acquire vehicle position information by using the detection result of the internal sensor, determine a target position to which the vehicle **100***v* should go next, generate a route from the current position of the vehicle **100***v* indicated by the acquired vehicle position information to the target position, generate a driving control signal for traveling along the generated route, and control the actuator group **120** by using the generated driving control signal. In this case, the vehicle **100***v* can travel without using the detection result of the external sensor **300** at all. Note that the vehicle **100***v* may acquire a target arrival time and traffic congestion information from outside the vehicle **100***v* and take the target arrival time and traffic congestion information into consideration in at least either the generation of a route or the generation of a driving control signal. Further, all the functions of the system **50***v* may be provided in the vehicle **100***v*. That is, the whole processing implemented by the system **50***v* according to the present disclosure may be implemented by the vehicle **100***v* alone.

[0103] (YY5) In Traveling Control Example 1, the server **200** automatically generates a driving control signal to be transmitted to the vehicle **100**. However, the server **200** may generate a driving control signal to be transmitted to the vehicle **100** according to an operation performed by an operator who is present outside the vehicle **100**. For example, an operator present outside the vehicle **100** may operate a controlling apparatus including a display for displaying a photographed image output from an external sensor **300**, a steering wheel, an accelerator pedal, and a brake pedal for remotely controlling the vehicle **100**, and a communication apparatus for communicating with the server **200** through wired communication or wireless communication. Then, the server **200** may generate a driving control signal according to operations performed on the controlling apparatus.

[0104] (YY6) In each of the above-described traveling control examples, it is sufficient if the vehicle **100** has a configuration capable of moving the vehicle **100** by an unattended operation. For example, the vehicle **100** may be in the form of a platform including the below-described configuration. Specifically, it is sufficient if the vehicle **100** include at least a vehicle control apparatus **110** and an actuator group **120** in order to perform three functions of “running”, “turning”, and “stopping” by an unattended operation. In the case where the vehicle **100** acquires information from the outside the vehicle **100** in order to perform an unattended operation, it is sufficient if the vehicle **100** further include a communication apparatus **130**. That is, the vehicle **100** capable of moving by an unattended operation may not include at least some of interior components such as a driver's seat and a dashboard, may not include at least some of exterior components such as a bumper and a fender, and may not include a body shell. In this case, the remaining components such as a body shell may be attached to the vehicle **100** until the vehicle **100** is shipped from the factory FC. Alternatively, the vehicle **100** may be shipped from the factory FC without the remaining components such as a body shell, and then these remaining components such as a body shell may be attached to the vehicle **100** after the shipment. These components may be attached from arbitrary directions such as from above, from below, from front, from rear, from the right side, or from the left side of the vehicle **100**. Further, they may be attached from the same direction or from different directions. Note that in the case of being formed as a platform, its position may be determined in the same manner as the position of the vehicle **100** is determined in the first embodiment.

[0105] (YY7) The vehicle **100** may be manufactured by combining a plurality of modules with each other. The module means a unit composed of a plurality of components that are assembled according to the place in the vehicle **100** at which the module is used and/or according to the function in the vehicle **100**. For example, the platform of the vehicle **100** may be manufactured by combining a front module constituting the front part of the platform, a center module constituting the central part of the platform, and a rear module constituting the rear part of the platform with each other. Note that the number of modules constituting the platform is not limited to three, but may be two or less, or four or more. Further, in addition to or instead of the components constituting the platform, components constituting a part of the vehicle **100** other than the platform may be assembled into a module. Further, they include various modules including optional exterior components such as a bumper and a grill, and optional interior components such as a seat and a console. Further, what is manufactured is not limited to the vehicle **100**. That is, any type of mobile object may be manufactured by combining a plurality of modules with each other. Such modules may be manufactured, for example, by joining a plurality of components by welding or by using fixtures, or may be manufactured by integrally molding at least some of the components constituting the module into one component by casting. A molding method for integrally molding one component, particularly a relatively large component, may also be called giga-casting or mega-casting. For example, the aforementioned front module, the center module, and the rear module may be manufactured by giga-casting.

[0106] (YY8) The conveyance of a vehicle **100** that is carried out by making the vehicle **100** travel by an unattended operation is also called “self-propelled conveyance”. Further, the configuration for carrying out self-propelled conveyance is also called a “vehicle remote control autonomous traveling conveyance system”. Further, the production method for producing vehicles **100** by using self-propelled conveyance is also called “self-propelled production”. In the self-propelled production, for example, at least some of the conveyance of vehicles **100** is carried out by self-propelled conveyance in the factory FC in which vehicles **100** are manufactured.

[0107] (YY9) In each of the above-described traveling control examples, some or all of the functions and processes implemented by software may be implemented by hardware. Further, some

or all of the functions and processes implemented by hardware may be implemented by software. As the hardware for implementing various functions in each of the above-described embodiments, various circuits such as integrated circuits and/or discrete circuits may be used.
[0108] Further, some or all of the processes performed in the above-described external sensor **300**, the vehicle **100**, the server **200**, and the like can be implemented in the form of a computer program. Such a program can be stored and provided to the computer by using any type of non-transitory computer readable media. Non-temporary computer readable media include various types of substantial recording media. Examples of the non-transitory computer readable media include a magnetic recording medium (such as a flexible disk, a magnetic tape, and a hard disk drive), a magneto-optic recording medium (such as a magneto-optic disk), a CD-ROM (Read Only Memory), a CD-R, a CD-R/W, and a semiconductor memory (such as a mask ROM, a PROM (Programmable ROM), an EPROM (Erasable PROM), a flash ROM, and a RAM (Random Access Memory)). Further, the program may be supplied to the computer by various types of temporary computer readable media. Examples of transitory computer readable media include electric signals, optical signals, and electromagnetic waves. Temporary computer readable media can provide programs to computers through wired or wireless communication channels such as wires and optical fibers.
[0109] Note that the present invention is not limited to the above-described example embodiments, and they can be modified as appropriate without departing from the scope and spirit of the invention.
[0110] From the disclosure thus described, it will be obvious that the embodiments of the disclosure may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the disclosure, and all such modifications as would be obvious to one skilled in the art are intended for inclusion within the scope of the following claims.

Claims

1. A vehicle manufacturing system comprising: a first information acquisition unit configured to acquire first information indicating positions and attitudes of a plurality of vehicles from outside of the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; a second information acquisition unit configured to acquire second information, provided in at least one of the vehicles, the second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition means is provided; and an abnormality occurrence detection unit configured to switch control of the plurality of vehicles or notify someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information and the positions and attitudes of the plurality of vehicles acquired from the second information is larger than a predetermined value.
2. The vehicle manufacturing system according to claim 1, wherein the first information is an image or a distance, the second information is an image or a distance, the first information acquisition unit is a photographing apparatus, a LiDAR, a radar, a GPS, or an ultrasonic sensor, and the second information acquisition unit is a photographing apparatus, a LiDAR, a radar, a GPS, or an ultrasonic sensor.
3. The vehicle manufacturing system according to claim 1, wherein the switching of control of the plurality of vehicles is to stop or decelerate the plurality of vehicles.
4. The vehicle manufacturing system according to claim 1, wherein the notification to the outside is to notify a manager, an operator, or a production management system of an abnormality.
5. The vehicle manufacturing system according to claim 1, wherein the predetermined value is changed according to a specific section.
6. The vehicle manufacturing system according to claim 5, wherein the specific section is a section

in which a vehicle makes a U-turn, a section having a large turning curvature, or a slope.

7. A method for manufacturing vehicles, comprising: acquiring first information indicating positions and attitudes of a plurality of vehicles by using a first information acquisition unit provided outside the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; acquiring, by using a second information acquisition unit provided in at least one of the vehicles, second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition unit is provided; and switching control of the plurality of vehicles or notifying someone or something outside the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information acquisition unit and the positions and attitudes of the plurality of vehicles acquired from the second information acquisition unit is larger than a predetermined value.

8. A non-transitory computer readable medium storing a program for causing an information processing apparatus to: acquire first information indicating positions and attitudes of a plurality of vehicles by using a first information acquisition unit provided outside the plurality of vehicles, the plurality of vehicles being manufactured step by step while they are continuously moving; acquire, by using a second information acquisition unit provided in at least one of the vehicles, second information indicating a position and an attitude of a vehicle in front of or behind the vehicle in which the second information acquisition unit is provided; and switch control of the plurality of vehicles or notify the outside of the plurality of vehicles when a difference between the positions and attitudes of the plurality of vehicles acquired from the first information acquisition unit and the positions and attitudes of the plurality of vehicles acquired from the second information acquisition unit is larger than a predetermined value.
