(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 317 585 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
07.02.2024 Bulletin 2024/06

(21) Application number: **22780833.4**

(22) Date of filing: **28.03.2022**

(51) International Patent Classification (IPC):
E01C 19/48 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E01C 19/48

(86) International application number:
PCT/JP2022/015230

(87) International publication number:
WO 2022/210622 (06.10.2022 Gazette 2022/40)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **29.03.2021 JP 2021056024**

(71) Applicant: **Sumitomo Construction Machinery Co., Ltd.**
Tokyo 141-6025 (JP)

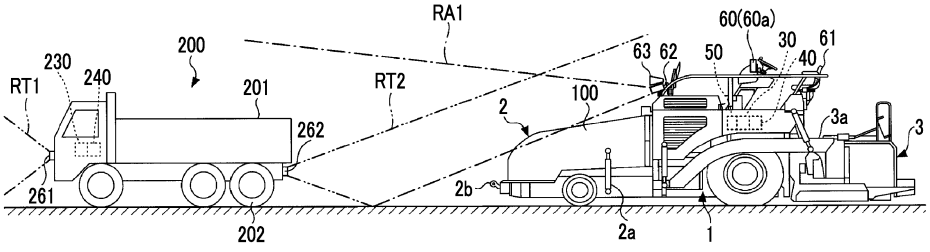
(72) Inventors:
- **MINO, Hisaho**
  Chiba-shi, Chiba 263-0001 (JP)
- **HAGIWARA, Kazuaki**
  Chiba-shi, Chiba 263-0001 (JP)

(74) Representative: **Louis Pöhlau Lohrentz Patentanwälte**
Postfach 30 55
90014 Nürnberg (DE)

(54) ASPHALT FINISHER AND ASPHALT FINISHER CONSTRUCTION ASSISTANCE SYSTEM

(57) An asphalt finisher includes a tractor, a hopper installed on a front side of the tractor, a conveyor that conveys a paving material inside the hopper to a rear side of the tractor, a screw that lays and spreads the paving material conveyed by the conveyor and scattered on a road surface in a vehicle width direction, and a screed device that lays and levels the paving material laid and spread by the screw on a rear side of the screw. An operation of a transport vehicle is synchronized to correspond to an operation of the asphalt finisher.

FIG. 1A



EP 4 317 585 A1

Description

Technical Field

[0001] The present invention relates to an asphalt finisher and an asphalt finisher construction assistance system.

Background Art

[0002] In the related art, an asphalt finisher is known which includes a tractor, a hopper installed on a front side of the tractor to receive a paving material, a conveyor that feeds the paving material inside the hopper to a rear side of the tractor, a screw that lays and spreads the paving material fed by the conveyor on the rear side of the tractor, and a screed that lays and levels the paving material laid and spread by the screw on a rear side of the screw.

[0003] When the asphalt finisher carries out construction, a transport vehicle (for example, a dump truck) exists in front of the asphalt finisher. Then, the paving material is supplied to the asphalt finisher from the transport vehicle. The asphalt finisher needs to continuously carry out the construction. Therefore, after the transport vehicle is positioned at the asphalt finisher, the transport vehicle needs to move forward together with the asphalt finisher so that the asphalt finisher continuously carries out the construction.

Citation List

Patent Literature

[0004] [PTL 1] International Publication No. 2017/010541

Summary of Invention

Technical Problem

[0005] While the paving material is supplied from the transport vehicle to the asphalt finisher, the asphalt finisher exists behind the transport vehicle. Therefore, a driver of the transport vehicle is less likely to confirm a situation of the asphalt finisher.

[0006] In view of the above-described circumstances, it is desirable to provide an asphalt finisher which can appropriately control a transport vehicle in accordance with a situation of the asphalt finisher.

Solution to Problem

[0007] According to an aspect of the present invention, there is provided an asphalt finisher including a tractor, a hopper installed on a front side of the tractor, a conveyor that conveys a paving material inside the hopper to a rear side of the tractor, a screw that lays and spreads the paving material conveyed by the conveyor and scattered on a road surface in a vehicle width direction, and a screed device that lays and levels the paving material laid and spread by the screw on a rear side of the screw. An operation of a transport vehicle is synchronized to correspond to an operation of the asphalt finisher.

Advantageous Effects of Invention

[0008] According to the aspect of the present invention, since the operation of the transport vehicle is synchronized with the operation of the asphalt finisher, a burden on a driver who is aboard a transport vehicle can be reduced.

Brief Description of Drawings

[0009]

Fig. 1A is a left side view illustrating an asphalt finisher and a dump truck which are examples of a road paving machine according to a first embodiment.

Fig. 1B is a top view illustrating the asphalt finisher and the dump truck which are the examples of the road paving machine according to the first embodiment.

Fig. 2 is a block diagram illustrating a configuration of the asphalt finisher and the dump truck according to the first embodiment.

Fig. 3 is a view illustrating a process procedure performed by the asphalt finisher according to the first embodiment.

Fig. 4 is a top view of a construction site, illustrating a first movement path and a second movement path which are generated by a path generation unit to construct a curved part (left curve) of a road.

Description of Embodiments

[0010] Hereinafter, embodiments of the present invention will be described with reference to the drawings. In each drawing, the same reference numerals will be assigned to the same or corresponding configurations, and description thereof may be omitted.

(First Embodiment)

[0011] Figs. 1A and 1B are views illustrating an asphalt finisher 100 and a dump truck 200, which are examples of a road paving machine according to a first embodiment. Specifically, Fig. 1A is a left side view, and Fig. 1B is a top view. Figs. 1A and 1B illustrate an example in which the dump truck 200 approaches the asphalt finisher 100 while moving rearward.

[0012] The asphalt finisher 100 is configured to mainly include a tractor 1, a hopper 2, and a screed device 3.

[0013] The screed device 3 is a mechanism for laying and leveling a paving material. In the present embodi-

ment, the screed device 3 is a floating screed device towed by the tractor 1, and is connected to the tractor 1 via a leveling arm 3a.

[0014] The hopper 2 is provided on a front side of the tractor 1 as a mechanism for receiving the paving material. The hopper 2 of the present embodiment has a mechanism that can be opened and closed in a vehicle width direction by a hopper cylinder 2a while movable mechanism portions 81a and 81b serve as axes. Then, when the asphalt finisher 100 is about to run out of the paving material (for example, an asphalt mixture) of the hopper 2, the asphalt finisher 100 can bring the hopper 2 into a fully opened state, and can receive the paving material from a loading platform 201 of the dump truck 200 serving as a paving material transport vehicle. Then, in a state where the dump truck 200 is in contact with the asphalt finisher 100, the paving material is supplied to the hopper 2 from the loading platform 201 of the dump truck 200.

[0015] In addition, even when the paving material is received from the loading platform 201 of the dump truck 200, the asphalt finisher 100 continues traveling (construction) while advancing in a traveling direction together with the dump truck 200. Specifically, a conveyor conveys the paving material received inside the hopper 2 to a rear side of the tractor 1. A screw lays and spreads the paving material conveyed by the conveyor and scattered on a road surface in the vehicle width direction. The screed device 3 lays and levels the paving material laid and spread by the screw on a rear side of the screw.

[0016] After the paving material is received from the loading platform 201 of the dump truck 200, an operator of the asphalt finisher 100 can put the paving material supplied to the hopper 2 on the conveyor by gradually closing the hopper 2. Thereafter, when the paving material supplied to the hopper 2 is conveyed rearward and the paving material inside the hopper 2 substantially runs out, the operator opens the hopper 2. Then, in a stage where the hopper 2 is in the fully opened state again, the hopper 2 can receive the paving material from the dump truck 200. Therefore, it is preferable that a driver of the dump truck 200 brings the dump truck 200 close to the asphalt finisher 100 after confirming that the hopper 2 is in the fully opened state.

[0017] Furthermore, the asphalt finisher 100 includes a roller 2b. The roller 2b is installed in front of the hopper 2. The roller 2b is configured to be capable of coming into contact with a rear wheel 202 of the dump truck 200, and when the rear wheel 202 of the dump truck 200 is in contact with the roller 2b, the roller 2b can rotate together with the rear wheel 202.

[0018] The tractor 1 is a mechanism for causing the asphalt finisher 100 to travel. In the present embodiment, the tractor 1 moves the asphalt finisher 100 in such a manner that a traveling hydraulic motor is used to rotate front wheels and rear wheels. The traveling hydraulic motor rotates by receiving hydraulic oil supply from a hydraulic source. The tractor 1 may include a crawler instead of the wheels.

[0019] In addition, the tractor 1 is equipped with a controller 30, a wireless communication device 40, a GPS module 50, a main monitor 60, a driving seat 61, an imaging device 62, and an audio output device 63. Specifically, a cab including the main monitor 60 and the driving seat 61 is installed on an upper surface of the tractor 1. The imaging device 62 and the audio output device 63 are installed at the center of the front end of the upper surface of the tractor 1.

[0020] The wireless communication device 40 directly performs short-range wireless communication with a device existing around the asphalt finisher 100, for example, such as a dump truck 200. In the present embodiment, for example, it is conceivable to use Wi-Fi (registered trademark) as a wireless communication standard of the wireless communication device 40. The wireless communication of the present embodiment is not limited to a method using the Wi-Fi (registered trademark), and wireless LAN or Bluetooth (registered trademark) may be used.

[0021] The GPS module 50 is an example of a Global Navigation Satellite System (GNSS) module, and receives position information indicating a result of two-dimensional positioning obtained by a Global Positioning System (GPS). The position information includes information representing a position of the asphalt finisher 100 in latitude and longitude. In the present embodiment, the GPS is used as a method for acquiring the position information. However, the method for acquiring the position information is not limited, and other well-known methods may be used.

[0022] The main monitor 60 is a device that displays various information to the operator of the asphalt finisher 100. In the present embodiment, the main monitor 60 is a liquid crystal display, and can display various information in accordance with a command from the controller 30. In addition, the main monitor 60 includes an input device 60a that receives an operation input of the operator of the asphalt finisher 100.

[0023] The imaging device 62 is a device that acquires an image of a space in front of the asphalt finisher 100. In the present embodiment, the imaging device 62 is a camera, and outputs the acquired image to the controller 30. The imaging device 62 may be a range image camera, an infrared camera, or a stereo camera.

[0024] The imaging device 62 (example of a detection device) according to the present embodiment images a space inside an imaging region RA1 (example of a detection range) existing in front of the asphalt finisher 100 and illustrated by a one-dot chain line in Figs. 1A and 1B. Then, the imaging device 62 outputs image information (example of detection information) relating to the captured image to the controller 30. In an example illustrated in Figs. 1A and 1B, the imaging device 62 can image the dump truck 200 existing in the imaging region RA1. In the present embodiment, an example in which the imaging device 62 is used as an example of a device capable of recognizing a space will be described. However, in the

present embodiment, the space recognition device is not limited to the imaging device 62. That is, any space recognition device may be used as long as the space can be recognized based on the asphalt finisher 100, and for example, a laser sensor may be used.

[0025] The audio output device 63 is a device that outputs audio toward a periphery of the asphalt finisher 100. In the present embodiment, the audio output device 63 is a speaker that outputs audio forward of the asphalt finisher 100, and can output an alarm in accordance with a command from the controller 30. The audio output device 63 may output an audio message.

[0026] The controller 30 is a control device that controls the asphalt finisher 100. For example, the controller 30 is configured to include, a computer, and has a CPU, an internal memory, and a storage medium. The controller 30 performs various types of control by causing the CPU to execute a program stored in the storage medium.

[0027] The controller 30 can assist a driving operation of the asphalt finisher 100 by using Advanced driver-assistance systems (ADAS), based on image information received from the imaging device 62 and detection signals received from various detection sensors (not illustrated). A driving operation assistance system used by the controller 30 according to the present embodiment is not limited to a driving operation system using the ADAS, and may be another driving operation assistance system. For example, the controller 30 may use Autonomous Driving (AD). Furthermore, the controller 30 may use any system as long as the system can perform movement control of the asphalt finisher 100 along a movement path generated in advance.

[0028] The dump truck 200 is configured to include the loading platform 201, a hoist cylinder (not illustrated), a first imaging device 261, a second imaging device 262, a controller 230, and a wireless communication device 240. The loading platform 201 can be equipped with the paving material to be supplied to the hopper 2 of the asphalt finisher 100. The hoist cylinder is a mechanism that tilts the loading platform 201 rearward, and expands and contracts in accordance with a command from the controller 230. In this manner, the hoist cylinder switches between a tilted state where the loading platform 201 is tilted rearward and a horizontal state where the loading platform 201 is on a horizontal level.

[0029] For example, the first imaging device 261 is a device provided in the vicinity of an emblem of the dump truck 200 to acquire an image of a space in front of the dump truck 200. The second imaging device 262 is a device that acquires the image of the space behind the dump truck 200. The first imaging device 261 and the second imaging device 262 according to the present embodiment are cameras, and output the acquired image to the controller 230. The first imaging device 261 and the second imaging device 262 may be range image cameras, infrared cameras, or stereo cameras. In the present embodiment, an example in which the first imaging device 261 and the second imaging device 262 are used as examples of devices capable of recognizing the space will be described. However, in the present embodiment, the space recognition device is not limited to the first imaging device 261 and the second imaging device 262. That is, any space recognition device may be used as long as the space can be recognized based on the dump truck 200, and for example, a laser sensor may be used.

[0030] The first imaging device 261 according to the present embodiment images a space inside an imaging region RT1 existing in front of the dump truck 200 and illustrated by a two-dot chain line in Figs. 1A and 1B. The first imaging device 261 outputs image information relating to the captured image to the controller 230.

[0031] The second imaging device 262 according to the present embodiment images a space inside an imaging region RT2 existing behind the dump truck 200 and illustrated by a two-dot chain line in Figs. 1A and 1B. The second imaging device 262 outputs image information relating to the captured image to the controller 230.

[0032] The wireless communication device 240 performs wireless communication with a device existing around the dump truck 200, for example, such as the wireless communication device 40 of the asphalt finisher 100. In the present embodiment, for example, it is conceivable to use Wi-Fi (registered trademark) as the wireless communication standard of the wireless communication device 240. The wireless communication of the present embodiment is not limited to a method using Wi-Fi (registered trademark), and wireless LAN of Bluetooth (registered trademark) may be used.

[0033] The controller 230 is a control device that controls the dump truck 200. For example, the controller 230 is configured to include a computer, and has a CPU, an internal memory, and a storage medium. The controller 230 performs various types of control by causing the CPU to execute a program stored in the storage medium.

[0034] The controller 230 according to the present embodiment can assist a driving operation of the dump truck 200 by using the ADAS, based on image information received from the first imaging device 261, image information received from the second imaging device 262, and detection signals received from various detection sensors (not illustrated). The driving operation assistance system used by the controller 230 according to the present embodiment is not limited to the driving operation system using the ADAS, and may be another driving operation assistance system. For example, AD may be used as the controller 230. Furthermore, the controller 230 may use any system as long as the system can perform movement control in accordance with a movement path or various control commands.

[0035] For example, the controller 230 according to the present embodiment realizes control for stopping the dump truck 200 in the vicinity of the hopper 2 of the asphalt finisher 100 by using parking assistance of the ADAS. In this case, the controller 230 of the present embodiment may receive a control command from the asphalt finisher 100 via the wireless communication device

240, and may perform drive control of the dump truck 200, based on the received control command.

[0036] When the dump truck 200 is positioned in the vicinity of the hopper 2 of the asphalt finisher 100, the asphalt finisher 100 is carrying out the construction. Therefore, after the dump truck 200 is positioned in the vicinity of the hopper 2 of the asphalt finisher 100, while the dump truck 200 supplies the paving material to the hopper 2 from the loading platform 201, the dump truck 200 needs to travel together with the asphalt finisher 100.

[0037] Therefore, the controller 30 of the asphalt finisher 100 according to the present embodiment controls to synchronize the operation of the dump truck 200 to correspond to the operation of the asphalt finisher 100.

[0038] In the present embodiment, the controller 30 of the asphalt finisher 100 generates a first movement path for the asphalt finisher 100 for moving the asphalt finisher 100 to pave a construction target region, based on a construction plan drawing. Then, the controller 30 controls the asphalt finisher 100 to move along the first movement path.

[0039] The construction plan drawing that can be stored in the storage medium of the controller 30 includes information indicating a region of a pavement target road surface of the asphalt finisher 100 in a reference coordinate system.

[0040] For example, the reference coordinate system used in the construction plan drawing is a world geodetic system. The world geodetic system is a three-dimensional orthogonal XYZ-coordinate system in which an origin is set at the center of gravity of the earth, an axis passing through an intersection point between the Greenwich meridian and the equator and the origin is set as an X-axis, an axis passing through an intersection point between the 90th meridian east and the equator and the origin is set as a Y-axis, and an axis passing through the north pole and the origin is set as a Z-axis. In other words, the construction plan drawing includes information indicating a region of a construction target road surface by using the three-dimensional orthogonal XYZ-coordinate system (world geodetic system).

[0041] In addition, the construction plan drawing may include various information relating to the construction target road surface. For example, the construction plan drawing may include information indicating a position of an obstacle existing on the construction target road surface. For example, as the obstacle, there is step difference information existing on the road surface. For example, the step difference information is information relating to a manhole existing on the road surface.

[0042] The asphalt finisher 100 acquires position information indicating the position of the asphalt finisher 100 in the latitude and the longitude via the GPS module 50. Therefore, the controller 30 of the asphalt finisher 100 can identify the position indicated by the position information acquired by the GPS module 50 on the construction plan drawing.

[0043] Based on the construction plan drawing, the controller 30 generates a second movement path for the dump truck 200 so that the dump truck 200 travels in a state where the loading platform 201 of the dump truck 200 and the hopper 2 of the asphalt finisher 100 are maintained in an overlapping state (in other words, in a synchronized state). Then, the controller 30 generates a control command instructing a steering angle and a speed of the dump truck 200 so that the dump truck 200 travels along the second movement path. Then, the controller 30 transmits the generated control command to the wireless communication device 240 of the dump truck 200 via the wireless communication device 40. In this manner, the controller 30 synchronizes the operation of the dump truck 200 to correspond to the operation of the asphalt finisher 100.

[0044] Fig. 2 is a block diagram illustrating a configuration of the asphalt finisher 100 and the dump truck 200 according to the present embodiment. As illustrated in Fig. 2, the dump truck 200 includes a first imaging device 261, a second imaging device 262, an input device 263, a controller 230, a wireless communication device 240, and a drive system controller 250. That is, in the present embodiment, in the asphalt finisher construction assistance system including the asphalt finisher 100 and the dump truck 200, an example will be described in which the controller 30 synchronizes the operation of the dump truck 200 to correspond to the operation of the asphalt finisher 100.

[0045] The controller 230 generates a control command relating to drive control, based on image information from the first imaging device 261 (for example, provided in the vicinity of the emblem on the front surface of the dump truck 200), image information from the second imaging device 262 (for example, provided in a rear end part of the dump truck 200), and a control signal from a detection sensor (not illustrated). Then, the controller 230 outputs the generated control command to the drive system controller 250. In this manner, the controller 230 realizes the driving operation assistance using the ADAS. The drive system controller 250 controls a drive system and an engine of the dump truck 200 in accordance with a control command.

[0046] In addition, the controller 230 performs various types of control by receiving an operation from a driver via the input device 263.

[0047] When the control command is received from the asphalt finisher 100 via the wireless communication device 240, the controller 230 outputs the received control command to the drive system controller 250. In this manner, the dump truck 200 realizes the driving operation assistance using the ADAS in accordance with a request from the asphalt finisher 100.

[0048] In addition, the controller 230 may transmit the image information captured by the first imaging device 261 and the image information captured by the second imaging device 262 to the asphalt finisher 100 via the wireless communication device 240.

[0049] The asphalt finisher 100 includes the imaging

device 62, the input device 60a, the controller 30, the drive system controller 55, and the wireless communication device 40. The drive system controller 55 controls the tractor 1 in accordance with the control command.

[0050] The controller 30 according to the present embodiment can perform the driving operation assistance using the Advanced driver-assistance systems (ADAS), based on the image information received from the imaging device 62 and the detection signals received from various detection sensors (not illustrated). In addition, the controller 30 according to the present embodiment may use other driving operation assistance instead of the driving operation assistance using the ADAS. For example, the controller 30 may use Autonomous Driving (AD).

[0051] The controller 30 of the present embodiment receives an input of the construction plan drawing via a connection I/F (not illustrated) or the wireless communication device 40.

[0052] Then, the controller 30 performs various types of control in order for the asphalt finisher 100 and the dump truck 200 to move on the pavement target road surface, based on the construction plan drawing.

[0053] Each functional block included in the controller 30 illustrated in Fig. 2 is conceptual, and does not necessarily have to be physically configured as illustrated. All or a part of each functional block may be functionally or physically distributed or integrated in any unit. All or any part of each processing function performed in each functional block is realized by a program executed by the CPU. Alternatively, each functional block may be realized as hardware using a wired logic. In addition, as illustrated in Fig. 2, the controller 30 includes a dump truck identification information storage unit 31, an acquisition unit 32, a path generation unit 33, a path correction unit 34, a detection unit 35, a determination unit 36, a command generation unit 37, and a communication control unit 38.

[0054] The dump truck identification information storage unit 31 is provided on a storage medium inside the controller 30. The dump truck identification information storage unit 31 stores information for the asphalt finisher 100 to identify the dump truck 200 serving as a communication target. For example, the dump truck identification information storage unit 31 stores number plate information of the dump truck 200 and identification information (for example, SSID) of the wireless communication device 240 mounted on the dump truck 200 in association with each other. In this manner, the controller 30 can identify the wireless communication device 240 serving as the communication target, based on the imaged number plate when the imaging device 62 images a rear part of the dump truck 200.

[0055] The acquisition unit 32 acquires image information captured by the imaging device 62. In addition, the acquisition unit 32 acquires operation information from the operator via the input device 60a.

[0056] In addition, the acquisition unit 32 acquires the construction plan drawing. For example, the acquisition unit 32 may acquire the construction plan drawing from a non-volatile storage medium connected via a connection I/F (for example, a USB I/F) (not illustrated). Furthermore, the acquisition unit 32 may acquire the construction plan drawing received from an external device via the wireless communication device 40 by the communication control unit 38.

[0057] The path generation unit 33 generates the movement paths of the asphalt finisher 100 and the dump truck 200, based on the construction plan drawing acquired by the acquisition unit 32. In the present embodiment, the movement path is generated after the construction plan drawing is acquired and before the asphalt finisher 100 starts the construction. In this manner, the path generation unit 33 can generate the movement path including a construction start position of the asphalt finisher 100.

[0058] The path generation unit 33 of the present embodiment generates the first movement path of the asphalt finisher 100 so that the whole pavement target region indicated in the construction plan drawing can be constructed. Furthermore, the path generation unit 33 generates the second movement path of the dump truck 200 when the dump truck 200 travels in a state of being in contact with the asphalt finisher 100 traveling along the first movement path.

[0059] When a construction target road indicated in the construction plan drawing has a step difference region such as a manhole, the path generation unit 33 generates the first movement path and the second movement path so that wheels of the asphalt finisher 100 and the dump truck 200 do not pass through the step difference region.

[0060] After the asphalt finisher 100 starts the construction, the detection unit 35 detects the transport vehicle such as the dump truck 200 existing in a front space of the asphalt finisher 100, based on the image information acquired from the imaging device 62. A technique for detecting the transport vehicle such as the dump truck 200 from the image may be any technique including a known image processing technique. The detection unit 35 may detect other objects when the transport vehicle is detected from the image. For example, the other objects may include a load cone, a person (worker), and a small machine (rammer or tamper). In addition, the determination unit 36 may be configured to recognize (detect) an object existing around the asphalt finisher 100 (example of a work machine), based on image information (output value) of the imaging device 62 serving as one type of the space recognition device. For example, the object serving as a recognition target includes the dump truck 200, a terrain shape (inclination or hole), an electric wire, an electric pole, a person, an animal, a vehicle, a construction machine, a building, a wall, a helmet, a safety vest, work clothes, or a predetermined mark on the helmet. In this way, the determination unit 36 may be configured to be able to identify at least one of a type, a position, and a shape of the object. For example, the determination unit 36 may be configured to be capable

of distinguishing between the dump truck 200 and an object other than the dump truck.

[0061] The determination unit 36 determines various types of information, based on the image information (example of detection information) from the imaging device 62 (example of the detection device).

[0062] For example, the determination unit 36 determines number plate information of the dump truck 200 existing in front of the asphalt finisher 100, based on the image information from the imaging device 62. In this manner, the determination unit 36 can identify the number plate information of the dump truck 200 serving as the control target.

[0063] Furthermore, the determination unit 36 may determine a distance between the dump truck 200 and the asphalt finisher 100. The determination unit 36 according to the present embodiment has a correspondence relationship between a size of the dump truck 200 captured in the image and a distance between the rear wheel 202 of the dump truck 200 and the roller 2b of the asphalt finisher 100. In this manner, the determination unit 36 can identify the distance between the rear wheel 202 of the dump truck 200 and the roller 2b of the asphalt finisher 100 from the image information acquired by the acquisition unit 32.

[0064] For example, the determination unit 36 determines whether or not the loading platform 201 of the dump truck 200 can be positioned at the designated position after the dump truck 200 is detected from the image captured by the imaging device 62. The designated position is a position of the loading platform 201 suitable for moving the paving material on the loading platform 201 into the hopper 2, and is a position partially overlapping the position of the hopper 2 of the asphalt finisher 100 in the vertical direction. In addition, the designated position is a position where the dump truck 200 moves in accordance with the movement of the asphalt finisher 100. Information relating to the designated position is typically stored in advance in the storage medium of the controller 30. In the present embodiment, the information relating to the designated position is information relating to a rectangular region having substantially the same size (area) as that of the loading platform 201 in a top view. In other words, the information relating to the designated position is information relating to a rectangular parallelepiped space having substantially the same size (volume) as that of the loading platform 201. Therefore, for example, "positioning the loading platform 201 of the dump truck 200 at the designated position" means causing the rectangular region corresponding to the actual loading platform 201 to coincide with the rectangular region corresponding to the designated position. A rectangular region ZN illustrated by a dotted line in Fig. 1B is an example of the rectangular region corresponding to the designated position.

[0065] The path correction unit 34 corrects the movement path generated by the path generation unit 33. The path correction unit 34 of the present embodiment corrects the movement path (first movement path or second movement path), based on a determination result of the determination unit 36.

[0066] For example, the determination unit 36 determines whether or not a space corresponding to the first movement path of the asphalt finisher 100 is captured on the image, based on position information input from the GPS module 50, the image captured by the imaging device 62, and the first movement path. When the determination unit 36 determines that the space corresponding to the first movement path of the asphalt finisher 100 is captured, the determination unit 36 determines whether or not an obstacle (for example, a manhole) exists on the path of the wheels of the asphalt finisher 100 moving along the first movement path.

[0067] When the determination unit 36 determines that the obstacle (for example, the manhole) exists on the path of the wheels of the asphalt finisher 100, the path correction unit 34 corrects the first movement path so that the obstacle does not overlap the path of the wheels of the asphalt finisher 100. In this manner, the path correction unit 34 can prevent the wheels of the asphalt finisher 100 from riding on the obstacle. In addition, the path correction unit 34 can prevent quality degradation of the paved asphalt described above by performing the correction.

[0068] Furthermore, the determination unit 36 determines whether or not the space corresponding to the second movement path of the dump truck 200 is captured on the image, based on the position information input from the GPS module 50, the image captured by the imaging device 62, and the second movement path. Then, when the determination unit 36 determines that the space corresponding to the second movement path is captured, the determination unit 36 determines whether or not the obstacle (for example, the manhole) exists on the path of the wheels of the dump truck 200 moving along the second movement path.

[0069] When the determination unit 36 determines that the obstacle (for example, the manhole) exists on the path of the wheels of the dump truck 200, the path correction unit 34 corrects the second movement path so that the obstacle does not overlap the path of the wheels of the dump truck 200. In this manner, the path correction unit 34 can prevent the wheels of the dump truck 200 from riding on the obstacle. In addition, the path correction unit 34 can prevent quality degradation of the paved asphalt described above by performing the correction.

[0070] In addition, the determination unit 36 determines whether or not a position deviates between the obstacle described in the construction plan drawing (for example, a step difference such as the manhole) and the obstacle detected by the detection unit 35 from the image captured by the imaging device 62. Whether or not the position deviates can be determined by comparing the position of the obstacle captured on the image and the position of the obstacle on the construction plan drawing after converting the position of the obstacle indicated by

the captured image into the coordinates in the world geodetic system. A method for converting the position into the coordinates in the world geodetic system can be realized by using a well-known method. A method for determining whether or not the position of the obstacle (for example, the step difference such as the manhole) described in the construction plan drawing deviates from the actual position of the obstacle is not limited to the determination based on the image captured by the imaging device 62. For example, the determination unit 36 may recognize that the position of the obstacle in the construction plan drawing deviates in accordance with an input from the operator.

[0071] Then, when the determination unit 36 determines that the position of the obstacle in the construction plan drawing deviates, the path correction unit 34 corrects the position of the obstacle in the construction plan drawing, based on the position of the obstacle in the image captured by the imaging device 62. Then, the path correction unit 34 corrects the first movement path so that the obstacle does not overlap the path of the wheels of the asphalt finisher 100. In addition, the path correction unit 34 corrects the second movement path so that the obstacle does not overlap the path of the wheels of the dump truck 200. As a method for correcting the first movement path and the second movement path, the path correction unit 34 may perform correction so that a construction starting position of the asphalt finisher 100 deviates in the leftward direction or in the rightward direction, for example.

[0072] The command generation unit 37 generates a control command for causing the asphalt finisher 100 to travel along the first movement path. Specifically, the command generation unit 37 of the present embodiment generates an acceleration command or a deceleration command of the asphalt finisher 100 to continue the construction. In addition, the command generation unit 37 generates a control command relating to steering for moving along the first movement path, based on the first movement path, the acceleration command or the deceleration command, and the position information of the asphalt finisher 100 which is received from the GPS module 50. Furthermore, the command generation unit 37 may generate a control command for performing braking when necessary. Then, the command generation unit 37 outputs the generated control command to the drive system controller 55.

[0073] For example, the control command generated by the command generation unit 37 of the present embodiment includes a control command for steering so that the loading platform 201 of the dump truck 200 is positioned at the designated position. For example, the other control command includes a control command for instructing the dump truck 200 to move rearward or stop so that the rear wheel 202 of the dump truck 200 comes into contact with the roller 2b.

[0074] Furthermore, the command generation unit 37 generates a control command for causing the transport vehicle (for example, the dump truck 200) to travel along the second movement path after performing steering so that the loading platform 201 of the dump truck 200 is positioned at the designated position. Then, the command generation unit 37 outputs the generated control command to the communication control unit 38. For example, the control command for traveling along the second movement path is a steering command in the rightward direction or in the leftward direction, a deceleration command, or a braking command.

[0075] The command generation unit 37 generates a control command for causing the dump truck 200 to travel along the second movement path. Specifically, the command generation unit 37 of the present embodiment generates the acceleration command or the deceleration command of the dump truck 200 to maintain a state where the hopper 2 of the asphalt finisher 100 and the loading platform 201 of the dump truck 200 overlap each other in the vertical direction. Furthermore, the command generation unit 37 generates a control command relating to steering for moving along the second movement path, based on the second movement path, the acceleration command or the deceleration command of the dump truck 200, and the position information of the dump truck 200. The position information of the dump truck 200 is calculated by the command generation unit 37 from the position information of the asphalt finisher 100 which is acquired from the GPS module 50 and the relative position relationship between the asphalt finisher 100 and the dump truck 200. In addition, the command generation unit 37 may generate a control command for braking the dump truck 200 when necessary. Then, the command generation unit 37 outputs the generated control command of the dump truck 200 to the wireless communication device 40.

[0076] The control command generated by the command generation unit 37 is not limited to the above-described command, and may be various other control commands. For example, the control command generated by the command generation unit 37 may be any command that can be performed by the ADAS of the asphalt finisher 100, such as turning on/off the headlight of the asphalt finisher 100 or warning the operator of the asphalt finisher 100. Similarly, the control command generated by the command generation unit 37 may include a command that can be performed by the ADAS of the dump truck 200, such as turning on/off the headlight of the dump truck 200 or warning the driver of the dump truck 200.

[0077] The communication control unit 38 performs communication control with the transport vehicle such as the dump truck 200 via the wireless communication device 240. For example, the communication control unit 38 controls communication with the wireless communication device 240 indicated by the identification information associated with the number plate information determined by the command generation unit 37. In this manner, the controller 30 can transmit the control command generated for the dump truck 200 to the dump truck 200.

For example, the communication control unit 38 transmits the control command for moving the dump truck 200 along the second movement path generated by the command generation unit 37, to the wireless communication device 240.

[0078] Furthermore, the communication control unit 38 receives the image information relating to the image captured by the first imaging device 261 of the dump truck 200 via the wireless communication device 240.

[0079] The operator of the asphalt finisher 100 is less likely to visually confirm the traveling direction, when the dump truck 200 exists in front of the asphalt finisher 100. Therefore, the communication control unit 38 according to the present embodiment receives the image information relating to the image captured in front of the dump truck 200, which is captured by the first imaging device 261 of the dump truck 200. The communication control unit 38 outputs the received image information to the main monitor 60. In this manner, the operator of the asphalt finisher 100 can understand a situation in front of the dump truck 200.

[0080] Then, the determination unit 36 determines whether or not the obstacle exists on the movement path of the dump truck 200 and the asphalt finisher 100, based on the received image information. The obstacle to be determined may be any object. For example, the obstacle serving as a determination target is a scoop or a pylon.

[0081] Then, when the determination unit 36 determines that the obstacle exists, the audio output device 63 outputs warning information indicating that the obstacle exists, in accordance with an instruction from the determination unit 36. In this manner, the operator can recognize the presence or absence of the obstacle in the movement path. Furthermore, the operator can recognize a situation of the movement path by visually confirming the image information.

[0082] Fig. 3 is a view illustrating a process procedure performed by the asphalt finisher 100 according to the present embodiment. The process procedure illustrated in Fig. 3 is performed before the asphalt finisher 100 carries out the construction. The dump truck 200 may be driven by the driver, or may be automatically steered by the ADAS.

[0083] The acquisition unit 32 acquires the construction plan drawing (S301).

[0084] The path generation unit 33 generates the first movement path of the asphalt finisher 100 and the second movement path of the dump truck 200, based on the construction plan drawing acquired by the acquisition unit 32 (S302).

[0085] The determination unit 36 determines whether or not the obstacle exists on the first movement path of the asphalt finisher 100 or on the second movement path of the dump truck 200 (S303). Whether or not the obstacle exists may be determined, based on the image captured by the imaging device 62 or may be determined, based on an operation received by the input device 60a from the operator. When the determination unit 36 determines that the obstacle does not exist (S303: No), the controller 30 performs a process in S305.

[0086] On the other hand, when the determination unit 36 determines that the obstacle exists on the first movement path of the asphalt finisher 100 or on the second movement path of the dump truck 200 (S303: Yes), the path correction unit 34 corrects the movement paths (first movement path and second movement path) not to come into contact with the obstacle (S304).

[0087] Then, the controller 30 starts movement control of the asphalt finisher 100 to move along the first movement path of the asphalt finisher 100 (S305).

[0088] The acquisition unit 32 acquires the image information indicating the image captured by the imaging device 62 (S306).

[0089] Then, the detection unit 35 determines whether or not the dump truck 200 exists in front of the asphalt finisher 100, based on the image information (S307). When the detection unit 35 determines that the dump truck 200 does not exist (S307: No), the controller 30 performs the process in S307 again after a predetermined time.

[0090] When the detection unit 35 determines that the dump truck 200 exists (S307: Yes), the communication control unit 38 identifies the identification information of the wireless communication device 240 from the number plate information of the dump truck 200. Then, the communication control unit 38 starts communication with the dump truck 200 equipped with the wireless communication device 240 indicated by the identified identification information (S308). In this manner, the controller 30 starts automatic control for the dump truck 200.

[0091] The communication control unit 38 transmits the control command generated by the command generation unit 37 to steer the dump truck 200 to position the loading platform 201 of the dump truck 200 at the designated position, to the wireless communication device 240 of the dump truck 200 (S309). In this manner, the dump truck 200 moves to a position where the loading platform 201 of the dump truck 200 overlaps the hopper 2 of the asphalt finisher 100 in the vertical direction. Thereafter, the dump truck 200 is movable together with the asphalt finisher 100.

[0092] The acquisition unit 32 acquires the position information from the GPS module 50 (S310). In this manner, the controller 30 can recognize the position information of the asphalt finisher 100 and the position information of the dump truck 200.

[0093] The command generation unit 37 generates the control command for the acceleration or the deceleration of the dump truck 200 to maintain an overlapping state between the dump truck 200 and the asphalt finisher 100 (state where the loading platform 201 of the dump truck 200 overlaps the hopper 2 of the asphalt finisher 100 in the vertical direction) (S311). More specifically, a distance between a component of the dump truck 200 (for example, a rear wheel) and a component of the asphalt finisher 100 (for example, a roller) is monitored, and even

when there is a change in the distance, control is performed so that the speed of the dump truck 200 is substantially the same as the speed of the asphalt finisher 100.

[0094] Furthermore, the command generation unit 37 generates the steering control command for causing the dump truck 200 to move along the second movement path, based on the position information of the dump truck 200, the second movement path of the dump truck 200, and the control command relating to the current speed, the acceleration, the deceleration, or speed maintenance of the dump truck 200 (S312).

[0095] Then, the communication control unit 38 transmits the steering control command and the control command for the acceleration or the deceleration, to the wireless communication device 240 of the dump truck 200 via the wireless communication device 40 (S313).

[0096] The command generation unit 37 generates the steering control command for the asphalt finisher 100 to move along the first movement path, based on the first movement path and the position information of the asphalt finisher 100. Then, the drive system controller 55 performs the steering control in accordance with the control command (S314). Next, the control command generated by the command generation unit 37 will be described.

[0097] Fig. 4 is a top view of a construction site, illustrating the first movement path and the second movement path which are generated by the path generation unit 33 for constructing a curved part (left curved part) of a road. In an example illustrated in Fig. 4, the asphalt finisher 100 paves a road surface between a left side boundary line LP and a right side boundary line RP with an asphalt mixture. Therefore, the asphalt finisher 100 spreads the screed device 3 until the screed device 3 reaches each of the left side boundary line LP and the right side boundary line RP.

[0098] A first movement path AFL is generated by the path generation unit 33 so that the asphalt mixture can be laid on the road surface between the left side boundary line LP and the right side boundary line RP by the asphalt finisher 100. The first movement path AFL is generated by the path generation unit 33 as a movement path relating to the asphalt finisher 100 which enables a construction target road to be paved with the asphalt mixture in accordance with the construction plan drawing.

[0099] In the present embodiment, the path generation unit 33 generates a second movement path DTL with reference to the first movement path AFL of the asphalt finisher 100. A second movement path DTL is a movement path relating to the dump truck 200 which maintains a state where the loading platform 201 of the dump truck 200 and the hopper 2 of the asphalt finisher 100 overlap each other in the vertical direction, while the asphalt finisher 100 moves along the first movement path AFL. Therefore, the dump truck 200 can realize stable supply of the paving material from the dump truck 200 to the asphalt finisher 100.

[0100] The second movement path DTL is a movement path used for control after the loading platform 201 of the dump truck 200 is positioned at the designated position. In other words, the controller 30 controls the dump truck 200 to position the loading platform 201 of the dump truck 200 at the designated position, and thereafter, performs automatic control along the second movement path DTL.

[0101] Then, after the paving material is completely supplied from the dump truck 200 to the asphalt finisher 100, the controller 30 completes the control of the dump truck 200 moving along the second movement path DTL. In this way, the controller 30 of the present embodiment controls the dump truck 200 by using the second movement path DTL only while the loading platform 201 of the dump truck 200 is positioned at the designated position. In this manner, the controller 30 can control a plurality of the dump trucks 200 along the second movement path DTL.

[0102] The first movement path AFL and the second movement path DTL are indicated by using a reference coordinate system. For example, the reference coordinate system is the world geodetic system. The reference coordinate system is not limited to the world geodetic system, and may be any position coordinate system which can be associated with the position information received by the asphalt finisher 100.

[0103] A point AP1 indicates a position of a front end of the asphalt finisher 100 at a first time point at which the construction starts. A point AP2 indicates the position of the front end of the asphalt finisher 100 at a second time point after the asphalt finisher 100 moves forward along the first movement path AFL by a predetermined distance from the first time point. A point AP3 indicates the position of the front end of the asphalt finisher 100 at a third time point after the asphalt finisher 100 moves forward along the first movement path AFL by a predetermined distance from the second time point. In a curved part (left curved part) of the construction target road surface, the path generation unit 33 of the present embodiment generates the second movement path DTL (example of the second path) on the outer peripheral side of the first movement path AFL (example of the first path). In this manner, in the present embodiment, the overlapping state can be maintained even in the curved part.

[0104] The command generation unit 37 generates a control command for operating the asphalt finisher 100 so that an actual position coordinate indicated by the position (for example, the point AP1, the point AP2, or the point AP3) of the front end of the asphalt finisher 100 coincides with one of the position coordinates forming the first movement path AFL.

[0105] Specifically, the steering control unit 50b calculates position information indicating the position (for example, the point AP1, the point AP2, or the point AP3) of the front end of the asphalt finisher 100, based on the position information from the GPS module 50. Then, when the steering control unit 50b determines that steering is required in the rightward direction or in the leftward

direction to move along the first movement path AFL, based on the calculated position information, the steering control unit 50b generates a control command for steering in the rightward direction or in the leftward direction. In addition, the steering control unit 50b calculates a steering angle for moving along the first movement path AFL in accordance with at least one of the current speed and the acceleration of the asphalt finisher 100. The calculated steering angle is included in the control command.

[0106] A point DP1 indicates the position of the front end of the dump truck 200 at the first time point at which the construction starts. A point DP2 indicates the position of the front end of the dump truck 200 at a second time point after the dump truck 200 moves forward along the second movement path DTL by a predetermined distance from the first time point. A point DP3 indicates the position of the front end of the dump truck 200 at a third time point after the dump truck 200 moves forward along the second movement path DTL by a predetermined distance from the second time point.

[0107] The command generation unit 37 generates a control command for operating the dump truck 200 so that the actual position coordinate indicated by the position (for example, the point DP1, the point DP2, or the point DP3) of the front end of the dump truck 200 coincides with one of the position coordinates forming the second movement path DTL. Furthermore, the command generation unit 37 generates a control command for maintaining a state where the hopper 2 of the asphalt finisher 100 and the loading platform 201 of the dump truck 200 overlap each other in the vertical direction. The speed of the dump truck 200 may be controlled, based on the speed of the asphalt finisher 100.

[0108] Specifically, the command generation unit 37 generates a control command indicating the acceleration, the deceleration, or the speed maintenance of the dump truck 200, based on at least one of the speed and the acceleration of the asphalt finisher 100. Furthermore, the command generation unit 37 calculates the position information indicating the position (for example, the point DP1, the point DP2, or the point DP3) of the front end of the dump truck 200, based on the position information from the GPS module 50. Then, when the command generation unit 37 determines that steering is required in the rightward direction or in the leftward direction to move along the second movement path, based on the calculated position information, the command generation unit 37 generates a control command for steering in the rightward direction or in the leftward direction. In addition, the command generation unit 37 calculates a steering angle for moving along the second movement path in accordance with at least one of the current speed and the acceleration of the dump truck 200. The calculated steering angle is included in the control command. Then, the communication control unit 38 transmits the control command for the dump truck 200 to the wireless communication device 240 of the dump truck 200 via the wireless communication device 40.

[0109] Referring back to Fig. 3, the communication control unit 38 receives the image information captured by the first imaging device 261 of the dump truck 200 via the wireless communication device 40 (S315).

[0110] The determination unit 36 determines whether or not the obstacle exists on the first movement path of the asphalt finisher 100 and the second movement path of the dump truck 200, based on the image information received by the communication control unit 38 (S316). When the determination unit 36 determines that the obstacle does not exist (S316: No), the controller 30 performs a process in S318.

[0111] On the other hand, when the determination unit 36 determines that the obstacle exists (S316: Yes), the audio output device 63 outputs warning information indicating that the obstacle exists, in accordance with an instruction from the determination unit 36 (S317).

[0112] Thereafter, the controller 30 determines whether or not the asphalt mixture is completely supplied from the dump truck 200 (S318). A method for determining whether or not the asphalt mixture is completely supplied may be any method, and for example, may be any determination based on a notification from the dump truck 200. When the controller 30 determines that the asphalt mixture is not completely supplied (S318: No), the controller 30 performs processes subsequent to S310.

[0113] When the controller 30 determines that the asphalt mixture is completely supplied (S318: No), the communication control unit 38 transmits a control command generated by the command generation unit 37 to separate the dump truck 200 from the asphalt finisher 100 to the wireless communication device 240 of the dump truck 200 (S319).

[0114] Thereafter, the controller 30 determines whether or not the construction along the first movement path is completed (S320). When it is determined that the construction is not completed (S320: No), the controller 30 performs processes subsequent to S307 again.

[0115] On the other hand, when it is determined that the construction is completed (S320: No), the controller 30 completes the process.

[0116] In the asphalt finisher 100 of the present embodiment, the construction target road surface can be paved with the asphalt mixture by performing the above-described process.

[0117] The controller 30 of the above-described embodiment generates the second movement path of the transport vehicle such as the dump truck 200 so that the overlapping state can be maintained when the asphalt finisher 100 travels along the first movement path. In this manner, the controller 30 can synchronize the steering of the asphalt finisher 100 and the steering of the dump truck 200 with each other. Furthermore, the controller 30 of the present embodiment generates a control command relating to acceleration and deceleration of the dump truck 200 in accordance with the position relationship between the asphalt finisher 100 and the dump truck 200.

In this manner, the controller 30 can synchronize the speed of the asphalt finisher 100 and the speed of the dump truck 200 with each other. The controller 30 according to the present embodiment can determine whether or not the hopper 2 maintains a state of overlapping the loading platform 201, based on the position relationship between the rear wheel of the dump truck 20 and the roller 2b of the asphalt finisher 100. However, in the present embodiment, it is not always necessary to use the rear wheel of the dump truck 20 or the roller 2b of the asphalt finisher 100 in determining whether or not the overlapping state is maintained. For example, it may be determined whether or not the hopper 2 maintains the overlapping state with the loading platform 201, based on the position relationship between a front end of the hopper 2 and a rear end of the loading platform 201. In other words, the controller 30 according to the present embodiment may perform control to maintain the overlapping state, based on the position relationship between the front end of the hopper 2 and the rear end of the loading platform 201.

[0118] The controller 30 of the present embodiment synchronizes the operation of the transport vehicle such as the dump truck 200 and the operation of the asphalt finisher 100 with each other by performing the above-described control. The operation to be synchronized is not limited to the steering and the speed, and may be turning on/off a headlight or a winker or outputting warning information.

[0119] In the above-described example, a case where the imaging device 62 images the space existing in front of the asphalt finisher 100 has been described. Then, when the dump truck 200 is detected in front of the asphalt finisher 100, the controller 30 controls the dump truck 200. However, the present embodiment is not limited to a case where the transport vehicle serving as a control target exists in front of the asphalt finisher 100. The controller 30 may control a transport vehicle existing around the asphalt finisher 100 as the control target. For example, when the asphalt finisher 100 further includes an imaging device capable of imaging in a rightward-leftward direction, the controller 30 may control the dump truck detected by the imaging device as the control target. In this case, for example, the controller 30 of the asphalt finisher 100 transmits a control command to the detected dump truck to move rearward after moving forward. The control subsequent thereto is the same as the control in the above-described embodiment. In this way, the detection device such as the imaging device may have a detection range as long as the range is located around the asphalt finisher 100. Then, the controller 30 may control the transport vehicle detected within the detection range.

[0120] In addition, in the above-described example, a case where the imaging device 62 detects the transport vehicle such as the dump truck 200 has been described. However, in the present embodiment, the detection device that detects the transport vehicle is not limited to the imaging device. The detection device may be a sensor capable of detecting the position of the dump truck 200. For example, the detection device may be a range sensor such as Light Detection and Ranging, Laser Imaging Detection and Ranging (LIDAR) or a millimeter-wave radar.

[0121] The steering information for steering the dump truck 200, which is transmitted to the dump truck 200 by the asphalt finisher 100, is not limited to the steering control command, and may be any information necessary for steering the dump truck 200. For example, when the dump truck 200 receives the second movement path and can be steered along the second movement path, the asphalt finisher 100 may transmit the second movement path, as the steering information.

[0122] In the above-described embodiment, according to the above-described configuration, the asphalt finisher 100 synchronizes the operation of the asphalt finisher 100 and the operation of the dump truck 200 with each other. In this manner, it is possible to reduce a manual steering burden on the driver of the dump truck 200.

[0123] Furthermore, the asphalt finisher 100 synchronizes the steering of the asphalt finisher 100 and the steering of the dump truck 200 with each other. In this manner, a deviation in the position relationship between the loading platform 201 of the dump truck 200 and the hopper 2 of the asphalt finisher 100 can be prevented. Therefore, the paving material can be stably supplied from the dump truck 200 to the asphalt finisher 100. In this manner, the asphalt finisher 100 can prevent quality degradation of a pavement surface after the construction.

(Modification Example)

[0124] In the above-described embodiment, an example of generating the first movement path for the asphalt finisher 100 and the second movement path for the dump truck 200 in the asphalt finisher 100 has been described. However, the above-described embodiment is not limited to the case of generating the first movement path for the asphalt finisher 100 and the second movement path for the dump truck 200 in the asphalt finisher 100. Therefore, in a modification example, the movement path is generated by an externally provided information processing device. That is, in the present modification example, in an asphalt finisher construction assistance system including the asphalt finisher 100, the dump truck 200, and an information processing device, an example will be described in which the information processing device generates the first movement path for the asphalt finisher 100 and the second movement path for the dump truck 200 to synchronize the operation of the dump truck 200 to correspond to the operation of the asphalt finisher 100.

[0125] The externally provided information processing device generates a first movement path for the asphalt finisher 100 and a second movement path for the dump truck 200 after performing an input process of the construction plan drawing.

[0126] Then, the information processing device trans-

mits the first movement path for the asphalt finisher 100 and the second movement path for the dump truck 200 to the wireless communication device 40 of the asphalt finisher 100. The process subsequent thereto is the same as that in the above-described embodiment, and thus, description thereof will be omitted. As in the present modification example, in a case of the device included in the asphalt finisher construction assistance system, the control for synchronizing the operation of the dump truck 200 to correspond to the operation of the asphalt finisher 100 may be performed.

[0127] In the above-described embodiments and modification examples, the transport vehicle and the asphalt finisher are automatically controlled to move along the construction target road in a road pavement site. Therefore, safety relating to the road pavement is improved. Furthermore, in the above-described embodiment and modification example, the operator of the asphalt finisher can confirm a surrounding situation, based on the image information captured in front of the transport vehicle. Therefore, safety of the operator and surrounding workers is improved.

[0128] Hitherto, the embodiment and the modification example of the asphalt finisher, the dump truck (example of the transport vehicle), and the asphalt finisher construction assistance system have been described. However, the present invention is not limited to the above-described embodiment and modification example. Various changes, corrections, substitutions, additions, deletions, and combinations can be made within the scope described in the appended claims. As a matter of course, all of these also belong to the technical scope of the present invention.

[0129] The present application claims priority based on Japanese Patent Application No. 2021-056024 filed on March 29, 2021, and the entire contents of this Japanese patent application are incorporated herein by reference.

Reference Signs List

[0130]

100: Asphalt finisher
30: Controller
31: Dump truck identification information storage unit
32: Acquisition unit
33: Path generation unit
34: Path correction unit
35: Detection unit
36: Determination unit
37: Command generation unit
38: Communication control unit
62: Imaging device

Claims

1. An asphalt finisher comprising:

a tractor;
a hopper installed on a front side of the tractor;
a conveyor that conveys a paving material inside the hopper to a rear side of the tractor;
a screw that lays and spreads the paving material conveyed by the conveyor and scattered on a road surface in a vehicle width direction; and
a screed device that lays and levels the paving material laid and spread by the screw on a rear side of the screw,
wherein an operation of a transport vehicle is synchronized to correspond to an operation of the asphalt finisher.

2. The asphalt finisher according to claim 1, wherein steering information for steering the transport vehicle, which is generated based on a construction plan drawing indicating a construction target region of the asphalt finisher and position information of the asphalt finisher, is transmitted to the transport vehicle.

3. The asphalt finisher according to claim 2,

wherein the steering information transmitted to the transport vehicle is information indicating steering to move along a second path, and
the second path is a path through which the transport vehicle moves on an outer peripheral side of a first path through which the asphalt finisher is steered, in a curved part of the road surface.

4. The asphalt finisher according to claim 1,
wherein a path through which the asphalt finisher moves is further generated, based on a construction plan drawing indicating a construction target region of the asphalt finisher.

5. The asphalt finisher according to claim 4, wherein the generated path is corrected.

6. The asphalt finisher according to claim 1,
wherein a loading platform of the transport vehicle and the hopper are controlled to maintain a state of overlapping each other in a vertical direction.

7. The asphalt finisher according to claim 1,
wherein information detected by a detection device provided in front of the transport vehicle is received from the transport vehicle.

8. The asphalt finisher according to claim 7,
wherein the presence or absence of an obstacle is determined, based on the information detected by

the detection device.

9. An asphalt finisher construction assistance system used for an asphalt finisher including a tractor, a hopper installed on a front side of the tractor, a conveyor that conveys a paving material inside the hopper to a rear side of the tractor, a screw that lays and spreads the paving material conveyed by the conveyor and scattered on a road surface in a vehicle width direction, and a screed device that lays and levels the paving material laid and spread by the screw on a rear side of the screw, the system comprising:
a control device configured to synchronize an operation of a transport vehicle to correspond to an operation of the asphalt finisher.

10. The asphalt finisher construction assistance system according to claim 9, further comprising:
a communication device that transmits steering information for steering the transport vehicle, which is generated based on a construction plan drawing indicating a construction target region of the asphalt finisher and position information of the asphalt finisher, to the transport vehicle.

11. The asphalt finisher construction assistance system according to claim 10,

wherein the steering information transmitted to the transport vehicle is information indicating steering to move along a second path, and
the second path is a path through which the transport vehicle moves on an outer peripheral side of a first path through which the asphalt finisher is steered, in a curved part of the road surface.

12. The asphalt finisher construction assistance system according to claim 9,
wherein the control device is further configured to generate a path through which the asphalt finisher moves, based on a construction plan drawing indicating a construction target region of the asphalt finisher.

FIG. 1A

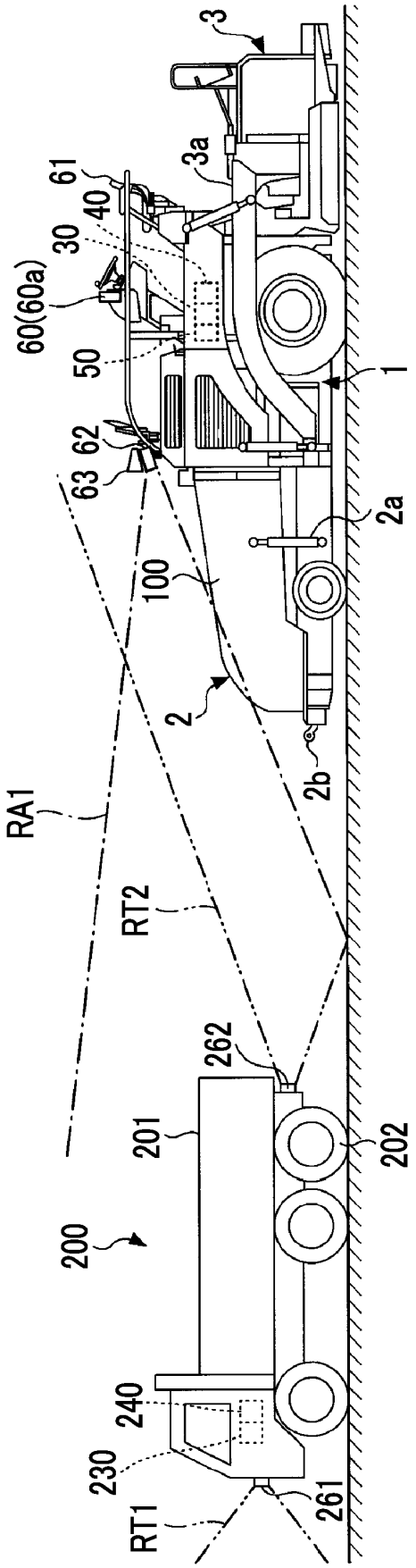

3
3a
61
40
30
60(60a)
50
62
63
1
2a
100
2
2b
RA1
RT2
262
201
202
200
240
230
261
RT1

FIG. 1B

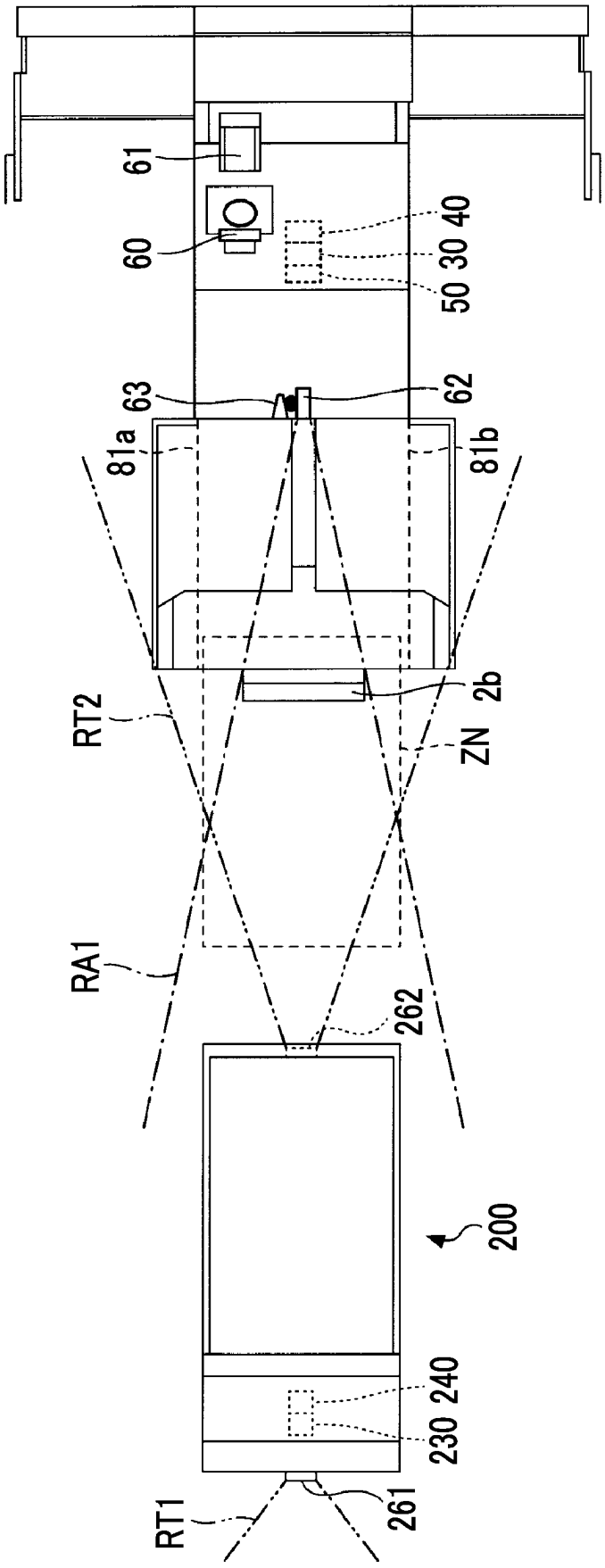


FIG. 2

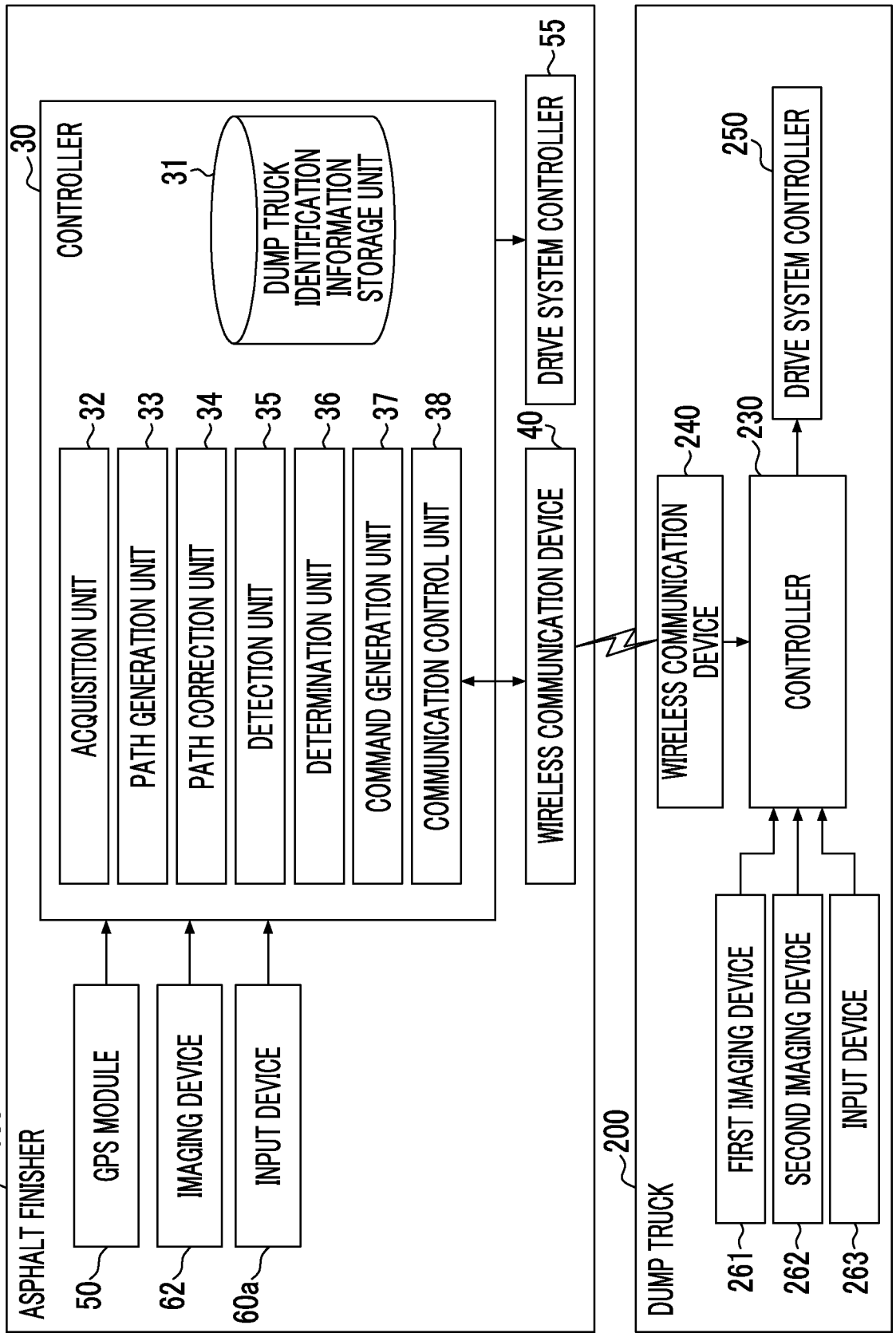

100
ASPHALT FINISHER
50
GPS MODULE
62
IMAGING DEVICE
60a
INPUT DEVICE
30
CONTROLLER
31
DUMP TRUCK IDENTIFICATION INFORMATION STORAGE UNIT
32
ACQUISITION UNIT
33
PATH GENERATION UNIT
34
PATH CORRECTION UNIT
35
DETECTION UNIT
36
DETERMINATION UNIT
37
COMMAND GENERATION UNIT
38
COMMUNICATION CONTROL UNIT
55
DRIVE SYSTEM CONTROLLER
40
WIRELESS COMMUNICATION DEVICE
200
DUMP TRUCK
240
WIRELESS COMMUNICATION DEVICE
230
CONTROLLER
250
DRIVE SYSTEM CONTROLLER
261
FIRST IMAGING DEVICE
262
SECOND IMAGING DEVICE
263
INPUT DEVICE

FIG. 3

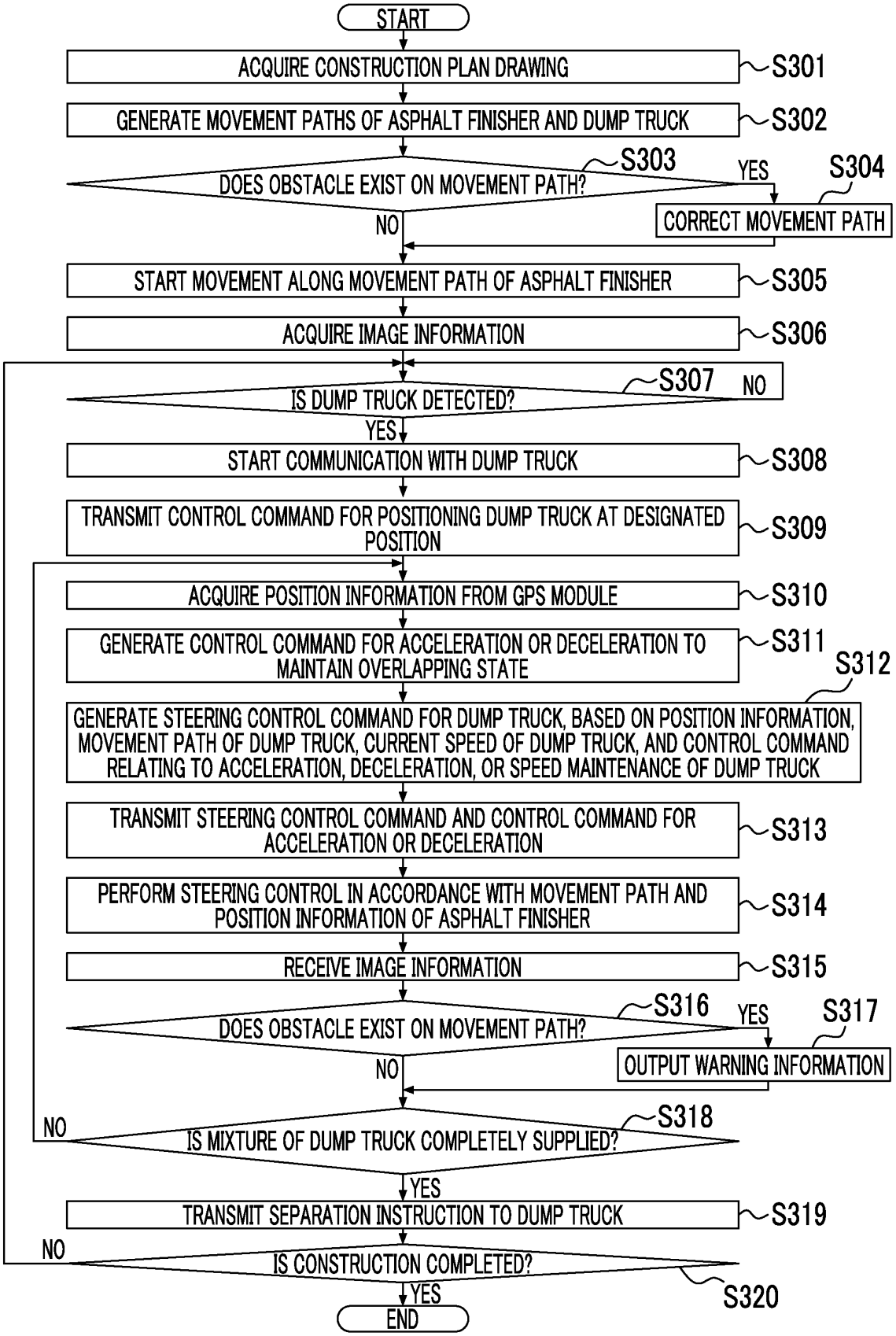
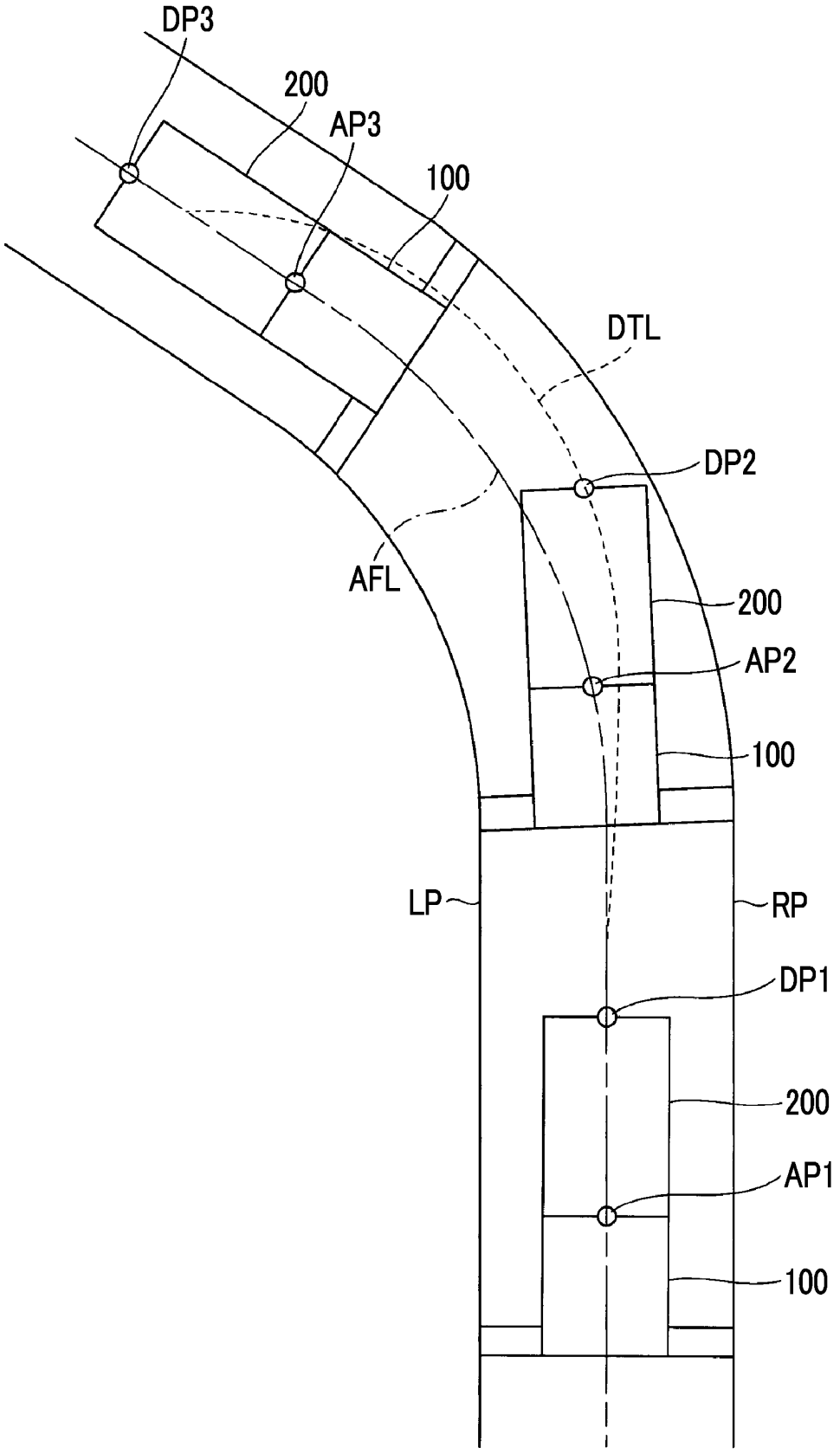

START
ACQUIRE CONSTRUCTION PLAN DRAWING
S301
GENERATE MOVEMENT PATHS OF ASPHALT FINISHER AND DUMP TRUCK
S302
DOES OBSTACLE EXIST ON MOVEMENT PATH?
S303
YES
S304
CORRECT MOVEMENT PATH
NO
START MOVEMENT ALONG MOVEMENT PATH OF ASPHALT FINISHER
S305
ACQUIRE IMAGE INFORMATION
S306
IS DUMP TRUCK DETECTED?
S307
NO
YES
START COMMUNICATION WITH DUMP TRUCK
S308
TRANSMIT CONTROL COMMAND FOR POSITIONING DUMP TRUCK AT DESIGNATED POSITION
S309
ACQUIRE POSITION INFORMATION FROM GPS MODULE
S310
GENERATE CONTROL COMMAND FOR ACCELERATION OR DECELERATION TO MAINTAIN OVERLAPPING STATE
S311
S312
GENERATE STEERING CONTROL COMMAND FOR DUMP TRUCK, BASED ON POSITION INFORMATION, MOVEMENT PATH OF DUMP TRUCK, CURRENT SPEED OF DUMP TRUCK, AND CONTROL COMMAND RELATING TO ACCELERATION, DECELERATION, OR SPEED MAINTENANCE OF DUMP TRUCK
TRANSMIT STEERING CONTROL COMMAND AND CONTROL COMMAND FOR ACCELERATION OR DECELERATION
S313
PERFORM STEERING CONTROL IN ACCORDANCE WITH MOVEMENT PATH AND POSITION INFORMATION OF ASPHALT FINISHER
S314
RECEIVE IMAGE INFORMATION
S315
DOES OBSTACLE EXIST ON MOVEMENT PATH?
S316
YES
S317
OUTPUT WARNING INFORMATION
NO
IS MIXTURE OF DUMP TRUCK COMPLETELY SUPPLIED?
S318
NO
YES
TRANSMIT SEPARATION INSTRUCTION TO DUMP TRUCK
S319
IS CONSTRUCTION COMPLETED?
NO
S320
YES
END

FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/015230

A. CLASSIFICATION OF SUBJECT MATTER

E01C 19/48(2006.01)i
FI: E01C19/48 A

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E01C19/48

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 018063/1993 (Laid-open No. 031908/1995) (KENSETSUSHO TOHOKU CHIHO KENSETSU KYOKUCHO et al.) 16 June 1995 (1995-06-16), paragraphs [0008]-[0021], fig. 1-2	1, 4-6, 9, 12
A	entire text, all drawings	2-3, 7-8, 10-11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 153138/1987 (Laid-open No. 057110/1989) (NIIGATA ENGINEERING CO., LTD.) 10 April 1989 (1989-04-10), p. 6, line 11 to p. 9, line 19, fig. 4-6	1, 4-6, 9, 12
A	entire text, all drawings	2-3, 7-8, 10-11
A	JP 10-219614 A (FUJITA CORP) 18 August 1998 (1998-08-18) entire text, all drawings	1-12
A	WO 2017/010541 A1 (SUMITOMO (S.H.I.) CONSTRUCTINO MACHINERY CO., LTD.) 19 January 2017 (2017-01-19) entire text, all drawings	1-12

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 May 2022	**14 June 2022**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/015230

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 7-031908 U1	16 June 1995	(Family: none)	
JP 64-057110 U1	10 April 1989	(Family: none)	
JP 10-219614 A	18 August 1998	(Family: none)	
WO 2017/010541 A1	19 January 2017	CN 107849830 A entire text, all drawings	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2017010541 A **[0004]**
- JP 2021056024 A **[0129]**