

DESCRIPTION

TRAVELING VEHICLE SYSTEM AND METHOD FOR CONTROLLING
TRAVELING BY TRAVELING VEHICLE SYSTEM

5 Field of the Invention

[0001]

The present invention relates to traveling vehicles such as an overhead traveling vehicle (OHT), an automated guided vehicle (AGV), a rail guided vehicle (RGV) or the like. In particular, the present invention relates to a technique of implementing control in
10 a diverging section or a merging section.

Background Art

[0002]

In a technique disclosed in Patent Publication 1 (JP2005-284779A), a collision
15 prevention sensor is provided in a traveling vehicle such as an overhead traveling vehicle to monitor a leading traveling vehicle for preventing interference with the leading traveling vehicle. Further, a ground controller restricts entry of the traveling vehicle into a diverging section and a merging section to ensure that only one traveling vehicle can enter the diverging section or the merging section. Hereinafter, control where the ground
20 controller's permission is required for the traveling vehicle to enter a certain area, and the number of traveling vehicles that can be present in the certain area is limited to one or less is referred to as the blocking control. Further, an area where entry of the traveling vehicle is restricted by blocking control is referred to as the blocking area.

[0003]

25 In general, the conventional blocking area is several times longer than the vehicle length of one traveling vehicle for the following reasons. For example, in the case of the diverging section, it is difficult to detect a traveling vehicle diverging from the diverging

section by a collision prevention sensor from a position upstream of the diverging section. Further, it is difficult for a traveling vehicle in a curve segment at the exit of the diverging section to monitor traveling vehicles in a straight segment downstream of the diverging section by the collision prevention sensor. Likewise, in the case of the merging section, it is difficult for a traveling vehicle curving at an entrance of the merging section for entering the merging section, to detect traveling vehicles in the merging section using the collision prevention sensor. Therefore, a region upstream of the merging section is also included in the blocking area. Further, it is difficult for a traveling vehicle curving in the merging section to detect traveling vehicles at the exit of the merging section by the collision prevention sensor. Therefore, a region at the merging section is included in the blocking area as well. Under the circumstances, the blocking area becomes large. Since the number of traveling vehicles that can pass through the blocking area per unit time is substantially inversely proportional to the size of the blocking area, the efficiency of the traveling vehicle system is low.

Patent Publication 1: JP2005-284779A

Disclosure of the Invention

Problems to be solved by the Invention

[0004]

An object of the present invention is to increase the number of traveling vehicles that can pass through a diverging section or a merging section.

Means for Solving the Problems

[0005]

According to the present invention, a system for a plurality of traveling vehicles traveling along a travel route including a diverging section and a merging section under control of a controller on a ground is provided.

The traveling vehicle has means for recognizing a position of own traveling vehicle, and means for obtaining a position of another traveling vehicle by communication.

5 A certain area of the travel route, including a diverging section and a merging section is designated as a blocking area. An area including the blocking area, and larger than the blocking area is designated as an inter-vehicle distance control area.

In the inter-vehicle distance control area, velocity control of the traveling vehicle is implemented by determining an inter-vehicle distance between the traveling vehicles based on the position of the other traveling vehicle obtained by communication and the
10 recognized position of the own traveling vehicle. The traveling vehicle is configured to enter the blocking area after obtaining a permission from the controller.

[0006]

Further, according to the present invention, a travel control method in a traveling vehicle system for a plurality of traveling vehicles traveling along a travel route including
15 a diverging section and a merging section under control of a controller on a ground is provided. The method includes the steps of:

designating a certain area of the travel route, including a diverging section and a merging section as a blocking area,

designating an area including the blocking area, and larger than the blocking area
20 as an inter-vehicle distance control area;

allowing the traveling vehicle to travel along the travel route, the traveling vehicle having a distance sensor for detecting a distance to a traveling vehicle ahead of own traveling vehicle, means for recognizing a position of the own traveling vehicle, and means for obtaining a position of another traveling vehicle by communication;

25 allowing the traveling vehicle in the inter-vehicle distance control area to determine an inter-vehicle distance between the traveling vehicles from the position of the other traveling vehicle obtained by communication and the recognized position of the

own traveling vehicle to implement velocity control of the own traveling vehicle for avoiding interference with the other traveling vehicle;

allowing the traveling vehicle to request a permission from the controller before entry into the blocking area, and allowing the traveling vehicle to enter the blocking area after obtaining the requested permission; and

allowing the traveling vehicle in a travel route other than the inter-vehicle distance control area to implement velocity control of the own traveling vehicle based on the distance determined by the distance sensor for avoiding interference with the other traveling vehicle.

In this specification, description regarding the traveling vehicle system is directly applicable to the travel control method.

Preferably, the traveling vehicle further includes a distance sensor for detecting a distance to a traveling vehicle ahead of the own traveling vehicle, and velocity control of the traveling vehicle in a travel route other than the inter-vehicle distance control area is implemented based on a distance determined by the distance sensor instead of the position of the other traveling vehicle obtained by communication.

Further, preferably, the traveling vehicle is configured to request a permission from the controller before entry into the merging section, and the controller is configured to provide permissions for entry into the merging section, preferentially to traveling vehicles coming from a same direction regardless of an arrival order of the request, for allowing the traveling vehicles coming from the same direction to successively enter the merging section.

In particular, preferably, marks are provided along the travel route and the means for recognizing the position of the own traveling vehicle reads the marks to recognize the position of the own traveling vehicle;

the traveling vehicle further includes communication means for transmitting the position of the own traveling vehicle to the controller on the ground; and

the means for obtaining the position of the other traveling vehicle intercepts communication of the transmission to the controller on the ground to obtain the position of the other traveling vehicle.

5 Advantages of the Invention

[0007]

In the present invention, since the size of the blocking area can be minimized, the number of traveling vehicles that can pass the diverging section or the merging section can be increased, and improvement in the system efficiency is achieved.

10 [0008]

Further, in the travel route other than the inter-vehicle distance control area, by implementing only velocity control based on the distance determined by the distance sensor, the control can be simplified since it is not required to obtain the inter-vehicle distance to the leading traveling vehicle by communication.

15 Further, by giving permissions for entry into the merging section, preferentially to traveling vehicles coming from a same direction regardless of an arrival order of the request, for allowing the traveling vehicles coming from the same direction to successively enter the merging section, the number of traveling vehicles that can pass the merging section can be further increased.

20

Brief Description of the Drawings

[0009]

[FIG. 1]

25 FIG. 1 is a diagram schematically showing a layout of overhead traveling vehicles according to an embodiment.

[FIG. 2]

FIG. 2 is a diagram showing a blocking area and an inter-vehicle distance control

area in a diverging section in the embodiment.

[FIG. 3]

FIG. 3 is a diagram showing a blocking area and an inter-vehicle distance control area in a merging section in the embodiment.

5 [FIG. 4]

FIG. 4 is a diagram showing a curve segment in the embodiment.

[FIG. 5]

FIG. 5 is a diagram showing the relationship between a controller and overhead traveling vehicles in the embodiment.

10 [FIG. 6]

FIG. 6 is a diagram showing a pattern of traveling vehicles passing through the merging section in the embodiment.

Description of the numerals

15 [0010]

2: overhead traveling vehicle system

4: inter-bay route

6: intra-bay route

8, 10: shortcut

20 12: ground controller

14: overhead traveling vehicle

20, 30: blocking area

21, 31: inter-vehicle distance control area

22: exit of diverging lane

25 23: exit of merging lane

24: entrance of diverging lane

32: entrance of merging lane

33: entrance of straight lane

34: exit of merging lane

50: LAN

51: controller body

5 52: communication interface

53: blocking controller

54: optical distance sensor

55: absolute position sensor

56: mark

10 61 to 64: permission request from straight lane

65 to 67: permission request from merging lane

68: travel permission pattern in embodiment

69: travel permission pattern in conventional example

D: diverging section

15 D1 to D15: diverging section

M: merging section

M1 to M15: merging section

C: curve segment

C1 to C4: curve segment

20

Best Mode for Carrying Out the Invention

[0011]

Hereinafter, an embodiment in the most preferred form for carrying out the present invention will be described.

25 EMBODIMENT

[0012]

FIGS. 1 to 6 show an overhead traveling vehicle system 2 according to the

embodiment. It should be noted that other types of overhead traveling vehicles may be used. For example, rail guided vehicles that travel on the ground or automated guided vehicles that travel without any rail may be used. FIG. 1 shows an overall layout of the overhead traveling vehicle system. A reference numeral 4 denotes an inter-bay route of a semiconductor factory or the like, reference numerals 6 denote intra-bay routes, and reference numerals 8 and 10 denote shortcuts. The overall control of the system 2 is implemented by a ground controller 12. A plurality of overhead traveling vehicles 14 travel to circulate along the routes 4, 6 or the like in one direction. The routes 4, 6 include straight segments, diverging sections D1 to D15, merging sections M1 to M15, and curve segments C1 to C4.

[0013]

FIG. 2 shows control in the diverging section D. Control in the diverging section D is applicable to each of the diverging sections D1 to D15 shown in FIG. 1. A reference numeral 20 denotes a blocking area. For entry into the blocking area 20, the overhead traveling vehicle 14 requires a permission from the ground controller 12. An inter-vehicle distance control area 21 including the blocking area 20, and larger than the blocking area 20 is provided. The inter-vehicle distance control area 21 is extended along the entrance of the blocking area 20 and an exit 22 of a diverging lane. No inter-vehicle distance control area is provided at an exit 23 of a straight lane. Further, in the inter-vehicle distance control area 21 including the blocking area 20, the overhead traveling vehicle 14 obtains the inter-vehicle distance to a leading traveling vehicle by communication. The overhead traveling vehicle 14 implements velocity control based on the inter-vehicle distance to avoid interference with the leading traveling vehicle. By blocking control, two overhead traveling vehicles 14 do not enter the blocking area 20 at the same time.

[0014]

The overhead traveling vehicle 14 determines an inter-vehicle distance with a

leading overhead traveling vehicle by an optical distance sensor 54 as described later, and implements velocity control to avoid interference. This control is implemented in the straight segment. Further, in the curve segment, since it is difficult to detect the leading traveling vehicle by the optical distance sensor, the curve segment is also included in the inter-vehicle distance control area. The inter-vehicle distance with the leading traveling vehicle is obtained by communication, and velocity control is implemented to avoid interference or the like.

[0015]

The range of the inter-vehicle distance control area 21 will be described. At the entrance 24 of the diverging lane, it may be difficult to detect an overhead traveling vehicle 14a diverging from the blocking area 20 by the optical distance sensor. Therefore, it is required to obtain the inter-vehicle distance by communication. Further, it may be difficult for an overhead traveling vehicle 14c in the middle of transition from straight movement to curving movement at the exit of the diverging lane, to detect a leading overhead traveling vehicle by the optical distance sensor. Therefore, likewise, it is required to obtain the inter-vehicle distance by communication. In contrast, the overhead traveling vehicle 14d at the exit 23 of the straight lane can detect the leading traveling vehicle by the optical distance sensor. Therefore, no inter-vehicle distance control area is required at the exit 23 of the straight lane. Further, the blocking area 20 is included in the inter-vehicle distance control area 21, and the overhead traveling vehicle 14a in the blocking area 20 obtains the position of the leading overhead traveling vehicle 14c by communication.

[0016]

In the inter-vehicle distance control area 21 including the blocking area 20, each of the overhead traveling vehicles 14a to 14c obtains the distance to the leading overhead traveling vehicle by communication, and implements velocity control in accordance with the distance. When the overhead traveling vehicle enters the blocking area 20 from the

entrance of the diverging lane, the overhead traveling vehicle obtains a permission from the ground controller 12. When the overhead traveling vehicle gets out of the blocking area 20, the overhead traveling vehicle reports the current position and velocity to the ground controller 12, and the ground controller 12 detects that the blocking area 20 became vacant.

[0017]

FIG. 3 shows control in the merging section M. This control is commonly applicable to the merging sections M1 to M15. A reference numeral 30 denotes a blocking area. When the overhead traveling vehicle 14 enters the blocking area 30, a permission from the ground controller 12 is required beforehand. An inter-vehicle distance control area 31 is present over an area including the blocking area 30, and larger than the blocking area 30. The inter-vehicle distance control area 31 includes an area at the entrance 32 of a merging lane of the blocking area 30 and an area at the exit 34 of the blocking area 30. Since the entrance 32 of the merging lane is provided in a curve segment, the entrance 32 of the merging lane is included in the inter-vehicle control area 31. It should be noted that the entrance 33 of the straight lane of the blocking area 30 is not included in the inter-vehicle distance control area 31.

[0018]

In each of the cases of FIG. 2 and FIG. 3, the length along the traveling path of the blocking area 20 or the blocking area 30 is substantially equal to the length of the vehicle body of the overhead traveling vehicle 14, and this length is the minimum size for avoiding interference between the 1 overhead traveling vehicles 14. Further, in the inter-vehicle distance control areas 21, 31, the overhead traveling vehicle 14 obtains the distance to the leading transportation vehicle by communication, and implements velocity control based on the distance to avoid interference. The entrance 33 of the straight lane of the blocking area 30 is not included in the inter-vehicle distance control area 31. It is because, in the presence of the blocking area 30, the traveling vehicle that has traveled in

the straight segment can avoid interference with the leading traveling vehicle. Further, when the overhead traveling vehicle 14g that travels at the exit 34 of the merging lane comes from the entrance 32 of the merging lane, the leading traveling vehicle may not be detected until the vehicle body is completely oriented straight. Therefore, the exit 34 of the merging lane is included in the inter-vehicle distance control area 31.

[0019]

FIG. 4 shows control in the curve segment C. In the straight segment, as described above, the overhead traveling vehicle 14 determines the distance to the leading transportation vehicle by the optical distance sensor to implement velocity control. In the curve segment C, since it may be difficult to detect the leading transportation vehicle by the optical distance sensor, the inter-vehicle distance is determined by communication to implement velocity control.

[0020]

As a result of these operations, in the straight segment, basically, interference avoidance by the optical distance sensor is performed. In the curve segment, the diverging section, or the merging section, interference avoidance based on the inter-vehicle distance determined by communication is performed. Blocking control is implemented only in the minimum requisite range, i.e., in the blocking areas 20, 30. In general, since only one overhead traveling vehicle 14 can travel in one blocking area at one time, the size of the blocking area is inversely proportional to the number of overhead traveling vehicles 14 that can pass through the blocking area. In the embodiment, the number of overhead traveling vehicles 14 that can travel within the blocking area 20 or the blocking area 30 is increased to improve the throughput of the system 2.

[0021]

FIG. 5 shows the relationship between the ground controller 12 and the overhead traveling vehicle 14. A reference numeral 50 denotes a wired or wireless LAN. For

example, a feeder cable or a non-contact feeder cable may be used to form a wired LAN. A wireless LAN may be adopted instead of the wired LAN. The ground controller 12 has a communication interface 52 and a blocking controller 53. The blocking controller 53 stores data as to whether the blocking area 20 or the blocking area 30 is occupied or not.

5 When the blocking controller 53 receives permission requests from the overhead traveling vehicles 14, the blocking controller 53 issues travel permissions in accordance with a predetermined order.

[0022]

10 In the areas other than the inter-vehicle control area, the overhead traveling vehicle 14 determines the inter-vehicle distance to the leading overhead traveling vehicle using an optical distance sensor 54 such as a laser distance sensor. It should be noted that a supersonic distance sensor, a microwave distance sensor or the like may be used instead of the optical distance sensor. Marks 56 such as magnetic marks are provided along the travel rail or the like of the overhead traveling vehicle 14, and an absolute position sensor
15 55 is used to detect the marks 56 for determining an absolute position of the overhead traveling vehicle 14. Alternatively, comb teeth like marks may be used as the marks 56. The overhead traveling vehicle 14 reports its own position and velocity determined by the absolute position sensor 55 to the ground controller 12 through the LAN 50. The overhead traveling vehicle 14 intercepts the current position and velocity of the other
20 overhead traveling vehicle 14 to determine the inter-vehicle distance, and implement velocity control to avoid interference.

[0023]

FIG. 6 shows a pattern of permissions issued in response to blocking requests to the merging section M. There are two options for the merging section M, i.e., whether a
25 priority is given to the overhead traveling vehicle coming from the merging lane or the overhead traveling vehicle coming from the straight lane. A reference numeral 69 denotes a velocity permission pattern in a conventional example. Permissions are given

to travel permission requests in the order of the earliest reception. In contrast, a reference numeral 68 denotes a velocity permission pattern in the embodiment. Permissions are preferentially given to permission requests coming from the same lane where a permission has already been given.

5 [0024]

As shown on the lower side of FIG. 6, it is assumed that permission requests 61 to 67 have reached the controller 12 separately. Reference numerals 61 to 64 denote permission requests from the straight lane, and reference numerals 65 to 67 denote permission requests from the merging lane. Since the blocking controller 53 firstly
10 received the permission request 61 from the straight lane, the blocking controller 53 gives a permission in response to the request, and performs blocking. It is assumed that the permission request 65 from the merging lane is received initially, and thereafter, the permission request 62 from the straight lane is received. In this case, a priority is given to the permission request 62 from straight lane where a permission has been given to the
15 previous request. In the absence of any other permission request before blocking for the permission request 62 is released, a permission is given to the permission request 65 from the merging lane. Since the permission request 63 from the straight lane and the permission request 66 from the merging lane have reached before blocking for the permission request 65 is released, a permission is given to the permission request 66 from
20 the merging lane. After blocking for the permission request 66 is released, a permission is given to the permission request 63 from the straight lane. In the meantime, if any permission request 67 from the merging lane is received, such a permission request is suspended, and a priority is given to the permission request 64 from the straight lane.
[0025]

25 In the algorithm of processing, a priority is given to the permission request from the lane where a permission has already been given to the previous permission request. In this manner, since permissions are given successively to permission requests from the

same lane, the overhead traveling vehicles 14 can travel more efficiently in the blocking area 30.

[0026]

In the embodiment, the following advantages are obtained.

5 (1) Since the sizes of the blocking areas 20, 30 are minimized, the number of overhead traveling vehicles 14 that can pass through the blocking areas 20, 30 per unit time is increased, and improvement in the transportation efficiency is achieved.

 (2) In the straight segment, since interference is avoided using the optical distance sensor 54, processing is simplified.

10 (3) In the inter-vehicle distance control area such as the curve segment, the diverging section, and the merging section, reports of positions of overhead traveling vehicles to the controller are intercepted by communication to implement inter-vehicle distance control. In the system, in comparison with the case of adopting direct communication between the traveling vehicles 14, communication traffic of the LAN 50
15 is reduced.

 (4) In the merging section, blocking permissions are given preferentially to the overhead traveling vehicles that enter the merging section from the same lane. Therefore, the overhead traveling vehicles can travel through the merging section more efficiently.

 It should be noted that the overhead traveling vehicle 14 reports its own position
20 to the ground controller 12, and such a report may be made only in the inter-vehicle distance control areas 21, 31.

CLAIMS

[Claim 1] A traveling vehicle system comprising a plurality of traveling vehicles, a travel route including at least a diverging section and at least a merging section and at least a controller on a ground, the traveling vehicles traveling along the travel route under control of the controller;

the traveling vehicles having means for recognizing a position of own traveling vehicle, means for obtaining a position of other traveling vehicles by communication, and a distance sensor for detecting a distance to a traveling vehicle ahead of the own traveling vehicle;

an inter-vehicle distance control area in the travel route comprising an blocking area, an entrance of a diverging section, an exit of a diverging lane of the diverging section, a curved entrance to the merging section, an exit from the merging section, and a curved segment, wherein the blocking area comprises the diverging section and the merging section,

wherein the traveling vehicles are configured to control the velocity of the traveling vehicles in the inter-vehicle control area by determining an inter-vehicle distances between the traveling vehicles based on the position of other traveling vehicles obtained by the communication and the recognized position of the own traveling vehicle,

to enter the blocking area with obtaining permissions from the controller, and to control the velocity of the traveling vehicles in the traveling route other than the inter-vehicle control area based on distances detected by the distance sensor instead of the positions of other traveling vehicles obtained by communication.

[Claim 2] The traveling vehicle system according to claim 1, the traveling vehicles being configured to request permissions from the controller before entry into the merging section, the controller being configured to provide permissions for entry into the merging

section, preferentially to traveling vehicles coming from a same direction regardless of an arrival order of the requests, for allowing the traveling vehicles coming from the same direction to successively enter the merging section.

5 [Claim 3] The traveling vehicle system according to claim 1, marks being provided along the travel route, and the means for recognizing the position of the own traveling vehicle reading the marks to recognize the position of the own traveling vehicle;

the traveling vehicles further including communication means for transmitting the position of the own traveling vehicle to the controller; and

10 the means for obtaining the position of other traveling vehicles intercepting communication of the transmission to the controller to obtain the position of the other traveling vehicles.

[Claim 4] A travel control method in a traveling vehicle system for a plurality of
15 traveling vehicles traveling along a travel route including at least a diverging section and at least a merging section under control of at least a controller on a ground, the method comprising the steps of:

designating an area of the travel route, including a diverging section and a merging section as a blocking area,

20 designating an area including the blocking area, an entrance of the diverging section, an exit of a diverging lane of the diverging section, a curved entrance to the merging section, an exit from the merging section, and a curve segment as an inter-vehicle distance control area;

25 allowing the traveling vehicles to travel along the travel route, the traveling vehicles having a distance sensor for detecting a distance to a traveling vehicle ahead of own traveling vehicle, means for recognizing a position of the own traveling vehicle, and means for obtaining positions of other traveling vehicles by communication;

allowing the traveling vehicles in the inter-vehicle distance control area to determine inter-vehicle distances between the traveling vehicles from the position of other traveling vehicles obtained by the communication and the recognized position of the own traveling vehicle to implement velocity control of the own traveling vehicle for avoiding interference with other traveling vehicles;

allowing the traveling vehicles to request permissions from the controller before entry into the blocking area, and allowing the traveling vehicles to enter the blocking area after obtaining the requested permissions; and

allowing the traveling vehicles in the travel route other than the inter-vehicle distance control area to implement velocity control of the own traveling vehicle based on the distances detected by the distance sensor for avoiding interference with other traveling vehicles.