

DESCRIPTION
ELECTRIC VEHICLE POSITION DETECTION SYSTEM

Field

5 [0001]

The embodiments of the present invention relate to an electric vehicle position detection system.

Background

10 [0002]

In order to enable trains to run and stop safely, safety devices or operation support devices such as an ATS (Automatic Train Stop), an ATC (Automatic Train Control), an ATO (Automatic Train Operation), a TASC (Train Automatic Stop-position Controller), and a
15 CBTC (Communication Based Train Control) have been developed. These safety devices or operation support devices need a device to specify the positions of trains, such as a transponder or a track circuit. However, the transponder or the track circuit has a problem of being high in the device cost and the installation cost. Furthermore, when
20 a GPS (Global Positioning System) is used to specify the positions of trains, a range in which radio waves of the GPS reach is limited and there is a problem with reliability in the positional accuracy.

[0003]

In order to solve these problems, use of an RFID (Radio
25 Frequency Identifier) has been considered. Considering a signal processing time of the RFID, it is preferable that an ID readable range of tags be wide when a train runs at a high speed. That is, it is preferable that the tags be high in sensitivity. This enables a reader to reliably read IDs of tags even when the train runs at a high speed.

30 [0004]

On the other hand, when a train runs at a low speed to stop at a station, the position of the train needs to be detected correctly. However, if the ID readable range of the tags is wide, the position of the train within the wide range is unclear. Therefore, when the train
35 runs at a low speed, it is preferable that the ID readable range of the tags be narrow. That is, it is preferable that the tags be low in

sensitivity.

[0005]

As described above, in the case of using the RFID, an appropriate ID readable range has a trade-off relation with the speed
5 of a train.

Citation List

Patent Literature

[0006]

10 [Patent Literature 1] Japanese Patent Application Laid-open
No. 2009-149216

Summary

Technical Problem

15 [0007]

An object is to provide an electric vehicle position detection system that can detect the position of a train correctly and with low cost regardless of the speed of the train.

20 Solution to Problem

[0008]

An electric vehicle position detection system according to an embodiment includes a plurality of first tags, a plurality of second tags, and a reader. The first tags are installed along a track and
25 have identifiers mutually different from each other. The second tags are installed along the track and have identifiers mutually different from each other. The reader is mounted on an electric vehicle running on the track and can read the identifiers of the first tags and the identifiers of the second tags. The first tags include a first range
30 as a range in which the reader can read identifiers. The second tags include a second range different from the first range as a range in which the reader can read identifiers. An installation distance between the first tags is different from an installation distance between the second tags.

35

Brief Description of Drawings

[0009]

[FIG. 1] FIG. 1 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a first embodiment.

5 [FIG. 2] FIG. 2 is a diagram illustrating an example of a configuration of an electric vehicle 10.

[FIG. 3] FIG. 3 is a table illustrating an example of tag position information.

10 [FIG. 4] FIG. 4 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a second embodiment.

[FIG. 5] FIG. 5 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a third embodiment.

15 [FIG. 6] FIG. 6 is a diagram illustrating an ID readable range.

Description of Embodiments

[0010]

20 Embodiments of the present invention will be described below in detail with reference to the accompanying drawings. These embodiments do not limit the present invention.

[0011]

(First embodiment)

25 FIG. 1 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a first embodiment. The electric vehicle position detection system according to the first embodiment includes a plurality of first tags T1, a plurality of second tags T2, readers 11 and 12 (see FIG. 2), and a database 13 (see FIG. 2). The first tags T1 are tags having a same configuration. The second tags are tags having a same configuration. The first tags T1 and the second tags T2 have configurations mutually different from each other.

[0012]

35 The first and second tags T1 and T2 are, for example, RFID tags and can be either active tags or passive tags. However, in view of costs such as a system cost and an installation cost, the first and

second tags T1 and T2 are preferably passive tags not requiring a power source.

[0013]

5 The first tags T1 are installed along a track 1 and have identifiers mutually different from each other. The second tags T2 are also installed along the track 1 and have identifiers mutually different from each other. That is, the first and second tags T1 and T2 have unique identifiers, respectively, and it is possible to identify the tags by reading the respective identifiers.

10 [0014]

Each of the first tags T1 has a range (hereinafter, also "ID readable range") in which the readers 11 and 12 mounted on an electric vehicle 10 described later can read the identifier (hereinafter, also "ID"). The ID readable ranges of the first tags T1 are a first range D1. For example, the first range D1 has an ID readable range of about 2 meters along the track 1. Therefore, the readers 11 and 12 can read the ID of each of the first tags T1 within about 1 meter before and after the center of the first tag T1 along the track 1. In other words, the readers 11 and 12 can read the ID of each of the first tags T1 from about 1 meter short of the center of the first tag T1 to about 1 meter ahead of the center of the first tag T1 along the track 1.

[0015]

Each of the second tags T2 also has an ID readable range. The ID readable ranges of the second tags T2 are a second range D2. The second range D2 is different from the first range D1 and is narrower than the first range D1. For example, the second range D2 has an ID readable range of about 0.5 meter along the track 1. Therefore, the readers 11 and 12 can read the ID of each of the second tags T2 within about 0.25 meter before and after the center of the second tag T2 along the track 1. In other words, the readers 11 and 12 can read the ID of each of the second tags T2 from about 0.25 meter short of the center of the second tag T2 to about 0.25 meter ahead of the center of the second tag T2 along the track 1.

35 [0016]

The first and second tags T1 and T2 are arranged at stations

where the electric vehicle 10 stops and the vicinities of the stations (hereinafter, also collectively "stations ST") along the track 1. The first tags T1 are arranged with first installation distances DST1 and the second tags T2 are arranged with second installation distances DST2. That is, the distance between the centers of two adjacent first tags T1 is the first installation distance DST1 and the distance between the centers of two adjacent second tags T2 is the second installation distance DST2.

[0017]

10 The second installation distance DST2 is different from the first installation distance DST1 and is narrower than the first installation distance DST1. Therefore, as illustrated in FIG. 1, a plurality of the second tags T2 can be arranged between two adjacent first tags T1. In the first embodiment, three second tags T2 are
15 arranged between two adjacent first tags T1.

[0018]

 For example, the first installation distance DST1 is about 1.8 meters and the second installation distance DST2 is about 0.5 meter. In this case, the first installation distance DST1 is narrower than the
20 first range D1. Therefore, as illustrated in FIG. 1, ID readable ranges of two adjacent first tags T1 overlap with each other between the two first tags T1. The second installation distance DST2 is substantially equal to the second range D2. Therefore, as illustrated in FIG. 1, ID readable ranges of two adjacent second tags T2 are
25 substantially contiguous with each other between the two second tags T2.

[0019]

 In the first embodiment, three second tags T2 are arranged with respect to one first tag T1. That is, the ratio of the installation
30 number between the first tags T1 and the second tags T2 is 1:3. This ratio is substantially constant at the stations ST along the track 1. For example, the second tags T2 can be arranged substantially uniformly between adjacent first tags T1.

[0020]

35 Furthermore, the first tags T1 and the second tags T2 can be displaced from each other in a direction perpendicular to the

extending direction of the track 1. In this case, the second tags T2 can be arranged with the installation distances DST2 substantially uniformly on the entire track 1 without consideration for the installation positions of the first tags T1. That is, when viewed from
5 the side of the track 1, the second tags T2 can be installed at positions overlapped with the positions of the first tags T1.
[0021]

As described above, the electric vehicle position detection system according to the first embodiment includes both the first and
10 second tags T1 and T2 at the stations ST. The electric vehicle 10 may pass the stations ST at a high speed without running at a low speed or stopping at the stations ST. For example, when the electric vehicle 10 stops at the stations ST, the electric vehicle 10 runs at a low speed. Therefore, the readers 11 and 12 can correctly detect
15 the position of the electric vehicle 10 by reading the IDs of the second tags T2 with a relatively low sensitivity (with a relatively narrow ID readable range). On the other hand, when the electric vehicle passes the stations ST at a high speed, it is difficult for the readers 11 and 12 provided on the electric vehicle 10 to detect the IDs of the
20 second tags T2 with a relatively low sensitivity, and the position of the electric vehicle cannot be detected correctly with the second tags T2. Therefore, the electric vehicle position detection system according to the first embodiment includes the first tags T1 as well as the second tags T2 at the stations ST. This enables the readers 11
25 and 12 to read the IDs of the first tags T1 with a relatively high sensitivity (with a relatively wide ID readable range) to correctly detect the position of the electric vehicle 10 when the electric vehicle 10 passes the stations ST at a high speed. In this way, installation of both the first and second tags T1 and T2 at the stations ST, the
30 electric vehicle position detection system can detect the position of the electric vehicle 10 both when the electric vehicle 10 runs at a low speed or at a high speed.
[0022]

Meanwhile, at places other than the stations and the vicinities
35 thereof, the second tags T2 are not provided while the first tags T1 are arranged along the track 1. Because the electric vehicle 10 runs

at a high speed at places other than the stations and the vicinities thereof, installation of the second tags T2 with a low sensitivity is unnecessary. The first tags T1 are arranged with the first installation distances DST1 similarly to the first tags T1 at the stations ST.

[0023]

FIG. 2 is a diagram illustrating an example of a configuration of the electric vehicle 10. The electric vehicle 10 includes antennas ANT1 and ANT2, the readers 11 and 12, the database 13, comparators 14 and 15, a calculator 16, and a controller 17.

[0024]

The two antennas ANT1 and ANT2 are antennas for reading IDs and are connected to the readers 11 and 12, respectively. The antennas ANT1 and ANT2 have substantially equal gain characteristics.

[0025]

The readers 11 and 12 are configured to acquire IDs of the tags T1 or T2 via the antennas ANT1 and ANT2, respectively. The readers 11 and 12 have a same configuration.

[0026]

The database 13 has stored therein tag position information indicating a relation between IDs of the first and second tags T1 and T2 and installation positions of the first and second tags T1 and T2. The IDs of the first and second tags T1 and T2 are unique to the respective tags and correspond to the respective installation positions of the first and second tags T1 and T2 in a one-to-one relation. Therefore, when an ID detected via the antenna ANT1 or ANT2 is matched to the tag position information, the position of the electric vehicle 10 can be determined. The database 13 can further have stored therein other information such as track number information at the stations ST to be associated with the tag IDs.

[0027]

For example, FIG. 3 is a table illustrating an example of the tag position information. In the tag position information, the ID of each tag is associated with the position of the tag and the track number information at a station ST. The ID can be represented by a

numerical value, a character, a sign, or the like. The position of a tag can be represented by the latitude and the longitude, or the like. The track number at a station ST can be represented by a numerical value, or the like.

5 [0028]

The comparators 14 and 15 illustrated in FIG. 2 are connected to the readers 11 and 12, respectively, and are also connected to the database 13. The comparator 14 compares an ID from the reader 11 with tag position information from the database 13. The comparator 14 thereby matches the ID to the tag position information to specify the position of a tag having the corresponding ID. The comparator 15 compares an ID from the reader 12 with tag position information from the database 13 independently from the comparator 14. The comparator 15 thereby matches the ID to the tag position information to specify the position of a tag having the corresponding ID.

[0029]

The calculator 16 performs a logical operation between a result of the comparison and matching in the comparator 14 and a result of the comparison and matching in the comparator 15. For example, the calculator 16 is an AND operation circuit and calculates a logical conjunction of the comparison and matching results from the comparators 14 and 15. The calculator 16 outputs position information (the latitude and longitude) of the tag to the controller 17 when the comparison and matching result from the comparator 14 agrees with the comparison and matching result from the comparator 15. On the other hand, when the comparison and matching result from the comparator 14 does not agree with the comparison and matching result from the comparator 15, the calculator 16 does not output the position (the latitude and longitude) of the tag or outputs an error signal to the controller 17.

[0030]

The controller 17 outputs various control signals based on the position information from the calculator 16. For example, the controller 17 can output a control signal indicating that the electric vehicle 10 has stopped, using the position information from the

calculator 16 as well as speed information, brake information (the number of notches), and the like of the electric vehicle 10. At that time, the electric vehicle 10 can allow opening of doors of cars of the electric vehicle 10. Alternatively, opening of platform screen doors can be allowed at a station ST. It is needless to mention that the control signals from the controller 17 can be used for other operation control of the electric vehicle 10.

[0031]

In this way, the readers 11 and 12 read IDs of tags via the antennas ANT1 and ANT2 respectively and individually and the calculator 16 calculates the logical conjunction thereof, whereby the reliability in the tag IDs and the positions of the tags can be enhanced.

[0032]

Arrangement of the first tags T1 and the second tags T2 is discussed next referring back to FIG. 1. In the arrangement illustrated in FIG. 1, the installation distance DST1 (1.8 meters, for example) of the first tags T1 is smaller than the first range D1 (2 meters, for example). Therefore, ID readable ranges of two adjacent first tags T1 overlap with each other. Accordingly, the readers 11 and 12 can read an ID of either first tag T1 during running or stopping.

[0033]

The installation distance DST2 (0.5 meter, for example) of the second tags T2 is equal to the second range D2 (0.5 meter, for example). However, the second tags T2 are not provided at the installation positions of the first tags T1. Therefore, ID readable ranges of two adjacent second tags T2 are set to be contiguous with each other between two adjacent first tags T1. Accordingly, the readers 11 and 12 can read IDs of the second tags T2 between two adjacent first tags T1. By reading the IDs of the second tags T2, the readers 11 and 12 can detect a position at which the readers 11 and 12 are located between two adjacent first tags T1. In this way, the second tags T2 interpolate a space between the first tags T1 to enable the readers 11 and 12 to correctly detect the position of the electric vehicle 10.

[0034]

Because the first tags T1 are arranged with the first installation distances DST1 at the stations ST and in regions other than the stations ST, the readers 11 and 12 can also detect the position of an electric vehicle passing the stations ST or an electric vehicle running at a high speed in the regions other than the stations ST.

[0035]

As described above, in the first embodiment, the readers 11 and 12 can correctly detect the position of an electric vehicle running at a high speed at the stations ST and in regions other than the stations ST and also can correctly detect the position of an electric vehicle running at a low speed at the stations ST.

[0036]

When the electric vehicle 10 runs at a high speed, the readers 11 and 12 can specify the position of the electric vehicle with an accuracy of the first range D1 (2 meters, for example), that is, with an error of $\pm D1 \times 1/2$ (an error of ± 1 meter, for example). On the other hand, when the electric vehicle 10 runs at a low speed, the readers 11 and 12 can specify the position of the electric vehicle with an accuracy of the second range D2 (0.5 meter, for example), that is, with an error of $\pm D2 \times 1/2$ (an error of ± 0.25 meter, for example).

[0037]

In this way, the electric vehicle position detection system according to the first embodiment can correctly detect the position of an electric vehicle regardless of the speed of the electric vehicle. Furthermore, because the electric vehicle position detection system according to the first embodiment adopts the RFID (such as passive tags), an installation cost can be kept relatively low.

[0038]

The readers 11 and 12 can always detect IDs of both the first and second tags T1 and T2 or either the first tags T1 or the second tags T2. Therefore, the electric vehicle position detection system according to the first embodiment can continuously detect the position of the electric vehicle 10 with the accuracies described above while the electric vehicle 10 is running on the track 1.

[0039]

(Second embodiment)

FIG. 4 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a second embodiment. In the second embodiment, the installation distance DST2 of the second tags T2 is wider than that in the first embodiment. For example, the installation distance DST2 of the second tags T2 is about 1 meter. Other configurations of the second embodiment can be identical to corresponding configurations of the first embodiment.

10 [0040]

By setting the installation distance DST2 of the second tags T2 wider, the ID readable ranges of two adjacent second tags T2 are spaced away from each other as illustrated in FIG. 4. Therefore, between two adjacent first tags T1, there is a space region SP between the ID readable ranges of two adjacent second tags T2. The space region SP is a range in which the IDs of the second tags T2 cannot be read between two adjacent first tags T1.

[0041]

The readers 11 and 12 cannot read IDs of the second tags T2 in the space region SP. In this case, however, the electric vehicle position detection system knows that the readers 11 and 12 are in the space region SP. For example, when the readers 11 and 12 have detected an ID of a second tag T2_1 and thereafter have not detected an ID of a second tag T2_2 adjacent to the second tag T2_1, it is known that the readers 11 and 12 are in the space region SP between the two second tags T2_1 and T2_2. That is, it is known that the readers 11 and 12 are in the space region SP between the second tag T2_1 corresponding to the ID detected last and the second tag T2_2 that is adjacent to the second tag T2_1 and having the ID not having been detected yet.

30 [0042]

Therefore, the electric vehicle position detection system according to the second embodiment can detect the position of the electric vehicle 10 with an accuracy equivalent to that in the first embodiment despite that there is the space region SP between ID readable ranges of adjacent second tags T2. That is, even when the

number of the installed second tags T2 is reduced as in the second embodiment, the detection accuracy of the position of the electric vehicle 10 can be maintained.

[0043]

5 (Third embodiment)

FIG. 5 is a diagram illustrating an example of a configuration of an electric vehicle position detection system according to a third embodiment. The electric vehicle position detection system according to the third embodiment further includes a plurality of third
10 tags T3 installed along the track 1 at the stations ST and having IDs mutually different from each other.

[0044]

The third tags T3 are, for example, tags of the RFID and can be either active tags or passive tags. However, in view of costs such
15 as the system cost and the installation cost, it is preferable that the third tags T3 be also passive tags not requiring a power source similarly to the first and second tags T1 and T2.

[0045]

The third tags T3 are installed along the track 1 and have
20 identifiers mutually different from each other. That is, the third tags T3 have unique identifiers, respectively, and it is possible to identify the tags by reading the identifiers.

[0046]

The third tags T3 have a third range D3 as an ID readable
25 range. The third range D3 is narrower than the first and second ranges D1 and D2. That is, the third tags T3 are tags with a lower sensitivity than those of the first and second tags T1 and T2. For example, the third tags T3 have an ID readable range of about 0.25 meter along the track 1. Therefore, the readers 11 and 12 can read
30 an ID of each of the third tags T3 within about 0.125 meter before and after the center of the third tag T3 along the track 1. In other words, the readers 11 and 12 can read the ID of each of the third tags T3 from about 0.125 meter short of the center of the third tag T3 to about 0.125 meter ahead of the center of the third tag T3 along the
35 track 1.

[0047]

The third tags T3 are arranged at the stations ST along the track 1. The third tags T3 are arranged with third installation distances DST3. That is, the distance between the centers of two adjacent third tags T3 is the third installation distance DST3. The third installation distance DST3 is narrower than the installation distance DST1 of the first tags T1 and the installation distance DST2 of the second tags T2. As illustrated in FIG. 5, a plurality of third tags T3 can be arranged between two adjacent second tags T2. In the third embodiment, two third tags T3 are arranged between two adjacent second tags T2.

[0048]

For example, when the first installation distance DST1 is about 1.8 meters and the second installation distance DST2 is about 0.5 meter, the third installation distance DST3 can be set to, for example, about 0.25 meter to substantially align the center of the third installation distance DST3 with the centers of the first and second installation distances DST1 and DST2. That is, the third tags T3 can be arranged substantially uniformly between adjacent second tags T2.

[0049]

The third tags T3 can be displaced from the first and second tags T1 and T2 in a direction perpendicular to the extending direction of the track 1. In this case, the third tags T3 can be arranged with the installation distances DST3 substantially uniformly on the entire track 1 without consideration for the installation positions of the first and second tags T1 and T2. That is, the third tags T3 can be installed at positions overlapped with the first and second tags T1 and T2 when viewed from the side of the track 1.

[0050]

In this way, the electric vehicle position detection system according to the third embodiment includes the third tags T3 having the third range narrower than the first and second ranges as an ID readable range. The installation distance DST3 of the third tags T3 is narrower than the installation distance DST1 of the first tags T1 and the installation distance DST2 of the second tags T2. Accordingly, when the electric vehicle 10 runs at a low speed, the

readers 11 and 12 can specify the position of the electric vehicle with an accuracy of the third range D3 (0.25 meter, for example), that is, with an error of $\pm D3 \times 1/2$ (an error of ± 0.125 meter, for example). As a result, the position of an electric vehicle running at a low speed at the stations ST can be detected more correctly in the third embodiment. Other configurations of the third embodiment can be identical to corresponding configurations of the first or second embodiment. Therefore, the effects of the first or second embodiment can also be achieved in the third embodiment.

10 [0051]

The electric vehicle position detection system can further include tags (not illustrated) having an ID readable range narrower than the third range D3. This enables the electric vehicle position detection system to detect the position of the electric vehicle 10 more accurately. Alternatively, the electric vehicle position detection system can further include tags having an ID readable range wider than the first range D1. This enables the electric vehicle position detection system to read IDs of the tags with the readers 11 and 12 in the electric vehicle 10 running at a higher speed.

20 [0052]

The ID readable range is explained next.

[0053]

FIG. 6 is a diagram illustrating an ID readable range. The ID readable range explained below can be any of the first to third ranges D1 to D3. The ID readable range (the first range D1) of the first tags T1 is explained below.

[0054]

Read power V_{read} of the readers 11 and 12 changes in a substantially arched manner with a peak at the center of a first tag T1 and decreases as the distance from the center of the tag T1 increases. Assuming that a threshold voltage at which the readers 11 and 12 can read information is V_{th} , a range in which the readers 11 and 12 can reliably read the IDs of the first tags T1 is the first range D1 in which the V_{read} is surely above the V_{th} .

35 [0055]

The power V_{read} may exceed the threshold voltage V_{th} also

beyond the first range D1 due to reflection or refraction of radio waves. However, it is preferable to set the range in which the readers 11 and 12 can reliably read the IDs of the first tags T1 to the first range D1. Because the first range D1 is relevant to the speed of the electric vehicle 10, the first range D1 is set also in consideration of the speed of the electric vehicle 10.

[0056]

In the first range D1 set in this manner, a reception voltage Vrcv is surely at a high level. Therefore, the electric vehicle position detection system can reliably receive a reception signal Srcv in the first range D1. In this way, the first range D1 is set to a range in which the reception signal Srcv can be reliably received.

[0057]

In the above embodiments, the readers 11 and 12 continuously receive IDs of any of the tags T1 to T3 on the track 1. Therefore, the position of the electric vehicle 10 is continuously detected with any of the accuracies of the tags T1 to T3. As a result, the electric vehicle position detection system can provide highly-reliable position information.

[0058]

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

CLAIMS

1. An electric vehicle position detection system comprising:
a plurality of first tags installed along a track and having
identifiers mutually different from each other;
5 a plurality of second tags installed along the track and having
identifiers mutually different from each other; and
a reader mounted on an electric vehicle running on the track
and being capable of reading the identifiers of the first tags and the
identifiers of the second tags, wherein
10 the first tags include a first range as a range in which the
reader can read identifiers,
the second tags include a second range different from the first
range as a range in which the reader can read identifiers, and
an installation distance between the first tags is different from
15 an installation distance between the second tags.
2. The system of Claim 1, wherein
the second range is narrower than the first range, and
the installation distance between the second tags is narrower
20 than the installation position between the first tags.
3. The system of Claim 1, wherein a ratio of installation number
between the first tags and the second tags is substantially constant
along the track.
25
4. The system of Claim 1, wherein
both the first tags and the second tags are arranged along the
track at stations where the electric vehicle stops and in vicinities of
the stations, and
30 the second tags are not arranged while the first tags are
arranged along the track in a region other than the stations and the
vicinities of the stations.
5. The system of Claim 2, wherein
35 both the first tags and the second tags are arranged along the
track at stations where the electric vehicle stops and in vicinities of

the stations, and

the second tags are not arranged while the first tags are arranged along the track in a region other than the stations and the vicinities of the stations.

5

6. The system of Claim 1, wherein

an installation distance between the first tags is narrower than the first range, and

10 an installation distance between the second tags is equal to or wider than the second range.

7. The system of Claim 2, wherein

an installation distance between the first tags is narrower than the first range, and

15 an installation distance between the second tags is equal to or wider than the second range.

8. The system of Claim 6, wherein the reader determines to be on a space region between the second tag T2_1 and the second tag T2_2 adjacent to the second tag T2_1 in a running direction of the electric vehicle when the reader has not detected the second tag T2_2 after detecting the second tag T2_1.

20

9. The system of Claim 7, wherein the reader determines to be on a space region between the second tag T2_1 and the second tag T2_2 adjacent to the second tag T2_1 in a running direction of the electric vehicle when the reader has not detected the second tag T2_2 after detecting the second tag T2_1.

25

30 10. The system of Claim 1, further comprising a storage unit configured to have stored therein tag position information indicating a relation between identifiers of the first and second tags and installation positions of the first and second tags.

35 11. The system of Claim 1, further comprising a plurality of third tags installed along the track and having identifiers mutually

different from each other, wherein

the third tags include a third range narrower than the first and second ranges as a range in which the reader can read identifiers, and

5 an installation distance between the third tags is narrower than the installation distance between the first tags and the installation distance between the second tags.

12. The system of Claim 11, wherein a ratio of installation number
10 between the first tag to the third tag is substantially constant along the track.