

Technical Problem

The conventional autonomous vehicle changes the range of an estimable self position regardless of the error of an estimated a self position. For example, the conventional autonomous vehicle may expand the range of an estimable self position even when the error of an estimated self position is small. This may decrease reliability of a result of self position estimation by the autonomous vehicle. Conceived to address the problem, embodiments of the present invention ~~has an object of providing~~ provide an autonomous vehicle capable of estimating of self positions with high reliability.

Solution to Problem

~~In order to achieve the object, an autonomous vehicle according to the present invention is provided which includes: a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and a control unit configured to control a drive unit based on a self position, wherein the control unit includes: a first estimation unit configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and a second estimation unit configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and the control unit is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimation unit; and control the drive unit using the second estimate value as the self position.~~

According to a first aspect of the present invention, there is provided an autonomous vehicle comprising: a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and a controller configured to control a driver based on a self position, wherein the controller includes: a first estimator configured to calculate a first estimate value indicating an estimated self position, by estimation using a

probabilistic method based on the environmental information; and a second estimator configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and the controller is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimator; control the driver using the second estimate value as the self position; reduce the second estimate range when a first estimate range included in the first estimate value is smaller than a first threshold value; and expand the second estimate range when the first estimate range is larger than a second threshold value.

According to a second aspect of the present invention, there is provided an autonomous vehicle comprising: a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and a controller configured to control a driver based on a self position, wherein the controller includes: a first estimator configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and a second estimator configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and the controller is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimator; and control the driver using the second estimate value as the self position, wherein when a difference between the first estimate value and the second estimate value is larger than a third threshold value, the controller is configured to control the driver using the self position that is based on the first estimate value.

According to a third aspect of the present invention, there is provided an autonomous vehicle comprising: a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and a controller configured to control a

5 driver based on a self position, wherein the controller includes: a
first estimator configured to calculate a first estimate value
indicating an estimated self position, by estimation using a
probabilistic method based on the environmental information; and a
10 second estimator configured to calculate a second estimate value
indicating an estimated self position, by estimation using a matching
method based on the environmental information, and the controller
is configured to: change, according to the first estimate value, a
second estimate range for the calculating of the second estimate
15 value by the second estimator; and control the driver using the
second estimate value as the self position, a notificador configured to
give a notification of an error when a difference between the first
estimate value and the second estimate value is larger than a fourth
threshold value.

Advantageous Effects

20 The autonomous vehicle according to embodiments of the
present invention is capable of estimation of self positions with high
reliability.

Brief Description of Drawings

These and other ~~objects~~ aspects, advantages and features of
the

CLAIMS:

1. An autonomous vehicle comprising:

a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and

a controller configured to control a driver based on a self position, wherein the controller includes:

a first estimator configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and

a second estimator configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and

the controller is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimator;

control the driver using the second estimate value as the self position;

reduce the second estimate range when a first estimate range included in the first estimate value is smaller than a first threshold value; and

expand the second estimate range when the first estimate range is larger than a second threshold value.

2. The autonomous vehicle according to Claim 1,

wherein the first estimator is configured to estimate a self position using the probabilistic method which involves a particle filter, and

the second estimator is configured to estimate a self position using the matching method which involves line matching.

3. An autonomous vehicle comprising:

a first sensor which obtains environmental information on surrounding

environment of the autonomous vehicle; and

a controller configured to control a driver based on a self position,
wherein the controller includes:

a first estimator configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and

a second estimator configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and

the controller is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimator; and control the driver using the second estimate value as the self position,

wherein when a difference between the first estimate value and the second estimate value is larger than a third threshold value, the controller is configured to control the driver using the self position that is based on the first estimate value.

4. An autonomous vehicle comprising:

a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and

a controller configured to control a driver based on a self position,
wherein the controller includes:

a first estimator configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and

a second estimator configured to calculate a second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and

the controller is configured to: change, according to the first estimate value, a second estimate range for the calculating of the second estimate value by the second estimator; and control the driver using the second estimate value as the self position,

a notifiicator configured to give a notification of an error when a difference between the first estimate value and the second estimate value is larger than a fourth threshold value.

5. The autonomous vehicle according to Claim 1, wherein when a difference between the first estimate value and the second estimate value is larger than a fifth threshold value, and a matching rate of the second estimator is lower than a sixth threshold value, the controller is configured to control the driver using the self position that is based on the first estimate value.

6. The autonomous vehicle according to Claim 1, wherein the controller is configured to correct the estimated self position that is based on the second estimate value so that the corrected estimated self position falls within a first estimate range obtained as a result of the estimation of a self position by the first estimator.

7. The autonomous vehicle according to Claim 1, wherein the controller is configured to set the first estimate value as the self position at a predetermined interval.

8. The autonomous vehicle according to Claim 1, wherein the first estimator is configured to calculate the first estimate value after every predetermined number of times of the calculating of a second estimate value.

9. The autonomous vehicle according to Claim 1, wherein the controller is configured to determine, for each region in map information, whether or not the calculating of a first estimate value is necessary.

10. The autonomous vehicle according to Claim 1, wherein the controller is configured to determine whether or not the calculating of a first estimate value is necessary according to time of day.

11. The autonomous vehicle according to Claim 1, wherein the controller is configured to determine whether or not the calculating of a first estimate value is necessary according to a type of a package being carried by the autonomous vehicle.

12. The autonomous vehicle according to Claim 1, wherein the second estimator is configured to change, for each region in map information, a length of a line segment for use in the calculating of a second estimate value.

13. The autonomous vehicle according to Claim 1, wherein the second estimator is configured to change, depending on a result of the estimation by the first estimator, a length of a line segment for use in the calculating of a second estimate value.

14. The autonomous vehicle according to Claim 1, wherein the first sensor includes: a third sensor which obtains the environmental information to be used by the first estimator; and a fourth sensor which obtains the environmental information to be used by the second estimator.

CLAIMS

[Claim 1]

An autonomous vehicle comprising:

- 5 a first sensor which obtains environmental information on surrounding environment of the autonomous vehicle; and
 a control unit configured to control a drive unit based on a self position,

wherein the control unit includes:

- 10 a first estimation unit configured to calculate a first estimate value indicating an estimated self position, by estimation using a probabilistic method based on the environmental information; and

- a second estimation unit configured to calculate a
15 second estimate value indicating an estimated self position, by estimation using a matching method based on the environmental information, and

- the control unit is configured to: change, according to the first estimate value, a second estimate range for the calculating
20 of the second estimate value by the second estimation unit; and

 control the drive unit using the second estimate value as the self position.

[Claim 2]

- 25 The autonomous vehicle according to Claim 1,

 wherein the first estimation unit is configured to estimate a self position using the probabilistic method which involves a particle filter, and

- the second estimation unit is configured to estimate a self
30 position using the matching method which involves line matching.

[Claim 3]

The autonomous vehicle according to Claim 1 or Claim 2,

- wherein the control unit is configured to reduce the second
35 estimate range when a first estimate range included in the first

estimate value is smaller than a first threshold value, and expand the second estimate range when the first estimate range is larger than a second threshold value.

5 **[Claim 4]**

The autonomous vehicle according to any one of Claims 1 to 3,
 wherein when a difference between the first estimate value
and the second estimate value is larger than a third threshold value,
the control unit is configured to control the drive unit using the self
10 position that is based on the first estimate value.

[Claim 5]

The autonomous vehicle according to any one of Claims 1 to 4,
further comprising

15 a notification unit configured to give a notification of an error
when a difference between the first estimate value and the second
estimate value is larger than a fourth threshold value.

[Claim 6]

20 The autonomous vehicle according to any one of Claims 1 to 5,
 wherein when a difference between the first estimate value
and the second estimate value is larger than a fifth threshold value,
and a matching rate of the second estimation unit is lower than a
sixth threshold value, the control unit is configured to control the
25 drive unit using the self position that is based on the first estimate
value.

[Claim 7]

The autonomous vehicle according to any one of Claims 1 to 6,
30 wherein the control unit is configured to correct the estimated
self position that is based on the second estimate value so that the
corrected estimated self position falls within a first estimate range
obtained as a result of the estimation of a self position by the first
estimation unit.

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[Claim 8]

The autonomous vehicle according to any one of Claims 1 to 7,
wherein the control unit is configured to set the first estimate
value as the self position at a predetermined interval.

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[Claim 9]

The autonomous vehicle according to any one of Claims 1 to 8,
wherein the first estimation unit is configured to calculate the
first estimate value after every predetermined number of times of
the calculating of a second estimate value.

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[Claim 10]

The autonomous vehicle according to any one of Claims 1 to 9,
wherein the control unit is configured to determine, for each
region in map information, whether or not the calculating of a first
estimate value is necessary.

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[Claim 11]

The autonomous vehicle according to any one of Claims 1 to 9,
wherein the control unit is configured to determine whether or
not the calculating of a first estimate value is necessary according to
time of day.

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[Claim 12]

The autonomous vehicle according to any one of Claims 1 to 9,
wherein the control unit is configured to determine whether or
not the calculating of a first estimate value is necessary according to
a type of a package being carried by the autonomous vehicle.

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[Claim 13]

The autonomous vehicle according to any one of Claims 1 to 12,
wherein the second estimation unit is configured to change,
for each region in map information, a length of a line segment for use
in the calculating of a second estimate value.

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35 **[Claim 14]**

The autonomous vehicle according to any one of Claims 1 to 12,
wherein the second estimation unit is configured to change,
depending on a result of the estimation by the first estimation unit,
a length of a line segment for use in the calculating of a second
5 estimate value.

[Claim 15]

The autonomous vehicle according to any one of Claims 1 to 14,
wherein the first sensor includes: a third sensor which obtains
10 the environmental information to be used by the first estimation
unit; and a fourth sensor which obtains the environmental
information to be used by the second estimation unit.

[Claim 16]

15 A method of estimating a self position of an autonomous
vehicle including: a first sensor which obtains environmental
information on surrounding environment of the autonomous vehicle;
and a control unit configured to control a drive unit based on the
environmental information, the method comprising:

20 changing a second estimate range for calculation of a second
estimate value using a matching method, according to a first
estimate value indicating an estimated self position calculated using
a probabilistic method; and

controlling the drive unit using, as the self position, the second
25 estimate value calculated within the second estimate range after
being changed.