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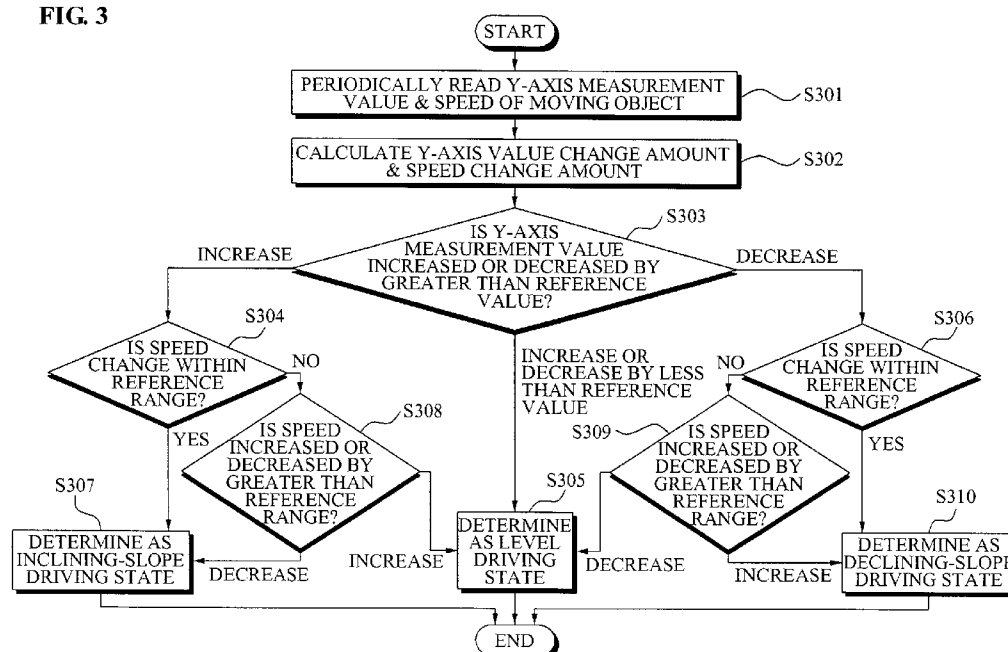
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FIG. 3



(57) Abstract: An apparatus and method of determining a driving state of a moving object using a gravity value sensor and a speed measurement device is provided. Specifically, disclosed is an apparatus and method that can determine whether a moving object is in a level driving state or in an inclining/declining-slope driving state using a Y-axis measurement value of an acceleration sensor and a speed of a speed measurement unit.

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**APPARATUS AND METHOD FOR DECIDING TRAVEL CONDITION OF
VEHICLE**

Technical Field

5 The present invention relates to a navigation system, and more particularly, to a method and apparatus for determining whether a vehicle is inclined using an acceleration sensor and a speed of a moving object in order to determine whether the moving object is in a level driving state or in an inclining/declining-slope driving state, that is, whether the vehicle is inclined.

10

Background Art

 Generally, a navigation system is a system which provides information for driving of a transportation device, such as a vehicle, using an artificial satellite. The navigation system is also referred to as an automatic navigation system.

15 A typical navigation system is configured into one terminal and includes a storage medium to store map data. Also, the navigation system includes a Global Positioning System (GPS) receiver to receive GPS signals.

 The navigation system calculates a location of a vehicle, and informs a user of a current location of the vehicle based on the calculated location of the vehicle. Also,
20 the navigation system routes an optimal path from the current location to the user's desired destination and guides the user to the desired location, providing the user with various types of associated information along the path.

 A method of calculating a location of a vehicle receives location data from a GPS satellite using a GPS receiver, and calculates the current location of the vehicle
25 based on the received location data.

 Another method of calculating a location of a vehicle calculates the current location of the vehicle using a gyro sensor and an acceleration sensor, which are installed in the vehicle. In this instance, the other method receives GPS signals, calculates the current location of the vehicle based on the received GPS signals, and
30 corrects the calculated current location based on results detected by the gyro sensor and the acceleration sensor.

 Also, a slope value of a sensor is determined using the acceleration sensor and

an inclination of a vehicle is determined based on the determined slope value. For this, the acceleration sensor is vertically mounted in a front/side/bottom surface of a vehicle. The condition that an output value of the acceleration sensor is set as an initial value is required when a vehicle is in a horizontal state.

5 Specifically, in order to determine whether the vehicle is currently inclined using a three-axis acceleration sensor installed in the vehicle, or embedded in a PND-typed terminal installed in the vehicle, the inclination of the vehicle may be determined using a value of a Y axis near to a travel direction of the vehicle and a value of a Z axis vertical to the ground.

10 In this instance, when a front portion of the vehicle goes up, that is, when the vehicle is in the inclining-slope driving state, gravity acting on the Y axis may increase to thereby increase a measurement value. Conversely, when the front portion of the vehicle goes down, that is, when the vehicle is in the declining-slope driving state, the measurement value of the Y axis may be decreased. In both cases where the front
15 portion of the vehicle goes up and where the front portion of the vehicle goes down, the Z axis may be decreased.

 In the conventional art, when the vehicle is being driven, the value of the Y axis may be measured by adding the force by the gravity and the force by acceleration/deceleration. Therefore, an inclination level cannot be measured using
20 only the measurement value.

 If it is possible to separate a measurement value by the gravity and a measurement value by the acceleration/deceleration, the inclination level may be measured using only the measurement value by the gravity. However, it is impossible to separate the above two forces from each other.

25 Accordingly, proposed is a method that can more accurately determine a driving state of a vehicle using an acceleration sensor value and a current speed.

Disclosure of Invention

Technical Goals

30 An aspect of the present invention provides a method that can more accurately determine a driving state of a vehicle using both a measurement value of an acceleration sensor and a speed change value of the vehicle by considering that the force applied by

acceleration/deceleration barely exists or is insignificant when the speed of the vehicle barely changes in the declining /inclining-slope driving state.

Other purposes and advantages of the invention will be described in the following description and be understood from embodiments of the invention. Also,
5 the purposes and advantages of the invention may be realized by constituent elements disclosed in claims and combinations thereof.

Technical solutions

According to an aspect of the present invention, there is provided an apparatus
10 for determining a driving state of a moving object, the apparatus including: a gravity value sensor to sense a value of gravity acting on the moving object; a speed measurement unit to measure a speed of the moving object; and a driving state decision unit to determine whether the moving object is in a level driving state or in an inclining/declining-slope driving state, based on the gravity value and the speed.

15 According to another aspect of the present invention, there is provided a method of determining a driving state of a moving object, the method including: reading an output value of an acceleration sensor that senses a value of gravity acting on the moving object; reading a speed of the moving object from a speed measurement unit; and determining whether the moving object is in a level driving state or in an
20 inclining/declining-slope driving state based on the output value and the speed.

Advantageous Effect

According to the present invention, there is provided a new method of determining a driving state of a moving object that can determine whether a moving
25 object is in an inclining/declining-slope driving state, etc., using a Y axis measurement value of an acceleration sensor and a speed of the moving object.

Also, according to the present invention, there is provided a method of determining a driving state of a moving object that can overcome the disadvantage of the conventional art where it is difficult to accurately measure a driving state of a
30 moving object since a measurement value by the gravity and the force by acceleration/deceleration are reflected in a measurement value of an acceleration sensor, and also can minimize the effect of acceleration values, excluding a value by the gravity,

on the moving object in a region where the force by acceleration/deceleration barely affects, to thereby more accurately determine the driving state of the moving object.

Brief Description of Drawings

5 FIG. 1 is a block diagram illustrating an apparatus for determining a driving state of a moving object using a sensor and a speed measurement device according to an embodiment of the present invention;

 FIG. 2 is a block diagram illustrating an apparatus for determining a driving state of a moving object using a sensor and a speed measurement device according to
10 another embodiment of the present invention;

 FIG. 3 is a flowchart illustrating a method of determining a driving state of a moving object using a sensor and a speed measurement device according to an embodiment of the present invention;

 FIG. 4 is a graph illustrating a speed change of a moving object over time and a
15 Y axis measurement value change of a sensor over time according to an embodiment of the present invention; and

 FIG. 5 is a graph illustrating a speed change of a moving object over time and a Y axis measurement value change of a sensor over time and the average change thereof according to an embodiment of the present invention.

20

Best Mode for Carrying Out the Invention

Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below
25 in order to explain the present invention by referring to the figures.

 FIG. 1 is a block diagram illustrating an apparatus for determining a driving state of a moving object using a sensor and a speed measurement device according to an embodiment of the present invention, and FIG. 2 is a block diagram illustrating an apparatus for determining a driving state of a moving object using a sensor and a speed
30 measurement device according to another embodiment of the present invention.

 The apparatus for determining the driving state of the moving object will be described in detail with reference to FIG. 1.

The apparatus may include a gravity value sensor 20 to sense a value of gravity acting on the moving object. A device such as a three-axis acceleration sensor installed in the vehicle, or embedded in a PND-typed terminal installed in the vehicle may be used for the gravity value sensor 20. The three-axis acceleration sensor may measure acceleration values at X, Y, and Z axes with respect to the moving object. The three-axis acceleration sensor may match the X axis with respect to left/right direction of the moving object, match the Y axis with respect to a travel direction of the moving object, and match the Z axis with respect to an up/down direction of the moving object. In particular, according to an aspect of the present invention, a measurement value of the Y axis among X, Y, and Z axes may be used to determine the driving state of the moving object. In this instance, since a measurement value of the acceleration sensor 20 is output in an analog signal, a decision unit 40 may convert the measurement value into a digital signal. For this, a signal processing unit 30 is further included to receive the Y axis measurement value of the acceleration sensor 20, convert the same to the digital signal of an identifiable range, and then transfer the converted Y axis measurement value to the decision unit 40. The signal processing unit 30 may be constructed as an analog-to-digital (A/D) converter.

Also, according to an aspect of the present invention, the apparatus may include a speed measurement unit 10 to measure a speed of the moving object. The speed measurement unit 10 may use a speed measured by a Global Positioning System (GPS). The speed measured in the GPS is a speed about one second in the past due to principles of the GPS and thus an output of the currently measured GPS may be identified as the speed of the moving object about one second in the past.

Also, according to an aspect of the present invention, the apparatus may include the decision unit 40 to determine whether the moving object is currently in a level driving state or in an inclining/declining-slope driving state using the measured speed and the Y axis measurement value. The decision unit 40 may further include: a speed change amount decision unit 41 to calculate a speed change amount that the measured speed is changed for a predetermined reference time; a Y-axis value change amount decision unit 42 to calculate a Y-axis value change amount that the sensed Y-axis measurement value is changed for a time corresponding to the reference time; and a driving state decision unit 43 to determine whether the moving object is in the level

driving state, or in the inclining/declining-slope driving state, based on the speed change amount and the Y-axis value change amount.

The apparatus of FIG. 2 is constructed similar to the apparatus of FIG. 1, but in FIG. 2, the driving state of the moving object is determined based on a speed change rate and a Y axis value change rate, instead of a speed change amount and a Y axis value change amount. In FIG. 2, the decision unit 40 may include a speed change rate decision unit 44 and a Y-axis value change rate decision unit 45.

In order to determine the driving state of the moving object based on the speed change rate and the Y-axis value change rate, when a period of receiving a speed and a Y axis measurement axis changes, a reference value for comparing a change amount of the speed and a change amount of the Y-axis value needs to be changed in FIG. 1. Unlike this, in FIG. 2, although the period changes, the reference value for comparing the change rate may be uniformly maintained and thus the efficiency may be enhanced.

FIG. 3 is a flowchart illustrating a method of determining a driving state of a moving object using a sensor and a speed measurement device according to an embodiment of the present invention.

In operation S301, an apparatus for determining the driving state of the moving object may periodically read a Y-axis measurement value from the gravity value sensor 20, that is, the three-axis acceleration sensor and a speed from the speed measurement unit 10. A change of the speed and the Y-axis measurement value needs to be used in order to measure the driving state of the moving object. Therefore, in operation S302, the apparatus may calculate a Y-axis value change amount that the Y-axis measurement value is changed for a predetermined reference time and a speed change amount that the speed is changed for a time corresponding to the reference time. The change amount of the Y-axis measurement value may be calculated by subtracting the Y-axis measurement value in time t_0 from the Y-axis measurement value in time t_1 where $t_1 > t_0$. In this case, when the Y-axis measurement value is increased, the value may be determined as a positive value. Conversely, when the Y-axis measurement value is decreased, the value may be determined as a negative value. The change amount may be calculated in real time. Whether the change amount is increased or decreased by greater than a predetermined reference value is continuously checked.

In operation S303, the apparatus may determine whether the Y-axis

measurement value is increased or decreased by greater than the set reference value based on a difference with the reference value. For example, when determining, as an increase or decrease in the Y-axis measurement value, a case where the change amount of the Y-axis measurement value for a unit time (e.g., one hour) is greater than the reference value (e.g., 15), it may be determined whether a value obtained by subtracting the reference value 15 from the Y-axis change amount is greater than 0. In this instance, when the Y-axis change amount calculated in operation S302 is a positive value and the value obtained by subtracting the reference value 15 from the Y-axis change amount is greater than 0, it may be determined the Y-axis measurement value is increased by greater than the reference value. Conversely, when the Y-axis change amount is a negative value and the value obtained by subtracting the reference value 15 from the absolute value of the Y-axis change amount is greater than 0, it may be determined the Y-axis measured value is decreased by greater than the reference value. If the Y-axis change amount is within 15, it may be determined the output value of the Y-axis is barely changed. Thus, the decision unit 40 may determine the moving object is in the level driving state in operation S305.

When it is determined the Y-axis measurement value is increased in operation S303, the driving state may be changed depending on a speed change. Thus, in operation S304, it may be checked whether the speed change is within a reference range. When the speed change is within the reference range, it corresponds to a case where the Y-axis measurement value is increased but the speed is barely changed. Thus, it may be determined the driving state of the moving object is in the inclining-slope driving state in operation S307. Conversely, when the speed change is outside the reference range, it may be determined whether the speed is increased or decreased by greater than the reference range in operation S308. In this instance, when the speed is increased by greater than the reference range, it corresponds to a case where both the Y-axis measurement value and the speed are increased. Thus, it may be determined the driving state of the moving object is in the level driving state in operation S305. Conversely, when the speed is decreased by greater than the reference range, it corresponds to a case where the Y-axis measurement value is increased but the speed is decreased. Thus, it may be determined the moving object is in the inclining-slope driving state in operation S307. In this instance, like operation S303, when

determining whether the speed is increased or decreased by greater than the reference range, it may be determined whether a value obtained by subtracting the reference range from the speed change is greater than 0. When the value is greater than 0, it may be determined the speed is increased or decreased by greater than the reference value. As
5 described above in operation S303, the speed change may be a negative value. Thus, in the case of decrease, whether the value obtained by subtracting the reference value from the absolute value of the speed change is greater than 0 may be determined.

Also, when it is determined the Y-axis measurement value is decreased in operation S303, it may be checked whether the speed is within the reference range in
10 operation S306. When the speed change is within the reference range, it corresponds to a case where the Y-axis measurement value is decreased but the speed is barely changed. Therefore, it may be determined the moving object is in the declining-slope driving state in operation S310. Conversely, when the speed change is outside the reference range, it may be determined whether the speed is increased or decreased by
15 greater than the reference range in operation S309. In this instance, when the speed is decreased by greater than the reference range, it may correspond to a case where both the Y-axis measurement value and the speed are decreased. Thus, it may be determined the moving object is in the level driving state in operation S305. Conversely, when the speed is increased by greater than the reference range, it
20 corresponds to a case where the Y-axis measurement value is decreased but the speed is increased. Thus, it may be determine the moving object is in the declining-slope driving state in operation S310.

The embodiments above-described with respect to FIGS. 1 to 3 correspond to an example of an apparatus for determining a driving state of a moving object using an
25 acceleration sensor and a speed measurement unit. The apparatus is provided for better comprehension and ease of description and thus the present invention is not limited thereto. Specifically, it will be apparent to those skilled in the art that various modifications and changes may be made from the description.

FIG. 4 is a graph illustrating a change of a Y-axis measurement value over time and a change of a GPS speed over time over time in an actual inclining-scope driving
30 state according to an embodiment of the present invention.

Hereinafter, a method of determining a driving state of a moving object will be

described in detail with reference to FIG. 4. Herein, it is assumed that when a change amount measured for a reference time 1 is greater than a reference value 15, it is determined a Y-axis measurement value is increased or decreased. The above values may be changed to appropriate values.

5 In FIG. 4, in a dotted square section is from time 73740 to 73741 in association with the Y-axis measurement value, and the change amount that the Y-axis measurement value is changed for one hour is 18. Specifically, the change amount 18 is greater than the reference value 15 and thus it is determined the Y-axis measurement value is increased by greater than the reference value. In this instance, a speed change amount
10 needs to be determined. Due to characteristics of a GPS, a speed about one second in the past is detected as a current output value. Thus, a section from time 73741 to time 73742 is a time corresponding to a time where the Y-axis change amount is calculated. Thus, the speed change of the GPS is -30 and the absolute value thereof is within a reference range (e.g., 70). It corresponds to a case where the Y-axis measurement
15 value is increased but the speed is barely changed. Thus, it may be determined the moving object is in the inclining-slope driving state.

In FIG. 5, rawY denotes a Y-axis measurement value and avgY denotes the average of ten Y values. -25 was the change amount of the Y-axis measurement value measured for a period of time from time 52519 to time 52522. The absolute value
20 thereof is 25 which is greater than the reference value 15. Therefore, it is determined the Y-axis measurement value is decreased by greater than the reference value. Thus, the speed change amount is measured, as 80, for a time corresponding to the above period of time, which is greater than the reference range (e.g., 70). It corresponds to a case where the Y-axis measurement value is decreased and the speed of the moving
25 object is increased by greater than the reference range. Thus, it may be determined the moving object is in the declining-slope driving state.

According to the above-described method, it is possible to more accurately determine whether the moving object is in the level driving state, or in the inclining/declining-slope driving state.

30 The exemplary embodiments of the present invention include computer-readable media including program instructions to implement various operations embodied by a computer. The media may also include, alone or in combination with the program

instructions, data files, data structures, tables, and the like. The media and program instructions may be those specially designed and constructed for the purposes of the present invention, or they may be of the kind well known and available to those having skill in the computer software arts. Examples of computer-readable media include
5 magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD ROM disks; magneto-optical media such as floptical disks; and hardware devices that are specially configured to store and perform program instructions, such as read-only memory devices (ROM) and random access memory (RAM). Examples of
program instructions include both machine code, such as produced by a compiler, and
10 files containing higher level code that may be executed by the computer using an interpreter.

Although a few embodiments of the present invention have been shown and described, the present invention is not limited to the described embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to these
15 embodiments without departing from the principles and spirit of the invention, the scope of which is defined by the claims and their equivalents.

CLAIMS

1. An apparatus for determining a driving state of a moving object, the apparatus comprising:
 - a gravity value sensor to sense a value of gravity acting on the moving object;
 - 5 a speed measurement unit to measure a speed of the moving object; and
 - a driving state decision unit to determine whether the moving object is in a level driving state or in an inclining/declining-slope driving state, based on the gravity value and the speed.
- 10 2. The apparatus of claim 1, wherein:
 - the gravity value sensor comprises an acceleration sensor, and
 - the acceleration sensor periodically senses a Y-axis measurement value that is obtained by matching a sensor axis of the acceleration sensor with a travel direction of the moving object.
- 15 3. The apparatus of claim 2, wherein the driving state decision unit comprises:
 - a speed change amount decision unit to calculate a speed change amount that the measured speed is changed for a predetermined reference time;
 - a Y-axis value change amount decision unit to calculate a Y-axis value change
 - 20 amount that the sensed Y-axis measurement value is changed for a time corresponding to the reference time; and
 - a driving state decision unit to determine whether the moving object is in the level driving state, or in the inclining/declining-slope driving state, based on the speed change amount and the Y-axis value change amount.
- 25 4. The apparatus of claim 3, wherein, when the Y-axis measurement value increases by greater than a predetermined reference value and the speed change amount is within a reference range, the driving state decision unit determines the moving object is in the inclining-slope driving state.
- 30 5. The apparatus of claim 3, wherein, when the Y-axis measurement value decreases by greater than a predetermined reference value and the speed change amount

is within a reference range, the driving state decision unit determines the moving object is in the declining-slope driving state.

6. The apparatus of claim 3, wherein:

5 when the Y-axis measurement value increases by greater than a predetermined reference value and the speed change amount decreases beyond a reference range, the driving state decision unit determines the moving object is in the inclining-slope driving state, and

10 when the Y-axis measurement value decreases by greater than the predetermined reference value and the speed change amount increases beyond the reference range, the driving state decision unit determines the moving object is in the declining-slope driving state.

7. The apparatus of claim 2, wherein the driving state decision unit comprises:

15 a speed change rate decision unit to calculate a speed change rate that the measured speed is changed for a predetermined reference time;

a Y-axis value change rate decision unit to calculate a Y-axis value change rate that the sensed Y-axis measurement value is changed for a time corresponding to the reference time; and

20 a driving state decision unit to determine whether the moving object is in the level driving state, or in the inclining/declining-slope driving state, based on the speed change rate and the Y-axis value change rate.

8. The apparatus of claim 7, wherein, when the Y-axis value change rate is a
25 positive value and is greater than a predetermined reference value, and when the speed change rate is within a reference range, the driving state decision unit determines the moving object is in the inclining-slope driving state.

9. The apparatus of claim 7, wherein, when the Y-axis value change rate is a
30 negative value and an absolute value thereof is greater than a predetermined reference value, and when the speed change rate is within a reference range, the driving state decision unit determines the moving object is in the declining-slope driving state.

10. The apparatus of claim 7, wherein:
when the Y-axis value change rate is a positive value and is greater than a predetermined reference value, and when the speed change rate decreases beyond a reference range, the driving state decision unit determines the moving object is in the inclining-slope driving state, and
when the Y-axis value change rate is a negative value and an absolute value thereof is greater than the predetermined reference value, and when the speed change rate increases beyond the reference range, the driving state decision unit determines the moving object is in the declining-slope driving state.
11. The apparatus of claim 1, further comprising:
a signal processing unit including an analog-to-digital (A/D) converter to convert an output signal of the gravity value sensor to a digital signal belonging to an identifiable range of the driving state decision unit.
12. The apparatus of claim 1, wherein the speed measurement unit comprises a Global Positioning System (GPS).
13. A method of determining a driving state of a moving object, the method comprising:
reading an output value of an acceleration sensor that senses a value of gravity acting on the moving object;
reading a speed of the moving object from a speed measurement unit; and
determining whether the moving object is in a level driving state or in an inclining/declining-slope driving state based on the output value and the speed.
14. The method of claim 13, wherein the reading of the output value periodically reads an output value of Y-axis corresponding to an acceleration sensor axis matching a travel direction of the moving object.
15. The method of claim 14, wherein the determining comprises:

calculating a Y-axis value change rate that the Y-axis value is changed for a predetermined reference time and a speed change rate that the speed is changed for a time corresponding to the reference time; and

5 determining whether the moving object is in the level driving state, or in the inclining/declining-slope driving state based on the speed change rate and the Y-axis value change rate.

16. The method of claim 15, wherein when the Y-axis value change rate is a positive value and is greater than a predetermined reference value, and when the speed change rate is within a reference range, the determining determines the moving object is in the inclining-slope driving state.

17. The method of claim 15, wherein when the Y-axis value change rate is a negative value and an absolute value thereof is greater than a predetermined reference value, and when the speed change rate is within a reference range, the determining determines the moving object is in the declining-slope driving state.

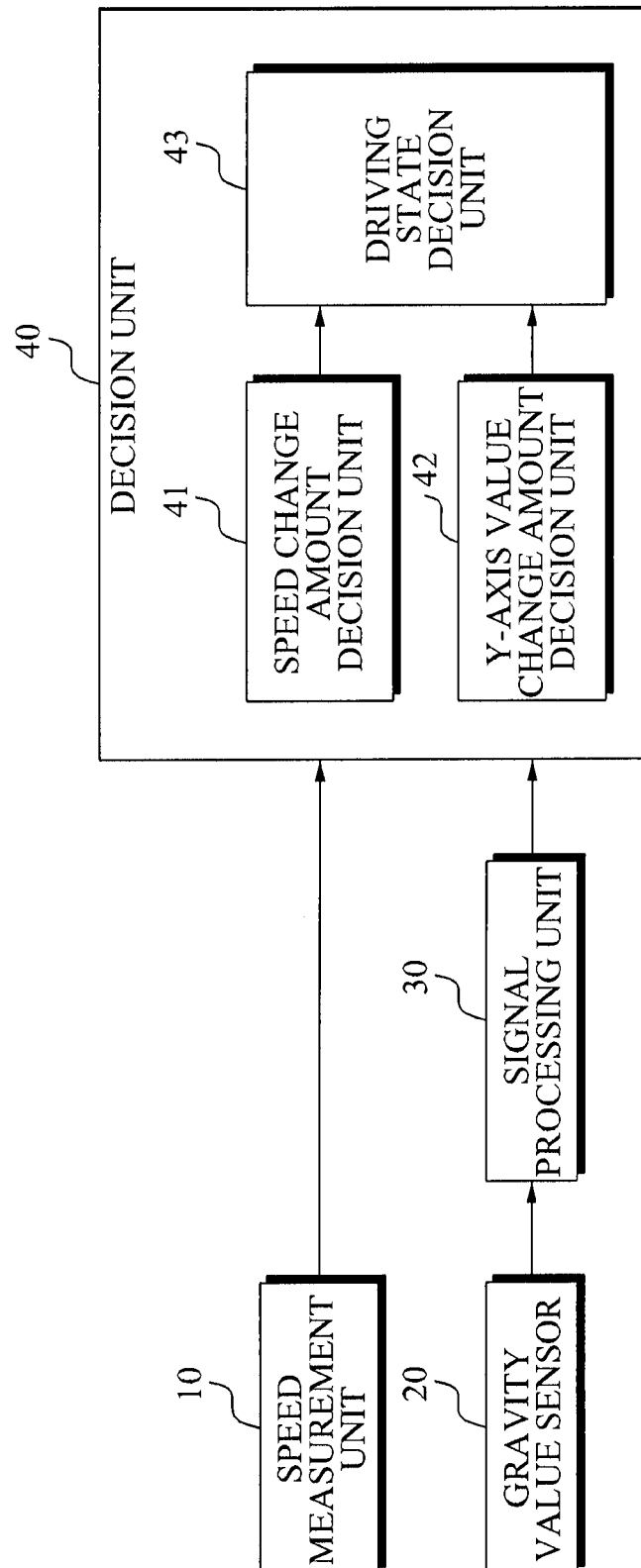
18. The method of claim 15, wherein:
when the Y-axis value change rate is a positive value and is greater than a predetermined reference value, and when the speed change rate decreases beyond a reference range, the determining determines the moving object is in the inclining-slope driving state, and

when the Y-axis value change rate is a negative value and an absolute value thereof is greater than the predetermined reference value, and when the speed change rate increases beyond the reference range, the determining determines the moving object is in the declining-slope driving state.

19. A computer-readable recording medium storing a program form implementing the method according to any one of claims 13 through 18.

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FIG. 1



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FIG. 2

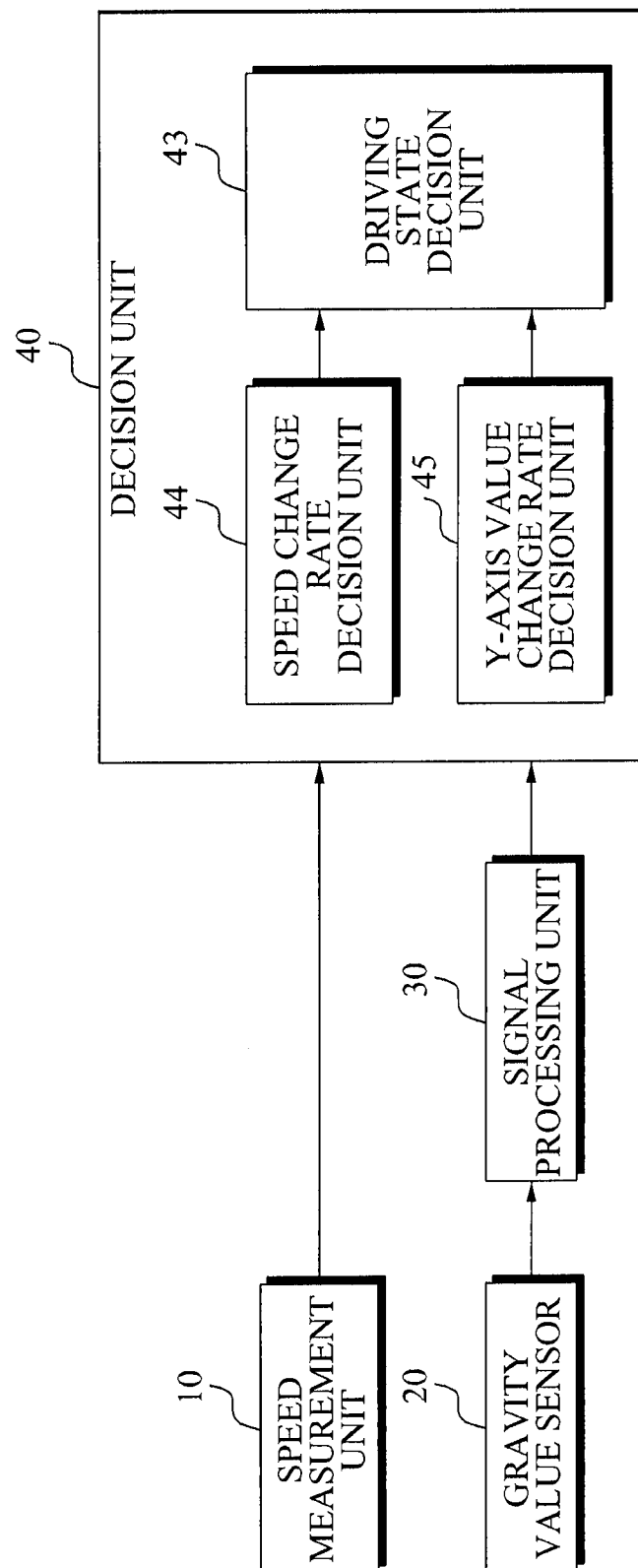


FIG. 3

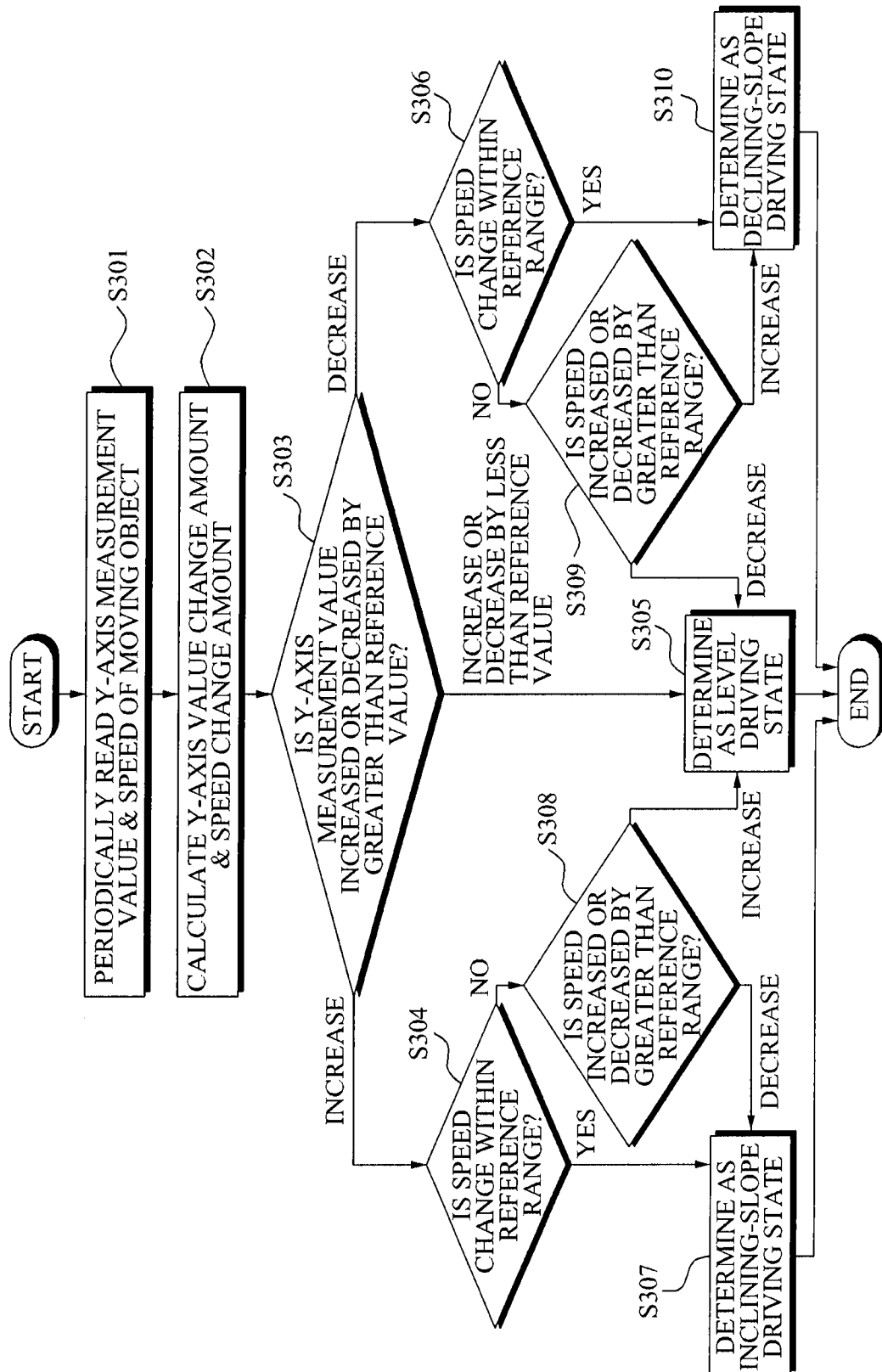
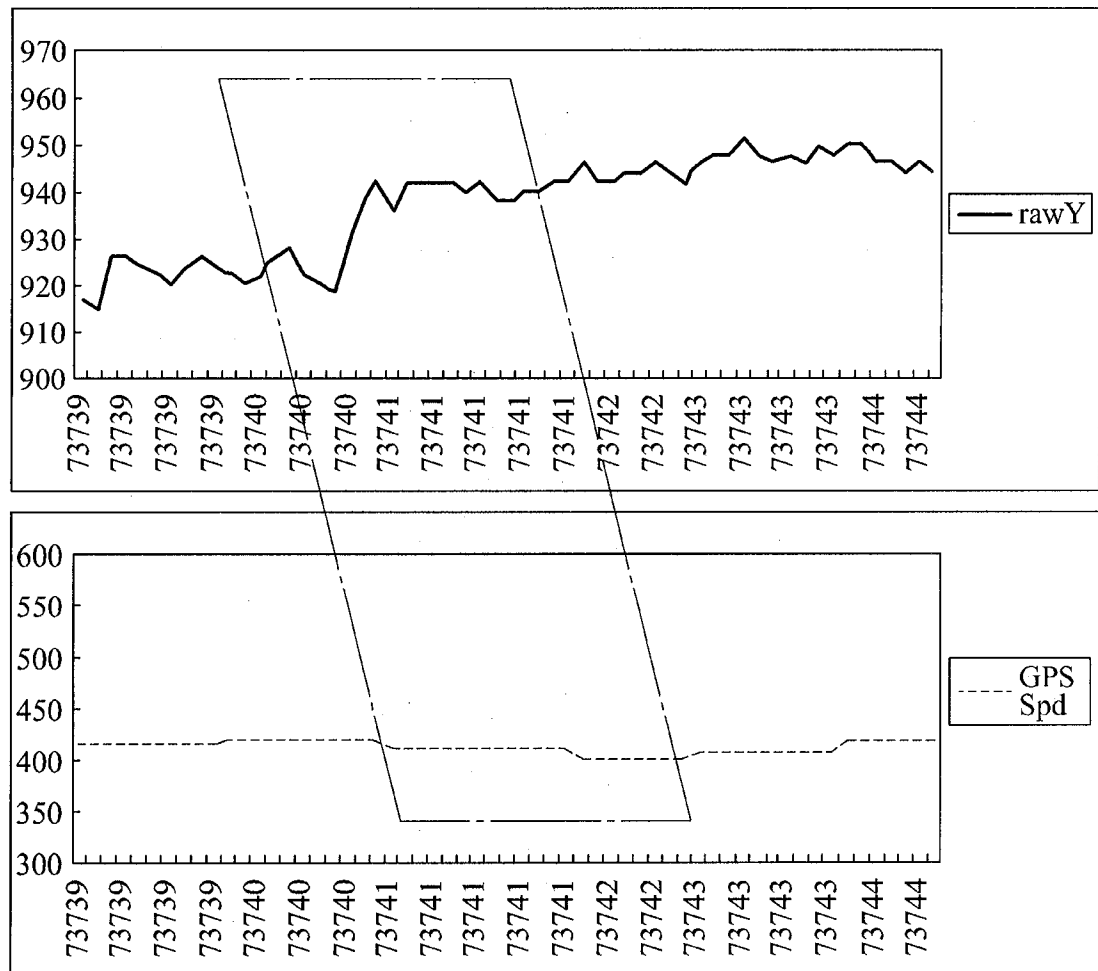
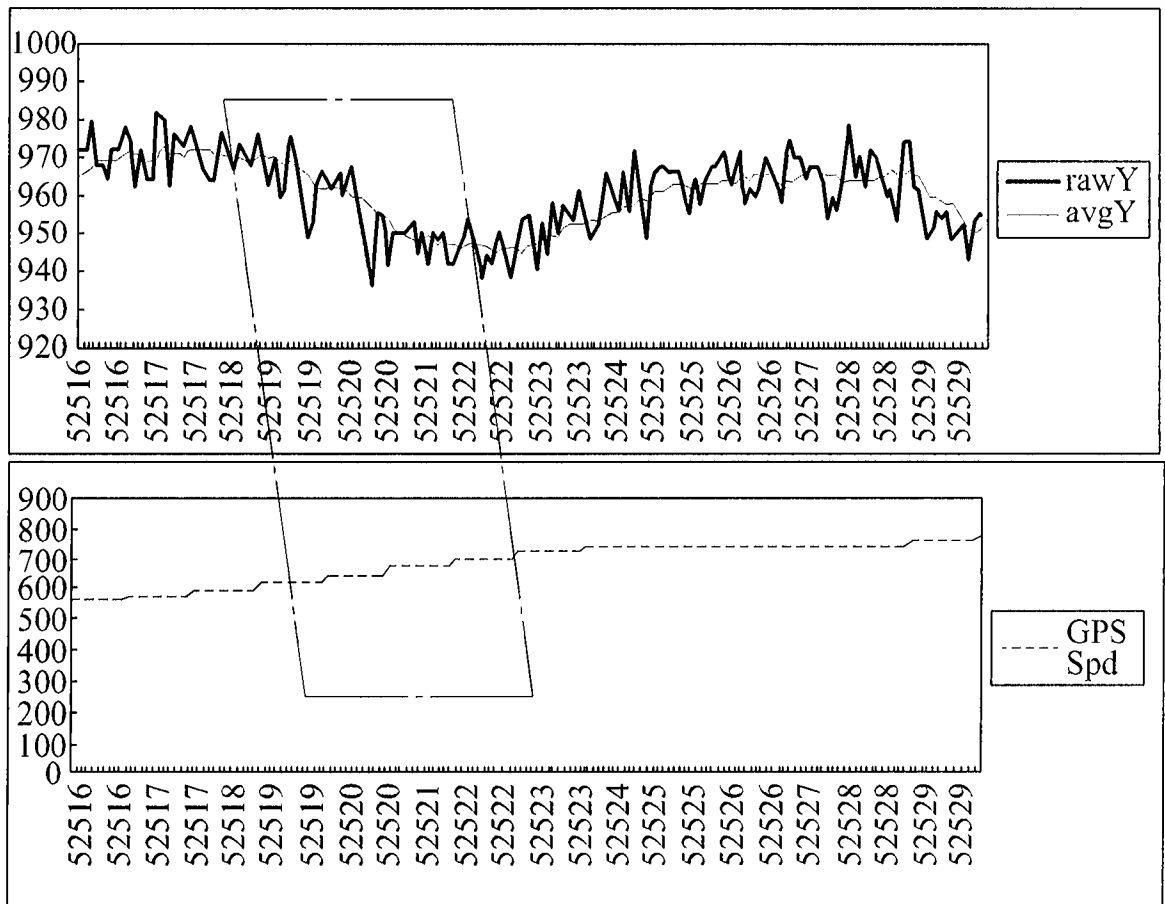


FIG. 4



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FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/003774**A. CLASSIFICATION OF SUBJECT MATTER****G01C 21/10(2006.01)i**

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)

IPC 8: G01C, G06F, G08G, G09B, G01P

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

Korean utility models and applications for utility models since 1975
Japanese utility models and applications for utility models since 1975Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internet) & Keywords: "gravity", "speed", "velocity", "rate", "GPS", "pitch", and "altitude"**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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19 DECEMBER 2008 (19.12.2008)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/003774

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