

## SPECIFICATION

Title of the invention

Vehicle behavior analysis device, vehicle behavior analysis program and drive recorder

Technical field

[0001]

The present invention relates to a vehicle behavior analysis device, a vehicle behavior analysis program, or the like that is preferably adapted to record behavior, surrounding situations, and the like of a vehicle at the time of the occurrence of an accident or in the case of a close call that does not result in an accident but could result in an accident, and perform an analysis or the like of a cause resulting in such a situation after the fact.

Background art

[0002]

In recent years, as a vehicle behavior data collecting device, for example, there has been developed a vehicle-mounted drive recorder that is adapted to automatically record video of the outside or inside of a vehicle during driving, and make an ex-post analysis of an objective situation at the time of an accident, close call, or the like, and therefore a driving tendency of a driver. For example, in a taxi or the like, for accident preventive measures by an ex-post analysis of daily driving, or in the case of the occurrence of an accident, for objective evidence, investigation, or the like of a cause of the accident, a movement to mount this sort of drive recorder has also appeared.

[0003]

Specifically, such a vehicle behavior data collecting device successively records situation data including, for example, internal and external image data, acceleration data, velocity data, position data, and the like acquired during moving in a memory sequentially in chronological order. Also, the vehicle behavior data collecting device is configured to be able to make an objective analysis of an accident or the like by, after the fact, referring to the pieces of situation data in the memory with another device (see Patent literature 1).

[0004]

However, in the case of, after the fact, attempting to analyze the pieces of situation data recorded in this manner, such pieces of situation data include situation data indicating various types of behavior in addition to specific vehicle behavior such as a close call, and therefore the number of pieces of collected situation data should be classified to extract situation data indicating desired vehicle behavior.

[0005]

In the conventional method, work of visually checking the number of pieces of collected situation data one by one to classify the pieces of situation data into, for example, a crash, a close call, sudden braking irrelevant to the close call, simple noise, and the like is done.

[0006]

However, the work of visually checking the pieces of situation data one by one to make the classification has some problems of not only too much working time to check one of the pieces of situation data but difficulty to accurately make the classification on the basis of user's arbitrary

determination. Also, there is a problem that physical and mental loads placed on a user are large.

[0007]

On the other hand, as disclosed in Patent literature 2, a device that, in order to reduce a load on a user, automatically classifies pieces of situation data into pieces of situation data caused by noise and pieces of situation data used for an analysis of behavior such as a close call is considered.

Specifically, this device is configured to, on the basis of a wave height and pulse width of a waveform of acceleration data, eliminate the pieces of unnecessary situation data caused by noise.

[0008]

However, as with the above device, a device that uses threshold values to discriminate the pieces of unnecessary situation data caused by noise and the pieces of situation data used for an analysis of behavior such as a close call from each other has a problem that, depending on how to set the threshold values, classification accuracy largely varies. Also, even if the pieces of data caused by noise can be eliminated with use of the threshold values, the pieces of remaining situation data should be visually checked and classified one by one.

[0009]

For example, if a level of the threshold values is set lower, the number of close call case candidates extracted from all pieces of situation data increases; however, a hitting ratio of a close call case in pieces of extracted data decreases, and a ratio of unnecessary data included increases. On the other hand, if the level of the threshold values is set higher, the

number of close call case candidates extracted from the all pieces of situation data decreases; however, the hitting ratio of a close call case in the pieces of extracted data increases, and the ratio of unnecessary data included decreases. However, in this case, an omission ratio of a close call case increases. That is, in the method that uses the threshold values to make the separation in a standardized manner, there is a trade-off between the hitting ratio and the omission ratio. Also, even if the level of the threshold values is set higher to increase the hitting ratio, the hitting ratio is considerably low as compared with the case of the visual classification, and therefore not practical. Accordingly, the current situation is that, in order to accurately make the classification into the close call case from pieces of situation data, the visual work is still necessary.

#### Citation List

##### Patent Literature

[0010]

Patent literature 1: JPA 2007-11909

Patent literature 2: Japanese patent No. 4238293

##### Summary of Invention

##### Technical Problem

[0011]

Therefore, the present invention is made for the first time by, as a result of intensive examination by the present inventors, focusing on the fact that for every behavior of a vehicle, there is a specific relative relationship among feature quantities of respective pieces of acceleration data, and a main intended object thereof is to, without only visually classifying vehicle

behavior indicated by situation data, automatically and highly reliably specify the vehicle behavior indicated by the situation data.

Solution to Problem

[0012]

That is, a vehicle behavior analysis device according to the present invention is provided with: a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.

[0013]

If so, the feature quantities of the respective pieces of acceleration data or the feature quantities of the respective pieces of angular acceleration data can be used to specify the vehicle behavior on the basis of the relative relationship among them, and therefore without depending on a visual check,

the vehicle behavior indicated by the situation data can be specified. This enables, in addition to being able to eliminate user's arbitrary determination to objectively specify the vehicle behavior, temporal, physical, and mental loads on a user to be reduced. Also, the vehicle behavior can be specified on the basis of the relative relationship among the feature quantities of the respective pieces of acceleration data or the feature quantities of the respective pieces of angular acceleration data, and therefore as compared with a vehicle behavior analysis device that makes a determination only with a threshold value, a highly reliable specified result can be obtained.

[0014]

Specifically, as a result of intensive examination by the present inventors, it has turned out that, in the following three types of vehicle behavior (1) to (3), there are respectively specific relative relationships among the feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration. That is, it is considered that, in the case where the received situation data includes the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration, the vehicle behavior specifying part uses the relative relationship among the feature quantities of the respective acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration to specify the vehicle behavior indicated by the situation data as any of the following (1) to (3):

(1) Close call etc. behavior indicating a crash, a close call that could result in a crash, or other sudden braking,

(2) Running on etc. behavior indicating running of a single wheel on a curb or running of a wheel into a side ditch, and

(3) Bound behavior indicating a bound caused by both wheels passing over unevenness on a road.

[0015]

More specifically, desirably, the vehicle behavior specifying part specifies the vehicle behavior indicated by the situation data as: in the case where the feature quantity of the longitudinal acceleration data is larger than the feature quantities of the lateral acceleration data and the vertical acceleration data, the close call etc. behavior; in the case where the feature quantity of the lateral acceleration data is larger than the feature quantities of the longitudinal acceleration data and the vertical acceleration data, the running on etc. behavior; and in the case where the feature quantity of the vertical acceleration data is larger than the feature quantities of the longitudinal acceleration data and the lateral acceleration data, the bound behavior.

[0016]

In the close call etc. behavior, in order to further subdivide and specify sudden braking irrelevant to a crash and a close call, desirably, the situation data includes blinker data indicating working information on blinkers of the vehicle; and in the case where in the situation data specified as the close call etc. behavior, the blinker data is included, the vehicle behavior specifying part specifies the situation data as behavior indicating sudden braking for pulling over to a shoulder of a road.

[0017]

Also, a vehicle behavior analysis program according to the present invention instructs a computer to be provided with functions as: a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.

[0018]

The above vehicle behavior analysis device is a device that acquires situation data from a drive recorder mounted in a vehicle to analyze the situation data. The functions of the vehicle behavior analysis device may be provided to the drive recorder. That is, a drive recorder according to the present invention is provided with: a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral

acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.

[0019]

If so, when the drive recorder stores situation data in a memory, vehicle behavior indicated by the situation data can be specified, and therefore work of classifying subsequently collected situation data can be made unnecessary or reduced. Also, only specific behavior can be selected and stored in the memory of the drive recorder, and therefore the memory can be efficiently used.

Advantageous Effects of Invention

[0020]

According to the present invention configured as described, without use of a method that visually classifies vehicle behavior indicated by situation data, or uses a threshold value to determine and classify, for example, acceleration data included in the situation data, the vehicle

behavior indicated by the situation data can be automatically and highly reliably specified.

Brief description of the drawings

[0021]

[Fig. 1] Fig. 1 is a diagram schematically illustrating a vehicle behavior analysis system in the present embodiment.

[Fig. 2] Fig. 2 is a diagram illustrating components of a drive recorder in the same embodiment.

[Fig. 3] Fig. 3 is a functional configuration diagram of a vehicle behavior analysis device in the same embodiment.

[Fig. 4] Fig. 4 is a flowchart illustrating operation of the vehicle behavior analysis device in the same embodiment.

[Fig. 5] Fig. 5 is a diagram illustrating a correspondence relationship between vehicle behavior and feature quantities of respective types of acceleration.

Reference Signs List

[0022]

100: Drive recorder

V: Vehicle

200: Vehicle behavior analysis device

201: Situation data receiving part

202: Vehicle behavior specifying part

Description of Embodiments

[0023]

In the following, one embodiment of a vehicle behavior analysis

system according to the present invention is described referring to the drawings.

[0024]

#### <1. System configuration>

A vehicle behavior analysis system according to the present invention is, as illustrated in Fig. 1, provided with: drive recorders 100 each of which images a forward area outside a corresponding one of vehicles V, or performs other operation; and a vehicle behavior analysis device 200 that acquires video data imaged by each of the drive recorders 100 to, on the basis of video shown by the video data, specify whether or not a corresponding one of the vehicles V exhibits predetermined behavior, or performs other operation.

[0025]

#### <2. Drive recorder>

The drive recorder 100 is a vehicle-mounted recorder that is bonded to a windshield, placed near a dashboard, or attached to an appropriate position inside a vehicle to record behavior, surrounding situation, and the like of the vehicle V during a certain period of time before and after the time of the occurrence of an accident, the time of a close call that does not results in the occurrence of an accident but could result in an accident, or another occasion, and has an integrated configuration in which inside a single or a plurality of casings, basic components, i.e., sensing means 3, information processing means 8, informing means 4, input means 5, communication means 6, detachable recording means 7, and the like are contained.

[0026]

The sensing means 3 is means adapted to sense situations such as behavior of a vehicle V and a surrounding situation to output situation data indicating the situations, and here uses at least three types of components, i.e., imaging means 31, an acceleration sensor 32, and a position sensor 33. The imaging means 31 is, for example, a CCD camera that images a vehicle exterior situation in a forward area of the vehicle, and outputs situation data (video data) showing images of the vehicle exterior situation. The acceleration sensor 32 is a sensor that is configured to use, for example, a piezoresistive effect, and senses three-dimensional acceleration acting on the vehicle to output situation data (acceleration data) indicating the acceleration. Specifically, the acceleration sensor 32 is a sensor that senses longitudinal acceleration acting in a longitudinal direction of the vehicle V, lateral acceleration acting in a lateral direction of the vehicle V, and vertical acceleration acting in a vertical direction of the vehicle V. The position sensor 33 is, for example, a GPS receiver that receives radio waves from a plurality of satellites to sense a position of the vehicle V, and outputs situation data (position data) indicating the position. In addition, various types of situation data include, besides, vehicle velocity data transmitted from a vehicle velocity sensor of the vehicle V, door open/close data indicating opening/closing of doors, brake data indicating on/off of brakes, blinker data indicating working information on blinkers of the vehicle, and other data, which are received through a connector CN. Further, the connector CN is also adapted to be used as a connector for power source.

[0027]

The informing means 4 includes: an LED 41 that is a light emitter

exposed on a surface of the casing; sound output bodies (not illustrated) such as a buzzer and a speaker incorporated in the casing; and the like.

[0028]

The input means 5 refers herein to a button switch that is provided on the surface of the casing.

[0029]

The communication means 6 refers herein to communication hardware that is incorporated in the casing and transceives radio waves with a base station or the after-mentioned vehicle behavior analysis device 200, such as a wireless LAN or a mobile phone.

[0030]

The detachable recording means 7 refers herein to, for example, a CF memory card or an SD memory card that is detachably attached to a slot opened laterally to the casing.

[0031]

The information processing means 8 is a so-called computer circuit that structurally has a CPU 81, an internal memory 82 (e.g., nonvolatile memory), an I/O buffer circuit (may include an AD converter and the like) 83, and the like, and incorporated in the casing. Also, the CPU 81 operates according to a program stored in a predetermined area of the memory 82 to thereby control each of the above-described means or perform information processing.

[0032]

To describe simply, the CPU 81 temporarily stores various types of situation data acquired during moving, i.e., acceleration data, position data,

video data, and other data in a temporary area (hereinafter also referred to as a temporary data storage part) set in the memory 82 while constantly continuously updating the various types of situation data, and also if an event indirectly indicating the occurrence of a close call, an accident, abnormality, or the like occurs, transfers the various types of situation data acquired for a certain period of time before and after the event to a regular area (hereinafter also referred to as a regular recording data storage part) in the memory 82 to perform recording.

[0033]

The event corresponds to the case where an acceleration value (deceleration value) indicated by acceleration data exceeds a predetermined reference value, the case where the acceleration value continues for a certain period of time or more, the case where any of doors is opened/closed, the case where electrical power of the vehicle has run out, or another case. The present embodiment is adapted to, depending on an event occurring, only in the case where some of other conditions such as the case where a vehicle velocity value is equal to or more than an upper limit velocity value, the case where the vehicle velocity value is equal to or less than a lower limit velocity value, and the presence or absence of braking collectively hold, use the case as a trigger to perform data recording, and perform useless data recording as little as possible.

[0034]

Also, from the viewpoint of preventing the useless data recording, a learning function is also provided. That is, the present embodiment is adapted to, before performing data recording, use the informing means to

surely inform a driver of whether or not a close call, an accident, or the like has occurred, and receive yes/no input (e.g., on/off of the button switch 5) from the driver. By repeating this, a driving tendency of the driver is grasped to some extent, and for example, by changing the predetermined reference value for an acceleration value, or performing other operation, events specific to the driver, which indirectly indicate an accident and the like, are learned.

[0035]

Further, the various types of recorded situation data are weighted on the basis of a situation at the time of the recording, and classified according to a degree of importance to be recorded. The present embodiment is configured to, in the case where a memory capacity is full, or in another case, delete pieces of situation data in ascending order of the degree of importance, and record new situation data.

[0036]

The various types of regularly recorded situation data in this manner are, in some specific location, transmitted to an analysis center (not illustrated) by wireless, or transferred to and detached in the detachable recording means 7, then carried to the analysis center, and used for ex-post analysis using the vehicle behavior analysis device 200.

[0037]

### <3. Vehicle behavior analysis device>

The vehicle behavior analysis device 200 is a device that classifies a situation data group acquired by the drive recorders 100 mounted in the plurality of vehicles V on a predetermined vehicle behavior basis to support

ex-post analysis. The vehicle behavior analysis device 200 is a general purpose or dedicated computer that is, in terms of a specific device configuration, provided with a CPU, a memory, an input/output interface, an AD converter, and the like, and cooperatively operates the CPU, peripheral devices, and the like according to a vehicle behavior analysis program stored in the predetermined area of the memory to thereby fulfill functions as, as illustrated in Fig. 3, a situation data receiving part 201, a situation data storage part D1, a vehicle behavior specifying part 202, an analyzed data storage part D2, and the like.

[0038]

In the following, the respective parts D1, 201, 202, and D2 are described along with their operation with use of Fig. 4.

[0039]

The situation data receiving part 201 receives situation data including video data and respective pieces of acceleration data stored in the regular recording data storage part of the drive recorder 100, and stores the situation data in the situation data storage part D1 (in Fig. 4, Step S1). The situation data receiving part 201 may be configured to be a receiver that receives the situation data transmitted by the communication means (transmitter) 6 provided in the drive recorder 100 through a wireless LAN or the like, or may be means adapted to acquire the situation data through, for example, a CF card that serves as the detachable recording means 7 provided in the drive recorder 100.

[0040]

The situation data storage part D1 stores and accumulates the

situation data including the video data imaged by the drive recorder 100 and other pieces of data (in Fig. 4, Step S2). In addition, in the present embodiment, the situation data storage part D1 is configured to systematically store a plurality of pieces of situation data acquired by the plurality of vehicles V, for example, for each of the vehicles V.

[0041]

The vehicle behavior specifying part 202 acquires the pieces of situation data stored in the situation data storage part D1 to calculate feature quantities of the respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration included in each of the pieces of situation data (in Fig. 4, Step S3). The vehicle behavior specifying part 202 of the present embodiment calculates, as the feature quantity of each of the pieces of acceleration data, for example, a standard deviation that is a measure of amplitude or variation of an acceleration waveform indicated by the acceleration data.

[0042]

Then, the vehicle behavior specifying part 202 specifies vehicle behavior indicated by each of the pieces of situation data with use of a relative magnitude relationship among, for example, standard deviations that are feature quantities of the pieces of acceleration data (in Fig. 4, Step S4). Specifically, the vehicle behavior specifying part 202 uses the relative magnitude relationship among the standard deviations of the pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration to specify vehicle behavior indicated by each of the pieces of situation data as at least any of the following (1) to (3):

(1) Close call etc. behavior indicating a crash, a close call that could result in a crash, or other sudden braking,

(2) Running on etc. behavior indicating running of a single wheel on a curb or running of a wheel into a side ditch, and

(3) Bound behavior indicating a bound caused by both wheels passing over unevenness on a road.

[0043]

More specifically, as illustrated in Fig. 5, in the case where a standard deviation of an acceleration waveform indicated by the longitudinal acceleration data is larger than standard deviations of acceleration waveforms respectively indicated by the lateral acceleration data and the vertical acceleration data, the vehicle behavior specifying part 202 specifies the vehicle behavior indicated by the situation data as the close call etc. behavior. This is based on the fact that due to impact at the time of a crash or sudden braking, the longitudinal acceleration among the respective types of acceleration exhibits the largest variation, and therefore a variation in longitudinal acceleration waveform becomes the largest. In addition, Fig. 5 is a schematic diagram in which a number of pieces of situation data acquired by the drive recorders 100 are visually classified into the above (1) to (3), and for each of the three types of behavior, the pieces of situation data are arranged to illustrate the standard deviations of the respective acceleration waveforms indicated by each of the pieces of situation data. A horizontal axis of Fig. 5 represents each of the pieces of situation data, and the vertical axis represents a standard deviation of each of the acceleration waveforms.

[0044]

Also, in the case where the standard deviation of the acceleration waveform indicated by the lateral acceleration data is larger than the standard deviations of the acceleration waveforms respectively indicated by the longitudinal acceleration data and the vertical acceleration data, the vehicle behavior specifying part 202 specifies the vehicle behavior indicated by the situation data as the running on etc. behavior (see Fig. 5). This is based on the fact that, due to a rapid variation of only one of front wheels of a vehicle V in the running on etc. behavior, the lateral acceleration among the respective types of acceleration exhibits the largest variation, and therefore a variation in lateral acceleration waveform becomes the largest.

[0045]

Further, in the case where the standard deviation of the acceleration waveform indicated by the vertical acceleration data is larger than the standard deviations of the acceleration waveforms respectively indicated by the longitudinal acceleration data and the lateral acceleration data, the vehicle behavior specifying part 202 specifies the vehicle behavior indicated by the situation data as the bound behavior (see Fig. 5). This is based on the fact that, due to a substantially simultaneous variation of both of the front wheels of the vehicle V in the bound behavior, i.e., due to substantially simultaneous vertical movement, the vertical acceleration among the respective types of acceleration exhibits the largest variation, and therefore a variation in vertical acceleration waveform becomes the largest.

[0046]

In addition, if the situation data specified as the close call etc.

behavior includes the blinker data, the vehicle behavior specifying part 202 specifies the vehicle behavior as behavior (shoulder stop behavior) indicating sudden braking for pulling over to a shoulder of a road (see Fig. 5). Such a specifying manner enables the close call etc. behavior to be automatically further subdivided and classified. In addition, in Fig. 5, the presence of a blinker is indicated by vertical thin lines in a lower part of the diagram. Also, a blinker signal dense part is indicated by hatching.

[0047]

Then, the vehicle behavior specifying part 202 relates the situation data indicating the vehicle behavior specified as described above with behavior specified data that is a specified result of the vehicle behavior to store them in the analyzed data storage part D2 (in Fig. 4, Step S5).

[0048]

The analyzed data storage part D2 systematically classifies and stores, for each of the types of vehicle behavior, together with the situation data that indicates the behavior specified by the vehicle behavior specifying part 202, the behavior specified data corresponding to the situation data. Specifically, the analyzed data storage part D2 stores, in a storage folder set for each of the close call etc. behavior, the running on etc. behavior, and the bound behavior, corresponding situation data and behavior specified data. For example, in the analyzed data storage part, a close call etc. behavior folder that stores pieces of situation data specified as the close call etc. behavior, a running on etc. behavior folder that stores pieces of situation data specified as the running on behavior, and a bound behavior folder that stores pieces of situation data specified as the bound behavior are set, and in

each of the folders, corresponding situation data and behavior specified data are stored.

[0049]

Further, in the analyzed data storage part D2, a shoulder stop behavior folder for further classifying the close call etc. behavior into the shoulder stop behavior to store the shoulder stop behavior is set with the close call etc. behavior folder being subdivided or stratified.

[0050]

Among the pieces of situation data stored in the analyzed data storage part D2 as described, only pieces of situation data classified as specific vehicle behavior are selected by an operator who operates input means such as a keyboard and a mouse, and then outputted to output means such as a display. Alternatively, only pieces of situation data classified as specific vehicle behavior are selected in the same manner, and then transferred to another analysis device, a memory, or the like.

[0051]

<Effects of present embodiment>

According to the vehicle behavior analysis system configured as described according to the present embodiment, on the basis of a magnitude relationship among standard deviations of a longitudinal acceleration waveform, a lateral acceleration waveform, and a vertical acceleration waveform respectively indicated by longitudinal acceleration data, lateral acceleration data, and vertical acceleration data, vehicle behavior can be specified. Accordingly, without depending on a visual check, vehicle behavior indicated by situation data can be specified, and therefore in

addition to being able to eliminate user's arbitrary determination to objectively specify vehicle behavior, temporal, physical, and mental loads on a user can be reduced. Also, without use of any threshold value, on the basis of a magnitude relationship among standard deviations of a longitudinal acceleration waveform, a lateral acceleration waveform, and a vertical acceleration waveform, vehicle behavior can be specified, and therefore a specified result having high reliability can be obtained.

[0052]

<Other variations>

Note that the present invention is not limited to the above-described embodiment.

[0053]

For example, the above-described embodiment uses respective pieces of acceleration data; however, if each of the drive recorders 100 has a gyro sensor, the present invention may be adapted to use feature quantities of respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration acting on a vehicle to specify vehicle behavior.

[0054]

Also, in the above-described embodiment, the analyzed data storage part has the storage folders respectively set for the close call etc. behavior, the running on etc. behavior, and the bound behavior to thereby simplify the selection of predetermined behavior; however the present invention is not limited to this. For example, the vehicle behavior analysis device may be further provided with a situation data extracting part that, from among

pieces of situation data stored in the analyzed data storage part, extracts situation data indicating predetermined vehicle behavior. Also, the situation data extracting part may be configured to extract situation data indicating predetermined vehicle behavior selected by an operator who operates input means such as a keyboard and a mouse on the basis of behavior specified data provided to the situation data.

[0055]

Further, the above-described embodiment is configured to collect situation data acquired by each of the drive recorders 100 into the vehicle behavior analysis device, and then uses the vehicle behavior analysis device to specify vehicle behavior indicated by the situation data; however, the present invention may be adapted to specify vehicle behavior indicated by situation data in each of the drive recorders 100 in the same manner. For example, each of the drive recorders 100 may be configured to have a situation data receiving part and a vehicle behavior specifying part, and transfer only situation data specified as predetermined behavior (e.g., the close call etc. behavior) by the vehicle behavior specifying part to the regular area (regular recording data storage part) in the memory to perform recording.

[0056]

In addition, the present invention may be configured to use a predetermined threshold value to subdivide situation data classified as the close call etc. behavior. For example, on the basis of a relation ship between a value obtained by subtracting a maximum value among vertical acceleration values from a maximum value among three-axis resultant

acceleration values obtained by the acceleration sensor and the threshold value, the subdivision may be made.

[0057]

Also, in the close call etc. behavior, in order to further subdivide a crash to specify vehicle behavior, it is desirable to specify the vehicle behavior as behavior indicating that feature quantities of lateral acceleration data, vertical acceleration data, and longitudinal acceleration data have significantly larger values than values of feature quantities based on friction force generated by normal braking between a road surface and a contact area of each of tires.

[0058]

In addition, the vehicle behavior analysis device may be a device that links situation data to map information. Specifically, the vehicle behavior analysis device uses position data included in situation data to link map information and the situation information to each other. This enables a road analysis to be made by estimating road information (such as a degraded state of a road surface) from situation data specified as the bound behavior, or performing other operation.

[0059]

Further in addition, the present invention may be configured to use a variation aspect of longitudinal acceleration data to classify a crash into behavior in the case where a vehicle crashes into another vehicle, a structure, or the like and behavior in the case a vehicle is crashed into by another vehicle. That is, in the close call etc. behavior, in order to specify vehicle behavior as a front-end accident in which a vehicle crashes into another car

or a rear-end accident in which a vehicle is crashed into by another car, it is desirable to specify the vehicle behavior on the basis of whether feature quantities of the lateral acceleration data, vertical acceleration data, and longitudinal acceleration data are positive or negative.

[0060]

Besides, in addition to the above-described embodiment, situation data indicating the running on etc. behavior may be treated as follows with use of blinker data included in the situation data. That is, the present invention may be adapted to determine whether a vehicle V has turned right or left on the basis of the blinker data, and specify whether or not at the time of turning left or right, the vehicle V has run on a curb or the like or has had another accident.

[0061]

Also, in order to determine whether the vehicle has run on a curve at the time of turning right or left, by without blinker data, checking whether a waveform of lateral acceleration first appears on a plus or minus side, which of left and right tires has first run on the curve can be found out, and therefore the determination can be made.

This enables a driving tendency of a driver, such as being likely to run on a curb at the time of turning left or turning right, to be easily analyzed.

[0062]

Further, by checking a waveform of lateral acceleration, it can be determined whether or not a U-turn has been made, and therefore it can also be determined, for example, whether vehicle behavior indicates an accident

or a close call at the time of a U-turn.

[0063]

A feature quantity of each of pieces of acceleration data in the above-described embodiment is a standard deviation of a corresponding acceleration waveform; however, besides, as the feature quantity, dispersion of the acceleration waveform may be used, or a mean of corresponding acceleration may be used. In addition, an operation value indicating a magnitude relationship specific to each behavior in each acceleration may be used.

[0064]

Besides, it should be appreciated that the present invention is not limited to the above-described embodiment, but can be variously modified without departing from the scope thereof.

Industrial applicability

[0065]

According to the present invention having such a configuration, without only visually classifying vehicle behavior indicated by situation data, the vehicle behavior indicated by the situation data can be automatically and highly reliably specified.

## CLAIMS

1. A vehicle behavior analysis device comprising:

a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and

a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.

2. The vehicle behavior analysis device according to claim 1, wherein

in a case where the received situation data includes the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration,

the vehicle behavior specifying part uses the relative relationship among the feature quantities of the respective pieces of acceleration data on

the longitudinal acceleration, the lateral acceleration, and the vertical acceleration to specify the vehicle behavior indicated by the situation data as any of close call etc. behavior indicating a crash, a close call that could result in a crash, or other sudden braking, running on etc. behavior indicating running of a single wheel on a curb, or running of a wheel into a side ditch, and bound behavior indicating a bound caused by both wheels passing over unevenness on a road.

3. The vehicle behavior analysis device according to claim 2, wherein the vehicle behavior specifying part specifies the vehicle behavior indicated by the situation data as:

in a case where the feature quantity of the longitudinal acceleration data is larger than the feature quantities of the lateral acceleration data and the vertical acceleration data, the close call etc. behavior;

in a case where the feature quantity of the lateral acceleration data is larger than the feature quantities of the longitudinal acceleration data and the vertical acceleration data, the running on etc. behavior; and

in a case where the feature quantity of the vertical acceleration data is larger than the feature quantities of the longitudinal acceleration data and the lateral acceleration data, the bound behavior.

4. The vehicle behavior analysis device according to claim 3, wherein: the situation data includes blinker data indicating working information on blinkers of the vehicle; and

in a case where in the situation data specified as the close call etc.

behavior, the blinker data is included, the vehicle behavior specifying part specifies the situation data as behavior indicating sudden braking for pulling over to a shoulder of a road.

5. The vehicle behavior analysis device according to claim 1, wherein the feature quantities of the respective pieces of acceleration data or the respective pieces of angular acceleration data are standard deviations of acceleration waveforms indicated by the respective pieces of acceleration data or the respective pieces of angular acceleration data.

6. A vehicle behavior analysis program instructing a computer to comprise functions as:

a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and

a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the

roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.

7. A drive recorder comprising:

a situation data receiving part that receives at least one piece of situation data of situation data including respective pieces of acceleration data on longitudinal acceleration, lateral acceleration, and vertical acceleration having acted on a vehicle, and situation data including respective pieces of angular acceleration data on roll angular acceleration, pitch angular acceleration, and yaw angular acceleration having acted on the vehicle; and

a vehicle behavior specifying part that, with use of at least one relative relationship among feature quantities of a relative relationship among feature quantities of the respective pieces of acceleration data on the longitudinal acceleration, the lateral acceleration, and the vertical acceleration in the received situation data, and a relative relationship among feature quantities of the respective pieces of angular acceleration data on the roll angular acceleration, the pitch angular acceleration, and the yaw angular acceleration in the received situation data, specifies vehicle behavior indicated by the situation data.