

SAFETY CHECK EVALUATION SYSTEM, VEHICLE-MOUNTED DEVICE USED
IN SAID SAFETY CHECK EVALUATION SYSTEM, PROCESSING DEVICE,
SAFETY CHECK EVALUATION METHOD, SAFETY CHECK EVALUATION
PROGRAM, AND STORAGE MEDIUM

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BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to a safety check evaluation system, a vehicle-mounted
10 device used in the safety check evaluation system, a processing device, a safety check
evaluation method, a safety check evaluation program, and a storage medium.

Description of Related Art

[0002] In Patent Document 1, a safe driving degree determining device which
determines the safe driving degree at an intersection is proposed. In a process for
15 determining the safe driving degree, whether a vehicle is about to enter an intersection is
determined based on a current location of the vehicle detected by a vehicle location
detection unit and intersection information of a map database. Specifically, whether
the vehicle has entered a prescribed range of the intersection, such as within a range of a
radius of 30 m the center of the intersection is determined. Then, it is configured that,
20 in a case where the vehicle is determined as approaching the intersection, recording of
velocity, yaw rate, acceleration data starts since the time when the vehicle is determined
as approaching the intersection.

[0003] [Issue(s) to be solved by the invention]

The safe driving degree determining device of Patent Document 1 is installed with a map database. In the process for determining whether the vehicle is approaching the intersection, the intersection information of the map database needs to be used. Therefore, there are issues such as a higher cost for installing the map database as well
5 as that the device configuration is complicated.

[Prior art documents]

[Patent documents]

[0004] [Patent document 1] Japanese Laid-open No. 2015-76000.

10 SUMMARY OF THE INVENTION

[Means for solving the issue(s) and its effects]

[0005] In view of the above issues, the objective of the invention is to provide a safety check evaluation system which, by means of a simple and low-cost configuration, can estimate the time at which a vehicle entered an intersection and can appropriately
15 evaluate the driver's safety check actions at the intersection, a vehicle-mounted device used in the safety check evaluation system, a processing device, a safety check evaluation method, a safety check evaluation program, and a storage medium.

[0006] In order to attain the above objective, a safety check evaluation system (1) according to the disclosure is a safety check evaluation system for evaluating safety
20 check actions of a driver of a vehicle, and includes: a vehicle-mounted device mounted in the vehicle; and a processing device processing data acquired by the vehicle-mounted device, wherein the vehicle-mounted device is provided with an angular velocity detection unit which detects an angular velocity of the vehicle, and the processing

device is provided with an intersection estimation unit which estimates an intersection entry time of the vehicle based on angular velocity data of the vehicle detected by the angular velocity detection unit; and a safety check evaluation unit which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated by the intersection estimation unit.

[0007] According to the above safety check system (1), the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, the time at which the vehicle enters the intersection can be estimated, and the safety check actions of the driver before and after entry into the intersection can be respectively appropriately evaluated by using the estimated intersection entry time.

[0008] In addition, regarding a safety check evaluation system (2) according to the disclosure, in the safety check evaluation system (1), the vehicle-mounted device is provided with a first time detection unit which detects a first time at which the angular velocity data detected by the angular velocity detection unit exceeds a prescribed angular velocity threshold, and the processing device is provided with an integral value calculation unit which calculates an integral value of the angular velocity data of prescribed time periods before and after the first time detected by the first time detection unit; and a second time detection unit which detects a second time at which the integral value calculated by the integral value calculation unit reaches a prescribed integral ratio, and the second time is estimated as the intersection entry time.

[0009] According to the safety check evaluation system (2), the first time at which the angular velocity data exceeds the prescribed angular velocity threshold is detected, the

integral value of the angular velocity data of the prescribed time periods before and after the first time is calculated, and the second time at which the calculated integral value reaches the prescribed integral ratio is estimated as the intersection entry time. Therefore, the time at which the vehicle enters the intersection can be accurately
5 estimated.

[0010] In addition, regarding a safety check evaluation system (3) according to the disclosure, in the safety check evaluation system (2), the integral value calculation unit calculates the integral value of angular velocity data equal to or greater than a prescribed angular velocity lower limit, among the angular velocity data of the prescribed time
10 periods before and after the first time.

[0011] According to the safety check evaluation system (3), with the calculation of the integral value by the integral value calculation unit not including the angular velocity data less than the prescribed angular velocity lower limit, such as low angular velocity data detected during meandering, the integral value when the vehicle turns right/left at
15 the intersection can be more accurately calculated.

[0012] In addition, regarding a safety check evaluation system (4) according to the disclosure, in the safety check evaluation system (2) or (3), the processing device is provided with a cancellation unit which, in a case where an angle represented by the integral value calculated by the integral value calculation unit is not within a prescribed
20 road intersection angle range, cancels detection of the second time.

[0013] According to the safety check evaluation system (4), in the case where the angle represented by the integral value is not within the prescribed road intersection angle range, such as traveling on a curved road or lane-changing to an adjacent lane but

not turning right/left at the intersection, the detection of the second time, i.e., the intersection entry time, can be canceled, and the detection accuracy of the intersection can be increased.

5 **[0014]** In addition, regarding a safety check evaluation system (5) according to the disclosure, in the safety check evaluation system any one of (2) to (4), the processing device is provided with a direction estimation unit which estimates a right/left turning direction of the vehicle based on a positive/negative sign of the integral value calculated by the integral value calculation unit.

10 **[0015]** According to the safety check evaluation system (5), based on the positive/negative sign of the integral value, the right/left turning direction of the vehicle can be easily estimated.

15 **[0016]** In addition, regarding a safety check evaluation system (6) according to the disclosure, in the safety check evaluation system any one of (2) to (4), the vehicle-mounted device is provided with a location detection unit which detects a location of the vehicle; a vehicle velocity calculation unit which calculates a velocity of the vehicle based on location data detected by the location detection unit; and a first time cancellation unit which, in a case where the velocity of the vehicle at the first time detected by the first time detection unit is equal to or greater than a prescribed velocity, cancels the first time.

20 **[0017]** According to the safety check evaluation system (6), in the case where the velocity of the vehicle at the first time detected by the first time detection unit is equal to or greater than the prescribed velocity, since the first time is canceled, for example, erroneously detecting traveling on a curved road as turning right/left at the intersection

can be prevented.

[0018] In addition, regarding a safety check evaluation system (7) according to the disclosure, in the safety check evaluation system (2) or (4), the vehicle-mounted device is provided with a first time cancellation unit which, in a case where the first time
5 detected by the first time detection unit does not pass a prescribed time period from a previously detected first time, cancels the first time.

[0019] According to the safety check evaluation system (7), in the case where the first time does not pass the prescribed time period, since the current first time is canceled, for example, erroneously detecting traveling on a curved road as entry into the intersection
10 in the case of traveling on a road with continuous curves can be prevented.

[0020] A vehicle-mounted device (1) according to the disclosure is a vehicle-mounted device used in a safety check evaluation system which evaluates safety check actions of a driver of a vehicle, and includes: an angular velocity detection unit which detects an angular velocity of the vehicle; a first time detection unit which detects a first time at
15 which angular velocity data detected by the angular velocity detection unit exceeds a prescribed angular velocity threshold; a storage unit which stores the angular velocity data and the first time; and an output unit which outputs data stored in the storage unit to a processing device used in the safety check evaluation system.

[0021] According to the vehicle-mounted device (1), by means of a simple and
20 low-cost configuration, the data for estimating the time at which the vehicle enters the intersection can be output to the processing device, and the cost for implementing the safety check evaluation system can be controlled.

[0022] In addition, a processing device (1) according to the disclosure is a processing

device used in a safety check evaluation system which evaluates safety check actions of a driver of a vehicle, and includes: an intersection estimation unit which estimates an intersection entry time of the vehicle based on angular velocity data of the vehicle acquired by a vehicle-mounted device mounted in the vehicle; and a safety check evaluation unit which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated by the intersection estimation unit.

[0023] According to the above processing device (1), the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, the time at which the vehicle enters the intersection can be estimated, and the safety check actions of the driver before and after entry into the intersection can be respectively appropriately evaluated by using the estimated intersection entry time.

[0024] In addition, a safety check evaluation method (1) according to the disclosure is a safety check evaluation method for evaluating safety check actions of a driver of a vehicle, and includes: an intersection estimation step of estimating an intersection entry time of the vehicle based on angular velocity data of the vehicle; and a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.

[0025] According to the above safety check evaluation method (1), the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, the time at which the vehicle

enters the intersection can be estimated, and the safety check actions of the driver before and after entry into the intersection can be respectively appropriately evaluated by using the estimated intersection entry time.

[0026] In addition, regarding a safety check evaluation method (2) according to the disclosure, in the safety check evaluation method (1), the intersection estimation step includes: a first time detection step of detecting a first time at which the angular velocity data exceeds a prescribed angular velocity threshold; an integral value calculation step of calculating an integral value of angular velocity data of prescribed time periods before and after the first time detected in the first time detection step; and a second time detection step of detecting a second time at which the integral value calculated in the integral value calculation step reaches a prescribed integral ratio, and the second time is estimated as the intersection entry time.

[0027] According to the safety check evaluation method (2), the first time at which the angular velocity data exceeds the prescribed angular velocity threshold is detected, the integral value of the angular velocity data of the prescribed time periods before and after the first time is calculated, and the second time at which the calculated integral value reaches the prescribed integral ratio is estimated as the intersection entry time. Therefore, the time at which the vehicle enters the intersection can be accurately estimated.

[0028] In addition, a safety check evaluation program according to the disclosure is a safety check evaluation program for at least one computer to execute a process for evaluating safety check actions of a driver of a vehicle, and the at least one computer executes: an intersection estimation step of estimating an intersection entry time of the

vehicle based on angular velocity data of the vehicle; and a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.

[0029] According to the above safety check program, the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, a processing device that can estimate the time at which the vehicle enters the intersection and respectively appropriately evaluate the safety check actions of the driver before and after entry into the intersection by using the estimated intersection entry time, and can execute these evaluations can be realized.

The safety check evaluation program may be a program stored in a storage medium, and may be a program transmittable via a communication network.

[0030] In addition, a computer readable storage medium is a computer-readable storage medium storing a safety check evaluation program for at least one computer to execute a process for evaluating safety check actions of a driver of a vehicle, and the at least one computer executes: an intersection estimation step of estimating an intersection entry time of the vehicle based on angular velocity data of the vehicle; and a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.

[0031] According to the computer readable storage medium, with the at least one computer reading the program and executing the above steps, the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, a processing device that can estimate the

time at which the vehicle enters the intersection and respectively appropriately evaluate the safety check actions of the driver before and after entry into the intersection by using the estimated intersection entry time can be realized.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

FIG. 1 is a schematic diagram illustrating an application example of a safety check evaluation system according to an embodiment.

FIG. 2 is a block diagram illustrating an example of a hardware configuration of a
10 vehicle-mounted device used in the safety check evaluation system according to an embodiment.

FIG. 3 is a block diagram illustrating an example of a hardware configuration of a server device used in the safety check evaluation system according to an embodiment.

FIG. 4 is a timing chart for describing a method for estimating an intersection entry time
15 performed by the safety check evaluation system according to an embodiment and illustrates an example of chronological changes of angular velocity of the vehicle.

FIG. 5 is a flowchart illustrating a processing operation performed by the vehicle-mounted device in the safety check evaluation system according to an embodiment.

20 FIG. 6 is a flowchart illustrating a processing operation performed by the server device in the safety check evaluation system according to an embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0033] In the following, a safety check evaluation system, a processing device, a vehicle-mounted device, a safety check evaluation method, a safety check evaluation program, and a storage medium according to an embodiment will be described based on the drawings.

[0034] [Application Example]

FIG. 1 is a schematic diagram illustrating an application example of a safety check evaluation system according to an embodiment.

A safety check evaluation system 1 is a system for evaluating safety check actions of a driver of a vehicle 2, and is configured to include a vehicle-mounted device 10 mounted in at least one or more vehicle 2 and at least one or more server device 40 processing data acquired at each vehicle-mounted device 10. The server device 40 is an example of the "processing device" of the invention.

[0035] The vehicle 2 in which the vehicle-mounted device 10 is mounted is not particularly limited. In the application example, vehicles managed by business operators running various businesses may serve as the target. For example, trucks managed by transportation business operators, buses managed by bus business operators, taxis managed by taxi business operators, car-sharing vehicles managed by car sharing business operators, rental cars managed by rental car business operators, company-owned cars owned by business operators, etc., may serve as the target.

[0036] The vehicle-mounted device 10 and the server device 40 may also be configured as being able to communicate via a communication network 3. The communication network 3 may include a wireless communication network such as a

mobile phone network (3G/4G) including a base station, a wireless local area network (LAN), etc., or may also include a wired communication network such as a public phone network, the Internet, or a dedicated network.

[0037] In addition, a terminal device 70 of a business operator managing the vehicle 2 (referred to as "business operator terminal" in the following) may also be configured as being able to communicate with the server device 40 via the communication network 3. The business operator terminal 70 may be a personal computer with a communication function, and may also be a mobile information terminal such as a mobile phone, a smart phone, or a tablet device.

[0038] In the safety check evaluation system 1, the server device 40 accumulates angular velocity data of the vehicle 2 acquired by the vehicle-mounted device 10, and perform a process for estimating the time at which the vehicle 2 enters an intersection (referred to as "intersection entry time" in the following) based on the accumulated angular velocity data of the vehicle 2. In other words, the intersection entry time is the time at which the vehicle 2 starts to turn right/left (right/left turn starting time), and also plays a role as boundary time for evaluating safety check actions of the driver before and after entry into the intersection.

[0039] The intersection, for example, is a portion at which two or more roads intersect with each other, and may also include a T junction or a Y junction, in addition to a crossroad (four-way intersection), and may also include an intersection of four ways or more. In addition, it is irrelevant whether there is a traffic light or a crosswalk or not. In other words, the intersection includes a spot at which the vehicle 2 changes a traveling direction due to a right turn or a left turn, and may also include a portion at

which a road intersects a path to roadside facilities (e.g., a store, parking lots, etc.), namely the entrance/exit point to the roadside facilities, in addition to a portion where a road intersect another road as mentioned above. A sidewalk portion in the path to the roadside facilities may also be included.

5 **[0040]** In addition, the server device performs a process for evaluating the safety check actions of the driver within prescribed time periods before and after the intersection entry time. For example, the processes respectively evaluating the safety check actions of the driver within the prescribed time period before the intersection entry time and the prescribed time period after the intersection entry time are performed,
10 and the evaluation results are stored. Then, for example, in the case where there is a request from the business operator terminal 70, a process for providing information such as the evaluation results of the safety check actions of the driver of the vehicle 2 to the business operator terminal 70 via the communication network 3 is performed.

[0041] According to the safety check system 1, the angular velocity data of the vehicle
15 2, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, the time at which the vehicle 2 enters the intersection can be estimated, and the safety check actions of the driver before and after entry into the intersection can be evaluated by using the estimated time at which the vehicle 2 enters the intersection.

20 **[0042]** [Configuration example]

FIG. 2 is a block diagram illustrating an example of a hardware configuration of the vehicle-mounted device 10 used in the safety check evaluation system 1 according to an embodiment.

The vehicle-mounted device 10 according to the embodiment is configured as including an inertial sensor 11, a control unit 20, and a storage unit 30. In addition, in the vehicle-mounted device 10, a global positioning system (GPS) receiver 14 as a position detection unit, a speaker 15 as a sound output unit may also be installed, and a communication unit 16 and an external interface (external I/F) 17 may also be installed. Moreover, in the vehicle-mounted device 10, a camera unit 18 capturing an image of the driver and an image analysis unit 19 performing a process for analyzing the driver's behavior from the image captured by the camera unit 18 may also be installed.

[0043] The inertial sensor 11 includes an angular velocity sensor 12 detecting the angular velocity of the vehicle 2. The angular velocity sensor 12 can use a sensor at least capable of detecting the angular velocity responsive to the rotation around the vertical axis (yaw direction), that is, the angular velocity data responsive to the rotation (turning) to the left-right direction of the vehicle 2, such as a gyro sensor (also referred to as a yaw rate sensor).

[0044] Moreover, in addition to the gyro sensor for one axis around the vertical axis, the angular velocity sensor 12 may also use a two-axis gyro sensor that also detects the angular velocity around the horizontal axis (pitch direction) of the left-right direction, a three-axis gyro sensor that further detects the angular velocity around the horizontal axis of the front-rear direction (roll direction). These gyro sensors may use an optical gyro sensor, a mechanical gyro sensor, in addition to a vibration gyro sensor.

[0045] In addition, regarding the detection direction of the angular velocity around the vertical axis of the angular velocity sensor 12, for example, it may be that the clockwise direction is set as the positive direction, and the counter-clockwise direction is set as the

negative direction. In this case, when the vehicle 2 turns right, positive angular velocity data is detected, and when the vehicle 2 turns left, negative angular velocity data is detected. The angular velocity sensor 12 detects the angular velocity at a prescribed period (e.g., a period of 33 ms), and the detected angular velocity data is associated with detection time and stored in an inertial data storage unit 31 of the storage unit 30.

[0046] In addition, the inertial sensor 11 may be configured as including an acceleration sensor 13 detecting acceleration of the vehicle 2, and may be one in which the angular velocity sensor 12 and the acceleration sensor 13 are mounted in one packet.

The acceleration sensor 13 may use a three-axis acceleration sensor detecting accelerations in three directions, i.e., X, Y, and Z axes, and may also use a two-axis acceleration sensor, a one-axis acceleration sensor, etc. The three-axis acceleration sensor, in addition to a capacitive type acceleration sensor, may also use a piezoresistive type acceleration sensor, a semiconductor acceleration sensor. The acceleration data detected by the acceleration sensor 13 may also be associated with detection time and stored in the inertial data storage unit 31.

[0047] The storage unit 30 is configured as including the inertial data storage unit 31 and a program storage unit 34, and may be configured as further including a location data storage unit 32 and an image analysis data storage unit 33. The storage unit 30 may be configured as one or more storage devices such as random access memory (RAM), read only memory (ROM), flash memory, solid state drive (SSD), hard disk drive (HDD). In addition, the storage unit 30 may also be configured as including a removable storage device such as a memory card.

[0048] The inertial data storage unit 31 stores the angular velocity data detected by the angular velocity sensor 12. The location data storage unit 32 stores location (longitude, latitude) data detected by the GPS receiver 14. The image analysis data storage unit 33 stores data of the driver's behavior analyzed by the image analysis unit 19. The program storage unit 34 stores various programs executed by the control unit 20.

[0049] The control unit 20 is configured as including a time t_0 detection unit 21 detecting a time t_0 indicating an intersection passing time, and may also be configured as further including a vehicle velocity calculation unit 22 and a time t_0 cancellation unit 23. The control unit 20 is configured as including one or more hardware processors such as a central processing unit (CPU). The control unit 20 may also be configured as including a RAM and a ROM.

[0050] The control unit 20 performs a process for storing various data acquired from the vehicle-mounted device 10 in the storage unit 30. In addition, the control unit 20 reads various data and program stored in the storage unit 30 and realizes the operations of the time t_0 detection unit 21 as well as the vehicle velocity calculation unit 22 and the time t_0 cancellation unit 23 by executing the program.

[0051] The time t_0 detection unit 21, as an example of a "first time detection unit" of the invention, performs a process for detecting the time t_0 at which the angular velocity data detected by the angular velocity sensor 12 exceeds a prescribed angular velocity threshold ω_{th} .

[0052] The vehicle velocity calculation unit 22 uses the location (longitude, latitude) data detected by the GPS receiver 14 and performs a process for calculating the velocity of the vehicle 2.

[0053] The time t_0 cancellation unit 23, as an example of a "first time cancellation unit" of the invention, performs a process for canceling the time t_0 in a case where the velocity of the vehicle 2 at the time t_0 detected by the time t_0 detection unit 21 is equal to or greater than a prescribed velocity. In addition, in a case where the time t_0 detected by the time t_0 detection unit 21 does not pass a prescribed time period from a previously detected intersection passing time t_0' , in other words, in a case where a detection interval of the time t_0 is less than the prescribed time period, a process for canceling the current time t_0 may be performed.

[0054] The GPS receiver 14 periodically receives GPS signals from a satellite via an antenna 14a and detects the location (longitude, latitude) data of the current spot. The location data detected by the GPS receiver 14 is associated with location detection time and stored in the location data storage unit 32 of the storage unit 30.

[0055] The communication unit 16, as an example of an "output unit" of the invention, and is configured as including a communication module for performing outputting of data, etc., to the server device 40 via the communication network 3.

[0056] The external I/F 17, for example, is configured as including an interface circuit, a connector, etc., for performing transmission and reception of data or signal with a vehicle-mounted machine (not shown) such as a vehicle-external camera that captures an image outside the vehicle.

[0057] The camera unit 18, for example, is configured as including a lens unit, an image capturing element unit, a light irradiation unit, an interface unit, etc., not shown herein. The image capturing element unit includes an image capturing element, such as a CCD, a CMOS, and the light irradiation unit may include a light emitting element

such as an infrared LED.

[0058] The image analysis unit 19, for example, is configured as including an image processing processor, etc., and performs a process for analyzing the driver's behavior from the image captured by the camera unit 18. The driver's behavior may include the face orientation, the gaze direction, etc. The data of the driver's behavior analyzed by the image analysis unit 19, etc., is stored in the image analysis data storage unit 33 of the storage unit 30. In addition, together with the data of the driver's behavior, the data of the image captured by the camera unit 18 may be stored in the image analysis data storage unit 33.

[0059] FIG. 3 is a block diagram illustrating an example of a hardware configuration of the server device 40 used in the safety check evaluation system 1 according to an embodiment.

The server device 40 according to the embodiment is configured as including a communication unit 41, a control unit 50, and a storage unit 60.

[0060] The communication unit 41 is configured as a device for performing communication control for transmitting and receiving various data and signals with an external device such as the vehicle-mounted device 10 or the business operator terminal 70 via the communication network 3.

[0061] The control unit 50 is configured as including an intersection estimation unit 51 and a safety check evaluation unit 56, and may be configured as further including a time t5 detection cancellation unit 54 that cancels detection of a time t5 as the intersection entry time and a direction estimation unit 55. The control unit 50, for example, is configured as including one or more hardware processors such as a CPU.

[0062] The storage unit 60 is configured as including an inertial data accumulation unit 61 and a program storage unit 64, and may be configured as further including a image analysis data accumulation unit 62 and an evaluation data storage unit 63. The storage unit 60 includes, for example, one or more high-volume storage device such as
5 HDD, SSD.

[0063] In the inertial data accumulation unit 61, the angular velocity data (also including the data of the time t_0 , etc.), etc., acquired from the vehicle-mounted device
10 accumulate. In the image analysis data accumulation unit 62, the image analysis data, etc., acquired from the vehicle-mounted device 10 accumulate. The evaluation data storage unit 63 stores data such as evaluation results of the safety check actions of the driver at each intersection. In addition, the program storage unit 64 stores various programs executed by the control unit 50.

[0064] The control unit 50 performs a process for storing various data acquired from the vehicle-mounted device 10 in the storage unit 60. In addition, the control unit 50
15 reads various data and program stored in the storage unit 60 and realizes the operations of the intersection estimation unit 51, the time t_5 detection cancellation unit 54, the direction estimation unit 55, the safety check evaluation unit 56, etc., by executing the program.

[0065] The intersection estimation unit 51, for example, includes an integral value
20 calculation unit 52 and a time t_5 detection unit 53, and perform a process for estimating the intersection entry time of the vehicle 2 based on the angular velocity data of the vehicle 2 stored in the inertial data storage unit 31 of the storage unit 30. The integral calculation unit 52 calculates an integral value of the angular velocity data of prescribed

time periods before and after the time t_0 . The time t_5 detection unit 53 detects the time t_5 at which the integral value calculated by the integral value calculation unit 52 reaches a prescribed integral ratio and performs a process for estimating the time t_5 as the intersection entry time.

5 **[0066]** In a case where the integral value calculated by the integral value calculation unit 52 is not within a prescribed road intersection angle range, the time t_5 detection cancellation unit 54 performs a process for canceling the detection of the time t_5 by the time t_5 detection unit 53.

10 **[0067]** The direction estimation unit 55 estimates a left/right turn direction of the vehicle 2 based on the positive or negative sign of the integral value calculated by the integral value estimation unit 52. In an example of the embodiment, in a case where the integral value is positive, a right turn is estimated, and in a case where the integral value is negative, a left turn is estimated.

15 **[0068]** The safety check evaluation unit 56 performs a process for evaluating the safety check actions of the driver during prescribed time periods before and after the time t_5 estimated by the intersection estimation unit 51.

20 **[0069]** In addition, in the server device 40 according to another embodiment, a configuration including a web server operating as a presentation layer, an application server operating as an application server, and a database server operating as a database layer and able to provide cloud service may be used.

[0070] The web server is one that operates as the communication unit 41, and, for example, may be configured to perform processes for processing an HTTP request made from the browser of the business operator terminal 70 and instructing a process

corresponding to the application server, or receiving a processing result from the application server and presenting the processing result to the business operator terminal 70 via the browser.

[0071] The application server is one that operates as the control unit 50, and, for example, may be configured to perform processes for accessing the database server responsive to a request from the web server, performing data search or data extraction necessary for a process, and performing a process as requested.

[0072] The database server is one that operates as the storage unit 60, and, for example, may be configured to perform processes for managing various data including the angular velocity data acquired from the vehicle-mounted device 10, and performing searching, extracting, and storing of data responsive to a request from the application server.

[0073] [Operation example]

FIG. 4 is a timing chart for describing a method for estimating the intersection entry time at the time when the vehicle 2 turns right/left at the intersection in the safety check evaluation system 1 according to the embodiment, and illustrates an example of chronological changes of the angular velocity of the vehicle 2.

[0074] The time t_0 represents the intersection passing time estimated from the angular velocity (ω) data of the vehicle 2. The time t_5 represents the intersection entry time estimated from the angular velocity data.

[0075] The time t_0 represents the time when the absolute value of the angular velocity of the vehicle 2 changes from a state of being less than a prescribed angular velocity lower limit ω_L to being equal to or greater than the prescribed angular velocity threshold

ω_{th} . The prescribed angular velocity threshold ω_{th} is set to a value greater than the prescribed angular velocity lower limit ω_L . The angular velocity lower limit ω_L can be set as, for example, any value of 5 dps to 15 dps, and the angular velocity threshold ω_{th} can be set as, for example, any value of 15 dps to 50 dps. The prescribed angular velocity lower limit ω_L may be set as, for example, an angular velocity value detected at the time when the vehicle 2 is meandering within a traveling lane (within the same lane). In addition, the prescribed angular velocity threshold ω_{th} may be set as, for example, an angular velocity value detected at the time when the vehicle 2 is turning (turning right/left) at the intersection. The time t_0 may be detected by the vehicle-mounted device 10 and may also be detected by the server device 40.

[0076] In addition, in the case where the vehicle 2 turns right/left at the intersection, the vehicle 2 travels at a lower velocity. Therefore, a case where the vehicle velocity at the time t_0 is equal to or greater than a prescribed intersection upper limit velocity is regarded as making not a right/left turn at the intersection, and the time t_0 may be canceled.

[0077] The vehicle velocity at the time t_0 is calculated based on the location data detected by the GPS receiver 14 of the vehicle-mounted device 10, such as being calculated from a movement distance (changes of longitude and latitude) of a detection period of the location data. In this case, since the detection period for the angular velocity by the angular velocity sensor 12 is shorter than the detection period for the location data by the GPS receiver 14, the error of the location data at the time t_0 is decreased. Therefore, it is preferable that the vehicle velocity calculated from the location data immediately before the time t_0 is set as the vehicle velocity at the time t_0 .

[0078] In addition, in a case where the orientation of the angular velocity changes (changing from positive to negative or from negative to positive) within a prescribed time period after the angular velocity data becomes equal to or greater than the angular velocity threshold ω_{th} , such as within a short time about equal to or less than 1 to 3 seconds, the vehicle is not making a right/left turn at the intersection, but is, for example, regarded as changing to another lane due to a drastic steering operation, and the time t_0 may be canceled.

[0079] In addition, in a case where the interval (time) between the time t_0 and the time t_0' is not equal to or greater than a prescribed time T_h , the vehicle is regarded as not making a right/left turn at the intersection, and the time t_0 may be canceled. The prescribed threshold time T_h can be set as, for example, the time during which the vehicle can be estimated as traveling on a road with continuous curves, such as a time about 10 to 20 seconds

[0080] Regarding the method for estimating the time t_5 , firstly, the angular velocity data of the prescribed time periods before and after the time t_0 (an interval of $\pm n$ seconds) is set in an analysis data range for estimating the intersection entry time. That is, the time t_0 becomes the central point of the analysis data range. The interval of $\pm n$ seconds can be set as, for example, any of ± 10 to 20 seconds.

[0081] Then, an integral value θ of the angular velocity data of the analysis data range is calculated. The integral value θ represents an angle at which the vehicle 2 has turned (at the time of turning right/left). At this time, it may also be that only the angular velocity data in which the absolute value of the angular velocity data is equal to or greater than the prescribed angular velocity lower limit ω_L is calculated. The

angular velocity lower limit ω_L can be set as, for example, the angular velocity value detected at the time when the vehicle 2 is meandering within a traveling lane (within the same lane). Accordingly, the calculated integral value θ does not include an error component of angular velocity resulting from meandering, etc.

5 **[0082]** The time when the integral value θ of the angular velocity data reaches a prescribed integral ratio θ_r (a ratio with respect to the integral value θ) is detected as the time t_5 , that is, the intersection entry time.

[0083] The integral ratio θ_r can be set as, for example, any ratio $x\%$ of less than or equal to 10% of the integral value θ of the angular velocity data. The set value of the
10 integral ratio θ_r may be changed responsive to the value of the integral value θ , and the set value of the integral ratio θ_r may also be changed responsive to a change state of the angular velocity within a time period of t_0-n seconds. For example, it may be configured that, within the t_0-n seconds, in a case where the angular velocity data is detected as equal to or greater than the angular velocity lower limit ω_L and less than the
15 angular velocity threshold ω_{th} , the integral ratio θ_r is changed to a value greater than the set value.

[0084] The absolute value of the integral value θ of the angular velocity data represents an angle. In a case where the absolute value of the integral value θ is not within the prescribed road intersection angle range, the vehicle is regarded as not an
20 intersection, and the time t_5 may be canceled. The prescribed road intersection angle range may be set as, for example, a range from an intersection angle lower limit to an intersection angle upper limit (e.g., 40 degrees to 120 degrees).

[0085] In addition, it can be determined that it is a right turn if the integral value of

the angular velocity data of the analysis data range is a positive value and it is a left turn if the integral value of the angular velocity data of the analysis data range is a negative value. Then, after the time t_5 is detected, the safety check actions of the driver within a prescribed time period before the time t_5 and a prescribed time period after the time t_5 are respectively evaluated.

[0086] FIG. 5 is a flowchart illustrating a processing operation performed by the control unit 20 of the vehicle-mounted device 10 according to an embodiment. The processing operation is, for example, executed at the timing (e.g., a prescribed period of 33 ms) at which the angular velocity is detected by the angular velocity sensor 12.

[0087] In Step S1, the control unit 20 acquires the angular velocity data detected by the angular velocity sensor 12. Then, in Step S2, the control unit 2 determines whether the absolute value of the angular velocity is equal to or greater than the prescribed angular velocity threshold ω_{th} , that is, whether the absolute value of the angular velocity becomes, for the first time, equal to or greater than the prescribed angular velocity threshold ω_{th} from the state of being less than the prescribed angular velocity lower limit ω_L .

[0088] In Step S2, if the control unit 20 determines that the absolute value of the angular velocity is less than the prescribed angular velocity threshold ω_{th} , the flow proceeds to Step S10. In Step S10, the process for associating the acquired angular velocity data with the detection time and storing them in the inertial data storage unit 31 is performed. Then, the flow proceeds to Step S11.

[0089] Alternatively, in Step S2, if the control unit 20 determines that the absolute value of the angular velocity is equal to or greater than the prescribed angular velocity

threshold ω_{th} , the flow proceeds to Step S3. In Step S3, the control unit 20 detects the time t_0 at which the absolute value of the angular velocity becomes equal to or greater than the angular velocity threshold ω_{th} and sets an intersection passing flag F as 1, and the flow proceeds to Step S4.

5 **[0090]** In Step S4, the control unit 20 detects the velocity (vehicle velocity) of the vehicle 2 at the time t_0 . The vehicle velocity is, for example, calculated based on the location data detected by the GPS receiver 14 immediately before the time t_0 .

10 **[0091]** In Step S5 that follows, the control unit 20 determines whether the vehicle velocity at the time t_0 is equal to or less than the prescribed intersection upper limit velocity. The predetermined intersection upper limit velocity can be set as a value of a low velocity preferable for checking safety within the intersection.

15 **[0092]** In Step S5, if the control unit 20 determines that the vehicle velocity at the time t_0 is equal to or less than the prescribed intersection upper limit velocity, the flow proceeds to Step S6. In Step S6, the control unit 20 reads the previous time t_0' from the inertial data storage unit 31. In Step S7 that follows, the control unit 20 determines whether the interval (time) from the previous time t_0' to the current time t_0 exceeds a prescribed time period. The prescribed time period can be set as the time during which the vehicle 2 can be estimated as traveling on a road on which the angular velocity of the vehicle 2 changes within a short time period, such as a road with continuous curves
20 like a winding road (e.g., a value about 10 to 20 seconds).

20 **[0093]** In Step S7, if the control unit 20 determines that the interval from the previous time t_0' to the current time t_0 is equal to or greater than the prescribed time period, the flow proceeds to Step S8. In Step S8, the control unit 20 performs a process for

associating the acquired angular velocity data, the intersection passing time t_0 and the intersection passing flag $F = 1$ and storing them in the inertial data storage unit 31, and the flow proceeds to Step S11.

[0094] Alternatively, in Step S5, if the control unit 20 determines that the vehicle velocity at the time t_0 is greater than the prescribed intersection upper limit velocity, that is, the vehicle is not traveling at an intersection but on a road that is curved (curved road), the flow proceeds Step S9.

[0095] In addition, in Step S7, if the control unit 20 determines that the interval from the previous time t_0' to the current time t_0 is less than the prescribed time period, such as traveling on a road on which the angular velocity changes within a short period of time, the flow proceeds to Step S9.

[0096] In Step S9, the control unit 20 performs a process for canceling the time t_0 detected in Step S3. In such case, the intersection passing flag F is set as 0, and then the flow proceeds to Step S10. In Step S10, the control unit 20 associates the angular velocity data acquired in Step S1 with the detection time and stores them in the inertial data storage unit 31. Then, the flow proceeds to Step S11.

[0097] In Step S11, the control unit 20 determines whether it is the timing of transmitting the angular velocity data stored in the inertial data storage unit 31 to the server device 40, i.e., determining whether a prescribed time period (e.g., about 1 minute to 5 minutes) from a previous transmission timing has lapsed. If the control unit 20 determines that it is not the transmission timing, the process is ended. Alternatively, if the control unit 20 determines that it is the transmission timing, the flow proceeds to Step S12.

[0098] In Step S12, the control unit 20 performs a process for transmitting data (data such as the angular velocity data of the prescribed time period, the detection time, the intersection passing time t_0 , and the intersection passing flag F) stored in the inertial data storage unit 31 to the server device 40, and the process is ended.

5 **[0099]** Among Steps S1 to S12, it may be configured that the processes of Steps S4 and S5 are omitted, it may also be configured that the processes of Steps S6 and S7 are omitted, or it may be configured that the processes of Steps S4 to S7 and S9 are omitted.

[00100] In addition, in the process of transmitting data the server device 40 in Step S12, in addition to the data stored in the inertial data storage unit 31, the data stored in the
10 location data storage unit 32, the data stored in the image analysis data storage unit 33 may also be transmitted.

[00101] In addition, it may also be configured that the processes of Steps S11 and S12 are omitted, the data stored in the inertial data storage unit 31 in Steps S8 and S10 is stored in a removable storage device, such as a memory card, and after traveling, the
15 data stored in the memory card is read by the business operator terminal 70 and transmitted from the business operator terminal 70 to the server device 40.

[00102] FIG. 6 is a flowchart illustrating a processing operation performed by the control unit 50 of the server device 40 according to an embodiment. The processing operation, for example, may be executed at a timing of receiving data from the
20 vehicle-mounted device 10 (e.g., a period of about 1 to 5 minutes), may be executed at each prescribed time period determined at the side of the server device 40, or may be executed when there is a request from the business operator terminal 70.

[00103] Firstly, in Step S21, the control unit 50 extracts the time t_0 associated with the

intersection passing flag $F = 1$ from the data accumulated in the inertial data accumulation unit 61. Then, the flow proceeds to Step S22. In Step S22, the control unit 50 reads the angular velocity data of the prescribed time periods before and after the time t_0 (e.g., $\pm n$ seconds from the time t_0), as the analysis data range for estimating the time t_5 , from the inertial data accumulation unit 61. Then, the flow proceeds to Step S23.

[00104] In Step S23, a process for integrating the angular speed data of the prescribed time periods before and after the time t_0 is performed. In the integrating process, it may be that only the angular velocity data in which the absolute value of the angular velocity is equal to or greater than the prescribed angular velocity lower limit ω_L is integrated. The prescribed angular velocity lower limit ω_L may be set as, for example, the angular velocity detected at the time when the vehicle 2 is meandering within a traveling lane (within the same lane).

[00105] In Step S24, the control unit 50 determines whether the absolute value (angle) of the integral value θ of the angular velocity data calculated in Step S23 is within the prescribed road intersection angle range. The prescribed road intersection angle range may be set as, for example, a range from an intersection angle lower limit to an intersection angle upper limit (e.g., 40 degrees to 120 degrees).

[00106] In Step S24, in a case where the control unit 50 determines that the absolute value of the of the integral value θ of the angular velocity data is not within the prescribed road intersection angle range, the detection of the time t_5 is not performed, and the flow proceeds to Step S32. The case of not within the prescribed road intersection angle range is, for example, traveling on a road with a gentle curve or a

sharp curve, or lane-changing to an adjacent lane, etc.

[00107] Meanwhile, in Step S24, in a case where the control unit 50 determines that the absolute value of the of the integral value θ of the angular velocity data is within the prescribed road intersection angle range, the flow proceeds to Step S25. In Step S25, the control unit 50 detects the time t_5 at which the integral value of the angular velocity data reaches the prescribed integral ratio θ_r . Then, in Step S26, the control unit 50 estimates the time t_5 detected in Step S25 as the intersection entry time, and the flow proceeds to Step S27.

[00108] The prescribed integral ratio θ_r may be set as any ratio $x\%$ of less than or equal to 10% of the integral value θ . For example, in a case where the absolute value of the integral value θ calculated in Step S23, i.e., the angle, is 90 degrees, the time t_5 at which the prescribed integral ratio θ_r reaches $x\%$ is the time when the angle becomes $90 \cdot (x/100)$ degrees, and the time is estimated as the intersection entry time.

[00109] In Step S27, the control unit 50 determines the right/left turn direction (turning right or left) of the vehicle 2 based on the positive or negative sign of the integral value θ calculated in Step S23. Then, in Step S28, the control unit 50 associates the time t_5 of the vehicle 2 with the right/left turning direction and stores them in the evaluation data storage unit 63 of the storage unit 60. Then, the flow proceeds to Step S29.

[00110] In Step S29, the control unit 50 performs a process for evaluating the safety check actions of the driver in the prescribed time period (e.g., 5 to 15 seconds) before the intersection entry time t_5 . Then, in Step S30, a process for evaluating the safety check actions of the driver in the prescribed time period (e.g., 5 to 15 seconds) after the intersection entry time t_5 .

[00111] The processes for evaluating the safety check actions of the driver in Steps S29 and S30 are not particularly limited. The safety check actions of the driver may be determined based on the image data analysis results of the driver acquired from the vehicle-mounted device 10 (such as the face orientation, the gaze direction) and/or the behavioral data of the vehicle 2 (such as acceleration, vehicle velocity, angular velocity, location) acquired from the vehicle-mounted device 10, etc., and be evaluated based on the determination results. The safety check actions of the driver may include the safety check actions of the driver during the right/left turn of the vehicle 2, such as the safety check actions for the left/right.

[00112] In Step S31, the control unit associates the evaluation results in Steps S29 and S30 with the time t_5 and stores them in the evaluation data storage unit 63. In Step S32, the control unit 50 determines whether there is a next time t_0 . If the control unit 50 determines that there is a next time t_0 , the flow returns to Step S21. The processes repeat until all the times t_0 are extracted. Alternatively, if the control unit 50 determines that there is no time t_0 , that is, if the control unit 50 determines that all the times t_0 are extracted from the accumulated data, the process is ended.

[00113] According to the safety check evaluation system 1 according to the embodiment, the angular velocity data, instead of intersection information of, for example, a map database, is used, and by means of a simple and low cost configuration, the time at which the vehicle 2 enters the intersection can be estimated, and the safety check actions of the driver before and after entry into the intersection can be respectively appropriately evaluated by using the estimated time t_5 .

[00114] In addition, according to the safety check evaluation system 1, the time t_0 at

which the angular velocity data exceeds the prescribed angular velocity threshold ω_{th} is detected, the integral value θ of the angular velocity data of the prescribed time periods before and after the time t_0 is calculated, and since the time t_5 at which the integral value θ reaches the prescribed integral ratio θ_r is estimated as the intersection entry time, the time at which the vehicle 2 enters the intersection can be more accurately estimated.

[00115] In addition, according to the safety check evaluation system 1, with the calculation of the integral value by the integral value calculation unit 52 not including the angular velocity data less than the prescribed angular velocity lower limit ω_L , such as low angular velocity data detected during meandering, the integral value when the vehicle 2 turns right/left at the intersection can be more accurately calculated.

[00116] In addition, according to the safety check evaluation system 1, in the case where the angle represented by the integral value θ is not within the prescribed road intersection angle range, such as traveling on a curved road or lane-changing to an adjacent lane but not turning right/left at the intersection, the detection of the time t_5 can be canceled, and the detection accuracy of the intersection can be increased.

[00117] In addition, according to the safety check evaluation system 1, in the case where the velocity of the vehicle 2 in the time t_0 detected by the time t_0 detection unit 21 is equal to or greater than the prescribed velocity, since the time t_0 is canceled, erroneously detecting traveling on a curved road as turning right/left at the intersection can be prevented.

[00118] In addition, according to the safety check evaluation system 1, in the case where the time t_0 does not pass the prescribed time period from the previously detected time t_0' , since the current time t_0 is canceled, erroneously detecting traveling on a

curved road as entry into the intersection in the case of traveling on a road with continuous curves can be prevented.

[00119] In addition, according to the vehicle-mounted device, the configuration can be simplified, the installation to the vehicle 2 can be performed easily, and the safety check evaluation system 1 can be introduced at a low cost.

[00120] While the embodiments of the invention have been described in detail as the above, the above descriptions are merely examples of the respective aspects of the invention. It goes without saying that various improvements and modifications can be made without departing from the scope of the invention.

[00121] In the above embodiment, it is configured that the time t_5 at which the vehicle 2 enters the intersection is estimated based on the angular velocity data of the vehicle 2, that is, the angular velocity data detected when the vehicle 2 turns right/left, etc., and the safety check actions of the driver within the prescribed time periods before and after the estimated time t_5 are evaluated.

[00122] For example, in other embodiments, it may also be configured that the time at which the vehicle 2 enters the entrance/exit point of roadside facilities is estimated based on the angular velocity data of the vehicle 2, and the safety check actions of the driver within the prescribed time periods before and after the estimated time are evaluated. According to the configuration, the safety check actions of the driver during entry from the road into the roadside facilities or exit from the roadside facilities onto the road can also be evaluated.

[00123] [Appendix]

The embodiments of the present invention may be described as in the following

appendices, but are not limited thereto.

(Appendix 1)

A safety check evaluation system (1) for evaluating safety check actions of a driver of a vehicle (2), the safety check evaluation system (1) including: a vehicle-mounted device
5 (10) mounted in the vehicle (2); and a processing device (40) processing data acquired by the vehicle-mounted device (10), wherein the vehicle-mounted device (10) is provided with an angular velocity detection unit (12) which detects an angular velocity of the vehicle, and the processing device (40) is provided with an intersection estimation unit (51) which estimates an intersection entry time of the vehicle (2) based on angular
10 velocity data of the vehicle (2) detected by the angular velocity detection unit (12); and a safety check evaluation unit (56) which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated by the intersection estimation unit (51).

[00124] (Appendix 2)

15 A processing device (40), used in a safety check evaluation system (1) which evaluates safety check actions of a driver of a vehicle (2), the processing device including: an intersection estimation unit (51) which estimates an intersection entry time of the vehicle (2) based on angular velocity data of the vehicle (2) acquired by a vehicle-mounted device (10) mounted in the vehicle (2); and a safety check evaluation
20 unit (56) which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated by the intersection estimation unit (51).

[00125] (Appendix 3)

A vehicle-mounted device (10), used in a safety check evaluation system (1) which evaluates safety check actions of a driver of a vehicle (2), the vehicle-mounted device (10) including: an angular velocity detection unit (12) which detects an angular velocity of the vehicle (2); a first time detection unit (21) which detects a first time at which
5 angular velocity data detected by the angular velocity detection unit (12) exceeds a prescribed angular velocity threshold; a storage unit (31) which stores the angular velocity data and the first time; and an output unit (16) which outputs data stored in the storage unit (31) to a processing device (40).

[00126] (Appendix 4)

10 A safety check evaluation method for evaluating safety check actions of a driver of a vehicle (2), the safety check evaluation method including: an intersection estimation step (S25, S26) of estimating an intersection entry time of the vehicle (2) based on angular velocity data of the vehicle (2); and a safety check evaluation step (S29, S30) of evaluating the safety check actions of the driver during prescribed time periods before
15 and after the intersection entry time estimated in the intersection estimation step.

[Industrial applicability]

[00127] The invention can be widely used in fields in which the evaluation results of the safety check actions of drivers driving vehicles managed by business operators running various businesses can be utilized, such as fields with services providing safety
20 education to improve drivers' safety awareness.

[Descriptions of Symbols]

[00128]

1: Safety check evaluation system

- 2: Vehicle
- 3: Communication network
- 10: Vehicle-mounted device
- 11: Inertial sensor
- 5 12: Angular velocity sensor
- 13: Acceleration sensor
- 14: GPS receiver
- 15: Speaker
- 16: Communication unit
- 10 17: External interface (External I/F)
- 18: Camera unit
- 19: Image analysis unit
- 20: Control unit
- 21: Time t0 detection unit (first time detection unit)
- 15 22: Vehicle velocity calculation unit
- 23: Time t0 cancellation unit (first time cancellation unit)
- 30: Storage unit
- 31: Inertial data storage unit
- 32: Location data storage unit
- 20 33: Image analysis data storage unit
- 34: Program storage unit
- 40: Server device (processing device)
- 41: Communication unit

- 50: Control unit
- 51: Intersection estimation unit
- 52: Integral value calculation unit
- 53: Time t5 detection unit (second time detection unit)
- 5 54: Time t5 detection cancellation unit (second time detection cancellation unit)
- 55: Direction estimation unit
- 56: Safety check evaluation unit
- 60: Storage unit
- 61: Inertial data accumulation unit
- 10 62: Image analysis data accumulation unit
- 63: Evaluation data storage unit
- 64: Program storage unit
- 70: Business operator terminal

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WHAT IS CLAIMED IS:

1. A safety check evaluation system for evaluating safety check actions of a driver of a vehicle, the safety check evaluation system comprising:

a vehicle-mounted device mounted in the vehicle; and

5 a processing device processing data acquired by the vehicle-mounted device,

wherein the vehicle-mounted device is provided with:

an angular velocity detection unit which detects an angular velocity of the vehicle, and

the processing device is provided with:

10 an intersection estimation unit which estimates an intersection entry time of the vehicle based on angular velocity data of the vehicle detected by the angular velocity detection unit; and

a safety check evaluation unit which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time

15 estimated by the intersection estimation unit.

2. The safety check evaluation system as claimed in claim 1, wherein the vehicle-mounted device is provided with:

a first time detection unit which detects a first time at which the angular velocity data detected by the angular velocity detection unit exceeds a prescribed

20 angular velocity threshold, and

the processing device is provided with:

an integral value calculation unit which calculates an integral value of the angular velocity data of prescribed time periods before and after the first time detected

by the first time detection unit; and

a second time detection unit which detects a second time at which the integral value calculated by the integral value calculation unit reaches a prescribed integral ratio, and

5 estimates the second time as the intersection entry time.

3. The safety check evaluation system as claimed in claim 2, wherein the integral value calculation unit calculates the integral value of angular velocity data equal to or greater than a prescribed angular velocity lower limit, among the angular velocity data of the prescribed time periods before and after the first time.

10 4. The safety check evaluation system as claimed in claim 2 or 3, wherein the processing device is provided with:

a cancellation unit which, in a case where an angle represented by the integral value calculated by the integral value calculation unit is not within a prescribed road intersection angle range, cancels detection of the second time.

15 5. The safety check evaluation system as claimed in claim 2 or 3, wherein the processing device is provided with:

a direction estimation unit which estimates a right/left turning direction of the vehicle based on a positive/negative sign of the integral value calculated by the integral value calculation unit.

20 6. The safety check evaluation system as claimed in claim 2 or 3, wherein the vehicle-mounted device is provided with:

a location detection unit which detects a location of the vehicle;

a vehicle velocity calculation unit which calculates a velocity of the vehicle

based on location data detected by the location detection unit; and

a first time cancellation unit which, in a case where the velocity of the vehicle at the first time detected by the first time detection unit is equal to or greater than a prescribed velocity, cancels the first time.

5 7. The safety check evaluation system as claimed in claim 2 or 3, wherein the vehicle-mounted device is provided with:

a first time cancellation unit which, in a case where the first time detected by the first time detection unit does not pass a prescribed time period from a previously detected first time, cancels the first time.

10 8. A vehicle-mounted device, used in a safety check evaluation system which evaluates safety check actions of a driver of a vehicle, the vehicle-mounted device comprising:

an angular velocity detection unit which detects an angular velocity of the vehicle;

15 a first time detection unit which detects a first time at which angular velocity data detected by the angular velocity detection unit exceeds a prescribed angular velocity threshold;

a storage unit which stores the angular velocity data and the first time; and

20 an output unit which outputs data stored in the storage unit to a processing device used in the safety check evaluation system.

9. A processing device, used in a safety check evaluation system which evaluates safety check actions of a driver of a vehicle, the processing device comprising:

an intersection estimation unit which estimates an intersection entry time of

the vehicle based on angular velocity data of the vehicle acquired by a vehicle-mounted device mounted in the vehicle; and

a safety check evaluation unit which evaluates the safety check actions of the driver during prescribed time periods before and after the intersection entry time
5 estimated by the intersection estimation unit.

10. A safety check evaluation method for evaluating safety check actions of a driver of a vehicle, the safety check evaluation method comprising:

an intersection estimation step of estimating an intersection entry time of the vehicle based on angular velocity data of the vehicle; and

10 a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.

11. The safety check evaluation method as claimed in claim 10, wherein the intersection estimation step comprises:

15 a first time detection step of detecting a first time at which the angular velocity data exceeds a prescribed angular velocity threshold;

an integral value calculation step of calculating an integral value of angular velocity data of prescribed time periods before and after the first time detected in the first time detection step; and

20 a second time detection step of detecting a second time at which the integral value calculated in the integral value calculation step reaches a prescribed integral ratio, and

the second time is estimated as the intersection entry time.

12. A safety check evaluation program for at least one computer to execute a process for evaluating safety check actions of a driver of a vehicle,

wherein the at least one computer executes:

an intersection estimation step of estimating an intersection entry time of the
5 vehicle based on angular velocity data of the vehicle; and

a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.

13. A computer-readable storage medium, storing a safety check evaluation
10 program for at least one computer to execute a process for evaluating safety check actions of a driver of a vehicle,

wherein the at least one computer executes:

an intersection estimation step of estimating an intersection entry time of the
vehicle based on angular velocity data of the vehicle; and

15 a safety check evaluation step of evaluating the safety check actions of the driver during prescribed time periods before and after the intersection entry time estimated in the intersection estimation step.