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(54) **COMPOSITE AUTONOMOUS DRIVING ASSISTANT SYSTEM FOR MAKING DECISION AND METHOD OF USING THE SAME**

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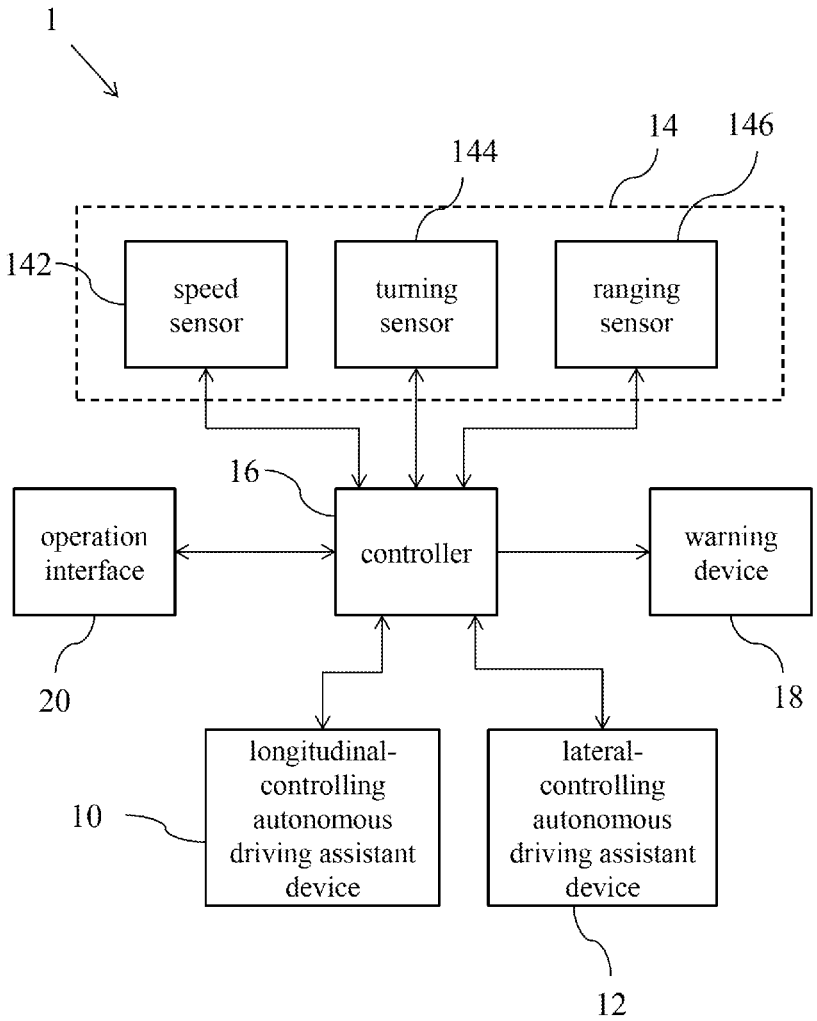
(57) **ABSTRACT**

A composite autonomous driving assistant system for making decision and a method of using the same is provided. A longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device start to automatically assist in driving a vehicle. Then, a sensing device senses states of the vehicle and an environment and generates one sensing signal. When a controller determines that the collision period is less than a preset collision period and that a deceleration signal of the sensing signal is larger than a preset deceleration, the controller generates a turn-stopping signal. When the controller determines that a rotation angle signal of the sensing signal is larger than a preset angle, the controller generates a speed-stopping signal. The present invention establishes an excellent switching threshold condition when the plurality autonomous driving assistant device coexist.



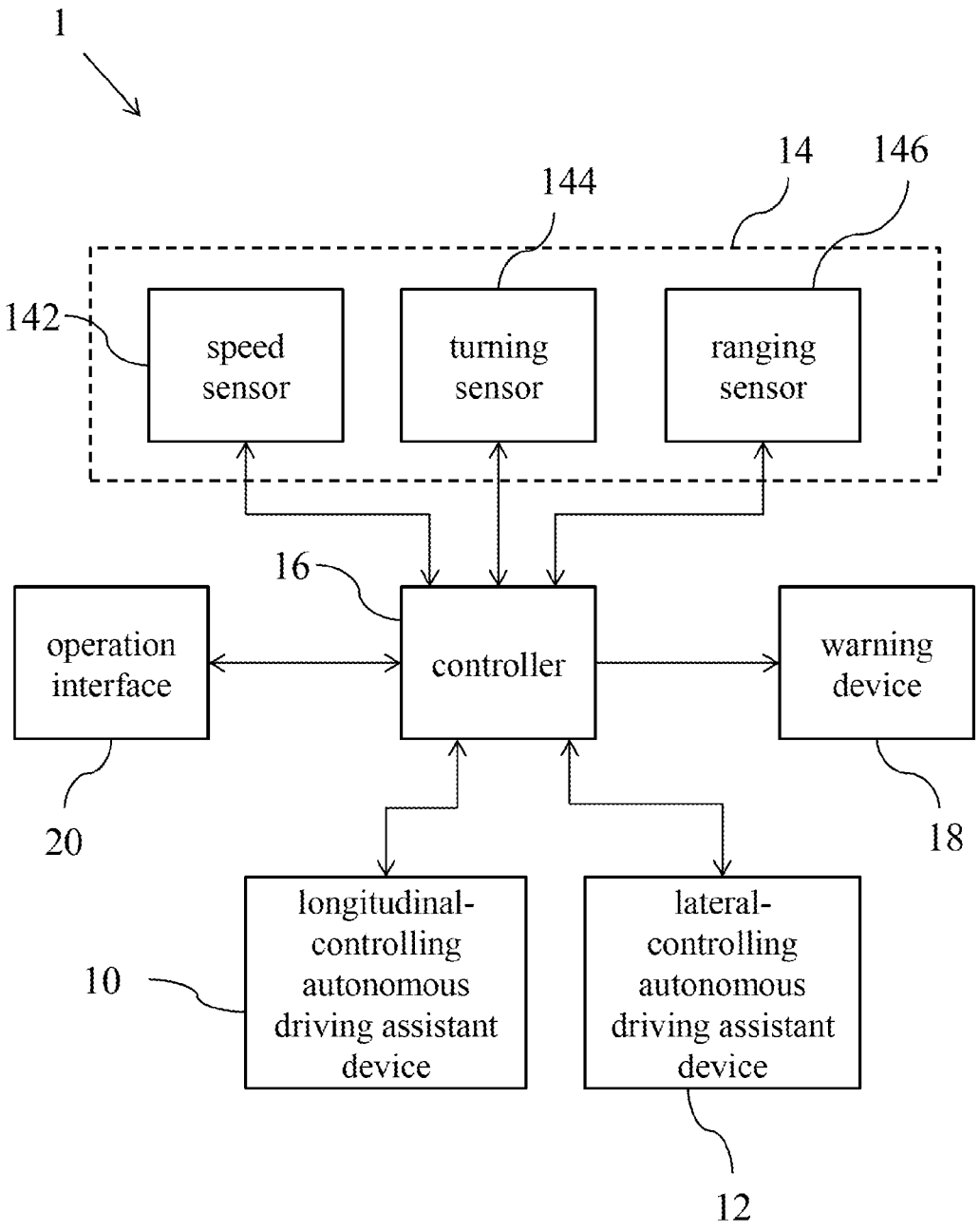

1
14
146
144
142
speed sensor
turning sensor
ranging sensor
16
operation interface
controller
warning device
20
18
longitudinal-controlling autonomous driving assistant device
10
lateral-controlling autonomous driving assistant device
12

Fig.1

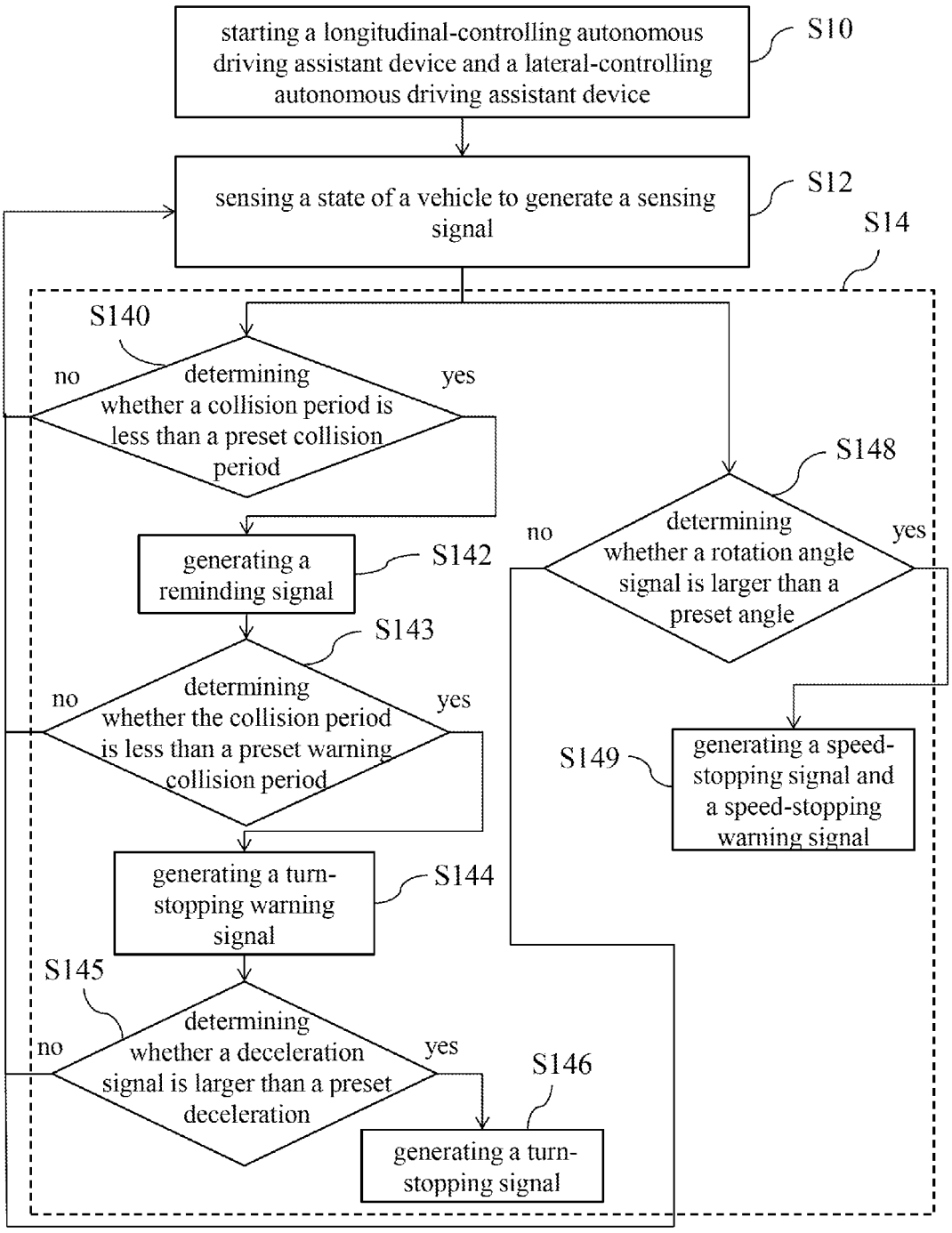

starting a longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device
S10
sensing a state of a vehicle to generate a sensing signal
S12
S14
S140
determining whether a collision period is less than a preset collision period
no
yes
generating a reminding signal
S142
S143
determining whether the collision period is less than a preset warning collision period
no
yes
generating a turn-stopping warning signal
S144
S145
determining whether a deceleration signal is larger than a preset deceleration
no
yes
S146
generating a turn-stopping signal
S148
determining whether a rotation angle signal is larger than a preset angle
no
yes
S149
generating a speed-stopping signal and a speed-stopping warning signal

Fig.2

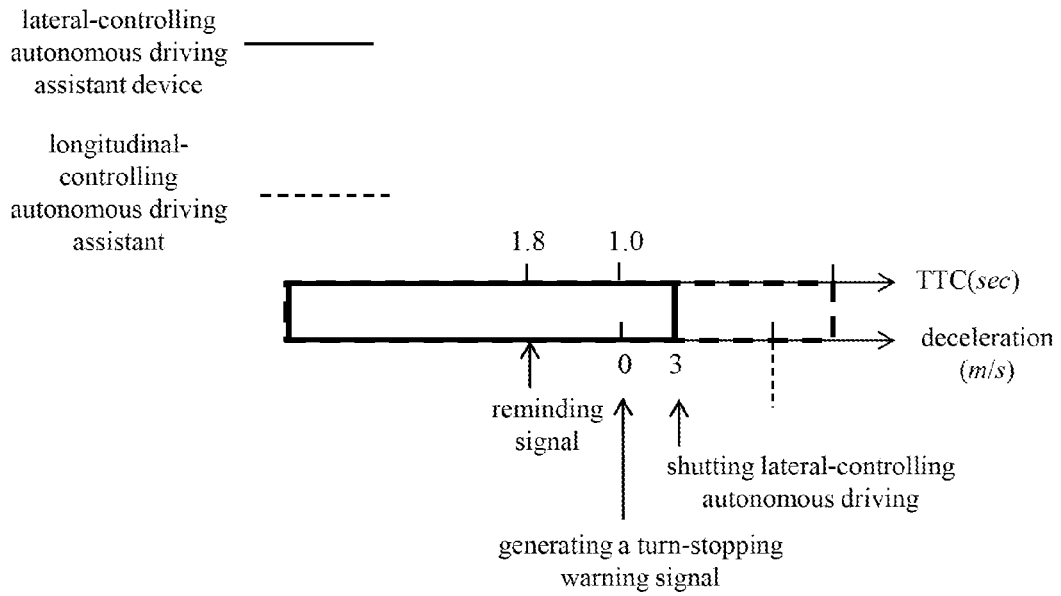

lateral-controlling autonomous driving assistant device
longitudinal-controlling autonomous driving assistant
1.8
1.0
TTC(sec)
deceleration (m/s)
0
3
reminding signal
shutting lateral-controlling autonomous driving
generating a turn-stopping warning signal

Fig.3

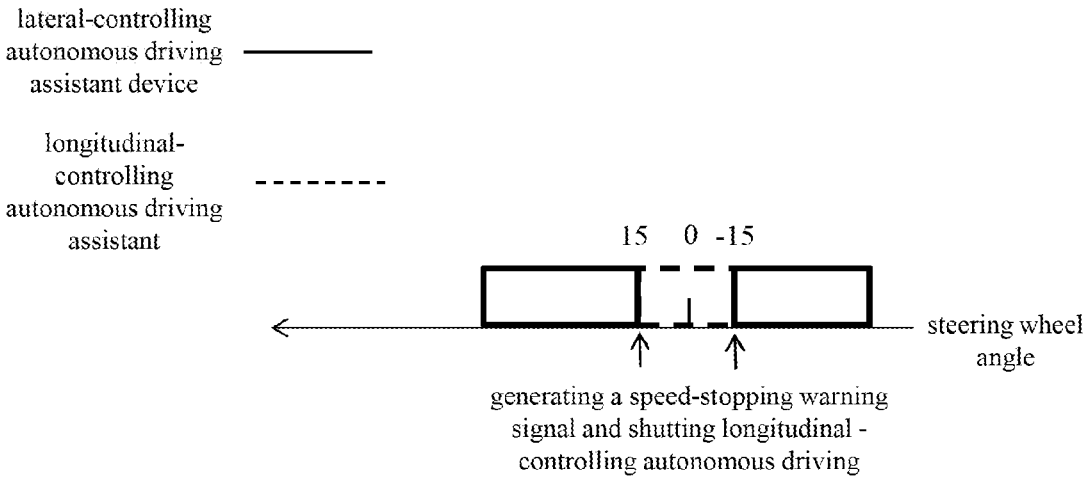

lateral-controlling autonomous driving assistant device
longitudinal-controlling autonomous driving assistant
15
0
-15
steering wheel angle
generating a speed-stopping warning signal and shutting longitudinal - controlling autonomous driving

Fig.4

COMPOSITE AUTONOMOUS DRIVING ASSISTANT SYSTEM FOR MAKING DECISION AND METHOD OF USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an autonomous driving assistant technology, particularly to a composite autonomous driving assistant system for making decision and a method of using the same. The system switches autonomous assistant driving required according to an environment.

Description of the Related Art

[0002] An autonomous driving assistant system can use distance or image sensing devices to sense an external environment of a vehicle body so that a processor generates a control vehicle body signal according to the external environment, so as to control the state that the vehicle body moves on. As a result, the autonomous driving assistant system can assist in driving the vehicle, thereby improving driving and road safety and reducing workload for long-term driving.

[0003] In the United States, the National Highway Traffic Safety Administration (NHTSA) of Department of Transportation (DOT) has proposed a formal classification system: The following pertains to automated vehicles. Level 0: No automation. Level 1: Function-specific automation. Level 2: Combined function automation. Level 3: Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control. Level 4: Full self-driving automation.

[0004] The longitudinal-controlling autonomous assistant system is used to control a longitudinal acceleration, a longitudinal deceleration, a speed, a relative speed, a relative acceleration and a relative deceleration of the vehicle body. For example, an autonomous emergency braking system (AEB) uses precise sensor and electrical equipment to determine whether there are objects in front of the vehicle. If the system determines that a collision possibly occurs, the system automatically makes a quick stop. The lateral-controlling autonomous assistant system is used to control a steering wheel angle, a heading angle, a sideslip angle, a lateral acceleration, a lateral speed and a steering wheel angular speed of the vehicle body. A lane keeping system (LKS) belongs to the lateral-controlling autonomous assistant system. The LKS uses a lens of a charge-coupled device (CCD) in front of the vehicle to catch an image of a lane to calculate a vehicle deviation. When a driver deviates from the lane, the system warns and provides turning control to assist the driver in driving within the lane.

[0005] However, when only one autonomous assistant system is installed on the vehicle, the autonomous assistant system is shut as long as a steering wheel, a throttle or a brake is driven. In the future, the autonomous assistant system will develop toward Level 3, namely combined autonomous assistant systems. When multiple autonomous assistant systems are installed on a vehicle, its situation is not simple. When a longitudinal-controlling autonomous assistant system and a lateral-controlling autonomous assistant system are installed on a vehicle, the vehicle is in the following dangerous situation without using conversion mechanism between the longitudinal-controlling autonomous assistant system and the lateral-controlling autonomous assistant system. When the vehicle corners too much, the longitudinal-controlling autonomous assistant system and the lateral-controlling autonomous assistant system simultaneously start whereby the vehicle turns over and deviates from the lane to cause greater damage. As a result, how to make the longitudinal-controlling autonomous assistant system and the lateral-controlling autonomous assistant system coexist and define a switching threshold condition for the two autonomous driving assistant systems is very important.

[0006] To overcome the abovementioned problems, the present invention provides a composite autonomous driving assistant system for making decision and a method of using the same, so as to solve the afore-mentioned problems of the prior art.

SUMMARY OF THE INVENTION

[0007] A primary objective of the present invention is to provide a composite autonomous driving assistant system for making decision and a method of using the same, which efficiently makes a longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device coexist and defines a threshold condition for two different autonomous driving assistant devices, and which determines that the longitudinal-controlling autonomous driving assistant device or the lateral-controlling autonomous driving assistant device has to shut at present according to states of a vehicle and an environment, thereby improving autonomous driving safety.

[0008] Another objective of the present invention is to provide a composite autonomous driving assistant system for making decision and a method of using the same, which shuts or starts autonomous assistant driving according to the driver's will, so as to control dominance of driving a vehicle, thereby improving driving safety.

[0009] To achieve the abovementioned objectives, the present invention provides a composite autonomous driving assistant system for making decision arranged on a vehicle to automatically assist in driving the vehicle, and the composite autonomous driving assistant system for making decision comprises: a longitudinal-controlling autonomous driving assistant device controlling a moving speed of the vehicle; a lateral-controlling autonomous driving assistant device controlling a rotating angle of the vehicle; a sensing device sensing states of the vehicle and an environment and generating at least one sensing signal comprising a speed signal, a distance signal, a rotation angle signal and a deceleration signal; and a controller electrically connected with the longitudinal-controlling autonomous driving assistant device, the lateral-controlling autonomous driving assistant device and the sensing device, receiving the sensing signal and figuring out a collision period according to the speed signal and the distance signal. When the controller determines that the collision period is less than a preset collision period and that the deceleration signal is larger than a preset deceleration, the controller generates a turn-stopping signal and transmits the turn-stopping signal to the lateral-controlling autonomous driving assistant device to

stop controlling the rotating angle of the vehicle. When the controller determines that the rotation angle signal is larger than a preset angle, the controller generates a speed-stopping signal whereby the longitudinal-controlling autonomous driving assistant device stops controlling the moving speed of the vehicle.

[0010] The longitudinal-controlling autonomous driving assistant device is an autonomous emergency braking system (AEB) or an adaptive cruise control (ACC). The lateral-controlling autonomous driving assistant device is a lane keeping system (LKS) or a lane following control (LFC).

[0011] The sensing device further comprises: a speed sensor sensing a speed of the vehicle to generate the speed signal and the deceleration signal and transmitting the speed signal and the deceleration signal to the controller; a turning sensor sensing a turning angle of the vehicle to generate the rotation angle signal and transmitting the rotation angle signal to the controller; and a ranging sensor sensing a distance to a front obstruction to generate the distance signal and transmitting the distance signal to the controller.

[0012] The present invention also provides a composite autonomous driving assistant method for making decision. Firstly, in Step (A), a longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device start to automatically assist in driving a vehicle. Then, in Step (B), states of the vehicle and an environment are sensed and at least one sensing signal comprising a speed signal, a distance signal, a rotation angle signal and a deceleration signal is generated, wherein the speed signal and the distance signal are used to figure out a collision period. Then, in Step (C), decision is made to determine whether to shut the longitudinal-controlling autonomous driving assistant device or the lateral-controlling autonomous driving assistant device. Step (C1) further comprises Step (C12) of determining whether the collision period is less than the preset collision period: if no, returning Step (B); and if yes, determining whether the deceleration signal is larger than the preset deceleration: if yes, generating the turn-stopping signal and transmitting the turn-stopping signal to the lateral-controlling autonomous driving assistant device to stop controlling the rotating angle of the vehicle; and if no, returning Step (B). When Step (C1) is performed, the process performs Step (C2) of determining whether the rotation angle signal is larger than a preset angle: if yes, generating a speed-stopping signal and transmitting the speed-stopping signal the longitudinal-controlling autonomous driving assistant device to stop controlling a moving speed of the vehicle; and if no, returning the Step (B).

[0013] Below, the embodiments are described in detail in cooperation with the drawings to make easily understood the technical contents; characteristics and accomplishments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a block diagram schematically showing a composite autonomous driving assistant system for making decision according to an embodiment of the present invention;

[0015] FIG. **2** is a flowchart schematically showing a composite autonomous driving assistant method for making decision according to an embodiment of the present invention; and

[0016] FIG. **3** and FIG. **4** are diagrams schematically showing conversion for a longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Refer to FIG. **1**. FIG. **1** is a block diagram schematically showing a composite autonomous driving assistant system for making decision **1** arranged on a vehicle to automatically assist in driving the vehicle. The composite autonomous driving assistant system for making decision **1** comprises a controller **16** electrically connected with a longitudinal-controlling autonomous driving assistant device **10**, a lateral-controlling autonomous driving assistant device **12**, a sensing device **14**, a warning device **18** and an operation interface **20**. The longitudinal-controlling autonomous driving assistant device **10** is used to control a moving speed of the vehicle. The longitudinal-controlling autonomous driving assistant device **10** is an autonomous emergency braking system (AEB) or an adaptive cruise control (ACC) to control a longitudinal acceleration, a longitudinal deceleration, a speed, a relative speed, a relative acceleration and a relative deceleration of the vehicle. The lateral-controlling autonomous driving assistant device **12** is used to control a rotating angle of the vehicle. The lateral-controlling autonomous driving assistant device **12** is a lane keeping system (LKS) or a lane following control (LFC), so as to control a steering wheel angle, a heading angle, a sideslip angle, a lateral acceleration, a lateral speed and a steering wheel angular speed of the vehicle.

[0018] The sensing device **14** is used to sense states of the vehicle and an environment and generate at least one sensing signal comprising a speed signal, a distance signal, a rotation angle signal and a deceleration signal. The sensing device **14** further comprises a speed sensor **142**, a turning sensor **144** and a ranging sensor **146**, which are all electrically connected with the controller **16**. The speed sensor **142** senses a speed of the vehicle to generate the speed signal and the deceleration signal. The turning sensor **144** senses a turning angle of the vehicle to generate the rotation angle signal. The ranging sensor **146** can emit a radar signal to a distance to a front obstruction to generate the distance signal.

[0019] The controller **16** receives the sensing signal of the sensing device **14** and figures out a collision period according to the speed signal generated by the speed sensor **142** and the distance signal generated by the ranging sensor **146**, whereby the controller **16** determines whether the collision period is less than a preset collision period. Simultaneously, the controller **16** determines whether the deceleration signal generated by the speed sensor **142** is larger than a preset deceleration. When the collision period is less than the preset collision period and the deceleration signal is larger than the preset deceleration, the controller **16** generates a turn-stopping signal and transmits the turn-stopping signal to the lateral-controlling autonomous driving assistant device **12** to stop controlling the rotating angle of the vehicle. When the collision period is less than the preset collision period, the controller **16** generates a reminding signal and transmits the reminding signal to the warning device **18** to warn a driver. When the collision period is less than a preset warning collision period, the controller **16** generates a turn-stopping warning signal and transmits the

turn-stopping warning signal to the warning device **18**, so as to warn the driver of the fact that the lateral-controlling autonomous driving assistant device **12** is shutting whereby the driver is careful at all times.

[0020] Besides, the controller **16** simultaneously determines whether the rotation angle signal is larger than a preset angle. When the rotation angle signal is larger than the preset angle, the controller **16** generates a speed-stopping signal and transmits the speed-stopping signal to the longitudinal-controlling autonomous driving assistant device **10** whereby the longitudinal-controlling autonomous driving assistant device **10** stops controlling the moving speed of the vehicle. When the controller **16** generates the speed-stopping signal, the controller **16** generates a speed-stopping warning signal and transmits the speed-stopping warning signal to the warning device **18**, so as to warn the driver of the fact that the longitudinal-controlling autonomous driving assistant device **10** shut.

[0021] The operation interface **20** provides an automation-lifting control signal to the controller **16** to generate the speed-stopping signal and the turn-stopping signal, so as to shut the longitudinal-controlling autonomous driving assistant device **10** or the lateral-controlling autonomous driving assistant device **12**, whereby autonomous assistant driving shuts and the driver regains dominance of driving the vehicle at all times. When autonomous assistant driving malfunctions, manned driving dominates to serve as a safety mechanism.

[0022] After explaining the system of the present invention, the flowchart of the present invention is explained. Refer to FIG. **1** and FIG. **2**. Firstly, in Step S**10**, the longitudinal-controlling autonomous driving assistant device **10** and the lateral-controlling autonomous driving assistant device **12** start to automatically assist in driving the Vehicle. Then, in Step S**12**, the sensing device **14** senses the states of the vehicle and the environment to generate at least one sensing signal which comprises a speed signal, a distance signal, a rotation angle signal and a deceleration signal, wherein the controller **16** uses the speed signal and the distance signal to figure out the collision period. Then, in Step S**14**, the controller **16** makes decision to determine whether to shut the longitudinal-controlling autonomous driving assistant device **10** or the lateral-controlling autonomous driving assistant device **12**. Refer to FIG. **1**, FIG. **2** and FIG. **3**. In Step S**14**, Step S**140** is firstly performed. In Step S**140**, the controller **16** determines whether the collision period is less than the preset collision period. For example, the preset collision period is 2-1.8 seconds, preferably 1.8 seconds, but the present invention is not limited thereto. When the controller **16** determines that the collision period is not less than the preset collision period, the process returns to Step S**12**. When the controller **16** determines that the collision period is less than the preset collision period, the process proceeds to Step S**142**. In Step S**142**, the controller **16** generates the reminding signal and transmits the reminding signal to the warning device **18** to earn the driver. Then, the process proceeds to Step **143**. In Step S**143**, the controller **16** determines whether the collision period is less than the preset warning collision period. For example, the preset warning collision period is 1.2-1 second, preferably 1 second. When the controller **16** determines that the collision period is not less than the preset warning collision period, the process returns to Step S**12**. When the controller **16** determines that the collision period is less than the preset warning collision period, the process proceeds to Step S**144**. In Step S**144**, the controller **16** generates a turn-stopping warning signal and transmits the turn-stopping warning signal to the warning device **18** to warn the driver of the fact that the lateral-controlling autonomous driving assistant device **12** is shutting. Then, the process proceeds to Step S**145**. In Step S**145**, the controller **16** determines whether the deceleration signal is larger than the preset deceleration. For example, the preset deceleration is 2-4 m/s, preferably 3 m/s, but the present invention is not limited thereto. When the deceleration signal is larger than the preset deceleration, the process proceeds to Step S**146**. In Step S**146**, the controller **16** generates the turn-stopping signal and transmits the turn-stopping signal to the lateral-controlling autonomous driving assistant device **12**. When the deceleration signal is not larger than the preset deceleration, the process returns to Step **12**.

[0023] Then, the present invention explains Step S**148**. Refer to FIG. **1**, FIG. **2** and FIG. **4**. In Step S**148**, the controller **16** determines whether the rotation angle signal is larger than a preset angle ranging 15-20 degrees. For example, the preset angle is 15 degrees in the embodiment, but the present invention is not limited thereto. When the rotation angle signal is larger than the preset angle, the process proceeds to Step S**149**. In Step S**149**, the controller **16** generates the speed-stopping signal and transmits the speed-stopping signal to the longitudinal-controlling autonomous driving assistant device **10** whereby the longitudinal-controlling autonomous driving assistant device **10** stops controlling the moving speed of the vehicle. Meanwhile, the controller **16** generates the speed-stopping warning signal and transmits the speed-stopping warning signal to the warning device **18**, so as to warn the driver of the fact that the longitudinal-controlling autonomous driving assistant device **10** shut. When the rotation angle signal is less than the preset angle, the process proceeds to Step S**12** to sense the state of the vehicle again.

[0024] After receiving the reminding signal, the speed-stopping warning signal and the turn-stopping warning signal generated by the warning device **18**, the operation interface **20** provides an automation-lifting control signal to generate the speed-stopping signal and the turn-stopping signal, so as to shut the longitudinal-controlling autonomous driving assistant device **10** or the lateral-controlling autonomous driving assistant device **12**, thereby shutting autonomous assistant driving whereby the driver regains dominance of driving. The activity can serve as a safety mechanism. Certainly, the operation interface **20** provides the automation-lifting control signal at all times to shut autonomous assistant driving whereby the driver regains dominance of driving at all times.

[0025] In conclusion, the present invention efficiently makes the longitudinal-controlling autonomous driving assistant device and the lateral-controlling autonomous driving assistant device coexist, defines a threshold condition for switching two different autonomous driving assistant devices, shuts the longitudinal-controlling autonomous driving assistant device or the lateral-controlling autonomous driving assistant device according to the states of the vehicle and the environment, thereby improving autonomous driving safety. The present invention shuts or starts autonomous assistant driving according to the driver's will. When the driver observes misjudgments and danger of autonomous

assistant driving, the driver can regain dominance of driving, thereby greatly improving driving safety.

[0026] The embodiments described above are only to exemplify the present invention but not to limit the scope of the present invention. Therefore, any equivalent modification or variation according to the shapes, structures, features, or spirit disclosed by the present invention is to be also included within the scope of the present invention.

What is claimed is:

1. A composite autonomous driving assistant system for making decision arranged on a vehicle to automatically assist in driving said vehicle, and said composite autonomous driving assistant system for making decision comprising:

a longitudinal-controlling autonomous driving assistant device controlling a moving speed of said vehicle;

a lateral-controlling autonomous driving assistant device controlling a rotating angle of said vehicle;

a sensing device sensing states of said vehicle and an environment and generating at least one sensing signal comprising a speed signal, a distance signal, a rotation angle signal and a deceleration signal; and

a controller electrically connected with said longitudinal-controlling autonomous driving assistant device, said lateral-controlling autonomous driving assistant device and said sensing device, receiving said sensing signal and figuring out a collision period according to said speed signal and said distance signal, and when said controller determines that said collision period is less than a preset collision period and that said deceleration signal is larger than a preset deceleration, said controller generates a turn-stopping signal and transmits said turn-stopping signal to said lateral-controlling autonomous driving assistant device to stop controlling said rotating angle of said vehicle, and when said controller determines that said rotation angle signal is larger than a preset angle, said controller generates a speed-stopping signal whereby said longitudinal-controlling autonomous driving assistant device stops controlling said moving speed of said vehicle.

2. The composite autonomous driving assistant system for making decision of claim **1**, wherein said longitudinal-controlling autonomous driving assistant device is an autonomous emergency braking system (AEB) or an adaptive cruise control (ACC).

3. The composite autonomous driving assistant system for making decision of claim **1**, wherein said lateral-controlling autonomous driving assistant device is a lane keeping system (LKS) or a lane following control (LFC).

4. The composite autonomous driving assistant system for making decision of claim **1**, wherein said sensing device further comprises:

a speed sensor sensing a speed of said vehicle to generate said speed signal and said deceleration signal and transmitting said speed signal and said deceleration signal to said controller;

a turning sensor sensing a turning angle of said vehicle to generate said rotation angle signal and transmitting said rotation angle signal to said controller; and

a ranging sensor sensing a distance to a front obstruction to generate said distance signal and transmitting said distance signal to said controller.

5. The composite autonomous driving assistant system for making decision of claim **1**, wherein when said controller determines that said collision period is less than said preset collision period, said controller generates a reminding signal; when said controller determines that said collision period is less than a preset warning collision period, said controller generates a turn-stopping warning signal to warns that said lateral-controlling autonomous driving assistant device is shutting; when said controller generates said speed-stopping signal, said controller generates a speed-stopping warning signal to warn that said longitudinal-controlling autonomous driving assistant device shut.

6. The composite autonomous driving assistant system for making decision of claim **5**, further comprising a warning device electrically connected with said controller, receiving said reminding signal, said turn-stopping warning signal and said speed-stopping warning signal, and correspondingly warning according to said reminding signal, said turn-stopping warning signal and said speed-stopping warning signal.

7. The composite autonomous driving assistant system for making decision of claim **1**, further comprising an operation interface electrically connected with said controller and providing an automation-lifting control signal to said controller to generate said speed-stopping signal and said turn-stopping signal, so as to shut said longitudinal-controlling autonomous driving assistant device or said lateral-controlling autonomous driving assistant device.

8. A composite autonomous driving assistant method for making decision comprising:

Step (A): starting a longitudinal-controlling autonomous driving assistant device and a lateral-controlling autonomous driving assistant device to automatically assist in driving a vehicle;

Step (B): sensing states of said vehicle and an environment and generating at least one sensing signal comprising a speed signal, a distance signal, a rotation angle signal and a deceleration signal, wherein said speed signal and said distance signal are used to figure out a collision period; and

Step (C): making decision to determine whether to shut said longitudinal-controlling autonomous driving assistant device or said lateral-controlling autonomous driving assistant device:

Step (C1): determining whether said collision period is less than a preset collision period and determining whether said deceleration signal is larger than a preset deceleration:

if yes, generating a turn-stopping signal and transmitting said turn-stopping signal to said lateral-controlling autonomous driving assistant device to stop controlling a rotating angle of said vehicle; and

if no, returning said Step (B);

Step (C2): determining whether said rotation angle signal is larger than a preset angle:

if yes, generating a speed-stopping signal and transmitting said speed-stopping signal said longitudinal-controlling autonomous driving assistant device to stop controlling a moving speed of said vehicle; and

if no, returning said Step (B).

9. The composite autonomous driving assistant method for making decision of claim **8**, wherein said longitudinal-

controlling autonomous driving assistant device is a autonomous emergency braking system (AEB) or an adaptive cruise control (ACC).

10. The composite autonomous driving assistant method for making decision of claim **8**, wherein said lateral-controlling autonomous driving assistant device is a lane keeping system (LKS) or a lane following control (LFC).

11. The composite autonomous driving assistant method for making decision of claim **8**, wherein said Step (C1) further comprises a Step (C12) of determining whether said collision period is less than said preset collision period:

if no, returning Step (B); and

if yes, determining whether said deceleration signal is larger than said preset deceleration:

if yes, generating said turn-stopping signal and transmitting said turn-stopping signal to said lateral-controlling autonomous driving assistant device to stop controlling said rotating angle of said vehicle; and

if no, returning Step (B).

12. The composite autonomous driving assistant method for making decision of claim **11**, wherein in said Step (C12) of determining whether said collision period is less than said preset collision period, a reminding signal is generated when said collision period is less than said preset collision period.

13. The composite autonomous driving assistant method for making decision of claim **12**, wherein in said Step (C12) of determining whether said collision period is less than said preset collision period, a turn-stopping warning signal is generated to warns that said lateral-controlling autonomous driving assistant device is shutting when said collision period is less than a preset warning collision period.

14. The composite autonomous driving assistant method for making decision of claim **8**, wherein in Step (C2), a speed-stopping warning signal is generated to warn that said longitudinal-controlling autonomous driving assistant device shut when said speed-stopping signal is generated.

15. The composite autonomous driving assistant method for making decision of claim **12**, wherein after generating said reminding signal in Step (C1), an automation-lifting control signal is inputted to generate said speed-stopping signal and said turn-stopping signal, so as to shut said longitudinal-controlling autonomous driving assistant device or said lateral-controlling autonomous driving assistant device.

* * * * *