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(54) Title: COLLISION WARNING

200

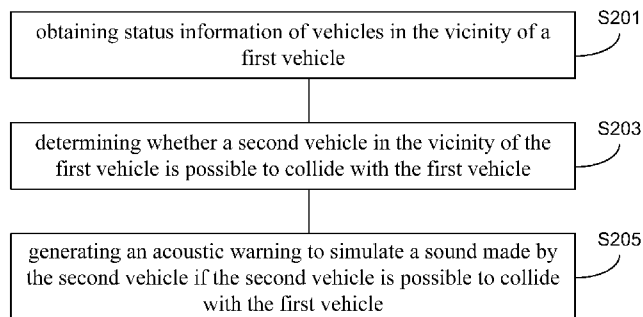


FIG. 2

(57) Abstract: A collision warning method and a collision warning system are provided. The methods includes: generating an acoustic warning to simulate a sound made by a first vehicle which is possible to collide with a second vehicle, wherein the acoustic warning is generated based on status information of the first vehicle obtained by the second vehicle. More realistic acoustic warnings can be provided.



COLLISION WARNING

TECHNICAL FIELD

[0001] The present disclosure generally relates to collision warning.

BACKGROUND

[0002] Nowadays, collision warning solutions have been introduced into some vehicle mounted systems to facilitate safety driving. In some collision warning solutions, a simple sound reminder, such as a tone, may be issued when possibility of a collision with a nearby vehicle exists, such that the driver can be aware of the potential risk.

SUMMARY

[0003] In one embodiment, a collision warning method is provided. The method includes: generating an acoustic warning to simulate a sound made by a first vehicle which is possible to collide with a second vehicle, wherein the acoustic warning is generated based on status information of the first vehicle obtained by the second vehicle.

[0004] In some embodiments, the acoustic warning may be generated further based on status information of the second vehicle.

[0005] In some embodiments, the status information of the first vehicle may include

information representing real-time driving status of the first vehicle. In some embodiments, the information representing real-time driving status of the first vehicle may include position, heading, speed, acceleration, brake status, yaw rate, throttle position, or any combination thereof.

[0006] In some embodiments, the status information of the first vehicle may include information representing at least one inherent feature of the first vehicle. In some embodiments, the at least one inherent feature of the first vehicle may include size, type, engine model, or any combination thereof.

[0007] In some embodiments, at least a part of the status information of the first vehicle may be sent from the first vehicle to the second vehicle through vehicle-to-vehicle communication. For example, the first vehicle may generate a basic safety message containing safety-related information of the first vehicle, and send the basic safety message to the second vehicle through vehicle-to-vehicle communication. The basic safety message may contain information like position, speed, heading, acceleration, yaw rate, size, type, etc.

[0008] In some embodiments, at least a part of the status information of the first vehicle may be obtained by the second vehicle using at least one sensor mounted on the second vehicle. For example, the second vehicle may be equipped with a lidar, a radar, a camera, or the like. By using these sensors, some information of the first vehicle, such as speed, size, position, shape, heading, and the like, can be detected by the second vehicle.

[0009] In some embodiments, the acoustic warning may be generated based on the status information of the first vehicle to simulate a sound having frequency shift effect.

[0010] In some embodiments, the acoustic warning may be generated based on the status information of the first vehicle to simulate a brake sound.

[0011] In some embodiments, the acoustic warning may be generated based on the status information of the first vehicle to simulate an engine sound.

[0012] In some embodiments, the acoustic warning may be generated based on the status information of the first vehicle to simulate a friction sound.

[0013] In some embodiments, the acoustic warning may be generated based on the status information of the first vehicle to simulate a sound made by an object matching with a size of the first vehicle.

[0014] In one embodiment, a collision warning system is provided. The system includes a first device mounted on a first vehicle for obtaining status information of vehicles in the vicinity of the first vehicle, and a second device for generating an acoustic warning to simulate a sound made by a second vehicle based on status information of the second vehicle obtained by the first device, where the second vehicle is in the vicinity of the first vehicle and is possible to collide with the first vehicle.

[0015] In some embodiments, the second device may be configured to generate the acoustic warning further based on status information of the first vehicle.

[0016] In some embodiments, the second device may include a processor and a memory. The memory may store a plurality pieces of acoustic files and/or a plurality of acoustic signal models. And the processor may detect the acoustic files and/or acoustic signal models stored in the memory, and use one or more of these acoustic files and/or acoustic signal models to generate the acoustic warning based on the status

information of the second vehicle obtained by the first device.

[0017] In some embodiments, the status information of the second vehicle may include information representing real-time driving status of the second vehicle.

[0018] In some embodiments, the status information of the second vehicle may include information representing at least one inherent feature of the second vehicle.

[0019] In some embodiments, the first device may include a communication device for receiving at least a part of the status information sent by the vehicles in the vicinity of the first vehicle.

[0020] In some embodiments, the first device may include at least one sensor for detecting at least a part of the status information of the vehicles in the vicinity of the first vehicle.

[0021] In some embodiments, the second device may be configured to generate the acoustic warning based on the status information of the second vehicle to simulate a sound having frequency shift effect.

[0022] In some embodiments, the second device may be configured to generate the acoustic warning based on the status information of the second vehicle to simulate a brake sound.

[0023] In some embodiments, the second device may be configured to generate the acoustic warning based on the status information of the second vehicle to simulate an engine sound.

[0024] In some embodiments, the second device may be configured to generate the

acoustic warning based on the status information of the second vehicle to simulate a friction sound.

[0025] In some embodiments, the second device may be configured to generate the acoustic warning based on the status information of the second vehicle to simulate a sound made by an object matching with a size of the second vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings.

[0027] FIG. 1 schematically illustrates a block diagram of a collision warning system according to one embodiment.

[0028] FIG. 2 schematically illustrates a flow chart of a collision warning method according to one embodiment.

DETAILED DESCRIPTION

[0029] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments

described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

[0030] During driving, it is important for drivers to hear sounds made by nearby vehicles, especially when there is a risk of collision with one or more nearby vehicles. Further, compared with merely hearing a simple warning tone, it would be better for the drivers to hear the sound actually made by dangerous vehicles. In this way, drivers may determine what to do in next step based on different situations.

[0031] Referring to FIG. 1, a collision warning system 100 including a first device 101 and a second device 103 is provided according to one embodiment. The system 100 may be mounted on a vehicle (hereinafter referred to as “host vehicle”), for giving sound warnings to the driver of the host vehicle when a risk of collision with another vehicle exists.

[0032] The first device 101 is adapted for obtaining status information of nearby vehicles within the vicinity of the host vehicle. The vicinity of the host vehicle is a range within which vehicles, are perceivable for the host vehicle, i.e., the host vehicle is capable of obtaining the status information of these vehicle through various ways. In some embodiments, the first device 101 may include a communication device adapted for receiving at least a part of the status information of the nearby vehicles through

vehicle-to-vehicle (V2V) communication. In such an occasion, the vicinity may be a V2V communication range. In some embodiments, the first device 101 may include at least one sensor mounted on the host vehicle. In such an occasion, the vicinity may be an effective detection range of the at least one sensor.

[0033] The second device 103 is adapted for generating an acoustic warning when there is a vehicle (hereinafter referred to as “remote vehicle”) that is in the vicinity of the host vehicle and is possible to collide with the host vehicle. The second device 103 may generate the acoustic warning to simulate a sound made by the remote vehicle, such that the driver can get a realistic feeling of a coming danger.

[0034] The sound made by the remote vehicle may depend on status of the remote vehicle. The status of the remote vehicle may for example include inherent feature of the remote vehicle, real-time status and so on. For example, larger vehicles make greater noise, so size, as an inherent feature, would influence the sound made by the remote vehicle. For another example, engines will make different sounds in acceleration mode or cruising mode (running in a constant speed), so speed and acceleration, as real-time status, can also influence the sound made by the remote vehicle.

[0035] In some embodiments, the status information of the remote vehicle may include information representing real-time driving status of the remote vehicle. For example, the real-time driving status may include: position, heading, speed, acceleration, brake status, yaw rate, throttle position of the remote vehicle, or any combination thereof.

[0036] In some embodiments, the status information of the remote vehicle may include information representing at least one inherent feature of the remote vehicle. For

example, the at least one inherent feature of the remote vehicle may include size, type, engine model of the remote vehicle, or any combination thereof.

[0037] There are various ways for the host vehicle to obtain such status information of the remote vehicle. As described above, the first device 101 may include a communication device. Safety-related information, such as position, heading, speed, acceleration, yaw rate, throttle position, size, etc., can be contained in safety messages to be transmitted between vehicles, so at least a part of the status information of the remote vehicle can be contained in a message, for example, a basic safety message, and received by the communication device through V2V communication. Besides, in some embodiments, the first device 101 may include one or more sensors. Sensors like radar, lidar, camera, or a combination thereof, can detect position, size, speed, heading, shape, etc., of an object. Therefore, in some embodiments, at least a part of the status information of the remote vehicle may be detected by the host vehicle by using the one or more sensors.

[0038] The second device 103 may include a memory and a processor. The memory may store multiple pieces of acoustic files and/or a plurality of acoustic signal models. The processor may detect the acoustic files and/or acoustic signal models stored in the memory, and use one or more of these acoustic files and/or acoustic signal models to generate the acoustic warning based on the status information of the remote vehicle obtained by the first device 101. For example, the first device 101 may obtain size information of the remote vehicle, based on which the processor may determine the remote vehicle could be a truck. Based on the determination, the processor may extract a truck engine sound stored in the memory to generate the acoustic warning.

[0039] Some examples of simulating the sound made by the remote vehicle based on the status information of the remote vehicle will be illustrated hereinafter.

[0040] In some embodiments, the second device 103 may be configured to generate the acoustic warning based on the status information of the remote vehicle and further based on status information of the host vehicle itself to simulate a sound having frequency shift effect. For example, the remote vehicle may be approaching the host vehicle or moving away from the host vehicle, which can be detected based on positions and speeds of both the host vehicle and the remote vehicle. As a result, Doppler effect may occur. Therefore, the sound made by the remote vehicle may have frequency shift effect. Specifically, based on the position and speed information of the remote vehicle, in conjunction with ego position and speed of the host vehicle, whether the remote vehicle is approaching or moving away can be determined and a frequency offset value can be calculated. To simulate the Doppler effect, frequency spectrum of the acoustic warning may be shifted with the calculated offset value to either higher frequency or lower frequency according to the calculation result.

[0041] In some embodiments, the second device 103 may be configured to generate the acoustic warning to simulate a brake sound. For example, if the remote vehicle is running in front of the host vehicle, which can be determined based on the position and heading information thereof, and if the brake status of the remote vehicle shows that the remote vehicle brakes at a specific moment, the acoustic warning can simulate a relatively shrill brake sound to inform the driver in the host vehicle of the emergency.

[0042] In some embodiments, the second device 103 may be configured to generate the acoustic warning to simulate an engine sound. Different engines in different states

may generate different sounds. Based on the status information of the remote vehicle, more particularly, based on the speed, acceleration and size information thereof, the second device 103 can synthesize a specific engine sound.

[0043] In some embodiments, the second device 103 may be configured to generate the acoustic warning to simulate a friction sound. When the remote vehicle is turning, friction between the ground and the remote vehicle becomes larger, such that a friction sound may be generated. Therefore, based on the yaw rate information of the remote vehicle, the second device 103 may generate a friction sound. In some embodiments, the friction sound may be synthesized when the yaw rate gets greater than a preset value. In some embodiments, the magnitude of the friction sound may be determined based on the yaw rate.

[0044] In some embodiments, the second device 103 may be configured to generate the acoustic warning to simulate a sound made by an object matching with a size of the remote vehicle. Based on the size information of the remote vehicle, the type of the remote vehicle can be determined. For example, if the size of the remote vehicle matches with the size of a motorcycle, an automobile, a small truck, a large truck, or the like, the second device 103 may generate a sound likely to be made by the matched type of vehicle. As a result, the driver can be aware of the type of the remote vehicle according to the acoustic warning.

[0045] The first device 101 and the second device 103 may be disposed at a same place, e.g., both on the host vehicle. It should be noted that, in some embodiments, the first device 101 and the second device 103 may be separated apart and disposed at different places. For example, the first device 101 may still be mounted on the host

vehicle, while the second device 103 may be disposed in a sever. As long as the host vehicle can communicate with the sever, for example, through wireless communication, the sever can receive the status information of the remote vehicle from the host vehicle. The second device 103 may be a processing device disposed in the sever. Based on the status information of the remote vehicle received from the host vehicle, the processing device may generate an acoustic signal. The host vehicle may receive the acoustic signal from the sever, and play the acoustic signal using its on-board acoustic system, for example, using one or more vehicle-mounted loudspeakers. In such a way, an acoustic warning corresponding to the acoustic signal can be provided.

[0046] In some embodiments, the second device 103 may be further adapted for determining whether a nearby vehicle is possible to collide with the host vehicle. Based on the status information of the nearby vehicles obtained by the first device 101, further with reference to other information such as map data, ego driving status data, and the like, the second device 103 may determine whether there is a possibility of collision between a nearby vehicle and the host vehicle. In some embodiments, if there are multiple dangerous vehicles possible to collide with the host vehicle, the second device 103 may further select one vehicle which has the greatest severity and generate an acoustic warning to simulate a sound made by the selected vehicle.

[0047] Referring to FIG. 2, a collision warning method 200 is provided according to one embodiment. The method 200 may include: S201, obtaining status information of vehicles in the vicinity of a first vehicle; S203, determining whether a second vehicle in the vicinity of the first vehicle is possible to collide with the first vehicle; and S205, generating an acoustic warning to simulate a sound made by the second vehicle if the

second vehicle is possible to collide with the first vehicle.

[0048] In S201, the status information may be obtained by the first vehicle using a V2V communication device, a sensor, or the like. In some embodiments, S201 may represent receiving the status information obtained by the first vehicle from the first vehicle. For example, the status information obtained by the first vehicle may be sent to a sever, and following processing based on the status information can be implemented in the sever. Details of obtaining the status information can be conceived by referring to above descriptions.

[0049] In S203, among the vehicles whose status information are perceivable for the first vehicle, whether there are one or more vehicles, for example, the second vehicle, possible to collide with the first vehicle is determined. The determination may be based on the status information of these vehicles, and further based on ego information of the first vehicle. Details of the determination can be obtained by referring to above descriptions.

[0050] In S205, if the second vehicle is determined to be possible to collide with the first vehicle, an acoustic warning is generated to inform the driver in the first vehicle of the emergency. The acoustic warning generated based on the status information of the second vehicle may simulate the sound made by the second vehicle. How to generate the acoustic warning can be conceived by referring to above descriptions, which will not be illustrated in detail here.

[0051] There is little distinction left between hardware and software implementations of aspects of systems; the use of hardware or software is generally a design choice representing cost vs. efficiency tradeoffs. For example, if an implementer determines

that speed and accuracy are paramount, the implementer may opt for a mainly hardware and/or firmware vehicle; if flexibility is paramount, the implementer may opt for a mainly software implementation; or, yet again alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

[0052] While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

We Claim:

1. A collision warning method, comprising:

generating an acoustic warning to simulate a sound made by a first vehicle which is possible to collide with a second vehicle, wherein the acoustic warning is generated based on status information of the first vehicle obtained by the second vehicle.
2. The method according to claim 1, wherein the status information of the first vehicle comprises information representing real-time driving status of the first vehicle.
3. The method according to claim 1, wherein the status information of the first vehicle comprises information representing at least one inherent feature of the first vehicle.
4. The method according to claim 1, wherein at least a part of the status information of the first vehicle is sent from the first vehicle to the second vehicle through vehicle-to-vehicle communication.
5. The method according to claim 1, wherein at least a part of the status information of the first vehicle is obtained by the second vehicle using at least one sensor mounted on the second vehicle.
6. The method according to claim 1, wherein the acoustic warning is generated based on the status information of the first vehicle to simulate a sound having frequency shift effect.
7. The method according to claim 1, wherein the acoustic warning is generated based on the status information of the first vehicle to simulate a brake sound.
8. The method according to claim 1, wherein the acoustic warning is generated based on the status information of the first vehicle to simulate an engine sound.

9. The method according to claim 1, wherein the acoustic warning is generated based on the status information of the first vehicle to simulate a friction sound.
10. The method according to claim 1, wherein the acoustic warning is generated based on the status information of the first vehicle to simulate a sound made by an object matching with a size of the first vehicle.
11. A collision warning system, comprising:
 - a first device mounted on a first vehicle for obtaining status information of vehicles in the vicinity of the first vehicle; and
 - a second device for generating an acoustic warning to simulate a sound made by a second vehicle based on status information of the second vehicle obtained by the first device, where the second vehicle is in the vicinity of the first vehicle and is possible to collide with the first vehicle.
12. The system according to claim 11, wherein the first device comprises a communication device for receiving at least a part of the status information sent by the vehicles in the vicinity of the first vehicle.
13. The system according to claim 11, wherein the first device comprises at least one sensor for detecting at least a part of the status information of the vehicles in the vicinity of the first vehicle.
14. The system according to claim 11, wherein the second device is configured to generate the acoustic warning based on the status information of the second vehicle to simulate a sound having frequency shift effect.
15. The system according to claim 11, wherein the second device is configured to generate the acoustic warning based on the status information of the second vehicle to simulate a brake sound.

16. The system according to claim 11, wherein the second device is configured to generate the acoustic warning based on the status information of the second vehicle to simulate an engine sound.
17. The system according to claim 11, wherein the second device is configured to generate the acoustic warning based on the status information of the second vehicle to simulate a friction sound.
18. The system according to claim 11, wherein the second device is configured to generate the acoustic warning based on the status information of the second vehicle to simulate a sound made by an object matching with a size of the second vehicle.

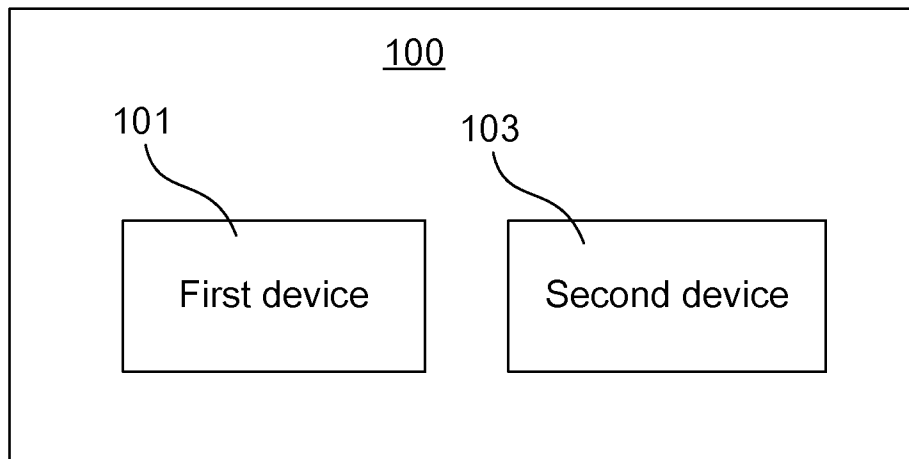


FIG. 1

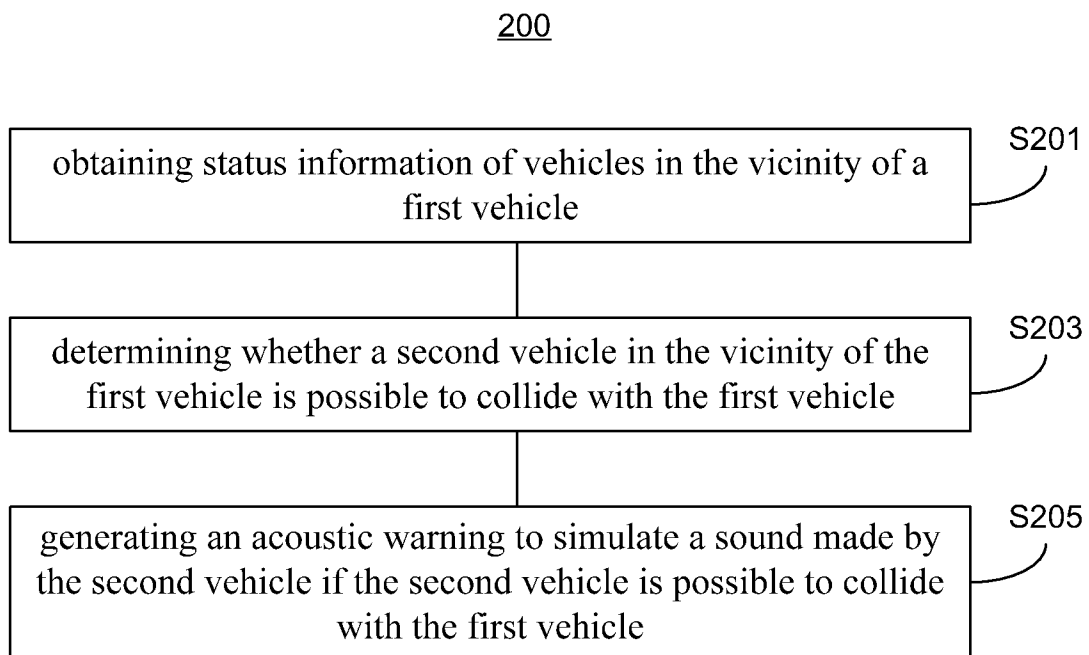


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/072631

A. CLASSIFICATION OF SUBJECT MATTER

B60R 21/0134(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60R, B60Q, G01S, G08C

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, VEN: vehicle, collide/collision, varning/alarm, sound/acoustic/audio

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008114940 A1 (JUNG GYU SUNG) 25 September 2008 (2008-09-25) abstract, figures 1 to 2 and description pages 3 to 4	1-2, 4-9, 11-12, 14-18
X	WO 2010149927 A2 (INRETS INST NAT DE RECH SUR LES TRANSPORTS ET LEUR SECURITE ET AL.) 29 December 2010 (2010-12-29) abstract, figure 1, and description pages 1 to 5	1-2, 4-9, 11-12, 14-18
X	CN 102837698 A (MANDO CORP) 26 December 2012 (2012-12-26) figures 1 to 3 and description pages 2 to 5	1-2, 4-9, 11-12, 14-18
X	DE 102004062497 A1 (DAIMLER CHRYSLER AG) 13 July 2006 (2006-07-13) figure 1 and description	1-2, 4-9, 11-12, 14-18
X	CN 202574100 U (GEELY AUTOMOBILE RES INST ZJ ET AL.) 05 December 2012 (2012-12-05) the whole document	1-2, 4-9, 11-12, 14-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

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“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

09 September 2015

Date of mailing of the international search report

24 November 2015

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/072631

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 102011119959 A1 (DAIMLER AG) 30 April 2014 (2014-04-30) the whole document	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/072631

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WO	2010149927	A2	29 December 2010	FR	2946936	A1	24 December 2010
				EP	2445759	B1	28 August 2013
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				DE	102012012591	A1	27 December 2012
				US	2013024073	A1	24 January 2013
DE	102004062497	A1	13 July 2006	None			
CN	202574100	U	05 December 2012	None			
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