



(51) International Patent Classification:
B60Q 3/80 (2017.01)

(21) International Application Number:
PCT/EP2018/085435

(22) International Filing Date:
18 December 2018 (18.12.2018)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **TOYOTA MOTOR EUROPE** [BE/BE]; Avenue du Bourget 60, 1140 Brussels (BE).

(72) Inventor: **GENTNER, Alexandre**; c/o Toyota Motor Europe, European Technical Administration, Division, Avenue du Bourget 60, 1140 Brussels (BE).

(74) Agent: **HEWEL, Christoph** et al.; CABINET BEAU DE LOMENIE, 158 Rue de l'Université, 75340 PARIS CEDEX 07 (FR).

MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,

(54) Title: AUTOMATED DRIVING SYSTEM AND METHOD FOR CONTROLLING A CABIN ILLUMINATION

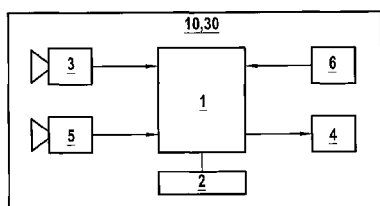


FIG.1

(57) Abstract: The invention relates to an automated driving system (30) for a self-driving vehicle comprising a passenger cabin with at least one window, the automated driving system comprising: • a cabin illumination control unit (4) configured to control the interior illumination being inside the passenger cabin, • a first sensor unit (3) configured to sense exterior illumination being outside the vehicle and directed toward the window, and • an electronic control unit (1) configured to: receive a sensor output of the first sensor unit (3), determine at least one first parameter of the exterior illumination based on the sensor output, and control the cabin illumination control unit (4) to generate an interior illumination pattern as a function of the at least one first parameter. The invention further relates to a self-driving vehicle and a method.

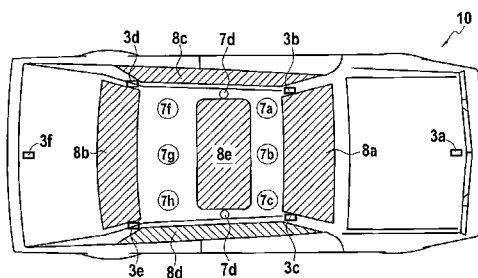


FIG.2

AUTOMATED DRIVING SYSTEM AND METHOD FOR CONTROLLING
A CABIN ILLUMINATION

FIELD OF THE DISCLOSURE

5 [0001] The present disclosure is related to an automated driving system, a self-driving vehicle, and a method of cabin illumination in a self-driving vehicle having an automated driving system.

 [0002] An automated driving system is a motor vehicle driving automation system that is capable of performing part or all of the dynamic driving task
10 (DDT) on a sustained basis. An automated driving system may be mounted or is to be mounted in a vehicle (such as a car, a truck, an airplane).

 [0003] In the case of road vehicles in particular, it may range in level from no driving automation (level 0) to full driving automation (level 5) according to SAE norm J3016.

15 [0004] In order to realize this function, an automated driving system normally comprises at least one sensor, an electronic control unit, and feedback devices which transmit information to the driver and/or act on control member(s) of the vehicle (for instance the steering shaft, the brake, the accelerator pedal or the like) instead of the driver to take some driving load off
20 the driver.

 [0005] An automated driving system is at least capable of assuming part of the driving task (for instance, to perform longitudinal control of the vehicle). In particular, many automated driving systems are designed to assist the driver and are therefore called Advanced Driver Assistance Systems (ADAS). Some
25 automated driving systems are capable of assuming the whole driving task, at least during some periods. Such systems are classified at level 3, 4 or 5 according to SAE norm J3016.

 [0006] The present disclosure concerns an automated driving system classified desirably at level 4 or 5 according to SAE norm J3016.

30

BACKGROUND OF THE DISCLOSURE

 [0007] During the periods when the automated driving system is activated (level 4 or 5 according to SAE norm J3016), all occupants (i.e. passengers or riders) will be able to focus their full attention on non-driving/monitoring related
35 tasks.

[0008] Due to this circumstance of not focusing on the road and upcoming events a sensory conflict might occur between visual perception and vestibular perception (i.e. inner ear). Such upcoming events may include (sudden or unexpected) changes in light, in particular due to changing (exterior) illumination being outside the vehicle. Since the vehicle usually has one or several windows, such changes also affect the (interior) illumination being inside the vehicle cabin. In other words, changes of exterior illumination may reach the cabin through the windows.

[0009] For example, exterior illumination may be influenced by e.g. shadow areas on the road (e.g. caused by landscape, building, tunnel...), punctual light sources (other vehicle lights, street lighting, etc.), changes in illuminance from sun/moon (e.g. clouds, etc.).

[0010] As a consequence, the occupants of the vehicle may feel a visual discomfort, as also described in Boyce, P.R, (2014). Human Factors in Lighting, Third Edition, CRC Press.

[0011] US20170253254A1 further discloses a sensory stimulation system for autonomous vehicle (AV) which can monitor a set of maneuvers of the AV. Based on each respective maneuver, the sensory stimulation system can determine a set of sensory stimulation outputs to provide a rider of the AV with sensory indications of the respective maneuver. The sensory stimulation system can then output the set of sensory stimulation outputs via an interior output system. For example maneuvers like vehicle acceleration, braking or change of direction are indicated by a respectively changing stimulation output.

[0012] However, such systems may be a source of further illumination changes inside the cabin and hence of an additional visual discomfort.

SUMMARY OF THE DISCLOSURE

[0013] Currently, it remains desirable to provide an automated driving system and a method of cabin illumination in a self-driving vehicle having an automated driving system which ameliorates the visual comfort for vehicle occupants when the automated driving system is activated.

[0014] Therefore, according to the embodiments of the present disclosure, an automated driving system for a self-driving vehicle is provided. The automated driving system comprises:

- a cabin illumination control unit (4) configured to control the interior illumination, which is the illumination inside the passenger cabin,
- a first sensor unit (3) configured to sense exterior illumination which is the illumination outside the vehicle and which is directed toward the window, and
- an electronic control unit (1) configured to:
 - o receive a sensor output of the first sensor unit (3),
 - o determine at least one first parameter of the exterior illumination based on the sensor output, and
 - o control the cabin illumination control unit (4) to generate an interior illumination pattern as a function of the at least one first parameter.

[0015] By providing such a control device, it becomes possible to improve the visual comfort of the occupants of the self-driving vehicle. In particular, by limiting the changes in illuminance in the field of view of the occupants, it is desirably still possible for them, to still have some visibility to the exterior (i.e. not completely shading or blackening the windows).

[0016] In particular, in this way it is e.g. possible to target a stable illuminance. Therefore, the occupants of the vehicle will not be confronted to e.g. glare, flicker, or shadows. These aspects of lighting are all sources of visual discomfort. By removing sources of visual discomfort, the performance and pleasure related to in-car activities involving vision can be improved (e.g. reading, discussing, watching a picture or movie). Additionally on improvement of passengers' visual comfort will also have a positive impact on their holistic comfort.

[0017] Sensing the exterior illumination may comprise sensing the illuminance of at least one exterior light source being outside the vehicle and/or the relative position of the exterior light source with regard to the vehicle.

[0018] Accordingly, in particular light spots, as e.g. electrical light sources or the sun can be detected and their light can be compensated.

[0019] The at least one first parameter may represent at least one of: the illuminance of the sensed exterior illumination, the colour of the sensed exterior illumination, and the spatial and/or temporal distribution of the sensed exterior illumination.

[0020] The interior illumination pattern may be generated such that the interior illumination corresponds to predetermined target illumination.

Accordingly, a stable or at least partially stabilized illuminance can be achieved.

5 [0021] The interior illumination pattern may be generated such that temporal and/or spatial changes of the interior illumination are minimized. Accordingly, any temporal or spatial changes of the external light can be compensated.

[0022] The at least one first parameter may represent an exterior illumination pattern based on the sensor output.

10 [0023] The exterior illumination pattern may comprise temporal and spatial characteristics of the exterior illumination. These may be caused e.g. by shadow areas on the road (e.g. caused by landscape, building, tunnel...) and/or punctual light sources (other vehicle lights, street lighting.). It is hence possible that periodic illumination patterns occur (e.g. due to tunnel lights).

15 [0024] The interior illumination pattern may comprise temporal and spatial characteristics which may be selected as a function of the exterior illumination pattern.

[0025] Accordingly, once the exterior illumination pattern has been recognized, the interior illumination pattern may be set such that it
20 compensates the exterior illumination pattern (i.e. to complement it). In particular periodic illumination patterns (e.g. tunnel lights at a constant vehicle speed) may be recognized and compensated reliably due to their stable frequency.

[0026] The cabin illumination control unit may comprises: at least one
25 dimmable light source configured to illuminate the cabin interior with a variable illuminance and/or colour and/or spatial distribution, and/or at least one shading unit configured to variably shade the at least one window including a variable opacity degree and/or colour filter and/or spatial distribution across the window. Alternatively the cabin illumination control unit may be connected to
30 and control the at least one dimmable light source and/or at least one shading unit.

[0027] Accordingly, the illumination control unit is able to generate light, i.e. to additionally illuminate, and to filter/block light from outside, i.e. to selectively reduce the illumination.

[0028] The shading unit comprises at least one controllable filter arranged on or inside the window.

[0029] The automated driving system may further comprise a geo localization unit, and a database configured to store map data.

5 [0030] The electronic control unit may be configured to determine the at least one first parameter of exterior illumination further based on the geo localization of the vehicle and the map data. Accordingly, by consulting a database of geotagged constant illuminance environments (e.g. shadows from tunnels, other elements), the at least one first parameter of exterior
10 illumination may be determined or refined / verified.

[0031] The automated driving system may further comprise: a second sensor unit configured to sense the interior illumination.

[0032] The electronic control unit may be configured to receive a sensor output of the second sensor unit, determine at least one second parameter of
15 the interior illumination based on the second sensor output, and control the cabin illumination control unit to generate the interior illumination pattern as a function of the at least one second parameter.

[0033] Accordingly, the cabin illumination control unit can also be controlled (in addition) based on the detected interior illumination. In this way it can be
20 verified that the interior illumination is stable.

[0034] The first sensor unit may comprise a plurality of light sensors (e.g. luxmeters) arranged to sense the exterior illumination, in particular illumination originating from the front and/or sides and/or back of the vehicle (and/or e.g. omnidirectionally).

25 [0035] For example, the illuminance from different incidence angles coming from light sources outside the vehicle may be measured by luxmeters located outside the vehicle.

[0036] The automated driving system may further comprise at least one camera sensor whose sensor data are used for controlling automated driving,
30 wherein the camera sensor is additionally used as the first sensor unit. In other words, the sensors which are already provided by the automated driving system to carry out (control) the automated driving function may additionally be used to detect the exterior illumination.

[0037] The present disclosure further relates to a self-driving vehicle comprising an automated driving system according to any one of the preceding claims.

[0038] Finally, the present disclosure further relates to a method of cabin illumination in a self-driving vehicle having an automated driving system. The method controls a cabin illumination control unit to control the interior illumination being inside the passenger cabin. The method comprises the steps of:

- sensing exterior illumination being outside the vehicle and directed toward the window,
- determining at least one first parameter of the exterior illumination based on the sensor output, and
- controlling the cabin illumination control unit to generate an interior illumination pattern as a function of the at least one first parameter.

[0039] The method may comprise further method steps which correspond to the functions of the automated driving system, as described above.

[0040] It is intended that combinations of the above-described elements and those within the specification may be made, except where otherwise contradictory.

[0041] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

[0042] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the description, and serve to explain the principles thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] Fig. 1 shows a block diagram of an automated driving system according to embodiments of the present disclosure;

[0044] Fig. 2 shows a schematic representation of a vehicle in a top view with a plurality of sensors, light sources and shading units according to embodiments of the present disclosure; and

[0045] Fig. 3 shows a schematic representation of an electronic control unit and its inputs according to embodiments of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0046] Reference will now be made in detail to exemplary embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0047] Fig. 1 shows a block diagram of an automated driving system 30 with an electronic control unit 1 according to embodiments of the present disclosure. The automated driving system 30 is part of a self-driving vehicle 10. The vehicle 10 has a vehicle cabin for transporting passengers (i.e. the occupants).

[0048] The electronic control unit 1 is connected to or comprises a data storage 2. Said data storage may be used e.g. to store map data.

[0049] The electronic control unit 1 is further connected to a geo localization unit 6 which provides geo localization data of the vehicle to the control unit 1.

[0050] The electronic control unit 1 may additionally carry out further functions in the vehicle 10. For example, the control device may also act as the general purpose ECU (electronic control unit) of the vehicle. In particular the electronic control unit 1 may control the automated driving function. The electronic control unit 1 may comprise an electronic circuit, a processor (shared, dedicated, or group), a combinational logic circuit, a memory that executes one or more software programs, and/or other suitable components that provide the described functionality.

[0051] The electronic control unit 1 is further connected to a (first) sensor unit 3, in particular comprising a plurality of light sensors, e.g. luxmeters and/or digital cameras. The sensor unit 3 is configured such that it can sense exterior illumination which, i.e. the illumination (comprising light sources) around the vehicle 10. The sensors of are desirably oriented to the exterior of the vehicle and in a plurality, preferably all directions.

[0052] The electronic control unit 1 may be further connected to a second sensor unit 5 (optional), in particular comprising at least one light sensor, e.g. a luxmeter and/or digital camera. The sensor unit 5 is configured such that it can sense interior illumination, i.e. the illumination inside the vehicle cabin.

[0053] The output of sensor unit 3 (and if existing of the sensor unit 5), in particular a recorded stream or single samples recorded at a predetermined sampling frequency (e.g. every second), is transmitted to the electronic control

unit 1. Desirably, the output is transmitted instantaneously, i.e. in real time or in quasi real time. Hence, the exterior (and optionally also the interior) illumination can also be determined by the electronic control unit in real time or in quasi real time.

5 [0054] The electronic control unit 1 is further connected to a cabin illumination control unit 4. The cabin illumination control unit 4 may be configured to control the interior illumination, i.e. the illumination inside the passenger cabin. This may be done by generating artificial light inside the cabin and/or shading light coming from outside. Based on the output of the sensor
10 unit 3, the electronic control unit determines the at least one first parameter of the exterior illumination based on which the cabin illumination control unit 4 is controlled.

[0055] Fig. 2 shows a schematic representation of a vehicle 10 in a top view with a plurality of sensors 3a-f, light sources 7a-h and shading units 8a-e
15 according to embodiments of the present disclosure. Also more or less sensors 3a-f, light sources 7a-h and shading units 8a-e may be used. The light sources 7a-h and shading units 8a-e may be comprised by the illumination control unit 4 (cf. fig. 1) or external elements controlled by the illumination control unit 4.

[0056] The sensors 3a-f may be situated at the front and back (3a and 3f)
20 of the vehicle and/or on the corners of the cabin roof (3b-e). They are desirably oriented radially to the exterior of the vehicle, in order to sense light from any direction.

[0057] The light sources 7a – h are arranged inside the vehicle cabin, e.g. in the cabin roof inner side and or in the vicinity of the cabin windows. The light
25 sources may comprise each desirably a plurality of LEDs. The LEDs may be able to change their illuminance and/or the color of the emitted light. The light sources may additionally or alternatively comprise OLED surface(s) (that may be printed on the vehicle cabin's interior surfaces) or electroluminescent surfaces. Furthermore it is desirable that the orientation of the light sources or
30 at least of their emitted light may be changeable and controllable by the control unit 1.

[0058] The shading units 8a-e are desirably integrated into the cabin windows. In other words, each cabin window may be provided with a shading
unit in the form of a selectively controllable filter layer. The shading units may
35 therefore be configured to selectively set the opacity degree of the windows or

specific areas of the windows. The shading units may also act as color filters. The shading units may comprise or consist of electrochromic glass. For example, the shading units may comprise printed electrochromic films (e.g. formed on or in the vehicle window(s)) configured to control the opacity degree and/or the color filtered from specific areas of the surface they are printed on.

[0059] Accordingly, in order to control illuminance in various cabin locations for a vehicle equipped with windows, two light source categories need to be controlled: light coming from outside the vehicle and light coming from within the vehicle.

[0060] Illuminance from different incidence angles coming from light sources outside the vehicle can be obtained by the luxmeters 3a-f located outside the vehicle and/or by consulting a database of geotagged constant illuminance environments (e.g. shadows from tunnels, other elements). The impact of light source from outside the vehicle on interior luminance inside the cabin can be controlled by changing the opacity of windows by the shading units 8a-e. In a possible embodiment, the opacity degree of a complete window may be adjustable. In a further possible embodiment, areas within the window may be controlled to have different opacity degrees to each other.

[0061] The control of light generated inside the vehicle can be done by controlling the orientation and intensity of the artificial light sources 7a-h.

[0062] Fig. 3 shows a schematic representation of an electronic control unit 1 and its inputs according to embodiments of the present disclosure.

[0063] The control unit 1 (i.e. the data processing system E/) is part of an automated driving system and is configured to limit the changes in illuminance in the field of view of occupants (i.e. riders) of a self-driving vehicle, meanwhile still allowing them to have some visibility to the vehicle exterior (this means that e.g. the window of the vehicle are not just simply removed or blackened). The control unit 1 receives several inputs. A first input may be an input set by an vehicle occupant (i.e. a vehicle rider). This input may control the desired target illuminance and/or light color inside the vehicle cabin. In other words, it is a target parameter for the electronic control unit 1.

[0064] In particular, the control unit 1 may receive two different target values: A/ The target illumination for the vehicle interior set by the main rider (i.e. $Lux_{int_{target}}$), and B/ Local illumination targets that can be set by each rider located in the X location available in the vehicle (i.e. $Lux_{int_{target}} +$

$\alpha_{locationX}$). Accordingly, the illumination may be set individually and hence differ within the vehicle cabin.

[0065] The control unit 1 further receives sensor data, in order to control the cabin illumination as close as possible to the set target parameter. In particular, the control unit 1 may receive an input of at least one of the following sources:

[0066] C/ Upcoming exterior illuminance related to different incidence angles outside the vehicle originating from a database 2 in combination with global positioning data of a GPS sensor 6 and optionally time information: $Lux_{ext_{storeY}}$. This may e.g. include illumination information of external artificial light sources, e.g. street lights or tunnel lighting. This input is in particular useful in areas which are registered as constant illuminance environment, e.g. a tunnel.

[0067] D/ Real time data regarding illuminance from different incidence angles outside the vehicle: $Lux_{ext_{senseY}}$. This input may origin from a sensor unit 3, in particular from a plurality of light sensors.

[0068] Said input, in particular the real time data D/ of the sensor unit 3 may be raw data. The control unit therefore desirably determines at least one (measurement) parameter based on the received input. For example, the parameter may represent at least one of: the illuminance of the sensed exterior illumination, the colour of the sensed exterior illumination, and the spatial and/or temporal distribution of the sensed exterior illumination.

[0069] In order to keep interior illuminance close to target, the control unit 1 is configured to control the cabin illumination control unit (not shown in fig. 3) as a function of the determined parameter. In this regard the control unit 1 may determine at least one of the following control parameters which are provided to the cabin illumination control unit: F/ The opacity of each of the Z windows: Opa_{winZ} , G/ The intensity of each individual lighting system (total: N) inside the vehicle cabin: $Intens_{lightN}$, and H/ The orientation of each individual lighting system (total: N) inside the vehicle cabin: $Orien_{lightN}$.

[0070] In order to maintain a constant interior illuminance at every location the control unit 1 desirably is configured to keep the equilibrium point of the following equation system:

$$\begin{aligned} (1) \quad & Lux_{int_{target}} + \alpha_{location1} = f(Lux_{extY}, Intens_{lightN}, Orien_{lightN}, Opa_{winZ}) \\ (2) \quad & Lux_{int_{target}} + \alpha_{location2} = f(Lux_{extY}, Intens_{lightN}, Orien_{lightN}, Opa_{winZ}) \end{aligned}$$

$$(N) \text{Lux_int}_{target} + \alpha_{locationN} = f(\text{Lux_ext}_\gamma, \text{Intens}_{lightN}, \text{Orien}_{lightN}, \text{Opa}_{winz})$$

[0071] The function f may be specific to a vehicle configuration (e.g. according to its interior layout, window size, sensor location, etc.).

[0072] Throughout the description, including the claims, the term
 5 "comprising a" should be understood as being synonymous with "comprising at least one" unless otherwise stated. In addition, any range set forth in the description, including the claims should be understood as including its end value(s) unless otherwise stated. Specific values for described elements should
 10 be understood to be within accepted manufacturing or industry tolerances known to one of skill in the art, and any use of the terms "substantially" and/or "approximately" and/or "generally" should be understood to mean falling within such accepted tolerances.

[0073] Although the present disclosure herein has been described with reference to particular embodiments, it is to be understood that these
 15 embodiments are merely illustrative of the principles and applications of the present disclosure.

[0074] It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims.

CLAIMS

1. An automated driving system (30) for a self-driving vehicle comprising a passenger cabin with at least one window, the automated driving
5 system comprising:
a cabin illumination control unit (4) configured to control the interior illumination being inside the passenger cabin,
a first sensor unit (3) configured to sense exterior illumination being outside the vehicle and directed toward the window, and
10 an electronic control unit (1) configured to:
receive a sensor output of the first sensor unit (3),
determine at least one first parameter of the exterior illumination based on the sensor output, and
control the cabin illumination control unit (4) to generate an interior illumination
15 pattern as a function of the at least one first parameter.
2. The automated driving system (30) according claim 1, wherein
sensing the exterior illumination comprises sensing the illuminance of at least
one exterior light source being outside the vehicle and/or the relative position
20 of the exterior light source with regard to the vehicle.
3. The automated driving system (30) according to claim 1 or 2,
wherein
the at least one first parameter represents at least one of: the illuminance of
25 the sensed exterior illumination, the colour of the sensed exterior illumination,
and the spatial and/or temporal distribution of the sensed exterior illumination.
4. The automated driving system (30) according to any one of the
preceding claims, wherein
30 the interior illumination pattern is generated such that the interior illumination
corresponds to predetermined target illumination.
5. The automated driving system (30) according to any one of the
preceding claims, wherein

the interior illumination pattern is generated such that temporal and/or spatial changes of the interior illumination are minimized.

6. The automated driving system (30) according to any one of the preceding claims, wherein
5 the at least one first parameter represents an exterior illumination pattern determined based on the sensor output, the exterior illumination pattern comprising temporal and spatial characteristics of the exterior illumination, and the interior illumination pattern comprises temporal and spatial characteristics
10 which are selected as a function of the exterior illumination pattern.

7. The automated driving system (30) according to any one of the preceding claims, wherein
the cabin illumination control unit (4) comprises:
15 at least one dimmable light source configured to illuminate the cabin interior with a variable illuminance and/or colour and/or spatial distribution, and/or at least one shading unit configured to variably shade the at least one window including a variable opacity degree and/or colour filter and/or spatial distribution across the window.

20 8. The automated driving system (30) according to any one of the preceding claims, wherein
the shading unit comprises at least one controllable filter arranged on or inside the window.

25 9. The automated driving system (30) according to any one of the preceding claims, further comprising:
a geo localization unit, and
a database configured to store map data, wherein
30 the electronic control unit (1) is configured to:
determine the at least one first parameter of exterior illumination further based on the geo localization of the vehicle and the map data.

35 10. The automated driving system (30) according to any one of the preceding claims, further comprising:

a second sensor unit (5) configured to sense the interior illumination wherein the electronic control unit (1) is configured to:

receive a sensor output of the second sensor unit (5),

determine at least one second parameter of the interior illumination based on

5 the second sensor output, and

control the cabin illumination control unit (4) to generate the interior illumination pattern as a function of the at least one second parameter.

11. The automated driving system (30) according to any one of the
10 preceding claims, wherein

the first sensor unit comprises a plurality of light sensors arranged to sense the exterior illumination, in particular illumination originating from the front and/or sides and/or back of the vehicle.

12. The automated driving system (30) according to any one of the
15 preceding claims, further comprising:

at least one camera sensor whose sensor data are used for controlling automated driving, wherein the camera sensor is additionally used as the first sensor unit (3).

20

13. A self-driving vehicle comprising an automated driving system according to any one of the preceding claims.

14. A method of cabin illumination in a self-driving vehicle having an
25 automated driving system, the method controlling a cabin illumination control unit (4) which controls the interior illumination being inside the passenger cabin, comprising the steps of:

sensing exterior illumination being outside the vehicle and directed toward the window,

30 determining at least one first parameter of the exterior illumination based on the sensor output, and

controlling the cabin illumination control unit (4) to generate an interior illumination pattern as a function of the at least one first parameter.

1/2

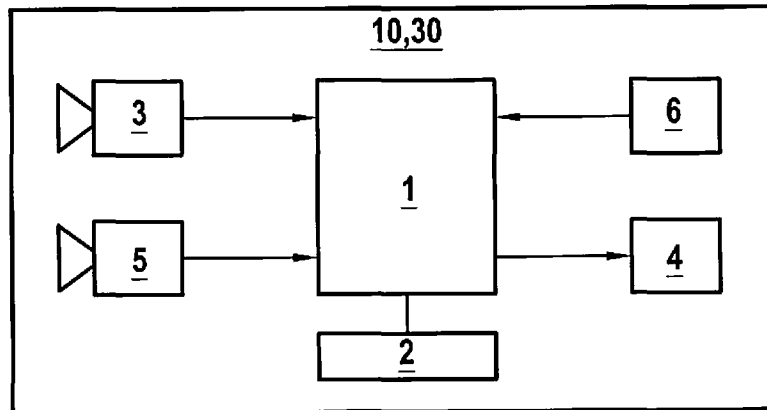


FIG.1

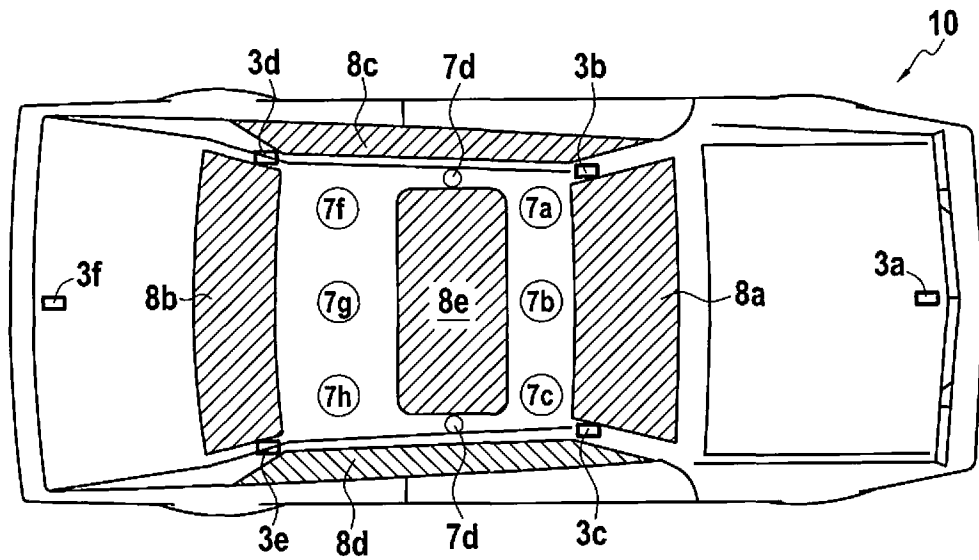


FIG.2

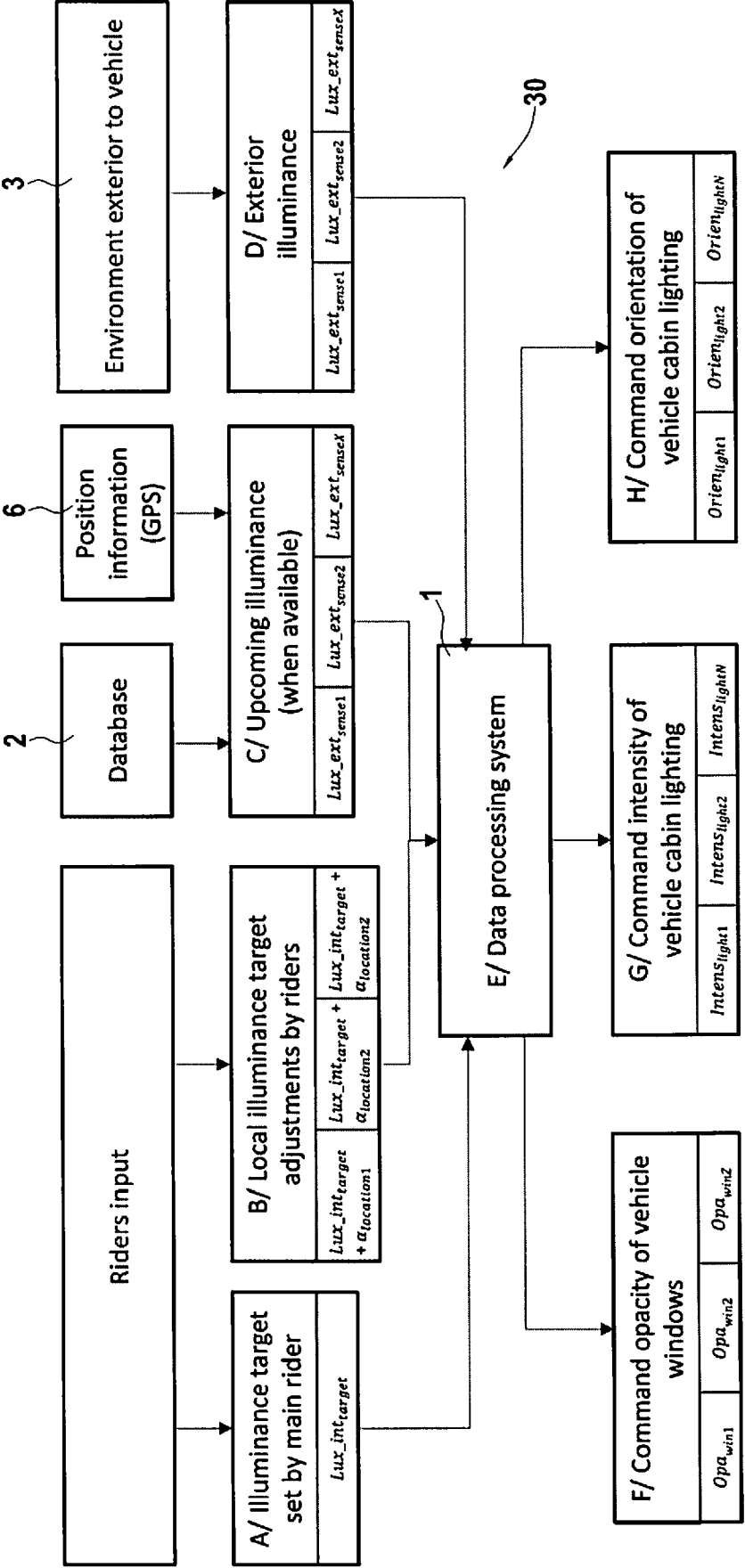


FIG.3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2018/085435

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60Q3/80

ADD.

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)

B60Q

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2015 115578 A1 (HELLA KGAA HUECK & CO [DE]) 16 March 2017 (2017-03-16)	1-4,6,7, 10-14
Y	paragraphs [0007] - [0022]; figure -----	8
X	US 2018/043825 A1 (NAKASHIMA KAZUHIKO [JP]) 15 February 2018 (2018-02-15)	1-4,7,9, 11-14
	paragraphs [0024] - [0074]; figures -----	
X	EP 3 300 953 A1 (VALEO VISION [FR]) 4 April 2018 (2018-04-04)	1-7, 11-14
	paragraphs [0008], [0009], [0015] - [0035], [0048]; figures -----	
X	WO 2014/009264 A1 (TRW AUTOMOTIVE ELECTRON & COMP [DE]) 16 January 2014 (2014-01-16)	1-7,9, 11,13,14
	page 5, line 14 - page 9, line 31; figures ----- -/-	



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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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

5 September 2019

Date of mailing of the international search report

13/09/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Sallard, Fabrice

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/085435

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 3 231 667 A1 (PHILIPS LIGHTING HOLDING BV [NL]) 18 October 2017 (2017-10-18) paragraphs [0040] - [0048]; figure -----	1-7,11, 13,14
X	DE 10 2016 203164 A1 (FORD GLOBAL TECH LLC [US]) 1 December 2016 (2016-12-01) paragraphs [0021] - [0049]; figures -----	1-7,10, 13,14
Y	DE 10 2016 217595 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 15 March 2018 (2018-03-15) paragraphs [0013] - [0028]; figure -----	8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/085435

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102015115578 A1	16-03-2017	DE 102015115578 A1	16-03-2017
		WO 2017045670 A2	23-03-2017
US 2018043825 A1	15-02-2018	CN 107728610 A	23-02-2018
		DE 102017117612 A1	19-07-2018
		JP 6489084 B2	27-03-2019
		JP 2018025986 A	15-02-2018
		US 2018043825 A1	15-02-2018
EP 3300953 A1	04-04-2018	CN 107869669 A	03-04-2018
		EP 3300953 A1	04-04-2018
		FR 3056500 A1	30-03-2018
		US 2018086259 A1	29-03-2018
WO 2014009264 A1	16-01-2014	CN 104428167 A	18-03-2015
		CN 104428168 A	18-03-2015
		DE 102012013783 A1	16-01-2014
		EP 2872364 A1	20-05-2015
		EP 2872365 A1	20-05-2015
		JP 6280547 B2	14-02-2018
		JP 2015525706 A	07-09-2015
		JP 2015528768 A	01-10-2015
		US 2015145410 A1	28-05-2015
		US 2015224924 A1	13-08-2015
		WO 2014009262 A1	16-01-2014
		WO 2014009264 A1	16-01-2014
EP 3231667 A1	18-10-2017	NONE	
DE 102016203164 A1	01-12-2016	CN 106211410 A	07-12-2016
		DE 102016203164 A1	01-12-2016
DE 102016217595 A1	15-03-2018	NONE	