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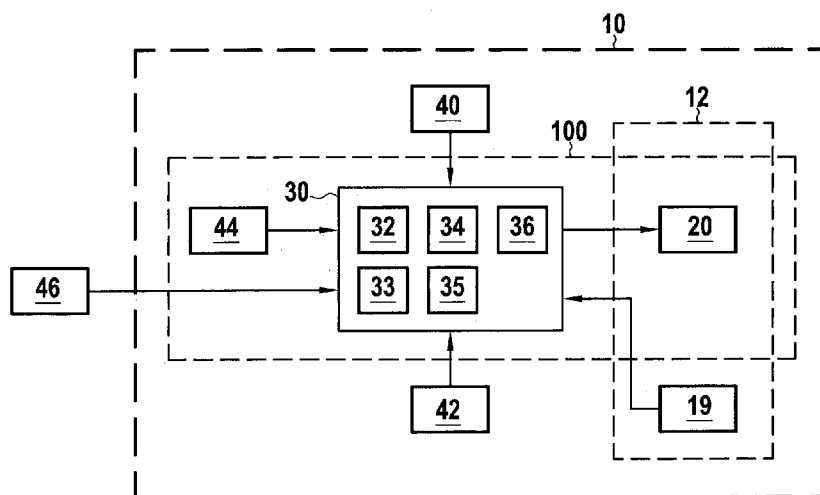


FIG.3

(57) Abstract: A lighting system (100) for a passenger compartment (12) of a vehicle (10), comprising a lighting device (20) configured to emit light and a control unit (30), the control unit (30) being configured to receive acceleration information about the vehicle (10) and to control the lighting device (20) to produce a light animation, wherein the control unit (30) is configured to determine a moving direction of the light animation on the basis of a direction of the acceleration information.



A lighting system for a vehicle passenger compartment

TECHNICAL FIELD

[0001] The present disclosure relates to the field of vehicles, such as automotive vehicles, and more particularly to a lighting system for a vehicle passenger compartment.

TECHNOLOGICAL BACKGROUND

[0002] Patent document US 2018/0086258 A1 relates to a lighting device having dynamic lighting effects to simulate the scrolling of the road inside a vehicle passenger compartment. This lighting device aims to restore a sensation of speed to the occupants of the vehicle.

[0003] However, simulating the scrolling of the road does not add much information as compared to watching the actual road and landscape scrolling and is limited in transmitting motion cues to the vehicle occupants. Therefore, there is a need for a new lighting system.

SUMMARY

[0004] In this respect, the present disclosure relates to a lighting system for a vehicle passenger compartment, comprising a lighting device configured to emit light and a control unit, the control unit being configured to receive acceleration information about the vehicle and to control the lighting device to produce a light animation, wherein the control unit is configured to determine a moving direction of the light animation on the basis of a direction of the acceleration information.

[0005] The passenger compartment is a compartment of the vehicle in which any occupant, including the driver and/or non-driving passengers, is supposed to travel.

[0006] The light animation, as opposed to a stationary lighting, may include changes of at least one light parameter such as the shape, size, pattern, color, brightness, light density, moving speed, etc. of the light emitted by the lighting device, and possibly a variation in the repetition

frequency of the change of at least one of aforementioned light parameters. In particular, the light animation has a moving direction, e.g. by successively modulating the light parameter(s) of adjacent lighting units, gives the occupants an impression of moving or scrolling.

- 5 Additionally, a light animation can be described in terms of color, moving speed, frequency, as well as brightness or light density.

[0007] The acceleration information is information about the acceleration of the vehicle in which the lighting system is mounted. The acceleration information includes at least a direction of the vector
10 representing this acceleration. As used herein, acceleration is a generic term including acceleration strictly speaking (i.e. positive acceleration) as well as deceleration (i.e. negative acceleration), in any direction, including longitudinal (forwards or backwards) or lateral (towards right or left) directions or a combination thereof. Generally speaking, acceleration is the
15 derivative of speed.

[0008] Since the moving direction of the light animation is based on a direction of the acceleration information, the lighting system provides lighting stimuli to moderate the acceleration perception of the vehicle occupants. In this way, the occupants' motion experience can be
20 enhanced without forcing an actual acceleration. Therefore, safety is maintained, if not improved.

[0009] In some embodiments, e.g. in a first control mode, the acceleration information comprises a current acceleration of the vehicle. In other words, the light animation represents the current or on-going
25 acceleration of the vehicle. It also represents the inertia of the elements in the passenger compartment. The overstatement of the motion perceived by the occupants facilitates the generation of emotional occupant experience without implying drastic acceleration in any direction. The current acceleration may be acquired by a sensor, e.g. an accelerometer,
30 and provided to the control unit.

[0010] In some embodiments, the control unit is configured to modulate a brightness, color, light density, frequency or moving speed of the light animation on the basis of a magnitude of the current acceleration of the vehicle. In other words, the direction of the current acceleration (current acceleration vector) is used to determine the moving direction of the light animation and the magnitude of the current acceleration (current acceleration vector) is used to determine the brightness, color, light density, frequency, or moving speed of the light animation. Therefore, the lighting system provides a somewhat complete representation of the current acceleration of the vehicle.

[0011] In some embodiments, e.g. in a second control mode, the acceleration information comprises an acceleration recommendation issued by a vehicle driving-assistance system. In other words, the light animation represents the desired driver's behavior which the driving-assistance system tries to encourage, so that the driver can react appropriately, on the basis of the light animation which carries recommendations from the driving-assistance system. For instance, the control unit may control the lighting device to produce a deceleration animation to encourage the driver to brake.

[0012] In some embodiments, the control unit is configured to modulate a brightness, color, light density, frequency, or moving speed of the light animation on the basis of an event class or a degree of criticality of the acceleration recommendation. The event class may describe the type of event related to which the acceleration recommendation is issued. For instance, a first event class may include acceleration recommendations relating to road infrastructure, such as accelerations that should be followed in response to a traffic light, roundabout, stop sign, speed sign, etc.; a second event class may include acceleration recommendations relating to surrounding vehicles and obstacles, such as acceleration that

should be followed in response to relative speed with surrounding vehicles, front collision warning, parking, etc.

[0013] Besides, the degree of criticality may quantify how it is important for the driver to follow the recommendation and/or how
5 urgently the driver should follow the recommendation, given the situation of the vehicle. Therefore, the lighting device can provide a clear indication about the recommended driver's behavior.

[0014] The control unit may be configured to carry out both the first control mode and the second control mode. In each control mode, the
10 control unit may ignore the acceleration information of the other control mode. Switching between the first and second control modes may be selected by the driver or automatically, e.g. based on the driving mode of the vehicle. For instance, the second control mode may be preferable when the vehicle is driven by the driver, in order to provide him with
15 recommendations, and the first control mode may be preferable when the vehicle is autonomously driven, in order to provide the driver with an accurate acceleration perception while he may not pay much attention to the road.

[0015] In some embodiments, the control unit is configured to
20 control the lighting device to provide ambient lighting. Ambient lighting may be a static, quasi-static, steady or uniform lighting. In particular, the ambient lighting may be independent from the acceleration information. The ambient lighting may depend on settings of the control unit, on an ambient luminosity in the vehicle passenger compartment or outside the
25 vehicle, etc. The ambient lighting may be provided in combination with the light animation; in other words, the lighting device may produce the light animation on top of the ambient lighting.

[0016] In some embodiments, the control unit is configured to
adapt a brightness, color or light density of the light animation on the
30 basis of the ambient lighting provided by the lighting device. Therefore,

the control unit may ensure that the light animation is always visible enough over the ambient lighting. For instance, the brighter the ambient lighting, the brighter the light animation.

[0017] In some embodiments, the control unit is configured to adapt a brightness, color or light density of the light emitted by the lighting device on the basis of an ambient luminosity in the vehicle passenger compartment. Therefore, the control unit may ensure that the light animation is always visible enough, irrespective of the ambient luminosity conditions (which may come from the ambient lighting produced by the lighting device but also from outside light). For instance, the more luminous the vehicle passenger compartment, the brighter the light animation.

[0018] In some embodiments, the control unit is configured to determine the moving direction of the light animation on the basis of at least one of, or both, a longitudinal component and a lateral component of the direction of the acceleration information. In accordance with usual conventions in the art, the longitudinal direction corresponds to a fore-aft direction of the vehicle, and the lateral or traverse direction corresponds to a right-left direction of the vehicle (width direction of the vehicle).

[0019] The control unit may be configured to receive, in the acceleration information, a longitudinal component of the direction of the acceleration information, i.e. the component of said direction along the longitudinal direction, and/or a lateral component of the direction of the acceleration information, i.e. the component of said direction along the lateral direction. These components may be directly received by the control unit, or the control unit may be configured to process the acceleration information to derive these components. While the longitudinal component provides information about what a driver conventionally regards as acceleration or deceleration, the lateral component provides information about turning or cornering.

[0020] In some embodiments, the control unit is configured to control the lighting device not to produce the light animation if the acceleration information is less than a threshold. In order to determine whether the acceleration information is less than a threshold, the acceleration information may be quantified by any appropriate quantifier, such as the current/recommended acceleration magnitude, the above-mentioned event class or criticality of the recommendation, etc., or a combination thereof.

[0021] The threshold may be preset by the driver. The condition of the acceleration information being less than a threshold may be verified for its absolute value or at least one of the longitudinal component and the lateral component, and the conditions being verified may be combined, e.g. with a Boolean operator such as AND, OR, or handled separately. For instance, if the longitudinal component is greater than the threshold and the lateral component is less than the threshold, the control unit may control the lighting device to produce either a light animation with a moving direction based only on the longitudinal component, or a light animation with a moving direction based on both the longitudinal component and the lateral component.

[0022] When the lighting device is controlled not to produce the light animation, it may however still emit other light signals, such as the ambient lighting.

[0023] In some embodiments, the lighting device comprises a plurality of light sources, the control unit being configured to individually control the light sources or groups of the light sources. Thus, the light animation can be realized without mechanically moving parts. As a consequence, reliability is improved.

[0024] In some embodiments, the light sources are arranged as an array, and the light animation comprises forming a light pattern by illuminating some of the light sources, and moving said light pattern along

the array in the moving direction. The moving direction may substantially correspond to the direction of the acceleration information or to a direction opposite thereto. For instance, the moving may be carried out as follows: a first set of light sources is illuminated in the array, and a second set of light sources is subsequently illuminated in the array, the second set having the same shape and being located on a side of the first set, generally adjacent, in the moving direction. Of course, the so-called same shape may adapt to the available light sources; for example, when the pattern intersects an edge of the array, only the light sources corresponding to the portion of the pattern that is within the boundaries of the array may be illuminated.

[0025] In some embodiments, the light pattern may be a line, e.g. a line that is perpendicular to the direction of the acceleration information.

[0026] In some embodiments, the light pattern may be an arrow, e.g. an arrow pointing towards the direction of the acceleration information.

[0027] In some embodiments, the light animation comprises each light source reaching a maximum brightness at a given frequency.

[0028] In some embodiments, the lighting system further comprises a user interface interfaced with the control unit. The interface may be an in-vehicle interface. Alternatively or in addition, the control unit may be configured to interface with a remote device, such as a distant server or a mobile device (e.g. a smartphone).

[0029] The present disclosure is further related to a method for controlling a lighting system for a vehicle passenger compartment, the method comprising receiving acceleration information about the vehicle, determining a moving direction on the basis of a direction of the acceleration information, and controlling a lighting device, configured to emit light, to produce a light animation moving in the moving direction.

The method may use any one of the above-described embodiments of the lighting system.

[0030] The control unit may have the hardware architecture of a computer. Thus, the present disclosure is further related to a computer
5 program including instructions for executing the steps of a control method as defined above when said program is executed by a computer.

[0031] This program can use any programming language and take the form of source code, object code or a code intermediate between source code and object code, such as a partially compiled form, or any
10 other desirable form.

[0032] According to another aspect of the embodiments of the present disclosure, there is provided a recording medium readable by a computer and having recorded thereon a computer program including instructions for executing the steps of a method as defined above.

15 [0033] The recording medium can be any entity or device capable of storing the program. For example, the medium can include storage means such as a ROM, for example a CD ROM or a microelectronic circuit ROM, or magnetic storage means, for example a diskette (floppy disk) or a hard disk.

20 [0034] Alternatively, the recording medium can be an integrated circuit in which the program is incorporated, the circuit being adapted to execute the method in question or to be used in its execution.

[0035] The present disclosure is further related to a vehicle comprising the lighting system as described above.

25 [0036] The vehicle may be any vehicle, e.g. an automotive or self-propelled vehicle, including but not limited to road vehicles such as cars, buses, trucks motorcycles and the like. The vehicle may be equipped with autonomous driving functions or driving-assistance functions.

[0037] In some embodiments, the lighting device is provided in an
30 area of the passenger compartment that corresponds to a driver's

peripheral vision area. In particular, the lighting device may be provided out of the driver's macular vision area, in order to provide him with contextual information without disturbing his focusing onto the road.

[0038] For example, in some embodiments, the lighting device may be provided on at least one of a ceiling, a door, a center console, a top of A-pillars of the vehicle.

[0039] In some embodiments, the vehicle further comprises an accelerometer configured to output a current acceleration of the vehicle to the control unit. The accelerometer may be a single-axis or a multi-axis accelerometer.

[0040] In some embodiments, the vehicle further comprises a luminosity sensor configured to measure ambient luminosity, e.g. in the passenger compartment, and output an ambient luminosity measurement to the control unit.

15 BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The invention and advantages thereof will be better understood upon reading the detailed description which follows, of embodiments given as non-limiting examples. This description refers to the appended drawings, wherein:

- 20 - Fig. 1 shows a side view and a passenger compartment inner view of a vehicle according to an embodiment;
- Fig. 2 illustrates a driver's vision areas within a vehicle;
- Fig. 3 is a diagram representing a lighting system according to an embodiment;
- 25 - Fig. 4 is a diagram representing components of acceleration information;
- Fig. 5 is a diagram illustrating a light animation according to two embodiments;
- Fig. 6 illustrates the variation of a light parameter as a function of time according to three embodiments.

30 DETAILED DESCRIPTION OF EMBODIMENTS

[0042] A vehicle 10 according an embodiment is shown in Fig. 1. In this embodiment, the vehicle 10 is an automotive vehicle, namely a car. The vehicle has a vehicle passenger compartment 12, in which at least one occupant, such as a driver or a non-driving passenger, may travel.

5 [0043] A lighting device 20 is provided in the vehicle passenger compartment 12. The lighting device 20 is configured to emit light and is capable of being controlled in order to produce a light animation, as will be explained hereafter.

[0044] In this embodiment, the lighting device 20 comprises at least
10 one lighting strip or, as illustrated, a plurality of lighting strips 22. As shown in Fig. 1, the lighting device 20, or particularly the lighting strips 22, may be provided in at least one of a ceiling 13, a door 14 (e.g. a lateral door), a center console 15, a top of A-pillars 16 of the vehicle 10. The lighting strips 22 may generally extend in the longitudinal direction of
15 the vehicle 10.

[0045] With reference to Fig. 2, the field of view of human eye is classically divided in coaxial conical volumes of which the eye is the apex. In the following description, a conical volume is defined by its half top angle, i.e. the angle between an axis of the cone and a generatrix of the
20 cone. The axis of the cone is the direction in which the eye is focused. The angle values given below are given with a margin of $\pm 10\%$.

[0046] A conical volume of 5° (i.e. a conical volume of which the eye is the apex, the axis is the direction in which the eye is focused and the generatrix forms an angle of 5° with the axis) is referred to as a
25 central region. A conical volume between 5° and 8° is referred to as a paracentral region and a conical volume between 8° and 18° is referred to as a macular region. The central, paracentral and macular regions form together a conical volume of 18° called focused vision area 17, where the eye accurately perceives movements, shapes and colors. For a driver, the

focused vision area 17 is intended to be focused on road and driving conditions.

[0047] A conical volume between 18° and 30° is referred to as a near peripheral region. A conical volume between 30° and 60° is referred to as a mid-peripheral region. A conical volume between 60° and 100° - 110° is referred to as a far peripheral region. Together, the near, mid and far peripheral regions form a conical volume between 18° and 100° - 110° called peripheral vision area 18, where the look is not focused but movements, shapes and colors can still be perceived.

10 [0048] When a vehicle such as a car is designed, the various elements are arranged by taking into account the position of a seated average-size driver, whose head rests on a headrest of a driver's seat and whose look is focused on a windshield of the vehicle, i.e. virtually focused on the road in front of the vehicle. Therefore, the position of a seated average-size driver is well-defined in a vehicle and determined by the sub-assemblies of the vehicle itself.

[0049] The possible locations of the lighting device 20, as described above, are examples of the lighting device 20 being provided in an area of the passenger compartment 12 that corresponds to the peripheral vision area 18. Positioning and/or orienting the lighting device 20 so that the light emitted by the lighting device 20 is located in the peripheral vision area 18 of an average-size driver ensures an intuitive understanding of the emitted lighting signal without disruption or cognitive overload of the driver.

20 [0050] The position and/or orientation of the lighting device 20 may also be designed in accordance with other considerations, e.g. the position of the vehicle windows in order to avoid undesired reflections that could disturb the lighting message.

[0051] A lighting system 100 for a vehicle passenger compartment
30 according to an embodiment is diagrammatically shown in Fig. 3. The

lighting system 100 may be provided in the vehicle 10 and be used for the vehicle passenger compartment 12. As previously mentioned, the lighting system 100 comprises the above-described lighting device 20. The lighting system 100 further comprises a control unit 30 configured to receive
5 acceleration information about the vehicle 10.

[0052] The control unit 30 may be an electrical control unit (ECU). The control unit 30 may have the hardware architecture of a computer, as diagrammatically illustrated in Fig. 3. The control unit 30 may comprise a processor 32, a read-only memory (ROM) 33, a random access memory
10 (RAM) 34, a non-volatile memory 35 and communications means 36 for communicating with other components, such as the lighting device 20, wirelessly or in wired manner.

[0053] The ROM 33 forms a recording medium that can be read by the processor 32 and on which can be recorded a computer program
15 having instructions for executing the steps of a method for controlling the lighting system for a vehicle passenger compartment, which will be described later on.

[0054] The acceleration information received by the control unit 30 may comprise a current acceleration of the vehicle 10. The current
20 acceleration may be acquired by an appropriate sensor, such as an accelerometer 40 mounted on the vehicle 10. Alternatives are encompassed, e.g. determination of the vehicle current acceleration based on GPS measurements.

[0055] Alternatively or in addition, the acceleration information
25 received by the control unit 30 may comprise an acceleration recommendation issued by a vehicle driving-assistance system 42. The acceleration recommendation may be an appropriate signal that aims to prompt the driver to e.g. accelerate, brake, turn (which corresponds to a lateral acceleration), or a perform combination of these. Besides being
30 provided to the control unit 30, the acceleration recommendation may be

otherwise communicated to the driver, e.g. through a display or sound signal. In either case, the acceleration information has a direction and a magnitude.

[0056] Settings of the lighting system 100, such as a color and a brightness, may be provided to the control unit 30 by an interface, e.g. an interface provided in the lighting system 100, such as an in-vehicle interface 44, or a remote interface 46 such as a smartphone application. The interface may be a graphical user interface (GUI).

[0057] As described above, the control unit 30 may be configured to control the lighting device 20 to provide ambient lighting (AL). The settings of the ambient lighting may be set by a user through any one of the interfaces 44, 46. Alternatively or in combination, the ambient lighting may be automatically adjusted as a function of the luminosity sensed by a luminosity sensor 19 arranged e.g. in the passenger compartment 12. The ambient lighting may comprise lighting the lighting device 20 uniformly, e.g. at an intermediate brightness.

[0058] In addition to the optional ambient lighting mode, the control unit 30 is configured to control the lighting device 20 to produce a light animation, and to determine a moving direction of the light animation on the basis of a direction of the acceleration information. The light animation may override the ambient lighting. The moving direction of the light animation may substantially correspond to the direction of the acceleration information or to a direction opposite thereto. In this context, "substantially" means that the moving direction of the light animation may not correspond exactly to the direction of the acceleration information, e.g. due to discretization before displaying or sensitivity thresholds to take into account, as will be explained hereafter.

[0059] For instance, if the direction of the acceleration information is longitudinally forward (resp. backward) and/or laterally towards right (resp. left), the control unit 30 may control the lighting device 20 to

produce a light animation moving longitudinally backward (resp. forward) and/or laterally towards left (resp. right) respectively. Although less intuitive for the occupants, other correspondences can be set in the control unit 30, as long as there is a determination of the moving direction on the basis of the direction of the acceleration information.

[0060] In this embodiment, the control unit 30 may control the lighting device 20 according to two different modes. In a first control mode, the control unit 30 uses the current acceleration of the vehicle, e.g. provided by the accelerometer 40, to determine the moving direction of the light animation. In a second control mode, the control unit 30 rather uses the acceleration recommendation issued by the vehicle driving-assistance system 42 to determine the moving direction of the light animation.

[0061] Irrespective of which acceleration information is used, an example of determining the moving direction and producing the light animation is now explained with reference to Figs. 4-6.

[0062] Figure 4 is a diagram in which X represents the longitudinal direction, Y represents the lateral direction. On this diagram, the acceleration information A can be represented as a vector, the direction of the vector A corresponding to the direction of the acceleration information and the length of the vector corresponding to a quantity associated with the acceleration information, such as the acceleration magnitude (e.g. in the first control mode or in the second control mode), the event class or degree of criticality of the acceleration recommendation (e.g. in the second control mode), or any quantity derived from these.

[0063] In Fig. 4, positive X, noted as X+ below, represents positive acceleration forwards, e.g. an acceleration when driving forwards or a deceleration when driving backwards. In the second control mode, an X+ acceleration recommendation may be issued by an intelligent speed assistant, a parking assistant, and/or a restart assistant (e.g. when the

preceding vehicle moves again in a stop & go traffic, or when a traffic light becomes green). Conversely, negative X, noted as X- below, represents negative acceleration forwards, e.g. a deceleration when driving forwards or an acceleration when driving backwards. In the second control mode,
5 an X- acceleration recommendation may be issued in the context of a relative speed warning, a distance warning, an intelligent speed assistant, a forward collision warning, a parking assistant, a stop sign warning, and/or a roundabout warning.

[0064] Positive Y, noted as Y+ below, represents a right turn
10 irrespective of the vehicle driving forwards or backwards. Conversely, negative Y, noted as Y- below, represents a left turn irrespective of the vehicle driving forwards or backwards. In the second control mode, a Y+ or Y- acceleration recommendation may be issued in the context of a lane departure warning and/or a parking assistant.

15 [0065] In this embodiment, the longitudinal and lateral components of the moving direction of the light animation are determined separately, on the basis of the longitudinal and lateral components of the acceleration information, respectively. Namely, the acceleration information is decomposed into a longitudinal component A_x and a lateral component
20 A_y . More generally, the control unit 30 of the present embodiment is configured to determine the moving direction of the light animation on the basis of at least one of a longitudinal component A_x and a lateral component A_y of the direction of the acceleration information A.

[0066] Optionally, the control unit 30 may be configured to control
25 the lighting device 20 not to produce the light animation if the acceleration information is less than a threshold. In this embodiment, three sensitivity thresholds S_1 , S_2 , S_3 are defined for at least one component. As illustrated in Fig. 4, a sensitivity threshold, or simply threshold, is here defined for each component A_x , A_y , and the currently selected sensitivity
30 threshold is S_3 , i.e. the most sensitive one. The selection or change of a

sensitivity threshold may be performed by an occupant, e.g. on one of the aforementioned interfaces 44, 46. As applicable, different sensitivity thresholds may be selected for the longitudinal and lateral components.

[0067] In this embodiment, as shown in Fig. 4, the control unit 30
5 determines that the longitudinal component A_x is greater than the threshold $S3$. Therefore, the control unit 30 may determine that the moving direction has an $X+$ component. Conversely, the control unit determines that the lateral component A_y is less than the threshold $S3$. Therefore, the control unit may ignore the lateral component A_y and
10 determine that the moving direction has no Y component. If both components were less than the sensitivity threshold $S3$, e.g. when the vehicle 10 travels or is to travel at a substantially constant speed, the lighting device 20 would produce no light animation.

[0068] In the present example, the moving direction of the light
15 animation is determined based on an $X+$ component and no Y component. In doing so, the control unit 30 determines the moving direction of the light animation on the basis of a direction of the acceleration information A . Of course, other determinations, leading to other results, are also encompassed. For instance, as soon as at least one of the longitudinal
20 component A_x and the lateral component A_y exceeds the applicable threshold, the control unit 30 may take both components into account to determine the moving direction.

[0069] After determining the moving direction, the control unit 30 controls the lighting device 20 to produce a light animation moving in the
25 moving direction. Examples of light animations are described with reference to Fig. 5.

[0070] In this embodiment, the lighting device 20 comprises a plurality of light sources 24, the control unit 30 being configured to individually control the light sources 24 or groups of the light sources 24.
30 The light sources 24 may be Light Emitting Diodes (LEDs), organic LEDs

(OLEDs) or the like. The light sources 24 may be arranged as an array, e.g. in the respective lighting strips 22, as shown in the bottom part of Fig. 5. The array may approximately follow the longitudinal direction X and the lateral direction Y.

5 [0071] Specifically, Fig. 5 illustrates a first example E-I with two rows of two light sources 24, and a second example E-II with four rows of three light sources 24. However, the number and arrangement of the light sources 24 may be designed differently. Fig. 5 diagrammatically shows a top view of the light sources 24.

10 [0072] The table of Fig. 5 shows, for each of the first example E-I and the second example E-II, examples of light animations depending on the moving direction determined by the control unit 30. The moving direction components are indicated in the left column. In the table, the arrow above the diagrammatic lighting strips 22 represents a front
15 direction of the vehicle. Adjacent diagrammatic lighting strips represent the subsequent illumination states of the lighting strip 22 over time, from left to right. Finally, a white light source corresponds to a light source having a maximum brightness B_{MAX} . A black light source corresponds to a light source having a non-maximum brightness $B(t)$, to be described later.

20 [0073] Line 1 shows an example of ambient lighting (AL), in which all the light sources 24 are illuminated uniformly at an intermediate brightness B_{AL} less than the maximum brightness B_{MAX} .

[0074] As shown in the following lines, in this embodiment, the light animation comprises forming a light pattern by illuminating a group of the
25 light sources 24, and moving said light pattern along the array in the moving direction. In Fig. 5, for an easier understanding, the pattern is a straight line perpendicular to the moving direction. However other patterns are of course possible. The group of light sources 24 may have the shape of the pattern and the control unit 30 may be configured to
30 individually control such groups.

[0075] In this example, the moving direction substantially corresponds to the opposite of the direction of the acceleration information. For instance, with reference to line 2 of the table of Fig. 5, when the moving direction is to be determined based on an X+ component, the pattern (the line) is controlled to move in the X- direction, i.e. from front to rear.

[0076] Likewise, with reference to line 4 of the table of Fig. 5, when the moving direction is to be determined based on an Y+ component, i.e. a right turn, the pattern (the line) is controlled to move in the Y- direction, i.e. from right to left.

[0077] To produce this effect, the light animation comprises illuminating a first group (line) of light sources to a maximum brightness B_{MAX} , and subsequently illuminating a second group (line) of light sources, adjacent to the first group (line), to the maximum brightness B_{MAX} , while illuminating the first group (line) at a lesser brightness $B(t)$. A given light source 24 may reach its maximum brightness at a given frequency F .

[0078] As shown in lines 6-8, an X component and a Y component can be combined. As shown in these lines, due to edge effects, the number of illuminated light sources may vary over time; however, the pattern (here, the line) is still regarded as having the same shape.

[0079] In case of combination of X and Y components, the brightness may be computed as $B_{XY,MAX} = \max(B_{X,MAX}; B_{Y,MAX})$, where $B_{X,MAX}$ is the maximum brightness for the X component and $B_{Y,MAX}$ is the maximum brightness for the Y component. The frequency for reaching the maximum brightness may be computed as $F_{XY} = \max(F_X; F_Y)$, where F_X is the frequency for reaching the maximum brightness for the X component and F_Y is the frequency for reaching the maximum brightness for the Y component. The skilled person thus understands that the maximum brightness and the frequency may be set differently for the X and Y components.

[0080] Besides, the maximum brightness and/or the frequency may be set based on the magnitude of the respective components A_x and A_y , described above. For instance, the greater a component, the greater the corresponding brightness and/or frequency. More generally, the control unit 30 may be configured to modulate a brightness, color, light density or moving speed of the light animation on the basis of a magnitude of the current or recommended acceleration of the vehicle (e.g. in the first control mode or in the second control mode) or on the basis of an event class or degree of criticality of the acceleration recommendation (e.g. in the second control mode).

[0081] Figure 6 shows three examples of possible functions $B(t)$ for illuminating the light sources 24. In all three examples, the brightness B varies between the above-described maximum value B_{MAX} and a minimum value B_{MIN} . Both maximum and minimum values may take into account values set up by a user, the ambient lighting and/or the ambient luminosity. More generally, the control unit 30 may be configured to adapt a brightness, color, light density or moving speed of the light animation on the basis of the ambient lighting provided by the lighting device 20 and/or on the basis of the ambient luminosity in the vehicle passenger compartment 12, e.g. as measured by the luminosity sensor 19. The minimum brightness B_{MIN} may correspond to the light sources being switched off, in particular when no ambient lighting is provided by the lighting device 20.

[0082] Besides, in all three examples, the brightness periodically reaches a maximum at the frequency $F=1/P$, P being the corresponding time period.

[0083] In example (a), the light sources 24 are illuminated at the maximum brightness B_{MAX} at a frequency F , e.g. for a given time approximately equal to $P/2$, and otherwise illuminated at the minimum brightness B_{MIN} .

[0084] In example (b), the light sources are illuminated at the maximum brightness B_{MAX} at a frequency F , and the brightness otherwise varies proportionally with time until it reaches the minimum brightness B_{MIN} .

- 5 [0085] In example (c), the light sources are illuminated at the maximum brightness B_{MAX} and the minimum brightness B_{MIN} punctually at a frequency F , and follow smoothened increases and decreases in-between, e.g. sine-like increases and decreases.

[0086] Yet other examples are encompassed.

- 10 [0087] Although Figs. 4-6 have been described with the brightness of the light sources 24 as a light parameter to be changed in the light animation, the light animation may comprise changing another parameter instead, such as the shape, size, pattern, color, light density, moving speed, frequency, etc. of the light animation.

- 15 [0088] Although the present disclosure refers to specific exemplary embodiments, modifications may be provided to these examples without the departing from the general scope of the invention as defined by the claims. In particular, individual characteristics of the different illustrated/mentioned embodiments may be combined in additional
20 embodiments. Therefore, the description and the drawings should be considered in an illustrative rather than in a restrictive sense.

CLAIMS

1. A lighting system (100) for a passenger compartment (12) of a vehicle (10), comprising a lighting device (20) configured to emit light and
5 a control unit (30), the control unit (30) being configured to receive acceleration information (A) about the vehicle (10) and to control the lighting device (20) to produce a light animation, wherein the control unit (30) is configured to determine a moving direction of the light animation on the basis of a direction of the acceleration information (A).
10
2. The lighting system of claim 1, wherein the acceleration information (A) comprises a current acceleration of the vehicle (10).
3. The lighting system of claim 2, wherein the control unit (30) is
15 configured to modulate a brightness, color, light density, frequency or moving speed of the light animation on the basis of a magnitude of the current acceleration of the vehicle (10).
4. The lighting system of any one of claims 1 to 3, wherein the
20 acceleration information (A) comprises an acceleration recommendation issued by a vehicle driving-assistance system (42).
5. The lighting system of claim 4, wherein the control unit (30) is
25 configured to modulate a brightness, color, light density, frequency or moving speed of the light animation on the basis of an event class or degree of criticality of the acceleration recommendation.
6. The lighting system of any one of claims 1 to 5, wherein the control
30 unit (30) is configured to control the lighting device (20) to provide ambient lighting.

7. The lighting system of claim 6, wherein the control unit (30) is configured to adapt the brightness, color or light density of the light animation on the basis of the ambient lighting provided by the lighting
5 device (20).

8. The lighting system of any one of claims 1 to 7, wherein the control unit (30) is configured to adapt the brightness, color or light density of the light emitted by the lighting device (20) on the basis of an ambient
10 luminosity in the vehicle passenger compartment (12).

9. The lighting system of any one of claims 1 to 8, wherein the control unit (30) is configured to determine the moving direction of the light animation on the basis of at least one of a longitudinal component (A_x)
15 and a lateral component (A_y) of the direction of the acceleration information (A).

10. The lighting system of any one of claims 1 to 9, wherein the control unit (30) is configured to control the lighting device (20) not to produce
20 the light animation if the acceleration information is less than a threshold (S_1 , S_2 , S_3).

11. The lighting system of any one of claims 1 to 10, wherein the lighting device (20) comprises a plurality of light sources (24), the control
25 unit (30) being configured to individually control the light sources (24) or groups of the light sources (24).

12. The lighting system of claim 11, wherein the light sources (24) are arranged as an array, and the light animation comprises forming a light

pattern by illuminating some of the light sources (24), and moving said light pattern along the array in the moving direction.

13. A method for controlling a lighting system (100) for a passenger
5 compartment (12) of a vehicle (10), the method comprising receiving acceleration information (A) about the vehicle (10), determining a moving direction on the basis of a direction of the acceleration information (A), and controlling a lighting device (20), configured to emit light, to produce a light animation moving in the moving direction.

10

14. A vehicle (10) comprising the lighting system (100) of any one of claims 1 to 12.

15. The vehicle of claim 14, wherein the lighting device (20) is provided
15 in an area of the passenger compartment (12) that corresponds to a driver's peripheral vision area (18).

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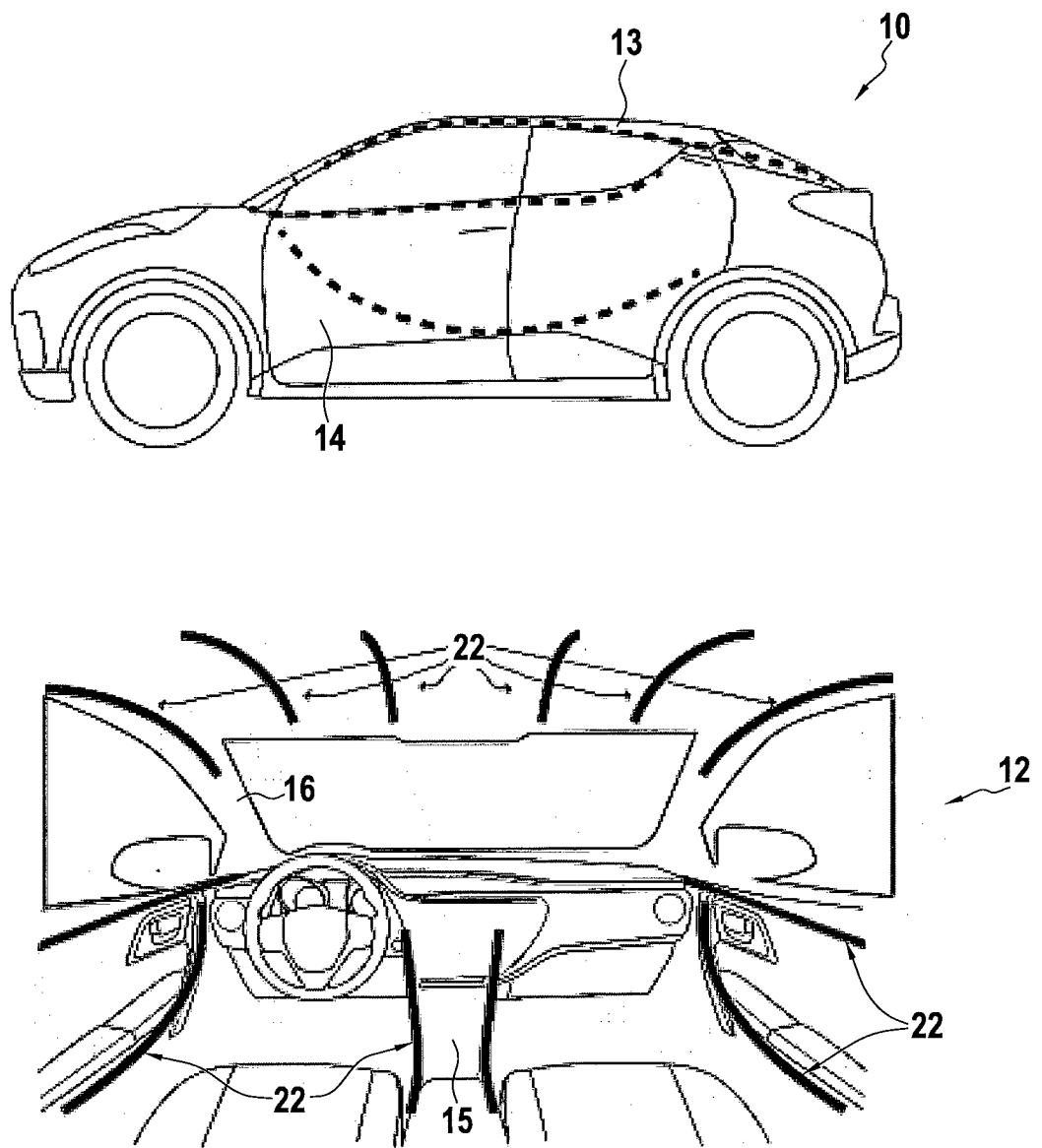


FIG.1

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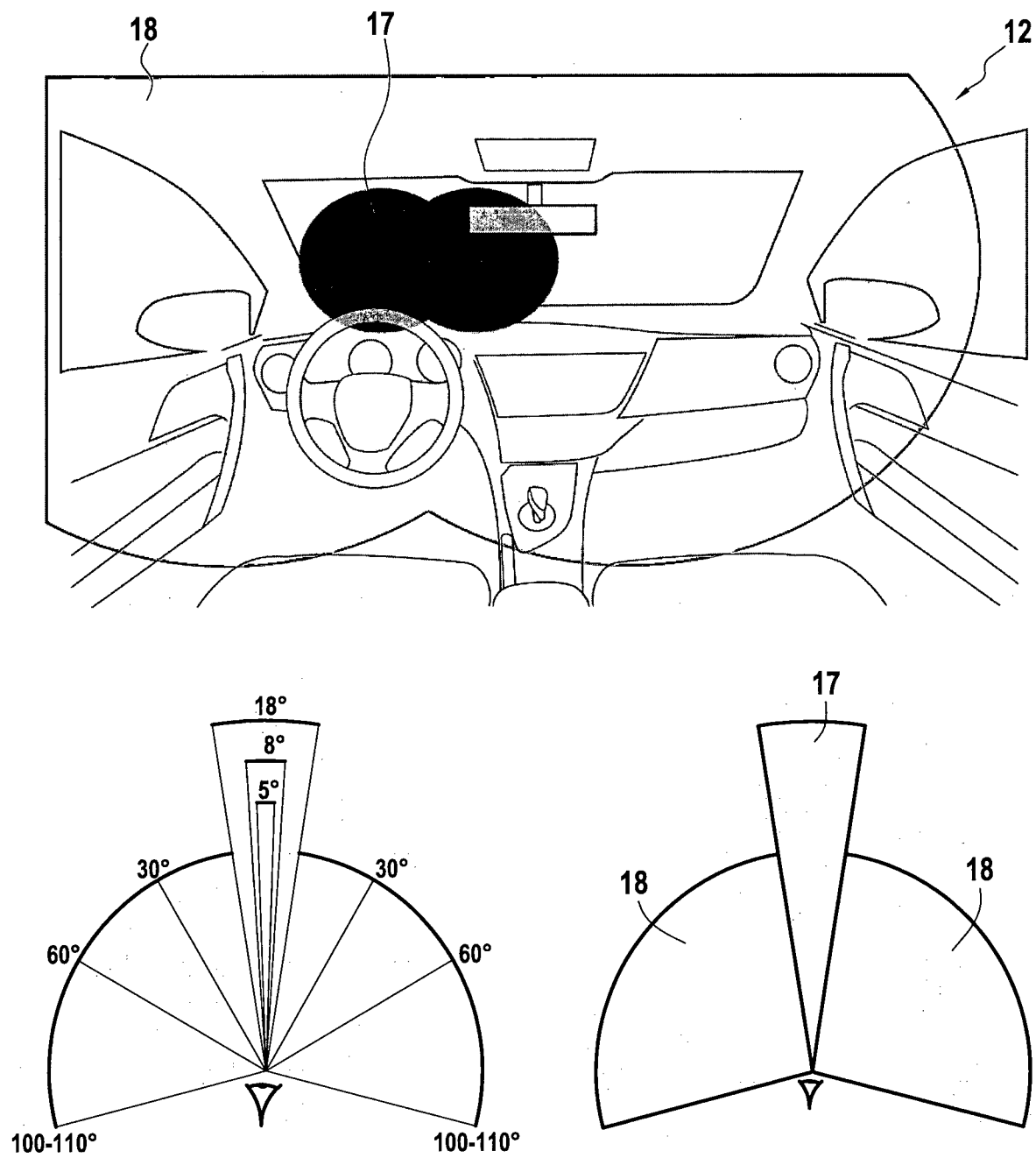


FIG.2

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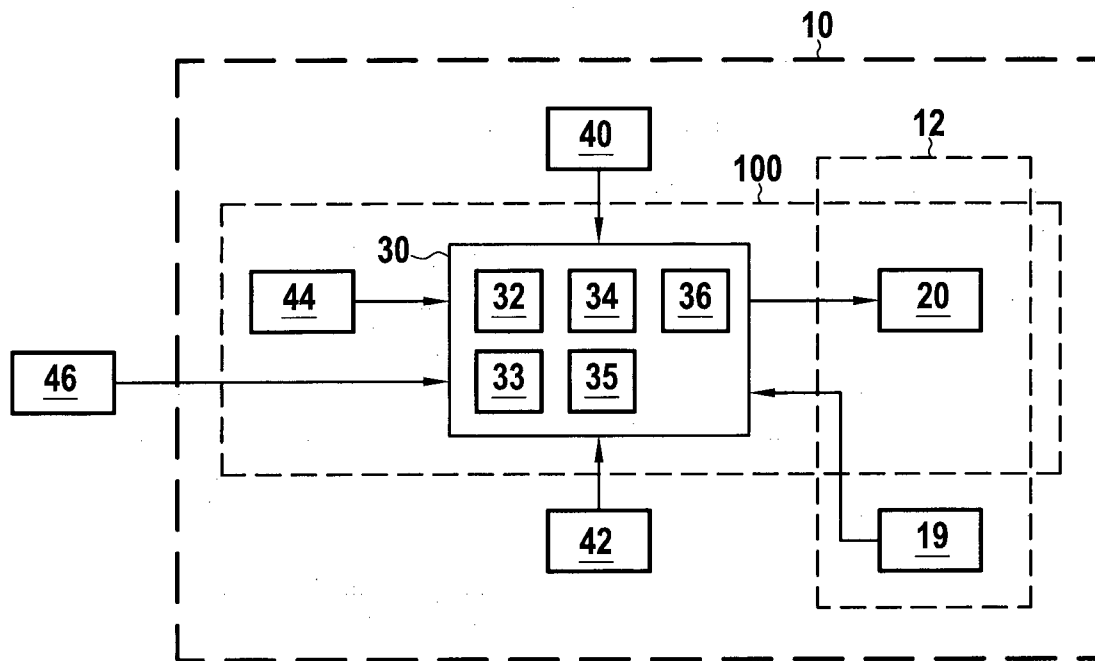


FIG.3

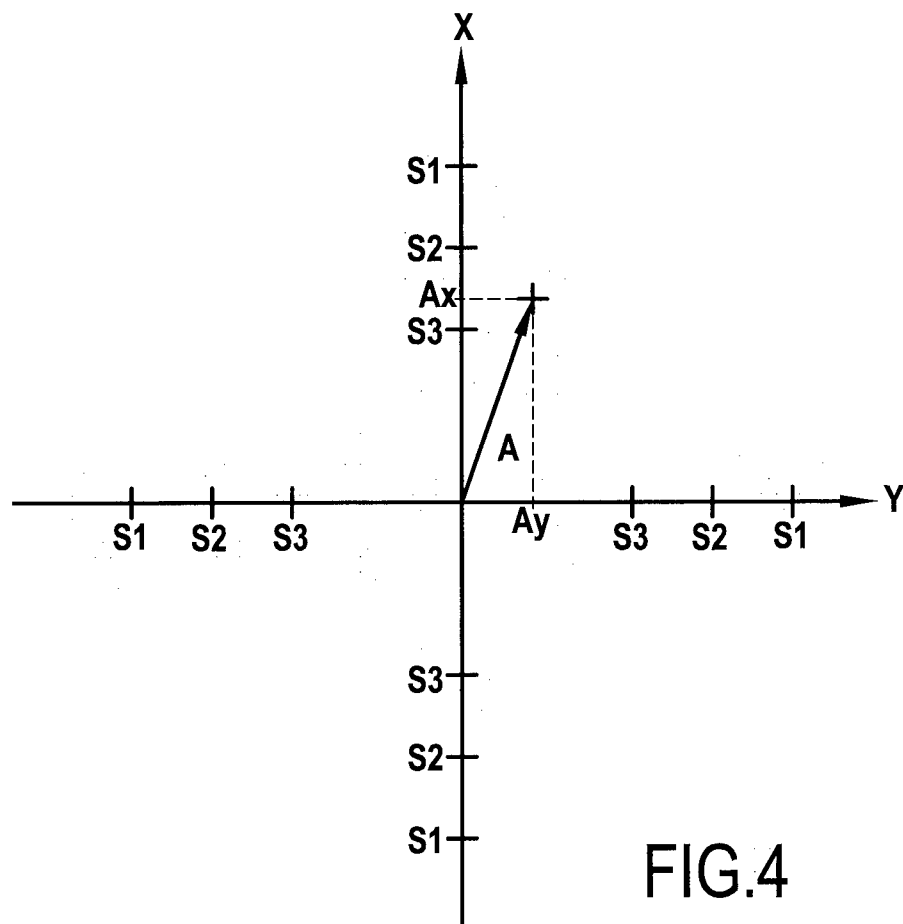


FIG.4

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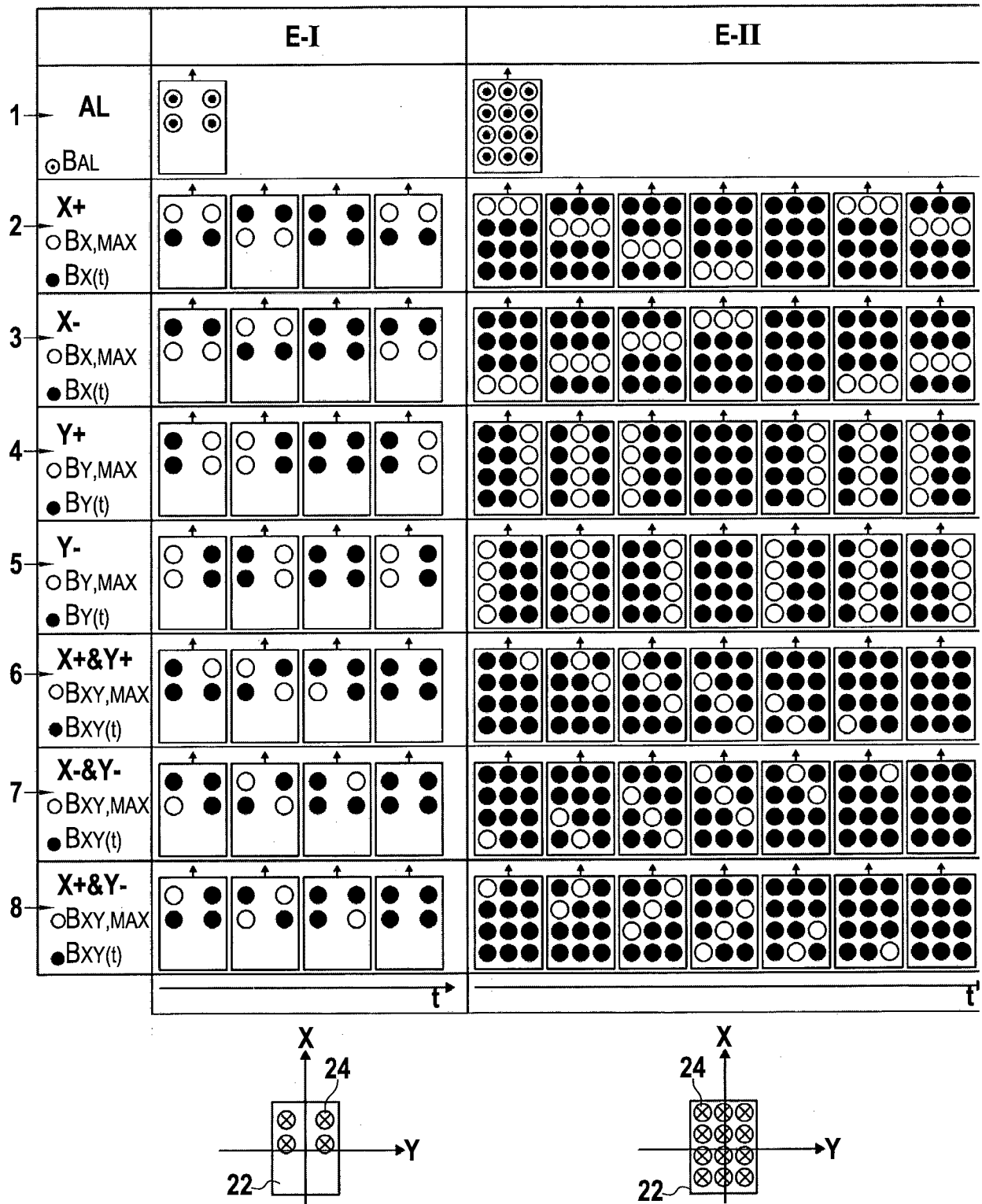
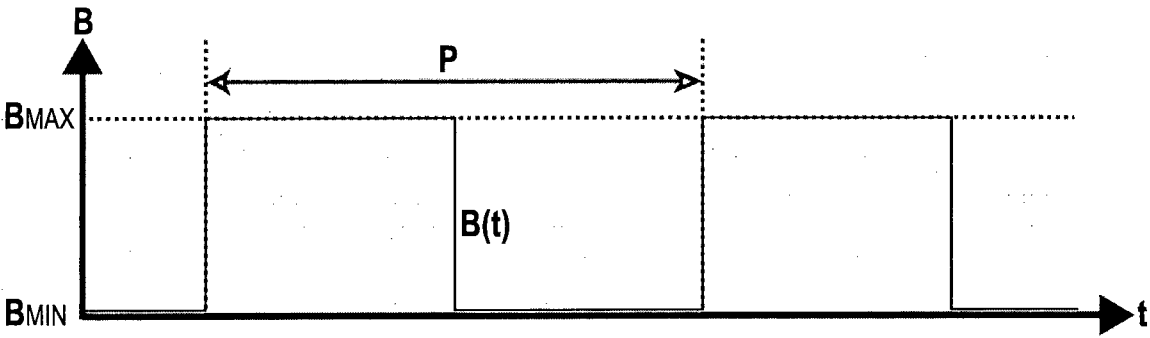
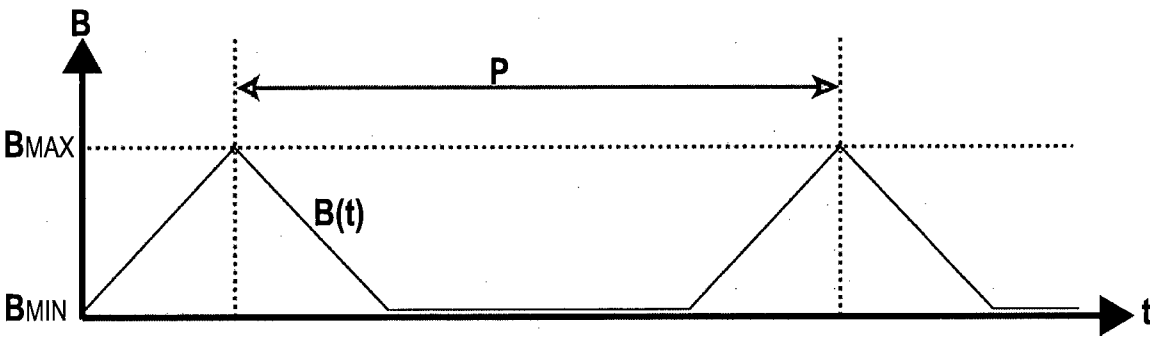


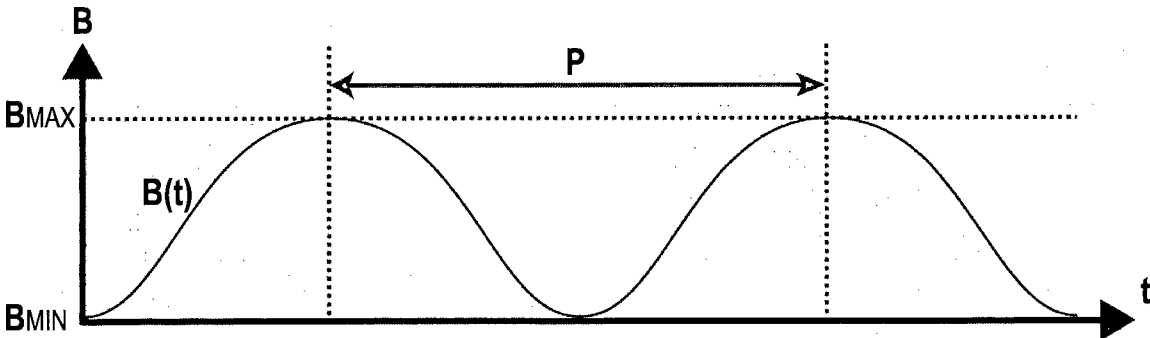
FIG.5



(a)



(b)



(c)

FIG.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/000727

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60Q3/51 B60Q3/78 B60Q3/80 B60Q9/00
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

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Y	paragraphs [0007] - [0014], [0030], [0031], [0036] - [0041], [0074]; claims 1-10; figures 1-4	4-8
X	JP 2008 230575 A (UNIV HAMAMATSU) 2 October 2008 (2008-10-02)	1-3,9, 11-15
Y	claims 1-4; figures 1-7	4,5
X	US 2019/061655 A1 (SON HYUNJI [US]) 28 February 2019 (2019-02-28)	1-15
Y	paragraphs [0004] - [0014], [0102], [0113]; claims 1-20; figures 1-17	4,5
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

8 April 2020

Date of mailing of the international search report

04/05/2020

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Carneiro, Joaquim

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/000727

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