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(54) Title of the Invention: **Method and device for controlling a light emission of a headlight of a vehicle**
Abstract Title: **Method and device for controlling a light emission of a headlight of a vehicle**

(57) A method (300) is proposed for controlling a light emission of at least one headlight of a vehicle. The method (300) has a step of combining (310) lane information with reference to a course of a road and position information in respect of at least one other vehicle located in the course of the road, in order to determine an envelope area not to be illuminated around the at-least one other vehicle. The method (300) also has a step of setting (320) a safety distance between light that can be radiated by the at least one headlight of the vehicle and the at least one other vehicle based on the envelope area, in order to control the light emission.

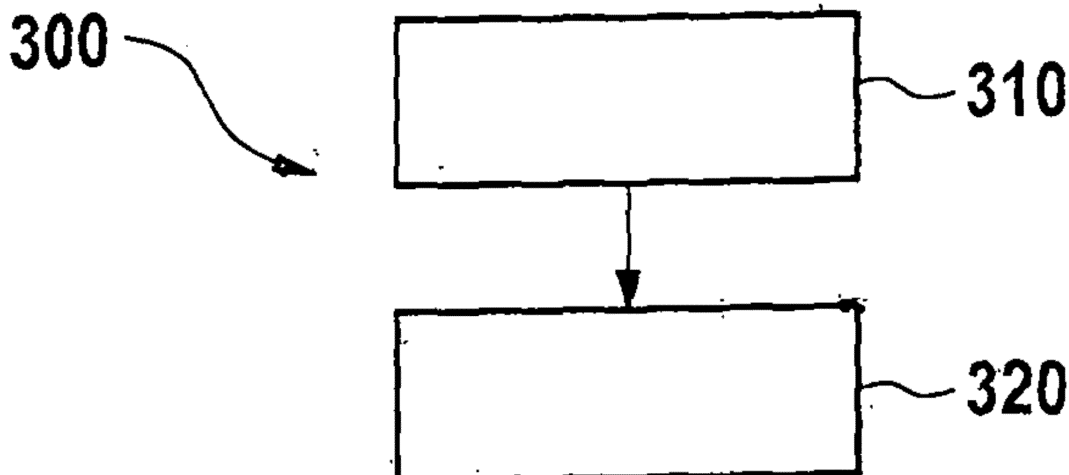


FIG. 3

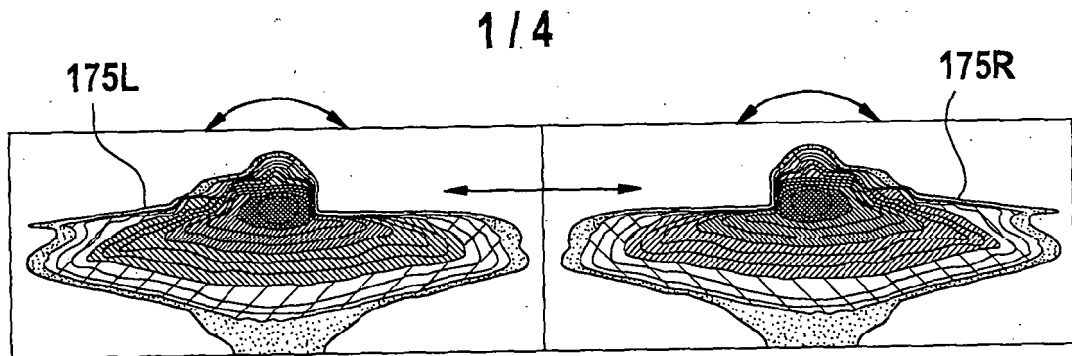


FIG. 1

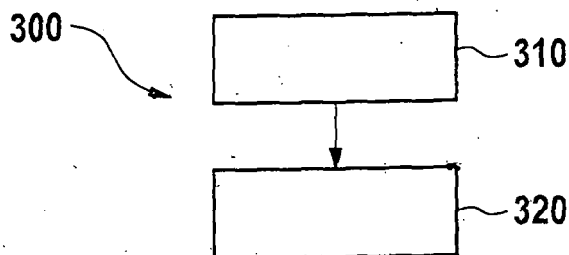
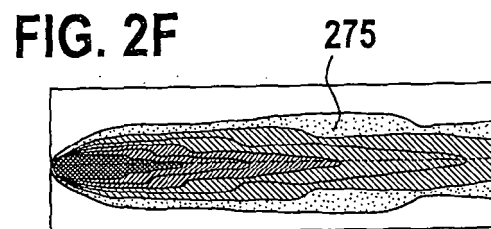
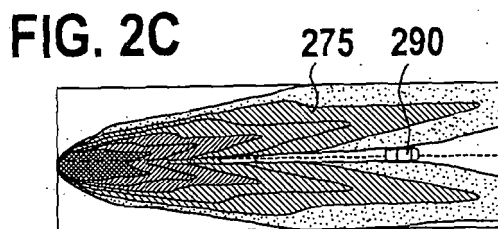
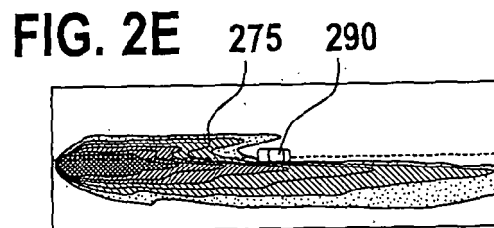
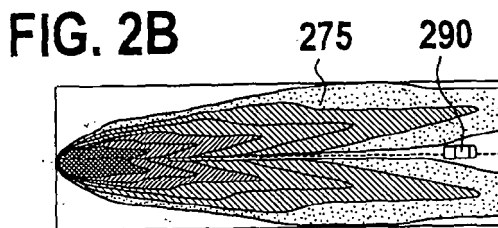
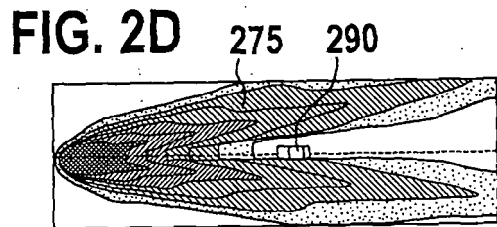
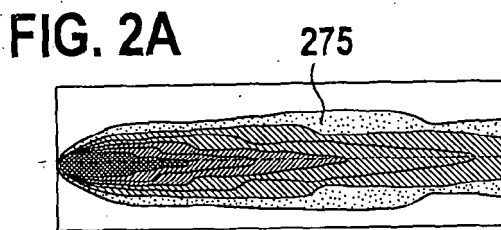


FIG. 3

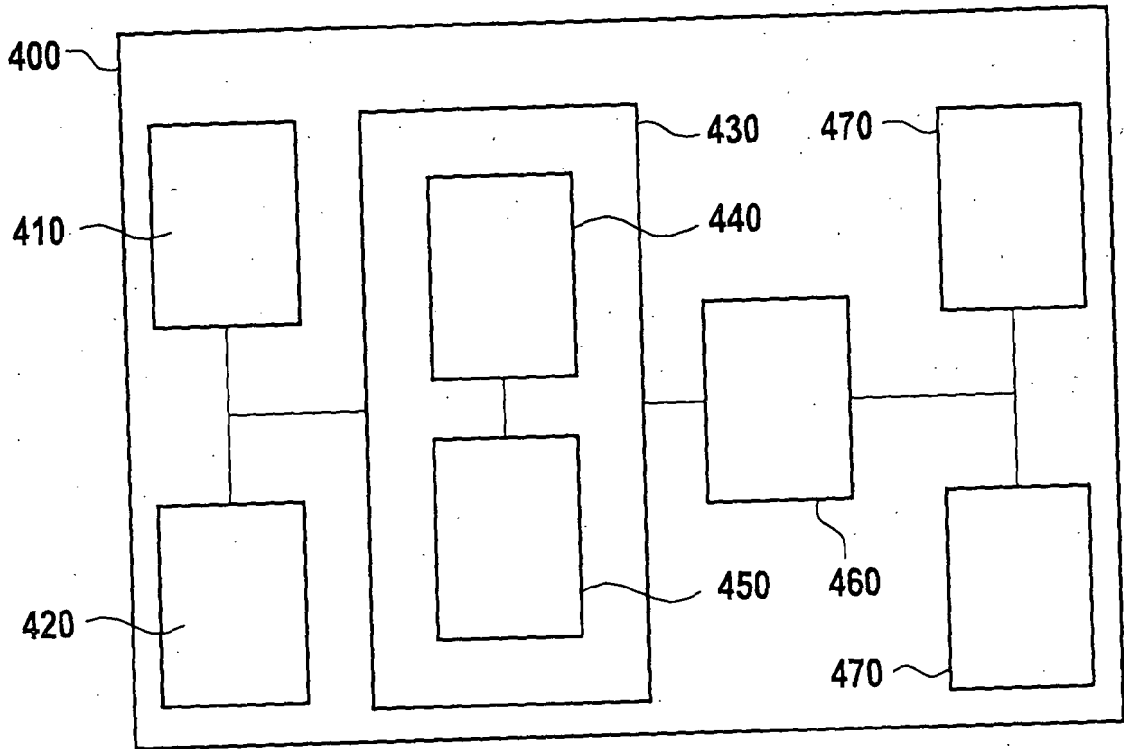


FIG. 4

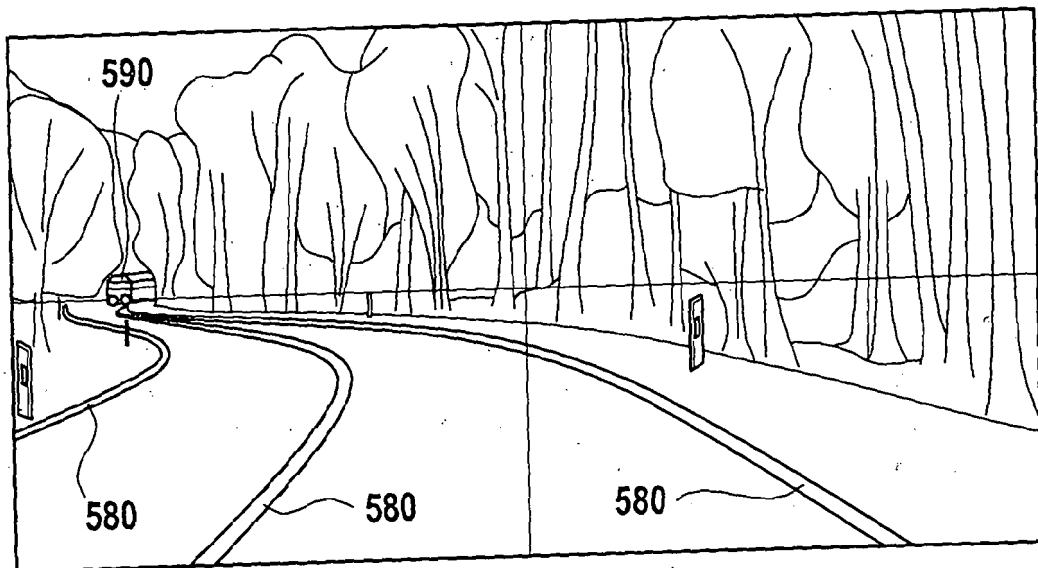


FIG. 5

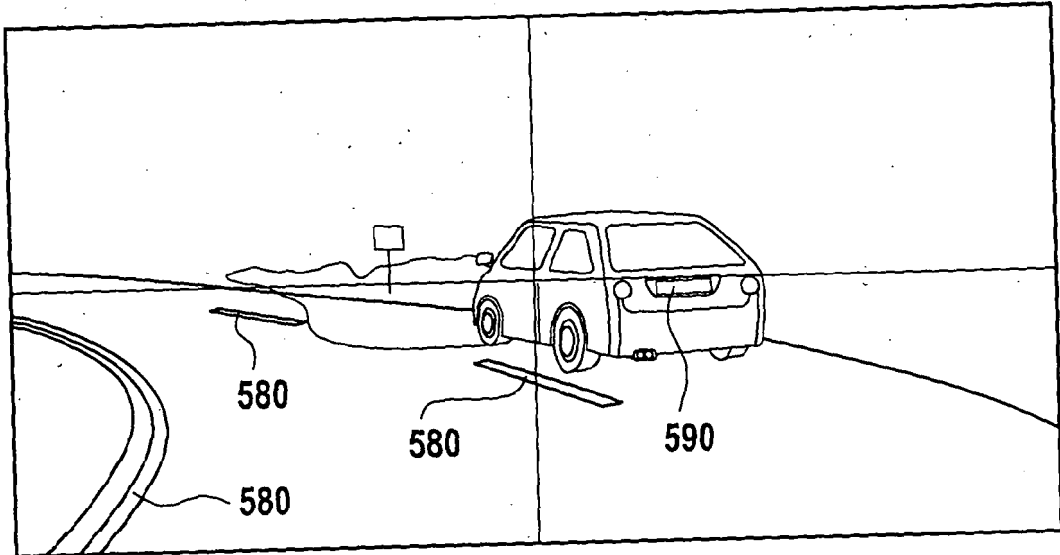


FIG. 6

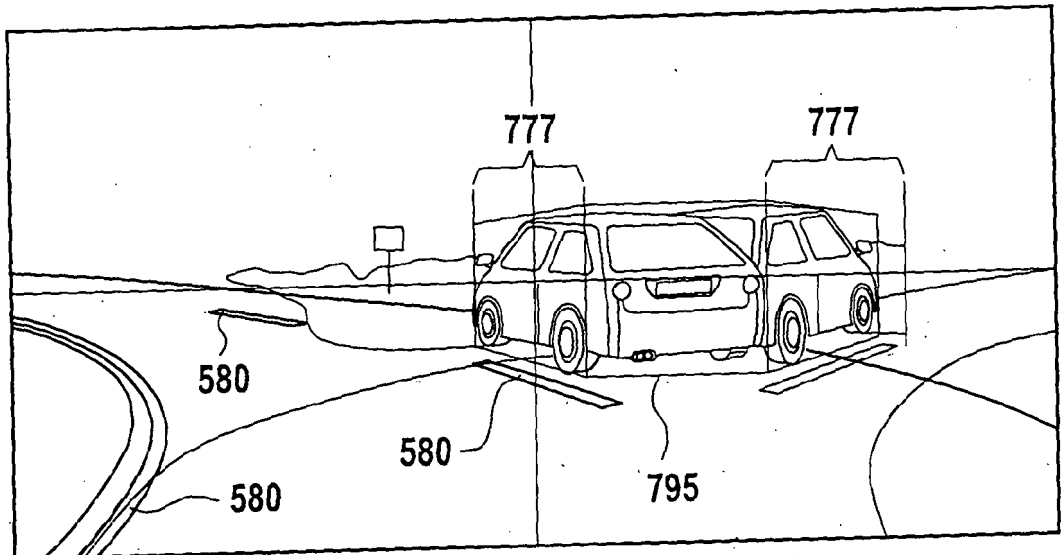


FIG. 7

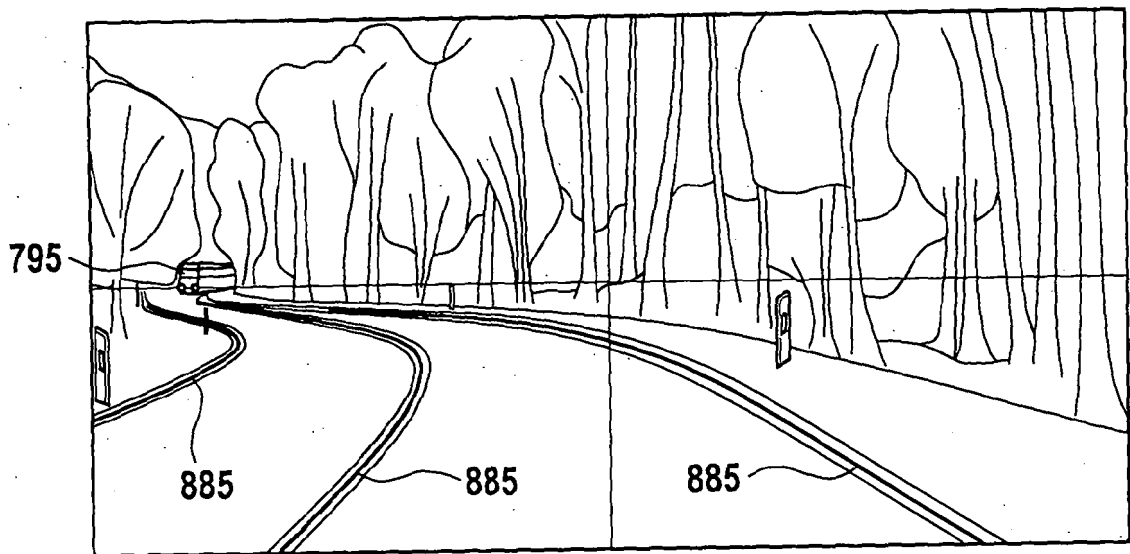


FIG. 8

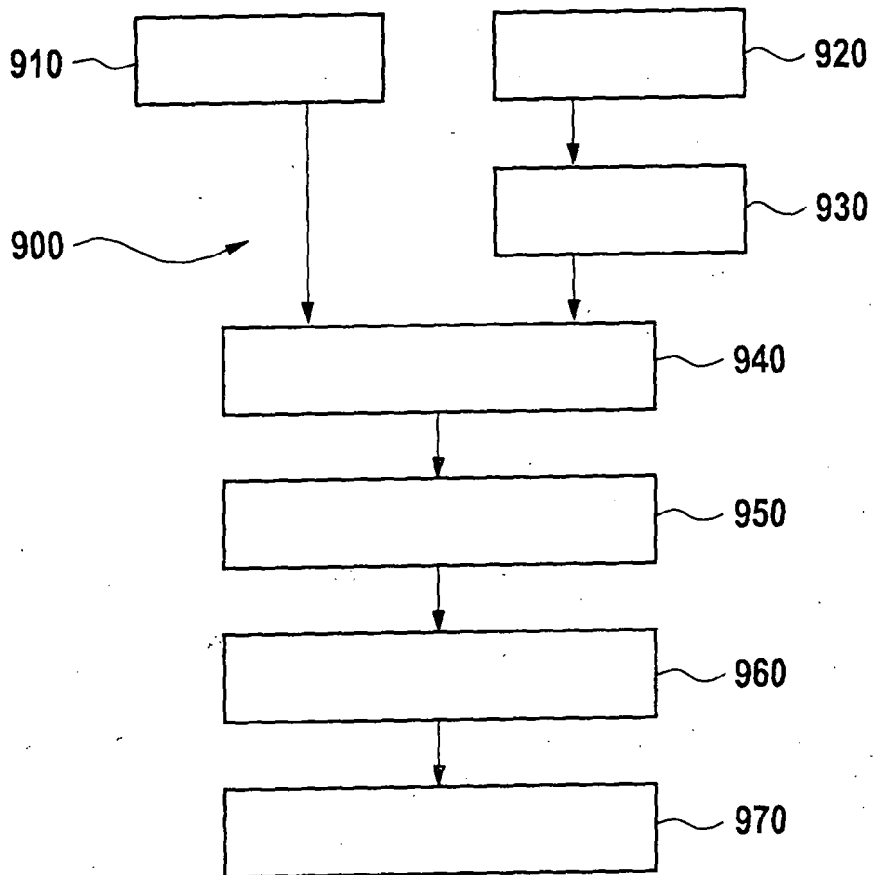


FIG. 9

Method and device for controlling a light emission of a headlight of a vehicle

Prior art

- 5 The present invention relates to a method and a device for controlling a light emission of at least one headlight of a vehicle, and to a corresponding computer program product.

Dazzle-free full beam, also known as Continuous Headlight Control, CHC, follows the
10 idea of illuminating the environment ahead of a vehicle at night continuously with full beam and only "deilluminating" those areas in which other vehicles are located. Among other things, the difficulty lies in not dazzling any other vehicle.

EP 2 165 882 A1 discloses a method for regulating the luminous intensity of motor
15 vehicle headlights.

Disclosure of the invention

Against this background, in the present invention a method for controlling a light
20 emission of at least one headlight of a vehicle, a device for controlling a light emission of at least one headlight of a vehicle and a computer program product are presented according to the main claims. Advantageous configurations result from the respective sub-claims and the following description.

25 The invention is based on the knowledge that a safety distance between the light produced by a vehicle headlight and at least one other vehicle can be set on the basis of information about the road course as well as information about a position of the other vehicle in the road course. Using this information, an envelope area surrounding the at least one vehicle can be determined, which is to be excluded from the light of the at
30 least one headlight or is not to be illuminated. A safety distance from the other vehicle with regard to the illumination, which distance takes the envelope area not to be illuminated into account, can thus be set.

An advantage of the present invention lies in the fact that the safety distance in the illumination can be set such that an advantageous balance can be achieved between dazzle avoidance and optimal visibility range. Traffic safety can thus be increased, as dazzling of a driver of the other vehicle can be avoided and illumination of the road improved. Since the envelope area takes account of the road course as well as the position of the other vehicle in the road course, an anticipatory adjustment of the safety distance that is adapted to the current road course and is consequently accurate as well as reliable is possible. The envelope area or an envelope curve defining the envelope area can be calculated according to one embodiment exclusively on camera data, which can comprise object data and lane information. According to an alternative embodiment, data of the navigation unit can be used in addition to the camera data.

The present invention creates a method for controlling a light emission of at least one headlight of a vehicle, wherein the method has the following steps:

15

Combining lane information with reference to a course of a road and position information in respect of at least one other vehicle located in the course of the road, in order to determine an envelope area that is not to be illuminated around the at least one other vehicle; and

20

Setting a safety distance between light that can be emitted by the at least one headlight of the vehicle and the at least one other vehicle based on the envelope area, in order to control the light emission.

25

The vehicle can be a motor vehicle, in particular a road vehicle, for example a car or a truck or a two-wheeled vehicle such as a motorcycle, for example. The at least one headlight can be a front headlight of the vehicle, for example. The light emission of the at least one headlight can be variable in this case in stages. For control, the light emission of the at least one headlight can be varied here with regard to a lighting angle,

30

a light distribution, a brightness, a quantity of light, an illumination intensity, a lighting width, a light-dark boundary and/or the like. Suitable values of lighting angle, light distribution, brightness, quantity of light, illumination intensity, lighting width, light-dark boundary and/or the like can be selected here that facilitate a setting of the safety

distance in such a way that the envelope area around the at least one other vehicle is excluded from the light of the at least one headlight. The envelope area can surround the at least one other vehicle in this case or have a surrounding area adjoining the at least one other vehicle. The envelope area can represent a safety area, which is to be excluded from illumination by the at least one headlight. The vehicle can be located on the road and follow the course of the road. If a cyclist is located on a cycle path situated next to the road, then the cyclist should not be dazzled either. Likewise other vehicles, which are driving on a bridge over the road. This means that the roads in the vicinity or field of view of the vehicle or of the course of the road can also be taken into consideration, not just the road on which the vehicle itself is located. The course of the road can thus also comprise roads turning off from the road. Expressed in general terms, the course of the road can comprise an area that can be lit up by the headlight.

In the step of combining, the envelope area can be determined additionally from an alignment of the at least one other vehicle with reference to the vehicle. A step of estimating the alignment based on the lane information and the position information can also be provided. The alignment can pertain to a relationship between a longitudinal axis of the at least one other vehicle, for example, and a longitudinal axis of the vehicle. The more the alignment of the at least one other vehicle differs from an alignment of the vehicle, the greater at least one dimension of the envelope area can be determined. In estimating or otherwise determining the alignment, a most probable alignment can be determined or several probable alignments can be determined, it then being possible to form a mean value of the several probable alignments. The formation of a weighted sum of the possible alignments as a function of their probabilities is advantageous when determining the most probable alignment. Such consideration of the alignment of the at least one other vehicle offers the advantage that the envelope area, and thus also the safety distance, can be adapted more correctly to a probable orientation of the at least one other vehicle. An illumination of the road as well as dazzle avoidance can thus be improved.

30

In the step of setting, at least one lateral section of the safety distance arranged to the side of the at least one other vehicle can be set additionally based on the alignment. A change in an alignment of the at least one other vehicle can lead to a changed setting

of the safety distance in a lateral section of the safety distance arranged to the side of the at least one other vehicle. If the alignment of the at least one other vehicle substantially corresponds to an alignment of the vehicle, the safety distance can be set so that the lateral section of the safety distance has a minimum dimension. If the
5 alignment of the at least one other vehicle deviates increasingly from the alignment of the vehicle, the safety distance can be set so that the lateral section of the safety distance has an increasingly greater dimension. Such an embodiment offers the advantage that the safety distance can be adapted with improved accuracy to a probable alignment of the at least one other vehicle. In this case the lateral section of
10 the safety distance can be set to a smallest possible dimension depending on the alignment. An illumination of the road as well as dazzle avoidance can thus be improved.

The method can comprise a step of determining the lane information and the position
15 information based on data of a camera of the vehicle. The step of determining lane information can take place before production of a digital representation of the course of the road.

In the step of combining, a digital representation of the course of the road can thus be
20 generated. The envelope area can be determined using the digital representation. The digital representation of the course of the road can be generated in this connection based on the lane information. Such a production and use of a digital representation offers the advantage that the position of the at least one other vehicle in the course of the road, and thus also the envelope area, can be determined more reliably and
25 accurately. An illumination of the road as well as dazzle avoidance can thereby be improved. The digital representation can comprise data according to a digital map. Map data from a navigation unit can also be used, wherein a content of the map data for use in the method can be copied from the map data, for example. By the generation of the digital representation, a virtual map can be produced by a sensor data fusion.
30 Such a sensor data fusion can be carried out optionally when executing the method. It is also possible to react exclusively to the road course measured by the camera, however, or already complete map data of the navigation unit can be used exclusively. If the step is not carried out via map generation, the method can instead be based on

camera data, thus a road course or lane course measured directly by the camera, for example. For example, the road course relative to the vehicle itself can be calculated at the position of the other vehicle.

- 5 In the step of combining, potential placings of the at least one other vehicle can be determined based on the lane information. In this case the envelope area can be determined using the potential placings. For example, the envelope area can be determined based on potential placings of the other vehicle on the lane information. According to one embodiment, pure lane courses can be used as lane information,
- 10 without an intermediate step of generating a digital representation or a digital map being required. According to one embodiment, another road user can be detected and their position information determined on the basis of data of a camera of the vehicle. Furthermore, lane information is determined based on data of the camera. Depending on the road course, e.g. a double bend, it can be the case that the other vehicle could
- 15 be positioned at two or more different points on the lane course. No intermediate step via a digital representation is necessary, however. According to an alternative embodiment, potential placings of the at least one other vehicle can be determined on a digital representation of the course of the road in the step of combining. The envelope area can be determined here using the potential placings on the digital representation.
- 20 The potential placings can pertain to an orientation, alignment, position, direction of travel, speed etc. of the at least one other vehicle in respect of the digital representation and/or lane information as well as of the vehicle. Such an embodiment offers the advantage that the position of the at least one other vehicle in the course of the road, and thus also the envelope area, can be determined more reliably and accurately. An
- 25 illumination of the road as well as dazzle avoidance can thereby be improved. An advantage of an optional map data generation lies in the abstraction of the measuring data and accordingly a good exchangeability and expandability with other sensors or measuring concepts. If no map is produced and only lane information is evaluated, however, the map representation can be dispensed with, due to which resources can
- 30 be saved on the control unit.

In addition, a step of determining the lane information and/or the position information based on image data and/or navigation data and/or driving data of the vehicle can be

provided. The lane information can thus be determined based on image data and additionally or alternatively based on navigation data. By means of suitable image processing, object recognition, pattern recognition or the like, the lane information can be determined from the image data. The position information, thus the relative position
5 of the other vehicle to the vehicle itself, defined e.g. by viewing angle and distance, and additionally or alternatively the lane information can be determined using the navigation data and/or information from image data. The relative position of the other road users can be determined advantageously via the camera. The position evaluation exclusively
10 via navigation information necessitates communication between the vehicles, wherein the vehicle is informed of the position of the other vehicle by the latter. The detection of the position of other road users can take place according to one embodiment only via the camera. The lane information can be determined from the data of the video camera, for example the data of a lane detection. Such a determination of the lane information offers the advantage that the lane information can be determined reliably
15 and accurately. It is also possible to determine the lane information from the navigation data, for example the map data and the position of the vehicle thereon. In addition, the option exists of validation of the lane information if both image data and navigation data are taken as a basis. Apart from the actual position determination, for example aided by satellite, navigation data in this context can be understood to mean also the related
20 navigation map data and/or the related electronic horizon. The electronic horizon is a section from the data of the navigation map data on which the vehicle will move in all likelihood. Depending on the system design, the navigation data can show roads in a certain circumference around the vehicle. In reference to the driving data, a potential route course can be estimated from the yaw rate and the speed or the steering angle.
25 The method can thus comprise a step of determining the lane information and/or position information based on image data. The image data can be data of a camera of the vehicle.

In addition or alternatively, the method can comprise a step of determining the lane information and/or the position information based on navigation data. In addition or
30 alternatively, the method can comprise a step of determining the lane information and/or the position information based on driving data of the vehicle.

In the step of setting, the safety distance can be set based on the envelope area and a validity of the lane information. The validity can be high if the lane information can be determined or measured with great accuracy. The validity can be low if the lane information is estimated. Furthermore, a step of estimating the lane information can be provided. An estimation of the lane information can be required if the other vehicle lies outside the lane detection area of the camera, for example, or if the lane course cannot be measured reliably enough or at all, for example, due to absent lane marking. A low validity of the lane information can be caused by an inaccurate measurement. A low validity can also exist if for example both data of the camera and navigation data are used and there are deviations between these, for example in the case of changes in the road course, which are not present in the navigation data due to the age of the latter. If a low validity of the lane information exists, the safety distance can be provided with an amplification factor in the step of setting. Such an embodiment offers the advantage that even if lane information can only be determined inaccurately or if determinability of the lane information is lacking, a suitable safety distance can be set, so that dazzling of other vehicles can still be avoided and an optimum visibility can be retained. A high validity can exist, for example, if the other vehicle is close to the vehicle and in this area lane information of high quality, for example from a combination of camera data and current navigation data, exists. It is possible that the lane information exists, but is very unreliable. This is the case, for example, if the lane marking is very far away, several markings lie over one another (e.g. in a construction site) or a poor marking quality exists. An estimation of the lane course is then not necessary, but a greater envelope area is sensible on account of the low quality. The envelope area can be determined, therefore, as a function of a quality and/or validity of the lane information.

25

According to one embodiment, a step of determining the lane information with reference to the course of the road can be provided. A step of receiving the position information in respect of the at least one other vehicle located in the course of the road can also be provided. The image data can be generated by means of a vehicle camera or other image recording device and received by an interface with the vehicle camera or other image recording device. The position information can be received by an interface with a vehicle camera or other image recording device or a navigation unit or other mobile data transmission unit. Such an embodiment offers the advantage that in

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this way even current lane information and position information can be available for controlling the light emission and setting the safety distance.

The method can comprise a step of validation or improvement of the position information based on movement data of the other vehicle. According to one embodiment, movement data of the vehicle and/or of the other vehicle can additionally be used advantageously in the step of combining and/or determining, in order to determine more accurately or to validate the determined position and alignment and/or to adapt an envelope curve according to the movement data of the other vehicle.

10 Movement data of the other vehicle can be understood as the movement of the other vehicle relative to the vehicle.

Furthermore, the present invention creates a device for controlling a light emission of at least one headlight of a vehicle, wherein the device is formed to execute or implement

15 the steps of the method according to the invention. In particular, the device can have apparatuses that are formed to each execute a step of the method. The object of the invention can be achieved quickly and efficiently also by this practical variant of the invention in the form of a device.

20 Roads are mostly marked by lane markings. A carriageway course can be understood as a traffic lane or driving lane on which the vehicle or the other vehicle is located. A carriageway course is often delimited by lane markings on the left and right. A road course consists of at least one carriageway course, with often at least one carriageway course being present for each driving direction, which mostly run parallel to one

25 another.

A camera, which records and evaluates an image of the environment in which a road course is located, can recognise the lane markings as such and identify them as a lane course. The carriageway course can be inferred from the lane course. The lane course, like the carriageway course and road course building on this, can be

30 represented internally as clothoids relative to the vehicle, for example. The lane course, which is detected by a camera, for example, is mostly shorter than the entire related lane marking, as the camera only has a limited recognition range, which is mostly shorter than the length of the lane marking.

If no lane markings are present, or these are not recognised as a lane course, the driving course and thus the carriageway course already driven on can be determined from the vehicle movement of the vehicle. The yaw rate, speed and steering angle can be used for this, for example. On the assumption that only small changes occur in the radius driven at any time, the future carriageway course can be estimated from the radius of the respective point in time, i.e. from the carriageway course already driven on. Estimation of the carriageway course without lane markings is not as accurate as determining the carriageway course with lane markings lying ahead of the vehicle.

5

10 Linking of the carriageway course already driven on with recognised lane courses (885) is advantageous, in order to estimate the carriageway course even more accurately.

The road course can also be taken, for example, from map information of navigation units. The road course can be taken directly from the navigation data. The carriageway course can be inferred in turn from the road course, especially if the number of driving lanes is present in the navigation data or can be estimated by the camera.

15

The use of the road course directly from the navigation data has the advantage that a mostly greater projection is achieved than with measurement by a video camera. Apart from the accuracy of the road course in the navigation data, the age of the map material also has a disadvantageous effect, as the road course can be changed for constructional reasons, which is often not currently reflected in the navigation data.

20

25 When determining the road course from navigation data, further roads running parallel or crosswise to the carriageway, for example, which can sometimes only be detected with difficulty or late by the camera at night, can be determined in an anticipatory manner.

30 Lane information can be understood as a carriageway course, road course and/or lane course. The lane information can be determined, for example, using a video camera, from navigation data and/or data of the vehicle dynamics (driving data), as well as from

a combination of various data sources, wherein an intermediate step is possible via an internal map representation.

The lane information is not restricted to the road course on which the vehicle is moving, but can also refer to another road course, which does not necessarily run parallel to the course of the carriageway of the vehicle. The alignment of the other vehicle can thereby be determined sufficiently accurately even in the case of roads running next to the carriageway (e.g. cycle path) or transversely to the carriageway (e.g. a bridge over the road or a crossing). It is advantageous to restrict the lane information to a certain radius around the vehicle, which can lie in the order of the detectability distance of the other road users, due to which calculating time can be saved.

The lane information, in particular the carriageway course, can be used advantageously to determine the required envelope curve and setting of the light distribution. It can be assumed that the vehicles move parallel to the carriageway course on the driving lane. For example, the alignment can be determined from the position of the other vehicle on the driving lane. The knowledge of the exact allocation of the other vehicle to the respective carriageway course is advantageous, in particular if several driving lanes are present for a direction of travel.

20

The lane courses that can be detected by the camera are subject to measuring variations, especially in the far range. Depending on the representation of the lane courses, for example via a clothoid relative to the vehicle, further inaccuracies are added. By evaluating the measured lane information (e.g. the lane courses) over a certain period, the actual carriageway course can be estimated more accurately. To do this, the measured lane information can be entered into a digital map, for example, which can be stored in a volatile or non-volatile manner. The representation of the lane information in a vehicle-independent format is especially advantageous, as the vehicle moves on the driving lane and can also undertake lane changes. A certain sensor independence is advantageous when using a digital map, whereby an exchange or an expansion is simplified. The sensor data fusion of camera data with navigation data in a digital map is especially advantageous, in order to increase the availability and the accuracy of the data.

In the case of large variations in the measuring data, the validity of the lane information can be reduced. In this case, enlargement of the envelope curve makes sense, in order not to dazzle other road users.

5

If navigation data are available in the vehicle, the lane data can be linked advantageously with the navigation data. Here too the storage and linking of the lane information in a common digital representation in the form of a digital map makes sense.

10

Position information of the other vehicle can be understood, for example, as information about a relative position, for example direction and distance, of the other vehicle to the vehicle.

- 15 The accuracy can be increased by evaluating the movement information of the other vehicle. If there are several potential placings of the other vehicle on the lane information, for example, the most probable placing and thus the alignment of the other vehicle can be determined by evaluation of the movement data. It is thus possible, for example in alternating curves (also called "double bend"), in which there are at least
- 20 two possible placings, to determine the correct positioning, alignment and thus also the matching envelope area reliably.

It is likewise possible to increase the validation of the lane information through the movement data. For example, in a far range, in which the lane information has a low

25 validity due to the measuring inaccuracy, it can be augmented by the movement data of the other vehicle and the validity thus increased.

In another embodiment, the movement data of the other vehicle can be used to determine a low validity of the lane information if the movement data cannot be

30 explained using the lane information. An enlargement of the envelope area is then advantageous.

A device can be understood as an electrical unit or control unit that processes sensor signals and emits control signals as a function thereof. The device can have an interface, which can be formed by hardware and/or software. In a hardware formation, the interfaces can be part of a so-called system ASIC, for example, which contains a wide variety of functions of the device. It is also possible, however, that the interfaces are dedicated integrated circuits or consist at least partly of discrete components. In a software formation, the interfaces can be software modules, which are present for example on a microcontroller next to other software modules.

10 A lighting system for a vehicle can also be provided, wherein the lighting system has at least one headlight of the vehicle and the above-mentioned device for controlling a light emission of the at least one headlight.

A computer program product with program code is also advantageous, which is stored on a machine-readable carrier such as a semiconductor memory, a hard disk storage unit or an optical storage unit and is used to execute the method according to one of the embodiments described above if the program is executed on a device.

The invention is explained in greater detail with reference to the enclosed drawings by way of example. These show:

Figures 1 to 2F, schematic representations of different radiation characteristics of vehicle headlights;

25 Fig. 3 a flow chart of a method according to a practical example of the present invention;

Fig. 4 a schematic representation of a vehicle with a control device according to a practical example of the present invention;

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Figures 5 to 8; camera images recorded by means of a vehicle camera; and

Fig. 9 a flow chart of an algorithm according to a practical example of the present invention.

In the following description of preferred practical examples of the present invention, the same or similar reference numerals are used for the elements shown and acting similarly in the different figures, a repeated description of these elements being dispensed with.

Fig. 1 shows a schematic representation of radiation characteristics of a pair of headlights. In particular, a possible realisation of a dazzle-free full beam is shown in figure 1. A first radiation characteristic 175L or first light distribution and a second radiation characteristic 175R or second light distribution are shown. The first radiation characteristic 175L can be assigned to a first headlight of a vehicle, e.g. a left headlight. The second radiation characteristic 175R can be assigned to a second headlight of the vehicle, e.g. a right headlight. In figure 1, arrows indicate areas in which the radiation characteristics 175L and 175R are modified so that the areas indicated by the arrows are excluded or eliminated from the light distribution. The positions of the two light distributions can be changed by pivoting, for example, whereby a (partial) overlap of the light distributions is also possible. If different light distributions are overlapped, new light distributions can be produced from this, which can be used, for example, to realise a dazzle-free full beam. In a schematic view, the radiation characteristics 175L, 175R can be represented in the centre respectively red and then towards the outside according to the spectral colours via orange, yellow, green, blue up to violet in the outermost ring.

25

Figures 2A to 2F show schematic representations of various radiation characteristics 275 of vehicle headlights. In particular, a bird's eye view of a realisation option for dazzle-free full beam is shown in figures 2A to 2F. The radiation characteristics 275 are shown in this case as light distributions and ranges or headlight ranges or illumination intensity curves of vehicle headlights. Expressed precisely, the various radiation characteristics 275 can be set by means of a full beam assistant, for example using Continuous Headlight Control (CHC). In figures 2A to 2F, the radiation characteristics 275 are produced respectively by headlights of a vehicle (not shown

30

explicitly), wherein such a vehicle is arranged at a left picture edge respectively of figures 2A to 2F. The radiation characteristics 275 have a light distribution and a progression of light intensities respectively.

- 5 Another vehicle 290 is also shown in figures 2B to 2E. In the course of figures 2B to 2E, the other vehicle 290 is disposed at an increasingly shorter distance with reference to the vehicle generating the radiation characteristics 275. The radiation characteristics 275 in this case are adapted respectively so that the other vehicle 290 is located outside the light distribution of the vehicle headlights or is excluded from the light
10 distribution.

In a schematic view, the radiation characteristics 275 in the centre illustrated on the left can be shown respectively red and then towards the outside according to the spectral colours via orange, yellow, green up to blue at the outermost edge.

15

- Figure 3 shows a flow chart of a method 300 for controlling a light emission of at least one headlight of a vehicle according to a practical example of the present invention. The method 300 has a step of combining 310 lane information with reference to a course of a road, on which the vehicle is currently located, and position information in
20 respect of at least one other vehicle located in the course of the road, in order to determine an envelope area not to be illuminated around the at least one other vehicle. The method 300 also has a step of setting 320 a safety distance between light that can be radiated by the at least one headlight of the vehicle and the at least one other vehicle based on the envelope area, in order to control the light emission. The method
25 300 can be executed advantageously in connection with a device, such as the control device from figure 4, for example.

- Figure 4 shows a schematic representation of a vehicle with a control device according to a practical example of the present invention. The vehicle 400 has a vehicle camera
30 410, a navigation unit 420, a control device 430 with a combining apparatus 440 and a setting apparatus 450, an activation unit 460 and two headlights 470. The vehicle camera 410 and the navigation unit 420 are connected to the control device 430, for example via at least one signal line. The activation unit 460 is connected to the control

device 430, for example via at least one signal line. The control device 430 is thus connected between the vehicle camera 410 and the navigation unit 420 and the activation unit 460. The headlights 470 are connected to the activation unit 460, for example via at least one signal line. The activation unit 460 is thus connected between
5 the control device 430 and the headlights 470. Even if it is not represented as such in figure 4, the activation unit 460 can also be a part of the control device 430 or the control device 430 can also be a part of the activation unit 460.

The vehicle camera 410 is formed to take at least one picture of a road section in the
10 driving direction ahead of the vehicle 400 and process and/or output it in the form of picture information, picture data or a picture signal. The vehicle camera 410 can have image processing electronics. In this case the vehicle camera 410 can also be formed to analyse the picture information, in order to produce lane information with reference to a course of the road on which the vehicle 400 is currently located, and/or position
15 information in respect of at least one other vehicle located in the course of the road. The vehicle camera 410 can output the picture information, or the lane information and/or the position information to the control device 430.

The navigation unit 420 can be provided optionally in the vehicle 400. Instead of the
20 navigation unit, another mobile data transmission unit, for example a mobile telephone with Internet capability, can be provided. The navigation unit can have map data or access map data. The navigation unit 420 can be formed to determine a position of the vehicle 400. The navigation unit 420 can also be formed to receive position data in respect of at least one other vehicle located in the course of the road and combine
25 them with the map data, in order to generate position information. The navigation unit 420 can output the position information and extracts of the map data (electronic horizon) to the control device 430.

The control device 430 is formed to receive the lane information and the position
30 information from the vehicle camera 410, and if applicable from the navigation unit 420. The control device 430 has the combining apparatus 440 and the setting apparatus 450. The control device 430 is formed to effect a control of a light emission of the headlights 470 of the vehicle 400. In particular, the control device 430 is formed to

execute a method for the control of a light emission of at least one headlight of a vehicle, such as the method according to figure 3, for example.

The combination apparatus 440 is formed to combine the lane information with
5 reference to the course of the road on which the vehicle 400 is currently located, and the position information in respect of at least one other vehicle located in the course of the road, in order to determine an envelope area not to be illuminated around the at least one other vehicle. The combination apparatus 440 is also formed to output the data representing the envelope area determined to the setting apparatus 450.

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The setting apparatus 450 is formed to receive the data, which represent the envelope area determined, from the combination apparatus 440. The setting apparatus 450 is formed to set a safety distance between light that can be radiated by the headlights 470 of the vehicle 400 and the at least one other vehicle based on the envelope area, in
15 order to effect a control of the light emission based on the safety distance.

The control device 430 is formed to output activation information representing the safety distance to the activation unit 460.

20 The activation unit 460 is formed to receive the activation information from the control device 430. The activation unit 460 is also formed to generate a control signal for control of the headlights 470. The activation unit 460 can take account of or use the activation information from the control device 430 when generating the control signal. The control signal can thus contain the activation information. The activation unit 460 is
25 formed to output the control signal to the headlights 470.

The headlights 470 can receive the control signal from the activation unit 460. The activation information, which is taken into account in the control signal, can cause the light emission to be controlled-based on the safety distance. In particular, the safety
30 distance between the light that can be radiated by the headlights 470 of the vehicle 400 and the at least one other vehicle can be adhered to here, in order not to illuminate the envelope area.

Figure 5 shows a camera picture taken by means of a vehicle camera. The camera picture can be taken by means of the vehicle camera from figure 4, for example. A course of a road with lane markings 580 and another vehicle 590 in the road course are shown. The lane markings 580 are delimiting lines, such as a left and a right sideline and a continuous centre line or a centre stripe, for example. The course of the road in figure 5 represents a double bend. The other vehicle 590 is a truck. Here the other vehicle 590 can have become visible in the course of the road shortly before a recording time of the camera picture. In particular, two front headlights of the other vehicle 590 are recognisable. The other vehicle 590 is thus an oncoming vehicle.

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Figure 6 shows a camera picture taken by means of a vehicle camera. The camera picture can be taken for example by means of the vehicle camera from figure 4. A course of a road with lane markings 580 and another vehicle 590 in the road course are shown. The lane markings 580 are delimiting lines, such as a left sideline and a broken centre line or centre stripe. The course of the road in figure 6 represents a left-hand bend. The camera picture depicts a situation in which the other vehicle 590 is being overtaken on a left-hand bend. In particular, two tail lights or rear lights of the other vehicle 590, an illuminated number plate or vehicle licence plate of the other vehicle 590 and a cone of light from front headlights of the other vehicle 590 are recognisable. The other vehicle 590 is thus a vehicle travelling ahead that is being overtaken.

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Figure 7 shows a camera picture taken by means of a vehicle camera. The representation in figure 7 corresponds to the representation in figure 6, with the exception that a position 795 of the other vehicle as well as a left-hand section and a right-hand section of a safety distance 777 are shown. The position 795 of the other vehicle can be determined from the picture by means of the vehicle camera and/or image processing electronics provided separately from this and can be present, for example, in the form of position information. The safety distance 777 concerns a distance between light from at least one headlight of the vehicle, in which the vehicle camera is arranged, and the other vehicle. The safety distance 777 can be determined in connection with the method from figure 3 and/or the control device from figure 4. Instead of a safety distance, a safety angle can also be used. According to the practical example shown in figure 7, the left-hand section and the right-hand section of

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the safety distance 777 are of equal magnitude. It should be noted here that in the course of the bend shown, the right-hand section in particular of the safety distance 777 could also be set to be smaller, but in the case of an unclear or unknown road course both sections of the safety distance 777 could also be enlarged.

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Figure 8 shows a camera picture taken by means of a vehicle camera. The representation in figure 8 corresponds to the representation in figure 5 with the exception that a position 795 of the other vehicle as well as lane courses 885 are shown. The position 795 of the other vehicle can be determined from the picture by
10 means of the vehicle camera and/or image processing electronics provided separately from this and can be present in the form of position information, for example. Alternatively or in addition, the position 795 can also originate in the form of position information from a navigation unit or the like, for example. The position information can be determined using navigation data. The lane courses 885 are recognisable in the
15 camera picture as lines along the lane markings. The lane courses 885 can be determined by means of the vehicle camera and additionally or alternatively by means of the navigation unit and can be present in the form of lane information, for example.

Figure 9 shows a flow chart of an algorithm 900 according to a practical example of the
20 present invention. The algorithm 900 can be part of a method for controlling the light emission of at least one headlight of a vehicle, for example the method from figure 3. The method from figure 3 can also be part of the algorithm 900, for example. In step 910, information is received on objects detected at night by a vehicle camera, for example a video camera or also a still frame camera. The objects can be at least one
25 other vehicle or headlights of the same. In step 920, lane information is received from the vehicle camera or video camera and/or also direct map data from a navigation unit. In step 930, a (virtual) map is built up based on the lane information and/or map data. The step 930 and the map are optional in themselves. Instead of the map, the lane information can be used. In step 940, possible placings or alignments of the at least
30 one other vehicle are determined on the map and/or with the lane information. The knowledge of the approximate distance of the at least one other vehicle is advantageous, but not absolutely necessary. In step 950, an assumption is made that the at least one other vehicle is located in the lane, i.e. is not crosswise to the

carriageway. In step 960, a safety distance is calculated from all possible positions and from directions respectively of the at least one other vehicle on the map. In step 970, a safety distance optimised in this way is set.

5 With reference to figures 3 to 9, some of the principles that form the basis of the present invention are explained in summary. The detection algorithm VDD (vehicle detection in darkness), for example, detects headlights of the other vehicle 590 as light points. The difficulty in this case is that the alignment of the other vehicle 590 cannot be measured with reference to the headlight light points, or from the picture position or
10 position 795 in the picture. The knowledge of the alignment of the other vehicle 590 is important, however, in order to set the lateral safety distance 777 to the detected headlights correctly. Without knowledge of the alignment, the safety distance 777 must be equally great in both directions, so that no dazzling occurs. If the road course is known on account of the lane courses 885, the alignment of the other vehicle 590 can
15 be estimated. Due to the known road course, at least the side of the safety distance of the light can be determined, e.g. the right-hand section of the safety distance 777 in figure 7. If the alignment of the other vehicle 590 can be estimated sufficiently accurately, the safety distance 777 can be adapted or set according to the perspective contraction. Inside simple curves the alignment could generally be estimated also with
20 reference to the current curve radius. The current curve radius can be calculated, for example, from the driving data of the vehicle, such as velocity, yaw rate and/or steering angle. In double bends or curve entrances and exits, for example, this is no longer possible, however. Depending on how far the projection needs to be, the use of data of the navigation unit or the like makes sense.

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The method 300 described or the control device 430 described uses a video system, which on the one hand detects the headlights of other vehicles, if applicable also colour, i.e. direction of travel, and also the lanes or lane markings on the road. A dazzle-free full beam is also intended to function if no lane information is available. If
30 the lane information is removed, another or greater safety distance or safety angle is obtained, i.e. a larger shadow area, as the safety distance or safety angle is set larger to one or both sides than when the lanes are visible. According to practical examples of the present invention, the use of the safety distance in conjunction with the lane

detection thus facilitates a more accurate calculation or setting of the horizontal safety distance in particular, e.g. in the case of dazzle-free full beam through use of the road course, in order e.g. to increase the range of sight.

- 5 In the above description, a video system is assumed by way of example. In principle, however, it doesn't need to be a video system that detects other vehicles, for example the use of radar (systems) is also possible. The use of a video system makes sense, however, as at night greater distances, e.g. 1000 m or more, can and should be covered than with radar, with which roughly 250 m can be reached. A forward-looking
- 10 lane detection is sensible, as curve entrances and exits can also be detected thereby. The area covered by the lane detection can be relatively small, for example smaller than 100 m. Curve entrances and exits can be measured by a video system or determined e.g. from the map data of a navigation unit for even greater foresight.
- 15 The practical examples described and shown in the figures are only chosen by way of example. Different practical examples can be combined with one another completely or with reference to individual features. One practical example can also be completed by features of a further practical example. Furthermore, method steps according to the invention can be repeated as well as executed in an order other than that described.

CLAIMS

1. Method (300) for controlling a light emission of at least one headlight (470) of a vehicle (400), wherein the method (300) has the following steps:

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Combining (310) of lane information with reference to a course of a road and position information (795) in respect of at least one other vehicle (590) located in the course of the road, in order to determine an envelope area not to be illuminated around the at least one other vehicle (590); and

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Setting (320) of a safety distance (777) between light that can be radiated by the at least one headlight (470) of the vehicle (400) and the at least one other vehicle (590) based on the envelope area, in order to control the light emission.

- 15 2. Method (300) according to claim 1, in which in the step of combining (310), the envelope area is determined additionally from an alignment of the at least one other vehicle (590) with reference to the vehicle (400).

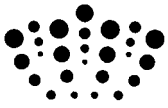
- 20 3. Method (300) according to claim 2, in which in the step of setting (320), at least one lateral section of the safety distance (777) arranged to the side of the at least one other vehicle (590) is set additionally based on the alignment.

- 25 4. Method (300) according to one of the preceding claims, in which in the step of combining (310), a digital representation of the course of the road is generated, wherein the envelope area is determined using the digital representation.

- 30 5. Method (300) according to one of the preceding claims, in which in the step of combining (310), potential placings of the at least one other vehicle (590) are determined based on the lane information, wherein the envelope area is determined using the potential placings.

6. Method (300) according to one of the preceding claims, with a step of determining the lane information and/or the position information based on image data.
- 5 7. Method (300) according to one of the preceding claims, with a step of determining the lane information and/or the position information based on navigation data.
- 10 8. Method (300) according to one of the preceding claims, with a step of determining the lane information and/or the position information based on driving data of the vehicle.
- 15 9. Method (300) according to one of the preceding claims, wherein in the step of setting (320), the safety distance (777) is set based on the envelope area and a validity of the lane information.
- 20 10. Method (300) according to one of the preceding claims, in which the envelope area is determined depending on a quality and/or validity of the lane information.
- 25 11. Method (300) according to one of the preceding claims, with a step of determining the lane information with reference to the course of the road and a step of receiving the position information (795) in respect of the at least one other vehicle (590) located in the course of the road.
- 30 12. Method (300) according to one of the preceding claims, with a step of validating or improving the position information (795) based on movement data of the other vehicle (590).
13. Device (430) for controlling a light emission of at least one headlight (470) of a vehicle (400), wherein the device (420) is formed in order to execute the steps of the method (300) according to one of claims 1 to 12.

14. Computer program product with program code for executing the method (300) according to one of claims 1 to 12, if the program is executed on a device (430).
- 5 15. Method for controlling a light emission of at least one headlight of a vehicle, substantially as hereinbefore described with reference to the accompanying drawings.
- 10 16. Device for controlling a light emission of at least one headlight of a vehicle, substantially as hereinbefore described with reference to the accompanying drawings.



Application No: GB1220177.8
Claims searched: 1 to 12 and 15

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Date of search: 8 March 2013

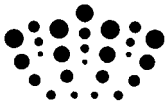
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,E	1 at least	US 2012/0314434 A1 (PARK ET AL) See the whole document
X	1 at least	US 2012/0275172 A1 (DENSO CORPORATION) See the whole document
X	1 at least	DE 102011002314 A1 (HELLA KGaA HUECK) See the whole document
X,E	1 at least	EP 2551155 A2 (KOITO MANUFACTURING CO) See the whole document
X	1 at least	EP 2495129 A2 (KOITO MANUFACTURING CO) See the whole document
X	1 at least	EP 2487068 A2 (KOITO MANUFACTURING CO) See the whole document
X	1 at least	EP 2479064 A1 (VALEO VISION) See the whole document
X	1 at least	EP 2388164 A2 (KOITO MANUFACTURING CO) See the whole document
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Field of Search:

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B60Q

The following online and other databases have been used in the preparation of this search report

ONLINE: WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
B60Q	0001/14	01/01/2006