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(54) [Title of the Invention] Automatic Adjustment Device for the Optical Axis Direction of Front Headlamps of a Vehicle

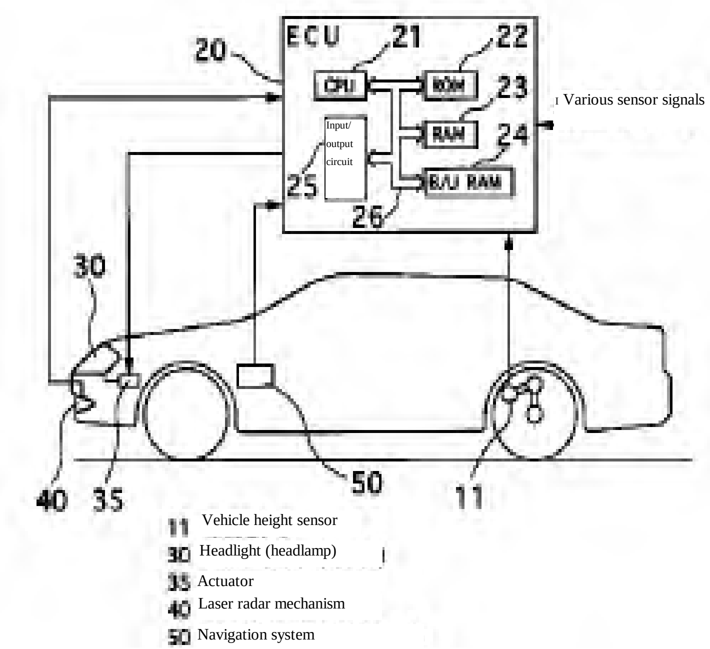
(57) [Abstract]

[Purpose]

To identify the functions mounted in a vehicle, to select the headlight (headlamp) optical axis control that can be realized by combining these, and to do suitable adjustment control of the optical axis direction and the irradiation range.

[Constitution]

When setting the optical axis direction or irradiation range of a headlight 30 based on detection information from various information detection systems such as of a navigation system 50, a laser radar mechanism 40, a vehicle height sensor 11 or the like, their mounting status is determined. Also, a preset variable light distribution function that can be realized by combining the various information detection systems is selected. By doing this, the optical axis direction and irradiation range of the headlight 30 undergo adjustment control.



[Claims]

[Claim 1]

An automatic adjustment device for the optical axis direction of front headlamps of a vehicle, comprising:

various information detection systems for detecting various types of information with a vehicle,

determination means for determining whether or not the information detection system is mounted in the vehicle and whether that detection function is normal or abnormal,

calculation means for calculating control values relating to optical axis control of the vehicle headlamp, using the detection function of the information detection system which is normal based on the results determined by the determination means, and

control means for implementing optical axis control of the headlamp based on the control values calculated by the calculation means.

[Claim 2]

The automatic adjustment device for the optical axis direction of front headlamps of a vehicle according to claim 1, wherein the information detection system is constituted from at least one of: road information detection means for detecting road information in the advancing direction of the vehicle, front information detection means for detecting information about in front of the car, vehicle information detection means for detecting vehicle information relating to the tilt orientation of the vehicle, steering angle detection means for detecting the steering angle of the vehicle steering wheel, and turning direction detection means for detecting the turning direction of the vehicle.

[Claim 3]

The automatic adjustment device for the optical axis direction of front headlamps of a vehicle according to claim 1 or 2, wherein the control means limits the control values so as not to exceed a designated range.

[Claim 4]

The automatic adjustment device for the optical axis direction of front headlamps of a vehicle according to claim 1 or 2, wherein when information is not detected by the information detection system that is mounted according to the detection results by the determination means, the control means sets the control value to a designated value.

[Detailed Description of the Invention]

[0001]

[Technological Field of the Invention]

The present invention relates to an automatic adjustment device for the optical axis direction of front headlamps of a vehicle that automatically adjusts the optical axis direction and irradiation range of headlamps installed on a vehicle.

[0002]

[Prior Art]

In the past, as an automatic adjustment device for the optical axis direction of front headlamps of a vehicle, for example, proposed was an item that detected the vehicle orientation from a vehicle height sensor and held the headlamp in a fixed optical axis (auto leveling function), operated the steering angle of the steering wheel and moved the optical axis direction of the headlamp in the lateral direction, changed the optical axis direction and irradiation range of the headlamp to match the travel state of the vehicle (city driving, highway driving or the like), or was equipped with a navigation system and front state detection mechanism and changed the optical axis direction and irradiation range of the headlamp. Here, the item that can change the irradiation range of the headlamp is an item that expands the leveling function and is called a variable light distribution system (AFS: Advanced Front Lighting System).

[0003]

[Problems the Invention Attempts to Solve]

However, with the system described above, each item is designed with a

single function, and it was not possible to expand the variable light distribution function even when a navigation system is mounted in a vehicle having device mounted for interlocking with the steering angle of the steering wheel to move the optical axis direction of the headlamp.

[0004]

In light of that, the present invention was created to address those problems, and an object is to provide an automatic adjustment device for the optical axis direction of front headlamps of a vehicle that identifies the functions mounted in a vehicle, selects optical axis control that can be realized by combining those, and that can suitably adjust the optical axis direction and irradiation range of the headlamps.

[0005]

[Means to Solve the Problems]

With the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of claim 1, based on the determination results by the determination means of whether or not various information detection systems that detect various types of information are mounted in the vehicle and whether the detection function thereof is normal or abnormal, control values relating to optical axis control of the vehicle headlamp using the normal items among those detection functions are calculated by the calculation means, and optical axis control of the headlamp is executed by the control means based on those control values. In other words, since the optical axis direction and irradiation range of the headlamps of a vehicle can be changed freely according to various types of information obtained with various information detection systems from the control angle with normal control, the optical axis direction of the headlamps is controlled to be suitably adjusted.

[0006]

With the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of claim 2, the information detection system is constituted from at least one of: road information detection means for the advancing direction of the vehicle, front information detection means for detecting front information, vehicle information detection means for detecting vehicle information relating to the tilt orientation of the vehicle, steering angle detection means for detecting the steering angle of the vehicle steering wheel, and turning direction detection means for detecting the turning direction of the vehicle. By doing this, the optical axis direction of the headlamps undergoes adjustment control using the vehicle specifications and the items for which the detection function is effective with the information detection system at that time.

[0007]

With the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of claim 3, the control means sets upper and lower limits for the control values so as not to exceed a designated range, preventing the optical axis direction of the headlamps from facing upward or downward.

[0008]

With the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of claim 4, when an information detection system is mounted according to the detection results by the determination means but information cannot be obtained from it, the control means sets the control value to a designated value. In other words, for the adjustment control of the optical axis direction for the vehicle headlamp, among the information detection systems mounted in the vehicle, the items for which the detection function is valid are used, but in a state when that information cannot be obtained, by setting to a preset control angle, unnatural control of the optical axis direction of the headlamps is prevented in advance.

[0009]

[Embodiments of the Invention]

Following, we will describe modes of carrying out the present invention based on embodiments.

[0010]

(Embodiment 1)

FIG. 1 is a schematic diagram showing the overall constitution when a laser radar mechanism and a navigation system are mounted in a vehicle which uses the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of the first embodiment of the modes of carrying out the present invention.

[0011]

In FIG. 1, a vehicle height sensor 11 is attached to an axle of the driver side or passenger side of the rear of the vehicle. From this vehicle height sensor 11, the relative displacement volume of the rear wheel side axle and the vehicle body, specifically, the rear vehicle height value as the vehicle height displacement volume (rear wheel side vehicle height displacement volume), and with other sensors, various sensor signals or the like from a vehicle speed sensor (not illustrate) or G sensor (not illustrated) or the like are input to an ECU (Electronic Control Unit) 20 mounted in the vehicle. For convenience, the ECU 20 is illustrated on the outside of the vehicle.

[0012]

The ECU 20 is constituted as a logic cooperating circuit consisting of a CPU 21 as a known central processing unit, a ROM 22 for storing control programs, a RAM 23 for storing various types of data, a B/U (backup) RAM 24, an input/output circuit 25, a bus line 26 for connecting those and the like. The output signals from this ECU 20 are input to an actuator 35 of the vehicle headlight (headlamp) 30 side, and as is described later, the optical axis direction of the headlight 30 is adjusted.

[0013]

Also, a known laser radar mechanism 40 for corresponding to specifications for detecting front information is mounted in the front bumper part, and as described later, the detection values detected by this laser radar mechanism 40 are input to the ECU 20 as the between-vehicle distance with the preceding vehicle, and are used when doing adjustment control of the optical axis direction of the headlights 30. Also, a known navigation system 50 for detecting road information is mounted in the vehicle. It is also possible to similarly build in an image information processing system using a millimeter wave radar mechanism or CCD camera instead of the laser radar mechanism 40 for detecting vehicle front information.

[0014]

FIG. 2 is a cross section diagram showing the major parts configuration of the headlight 30 of FIG. 1.

[0015]

In FIG. 2, the headlight 30 is mainly constituted by a lamp 31, a reflector 32 that fixes that lamp 31, one support part 33 that supports the reflector 32 so as to rock freely in the circle arc arrow direction, another moving part 34 that supports the reflector 32 and is able to move freely, and an actuator 35 consisting of a step motor or the like that drives the moving part 34 in the front-back arrow direction. The optical axis direction of the headlight 30 is initially set assuming a state with one driver riding and a road for which having the optical axis face upward is impossible.

[0016]

Next, we will describe the adjustment control processing means of the optical axis direction of the headlight 30 with the CPU 21 inside the ECU 20 used with the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of the first embodiment of the mode of carrying out the present invention based on the flow chart in FIG. 3, while referring to FIG. 4 and

FIG. 5. Here, FIG. 4 is an explanatory drawing showing the relationship between the between-vehicle distance and the topical axis center control angle when the laser radar mechanism 40 is mounted in a vehicle to which the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of an embodiment of the modes for carrying out the present invention is applied. FIG. 5 is an explanatory drawing showing the optical axis center control angle when the laser radar mechanism 40 is not mounted in a vehicle to which the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of an embodiment of the modes for carrying out the present invention is applied. This control routine is repeatedly executed by the CPU 21 at designated time intervals.

[0017]

In FIG. 3, at step S101, as the vehicle road information detection process, for example, road information is detected using the in-vehicle navigation system 50. Next, moving to step S102, tilt information is detected based on the rear vehicle height value from the vehicle height sensor 11 as the vehicle information detection process of the vehicle itself. As vehicle information relating to vehicle tilt orientation, in addition, it is also possible to add moving information, acceleration/deceleration information and the like detected by the vehicle speed sensor, G sensor or the like.

[0018]

Next, moving to step S103, a determination is made of whether this is a road for which it is possible to have the optical axis face upward based on road information read at step S101, specifically, whether or not it is a road in a state thought to not have a problem even when the optical axis center control angle θ target of the headlight 30 described later faces upward exceeding the control angle with normal control. Here, the control angle during normal control with the optical axis center control angle θ target of the headlight 30 that does not cause glare for facing vehicles or the like, and for which visibility for the driver is ensured is facing downward 1 [%] or 1.2 [%]. Also, as a road in a state thought to not have a problem even when the optical axis center control angle θ target of the headlight 30 described later faces upward exceeding the control angle with normal control, an example would be a highway, motorway or the like having a structure such that light from the headlights of facing vehicles is blocked at the center line part.

[0019]

When the determination conditions of step S103 are established, specifically, with a road in a state thought to not have a problem even when the optical axis center control angle θ target of the headlight 30 described later faces upward exceeding the control angle with normal control, the process moves to step S104, and a determination is made of whether it is possible to detect the vehicle front information, specifically, whether the laser radar mechanism 40 is mounted and if its detection value D is input. When the determination conditions of step S104 are established, specifically, when detection value D is input from the laser radar mechanism 40 to the vehicle, the process moves to step S105, and as shown in FIG. 4, as the vehicle front information detection process, the detection value D by the laser radar mechanism 40 is set as the between-vehicle distance d with the preceding vehicle. Meanwhile, when the determination conditions of step S104 are not established, specifically, when the laser radar mechanism 40 is not mounted in the vehicle and the detection value D is not input, the process moves to step S106, and as shown by the bold solid arrow in FIG. 5, the vehicle front information cannot be obtained regardless of the existence or position of a preceding vehicle, so as the constant Dc for which the between-vehicle distance d is preset, for example, 100 [m] is used. The between-vehicle distance d at this time can also be changed according to the vehicle speed and road conditions.

[0020]

After the processes according to step S105 or step S106, the process moves to step S107, and the optical axis center control angle θ target for the headlight 30 is calculated using the following formula (1). Here, h1 is the height that can be changed without blinding the preceding vehicle, and for example is the height up to the middle point of the reflector with both stop lights of the preceding vehicle from the road surface, and h2 is the height up to the optical axis center position of the headlight 30 of the vehicle from the road surface. For heights h1 and h2, it is possible to use preset constants. Also, height h1 can be changed by identifying the preceding vehicle, and height h2 can be a value calculated considering vehicle height, vehicle tilt, and the distance between the headlight 30 and the axle as the vehicle information.

[0021]

[Formula 1]

$$\theta\ target = \tan^{-1}\{(h2 - h1)/d\} \quad (1)$$

[0022]

Next, the process moves to step S108, and the upper and lower limit restriction process is executed so that a designated range is not exceeded in relation to the optical axis center control angle θ target calculated at step S107. In other words, when the optical axis center control angle θ target is large and exceeds the preset maximum optical axis center control angle θ max, as an upper limit guard, the maximum optical axis center control angle θ max is set to the optical axis center control angle θ target. On the other hand, when the optical axis center control angle θ target is the maximum optical axis center control angle θ max or less and a minimum optical axis center control angle θ min or greater, this is considered to be a suitable value, and the optical axis center control angle θ target is set as is. Also, when the optical axis center control angle θ target is small at less than the minimum optical axis center control angle θ min, as a lower limit guard, the minimum optical axis center control angle θ min is set to the optical axis center control angle θ target.

[0023]

Meanwhile, when the determination conditions of step S103, specifically, when the road is in a state thought to be a problem when the optical axis center control angle θ target of the headlight 30 faces upward exceeding the control angle during normal control, the process moves to step S109, and as shown in FIG. 5 with the dotted line arrow as the normal control angle, the optical axis center control angle θ target is set so as to face downward 1 [%] or 1.2 [%] as the control angle with normal control. As a road in this kind of state, examples include urban area roads and the like. After the processes at step S108 or step S109, the process moves to step S110, and as the optical axis control process, the actuator 35 is driven based on the optical axis center control angle θ target, and this routine ends.

[0024]

With the control routine described above, when with a vehicle in which the laser radar mechanism 40 is mounted, the between-vehicle distance d (= detection value D) with the preceding vehicle is large and exceeds a designated value, specifically, when there is no preceding vehicle, as shown by the bold solid line arrow in FIG. 4 (a), adjustment control is executed with the optical axis center control angle θ target facing upward up to the maximum optical axis center control angle θ max as the optical axis direction of the headlight 30. Also, when with a vehicle in which the laser radar mechanism 40 is mounted, the between-vehicle distance d (= detection value D) with the preceding vehicle is small at less than the designated value, as shown by the bold solid line arrows in FIG. 4 (b) and 4 (c), adjustment control is executed as appropriate so that the optical axis center control angle θ target is at height h1 with the position of the preceding vehicle as the optical axis direction of the headlight 30.

[0025]

Also, when with a vehicle in which the laser radar mechanism 40 is mounted, the between-vehicle distance d (= detection value D) with the preceding vehicle is small at less than the designated value, specifically, when the preceding vehicle is too close, as shown by the bold solid line arrow in FIG. 4 (d), as the optical axis direction of the headlight 30, adjustment control is executed with the optical axis center control angle θ target lowered to the minimum optical axis center control angle θ min which occurs when facing downward from the control angle during normal control. The speed control setting and the like for the actuator 35 is omitted.

[0026]

In this way, the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of this embodiment is equipped with various information detection systems for detecting various types of information with a vehicle, determination means for determining whether or not the information detection system is mounted in the vehicle and whether that detection function is normal or abnormal achieved using the CPU 21 inside the ECU 20, calculation means for calculating the optical axis center control angle θ target as the control values relating to optical axis control of the vehicle headlight (headlamp) 30 achieved using the CPU 21 inside the ECU 20, using the detection function of the information detection system which is normal based on the results determined by the determination means, and control means consisting of the CPU 21 inside the ECU 20 and the actuator 35 and the like for implementing optical axis control of the headlight 30 based on the optical axis center control angle θ target calculated by the calculation means.

[0027]

Also, the information detection system of the automatic adjustment device for the optical axis direction of front headlamps of a vehicle is constituted from a navigation system 50 as a road information detection means for detecting road information in the advancing direction of the vehicle, a laser radar mechanism 40 as a front information detection means for detecting the between-vehicle distance d (= detection value D) with the preceding vehicle as the information about in front of the car, and a vehicle height sensor 11 as vehicle information detection means for detecting vehicle information relating to the tilt orientation of the vehicle. Also, the control means consisting of the CPU 21 inside the ECU 20 and the actuator and the like of the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of this embodiment limits the optical axis center control angle θ target so as not to exceed a designated range, specifically, to be θ min ≤ θ target ≤ θ max.

[0028]

In other words, as the information detection system mounted in the vehicle for which the detection function is normal, the optical axis direction of the headlight 30 undergoes suitable adjustment control by the optical axis center control angle θ target for which the tilt angle of the vehicle calculated based on output from the vehicle height sensor 11 that detects vehicle information relating to the vehicle tilt orientation is changed according to the road information by the navigation system 50 and the front information by the laser radar mechanism 40 and set.

Specifically, highway driving or urban road travel or the like is known as road information with the navigation system 50, and whether or not there is a preceding vehicle and the between-vehicle distance is known as front information with the laser radar mechanism 40. By doing that, instead of adjustment control using the control angle with normal control which has the optical axis direction of the headlight 30 fixed downward at 1 [%] or 1.2 [%] only by the vehicle tilt orientation from the vehicle height sensor 11 as the vehicle information, with highway driving or the like, it is possible to have the optical axis direction of the headlight 30 face upward from the control angle with normal control so distance vision is improved, and with the between-vehicle distance d with the preceding vehicle, it is possible to have it face downward from the control angle with normal control, so it is possible to have the irradiation range in relation to the preceding vehicle be suitable. At this time, the optical axis center control angle θ target undergoes upper and lower limit control so as to satisfy the inequality equation of θ min ≤ θ target ≤ θ max, and having the optical axis direction of the headlight 30 face extremely upward or downward is prevented.

[0029]

However, as shown in FIG. 5, in the case of specifications without the laser radar mechanism 40 mounted in the vehicle, or when some kind of problem occurs with the laser radar mechanism 40 mounted in the vehicle, using the road information from the navigation system 50 or the like, for example, with permission to change the optical axis direction during highway driving, specifically, when the upward facing conditions are satisfied, the optical axis center control angle θ target as the optical axis direction of the headlight 30 undergoes adjustment control with the between-vehicle distance d as constant Dc, and so as to be height h1 at that position, and with other road conditions, adjustment control is done so as to be the control angle with normal control.

[0030]

Also, when there are specifications for which the laser radar mechanism 40 and the navigation system are not mounted, or when some kind of problem occurs with these if the laser radar mechanism 40 and the navigation system are mounted, whether or not there is a preceding vehicle and the between-vehicle distance as front information and the road information are not known, but the optical axis direction of the headlight 30 undergoes adjustment control based on the optical axis center control angle θ target by only the tilt angle by the vehicle information relating to the vehicle tilt orientation. By doing this, with the optical axis direction of the headlight 30 by only the vehicle tilt orientation as the vehicle information as the optical axis center control angle θ target with normal control, it is possible to set this to be fixed downward at 1 [%] or 1.2 [%], so it is possible to have the irradiation range in relation to the preceding vehicle be suitable. A warning or the like is given to the driver of problems with the laser radar mechanism 40, the navigation system or the like.

[0031]

(Embodiment 2)

FIG. 6 is a schematic diagram showing the overall constitution when the navigation system and the steering angle sensor for detecting the steering angle of the steering wheel are mounted in a vehicle to which is applied the automatic adjustment device for the optical axis direction of front headlamps of a vehicle of a second embodiment of the modes for carrying out the present invention. Also, FIG. 7 is a cross section diagram showing the major parts configuration of the headlight 30' of FIG. 6. In the drawings, the same constitution or items consisting of equivalent parts as those of the embodiment described above are given the same code numbers and the same symbols, and a detailed description of these is omitted.

[0032]

In FIG. 6, the output signals from the ECU 20 are input to the actuators 35 and 36 of the headlight 30' side of the vehicle, and as is described later, the optical axis direction of the headlight 30' is adjusted. Also, a well known navigation system 50 for detecting road information and a steering angle sensor 62 for detecting the steering angle of the steering wheel 61 by the driver or the like are mounted in the vehicle.

[0033]

FIG. 7 is a cross section diagram showing the major parts configuration of the headlight 30' of FIG. 6.

[0034]

In FIG. 7, the headlight 30' is mainly constituted by a lamp 31, a reflector 32 that fixes that lamp 31, one support part 33 that supports the reflector 32 so as to rock freely in the circle arc arrow direction, another moving part 34 that supports the reflector 32 and is able to move freely, an actuator 35 consisting of a step motor or the like that drives the moving part 34 in the front-back arrow direction, and an actuator 36 consisting of a step motor or the like for driving the assembled body for which these are an integrated unit in the horizontal rotation arrow direction. Here, the optical axis direction of the headlight 30' is initially set assuming a state with one driver riding.

[0035]

Next, we will refer to FIG. 8, FIG. 9, and FIG. 10 to describe a specific example of control of the optical axis direction of the headlight 30' described above.

[0036]

FIG. 8 is an explanatory drawing showing the left turn state of an intersection when at least one of steering interlocking control by the steering angle sensor 62 of the headlight 30' mounted in the vehicle or the blinker signal interlocking control by the blinker (turn signal light) showing the turning direction (not illustrated) functions. With FIG 8, road information from the navigation system 50 is not used.

[0037]

As shown in FIG. 8, when the steering angle of the steering wheel 61 by the driver or the like is detected by the steering angle sensor 62, the optical axis direction of the headlight 30' is controlled in the arrow direction according to this steering angle. Also, the optical axis direction is controlled in the arrow direction according to the blinker signal. In this way, the optical axis direction of the headlight 30' is controlled according to the left turn state at an intersection of the vehicle.

[0038]

FIG. 9 is an explanatory drawing showing the left turn state of an intersection when the irradiation range variable control by the navigation system 50 of the headlight 30' and the steering interlocking control by the steering angle sensor 62 mounted in the vehicle function.

[0039]

As shown in FIG. 9, when it is detected by the navigation system 50 that there is an intersection or a curve in front, control is done so that the irradiation range of the headlight 30' broadens in the arrow direction from before the intersection. At this time, the irradiation range of the headlight 30' does not broaden, and it is also possible to light an auxiliary light (not illustrated) that shines in the horizontal direction. Also, it is also possible to interlock to the steering angle of the steering wheel 61 and control the optical axis direction in the lateral direction.

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