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(54) (Title of the invention) FRONT LAMP OPTICAL AXIS CONTROL DEVICE FOR A MOTORCYCLE

(57) (Abstract)
(Problem) To ensure a stable range of illumination by a front lamp while a motorcycle is traveling even if a pitch angle, a bank angle, and a steering angle, etc., change.
(Means for solving) A front lamp optical axis control device 10 comprises potentiometers 121 and 122 that detect a pitch angle θp, an angular velocity sensor 14 that detects a bank angle θb, a steering angel sensor 16 that detects a steering angle θs, a vehicle speed sensor 18 that detects a vehicle speed v, step motors 22x, 22y, and 22z that rotate an optical axis of a front lamp 20 in a pitch angle direction Dp, a bank angle direction Db, and a steering angle direction Ds, and a controller 24 that finds a pitch angle direction correction amount Dpy, a bank angle direction correction amount Dbx, and a steering angle direction correction amount Dsz and corrects the angle of the optical axis via the step motors 22x, 22y, and 22z.

(SCOPE OF PATENT CLAIMS)
(CLAIM 1) A front lamp optical axis control device for a motorcycle, comprising a pitch angle sensor that detects a pitch angle, an actuator that rotates an optical axis of a front lamp in a pitch angle direction, and a controller that finds a pitch angle direction correction amount based on the pitch angle detected by the pitch angle sensor and corrects an angle of the optical axis via the actuator.
(CLAIM 2) A front lamp optical axis control device for a motorcycle, comprising a bank angle sensor that detects a bank angle, an actuator that rotates an optical axis of a front lamp in a bank angle direction, and a controller that finds a bank angle direction correction amount based on the bank angle detected by the bank angle sensor and corrects an angle of the optical axis via the actuator
(CLAIM 3) A front lamp optical axis control device for a motorcycle, comprising a pitch angle sensor that detects a pitch angle, a bank angle sensor that detects a bank angle, a vehicle speed sensor that detects a vehicle speed, an actuator that rotates an optical axis of a front lamp in a pitch angle direction, a bank angle direction, and a steering angle direction, and a controller that finds a pitch angle direction correction amount, a bank angle direction correction amount, and a steering angle direction correction amount based on the pitch angle, the bank angle, and the vehicle speed detected by the pitch angle sensor, the bank angle sensor, and the vehicle speed sensor and corrects an angle of the optical axis via the actuator.
(CLAIM 4) A front lamp optical axis control device for a motorcycle, comprising a pitch angle sensor that detects a pitch angle, a bank angle sensor that detects a bank angle, a steering angle sensor that detects a steering angle, a vehicle speed sensor that detects a vehicle speed, an actuator that rotates an optical axis of a front lamp in a pitch angle direction, a bank angle direction, and a steering angle direction, and a controller that finds a pitch angle direction correction amount, a bank angle direction correction amount, and a steering angle direction correction amount based on the pitch angle, the bank angle, the steering angle, and the vehicle speed detected by the pitch angle sensor, the bank angle sensor, the steering angle sensor, and the vehicle speed sensor and corrects an angle of the optical axis via the actuator.
(DETAILED DESCRIPTION OF THE INVENTION)
[0001]
[Industrial Field in which the Invention Belongs] The present invention relates to a front lamp optical axis control device that always maintains an optical axis of a front lamp of a motorcycle in a preferable angle.
[0002]
[Prior Art] Front lamp optical control devices that change an optical axis of a front lamp on a motorcycle in accordance with a vehicle speed, a steering angle, a bank angle, and so on are known (e.g., JP S63-53137 A, JP H7-195974 A). For example, by moving the front lamp up and down in accordance with the vehicle speed, a distant area is illuminated at high speed and a nearby area is illuminated at low speed. Additionally, the front lamp is turned left and right in accordance with the steering angle and/or the bank angle.
[0003]
[Problem to be Solved by the Invention] However, such conventional front lamp optical axis control devices have had the following problems.
[0004] The pitch angle of a motorcycle changes more readily than that of a car due to acceleration, deceleration, or bumps in the road. However, there have been none that change a range of illumination of the front lamp in accordance with a pitch angle. The front lamp has therefore moved up and down as the pitch angle changes during travel of the motorcycle, which has caused the range of illumination of the front lamp to swivel in a non-fixed manner.
[0005] In a motorcycle, if a vehicle body tilts in a bank angle direction a range of illumination of the front lamp becomes elongated as shown in FIG. 10. This is caused by an optical axis of the front lamp being pointed slightly below horizontal and a beam of light from the front lamp extending not as a round cone along the optical axis but rather as an elliptical cone have the horizontal direction as a long axis. The prior art has turned the front lamp left and right in accordance with the steering or bank angle, and as such has only turned the front lamp in the direction of the steering angle, i.e., turning the right when turning right or to the left when turning left, and has thus failed to provide any effect with respect to the elongation of the range of illumination of the front lamp. Note that in the following description, turning right also includes following a rightward curve and turning left also includes following a leftward curve.
[0006]
[Object of the Invention] Accordingly, an object of the present invention is to provide a front lamp optical axis control device in which a range of illumination of a front lamp can be ensured in a stable manner during travel of a motorcycle even if a pitch angle, a bank angle, a steering angle, and so on vary.
[0007]
[Means for Solving the Problem] A front lamp optical axis control device as described in claim 1 comprises a pitch angle sensor that detects a pitch angle, an actuator that rotates an optical axis of a front lamp in a pitch angle direction, and a controller that finds a pitch angel direction correction amount based on the pitch angle detected by the pitch angle sensor and corrects an angle of the optical axis via the actuator.
[0008] The pitch angle sensor detects changes in the pitch angle due to tilting of the vehicle body. The controller finds a pitch angle direction correction amount based on the pitch angle detected by the pitch angle sensor. The actuator rotates the optical axis of the front lamp in the pitch angle direction in accordance with the pitch angle direction correction amount output by the controller. Accordingly, up-and-down movement of the optical axis of the front lamp can be suppressed even if the pitch angle changes due to tilting of the vehicle body, thereby immediately correcting the range of illumination of the front lamp.
[0009] A front lamp optical axis control device as described in claim 2 comprises a bank angle sensor that detects a bank angle, an actuator that rotates an optical axis of a front lamp in a bank angle direction, and a controller that finds a bank angel direction correction amount based on the bank angle detected by the bank angle sensor and corrects an angle of the optical axis via the actuator.
[0010] The bank angle sensor detects changes in the bank angle due to tilting of the vehicle body. The controller finds a bank angle direction correction amount based on the bank angle detected by the bank angle sensor. The actuator rotates the optical axis of the front lamp in the bank angle direction in accordance with the bank angle direction correction amount output by the controller.

Accordingly, no elongation of the range of illumination of the front lamp occurs even if the bank angle changes due to tilting of the vehicle body. This is in order to always maintain the long axis of the light beam which spreads out in an elliptical cone horizontal.

[0011] A front lamp optical axis control device as described in claim 3 comprises a pitch angle sensor that detects a pitch angle, a bank angle sensor that detects a bank angle, a vehicle speed sensor that detects a vehicle speed, an actuator that rotates an optical axis of a front lamp in a pitch angel direction, a bank angle direction, and a steering angel direction, and a controller that finds a pitch angel direction correction amount, a bank angle direction correction amount, and a steering angle direction correction amount based on the pitch angle, the bank angle, and the vehicle speed detected by the pitch angle sensor, the bank angle sensor, and the vehicle speed sensor and corrects an angle of the optical axis via the actuator.

[0012] This front lamp optical axis control device is applied to a motorcycle in which the front lamp is affixed to the vehicle body, and can correct an angle of the optical axis via an actuator no matter how the vehicle body tilts by finding not only the pitch angle direction correction amount and the bank angle direction correction amount, but also the steering angle direction correction amount.

[0013] A front lamp optical axis control device as described in claim 4 comprises a pitch angle sensor that detects a pitch angle, a bank angle sensor that detects a bank angle, a steering angle sensor that detects a steering angle, a vehicle speed sensor that detects a vehicle speed, an actuator that rotates an optical axis of a front lamp in a pitch angel direction, a bank angle direction, and a steering angel direction, and a controller that finds a pitch angle direction correction amount, a bank angle direction correction amount, and a steering angle direction correction amount based on the pitch angle, the bank angle, the steering angle, and the vehicle speed detected by the pitch angle sensor, the bank angle sensor, the steering angle sensor, and the vehicle speed sensor and corrects an angle of the optical axis via the actuator.

[0014] This front lamp optical axis control device is applied to a motorcycle in which the front lamp is affixed to a handlebar, and can correct an angle of the optical axis via an actuator no matter how the vehicle body tilts by finding not only the pitch angle direction correction amount and the bank angle direction correction amount, but also the steering angle direction correction amount.

[0015]

[Embodiments of the Invention] FIG. 1 is a functional block diagram showing one embodiment of a front lamp optical axis control device according to the present invention. FIG. 2 is a general view showing the front lamp optical axis control device in FIG. 1 attached to a motorcycle. The description below references these drawings.

[0016] A front lamp optical axis control device 10 according the present embodiment comprises potentiometers 121 and 122, which serve as the pitch

velocity sensor 14, which serves as the bank angle sensor,

that detects a vehicle speed v, step motors 22x, 22y, and 22z, which serve as the actuator, that rotate an optical axis of a front lamp 20 in a pitch angel direction Dp, a bank angle direction Describe, and a steering angel direction, and a controller 24 that finds a pitch angel direction correction amount Dpy, a bank angle direction Db correction amount Dbx, and a steering angel direction correction amount Dsz based on the pitch angle direction Dp, the bank angle direction Db, and the steering angle direction Ds detected by the potentiometers 121 and 122,the angular velocity sensor 14, the steering angel sensor 16, and the vehicle speed sensor 18 and corrects the angle of the optical axis via the step motors 22x, 22y, and 22z.

[0017] The potentiometers 121 and 122 are rectilinear potentiometers which are provided to suspension on a front wheel and a back wheel and detect stroke length. The potentiometer 121 is for the front wheel and the potentiometer 122 is for the back wheel. The angular velocity sensor 14 is a piezoelectric angular velocity sensor that detects angular velocity in the bank angle

the angular velocity. The steering angel sensor 16 is a

an angle of manipulation of the handlebar. The vehicle speed sensor 18 is a general type that detects the vehicle speed v on the basis of a rotation speed of a wheel. The controller 24 is a microcomputer with a built-in program for optical axis control. The step motors 22x, 22y, and 22z turn forward and backward by a predetermined angle in accordance with a pulse signal output by the controller 24.

[0018] FIGs. 3 and 4 show a positional relationship between the front lamp 20 and the step motors 22x, 22y, and 22z; FIG. 3 is a frontal view and FIG. 4 is a top view. The description below references these drawings.

[0019] A front tip of a rotary shaft 30y of the step motor 22y is affixed to the front lamp 20 and the step motor 22y itself is affixed to an attachment stay 32x. The attachment stay 32x is a metal plate formed in a squared U-shape. A front tip of a rotary shaft 30x of the step motor 22x is affixed to an attachment stay 32x and the step motor 22x itself is affixed to an attachment stay 32z. The attachment stay 32z is a metal plate formed in an L-shape. A front tip of a rotary shaft 30z of the step motor 22z is affixed to an attachment stay 32z and the step motor 22z itself is affixed to an attachment stay 32. The attachment stay 32 is a flat plate affixed to the handlebar. The attachment stays 32, 32x, and 32z allow the front lamp 20 to rotate in three axial directions. Specifically, the step motor 22x rotates the optical axis of the front lamp 20 in the bank angle direction Db around an X-axis. The step motor 22y rotates the optical axis of the front lamp 20 in the pitch angle direction Dp around a Y-axis. And the step motor 22z rotates the optical axis of the front lamp 20 in the steering angle direction Ds around a Z-axis.

[0020] FIG. 5 is a descriptive view showing a principle of

and 122. FIG. 6 is a graph showing a relationship between

$_1$ of the potentiometer 121. FIG. 7 is a graph showing a

output voltage V_2 of the potentiometer 122. The detection principle of the pitch angle θp is described below with reference to these drawings.

[0021] As shown in FIG. 5, ends of a fixed distance L which is a straight line parallel to the ground in a motorcycle at rest are points A and B. When the motorcycle tilts forward during travel, the points A and B become points A' and B'. If it is assumed that vertical displacement amounts between the points A and B and the points A' and B' are Δa and Δb, a forward-back tilting angle of the motorcycle, i.e., the pitch angle θp, is given with the following formula.

[0022] $\theta p=\sin^{-1}\{(\Delta a-\Delta b)/L\}$ ・・・・・ ①

[0023] The potentiometers 121 and 122 are provided to the front and rear wheel suspensions, respectively (FIG. 2), and produce the output voltages V_1 and V_2, respectively, proportionally to extension and contraction of stroke lengths. As shown in FIGs. 6 and 7, the output voltages V_1 and V_2 are generally proportional to the displacement amounts Δa and Δb. This is because the displacement amounts Δa and Δb are generally proportional to the extension and contraction of the stroke length.

[0024] Accordingly, if the relationships in FIGs. 6 and 7 are mapped and stored in the controller 24 (FIG. 1), the displacement amounts Δa and Δb can be obtained accurately corresponding to the output voltages V_1 and V_2, making it possible to calculate the pitch angle θp immediately using the formula.

[0025] Next, a detection principle for the bank angle θb is described.

[0026] The bank angle θb is calculated by detecting an angular velocity in the bank angle direction using the angular velocity sensor 14, which is a piezoelectric oscillating gyro or the like, and integrating the angular velocity by time. In other words, the bank angle θb is given by the following formula, where t is time, wb(t) is the angular velocity of the bank angle direction, and θb_0 is an initial value of the bank angle.

[0027] $\theta b=\int_{t0}^{t} wb(t)dt+\theta b_0$ ・・・・・ ②

[0028] Next, a method for finding a pitch angle direction correction amount Dpy and a bank angle direction correction amount Dbx is described.

[0029] For example, let us assume that the pitch angle direction correction amount Dpy and the bank angle direction correction amount Dbx are inverted positively or negatively without changing absolute values of the pitch angle θp and the bank angle θb. Specifically, we assume that Dpy=-θp,Dbx=-θb. The step motors 22y and 22x (FIG. 1) are turned so as to eliminate the pitch angle θp and the bank angle θb created by the tilting of the motorcycle. This method is the simplest, as there is only one parameter each for calculating the pitch angle direction correction amount Dpy and the bank angle direction correction amount Dbx. In addition to the pitch angle θp, the bank angle θb, a steering angle θs, or a vehicle speed v can be used, alone or in combination, as parameters for calculating the pitch angle direction correction amount Dpy. Similarly, in addition to the bank angle θb, the pitch angle θp, the steering angle θs, or the vehicle speed v can be used, alone or in combination, as parameters for calculating the bank angle direction correction amount Dbx.

[0030] FIG. 8 is a graph that shows a three-dimensional map for finding a steering angle direction correction amount Dsz. A method for finding the steering angle direction correction amount Dsz is described below, with reference to this graph.

[0031] The graph in FIG. 8 finds a relationship between the bank angle θb, the vehicle speed v, and the optimal steering angle direction correction amount Dsz, both theoretically and practically. This three-dimensional map is stored in the controller 24 ahead of time. In the present embodiment, the front lamp 20 is affixed to the handlebar (FIG. 2), and the steering angle direction correction amount Dsz is found by subtracting the steering angle θs calculated by the steering angel sensor 16 (FIG. 1) from a steering angle direction correction amount Dsz' shown in FIG. 8 using the following formula.

[0032] Dsz=Dsz'-θs ・・・・・ ③

[0033] If the front lamp 20 is not affixed to the handlebar (if it's affixed to the vehicle body), Dsz=Dsz'.

[0034] FIG. 9 is a flowchart showing an operation of a front lamp optical axis control device 10. Operation of the front lamp optical axis control device 10 is described below with reference to FIGs. 1 and 9. This operation is executed in accordance with a program in the controller 24.

[0035] First, a determination is made as to whether or not the vehicle speed v detected by the vehicle speed sensor 18 is not zero (i.e., the motorcycle is traveling), the angular velocity wb(t) of the bank angle direction Db detected by the angular velocity sensor 14 is zero, and these states have held for at least a predetermined amount of time (step 101). If the states have held for at least the predetermined amount of time, it is determined that the vehicle body is upright relative to the road (i.e., is travelling in a straight line), the bank angle θb and the initial value thereof θb_0 are set to zero, and the integration operation according to the formula is reset (step 102). Next, if it is determined in step 101 that the states have not held for at least the predetermined amount of time or if the integration operation is reset in step 102, then the pitch angle direction correction amount Dpy, the bank angle direction correction amount Dbx, and the steering angle direction correction amount Dsz are calculated using the method below (steps 103–105). Next, the step motors 22y, 22x, and 22z are driven in accordance with the pitch angle direction correction amount Dpy, the bank angle direction correction amount Dbx, and the steering angle direction correction amount Dsz (steps 106–108).

[0036] Note that the present invention is naturally not limited to the embodiments above. For example, the pitch angle sensor, the bank angle sensor, and the steering angle sensor can be constituted by a piezoelectric oscillation gyro that can detect three directions. However, in that case, tilt angle (i.e., the initial value) on a hill or the like has to be taken into consideration as relates to the pitch angle.

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