Steering Control Headlights Mechanism

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Abstract:

The topic of this project is steering controlled (or directional) headlights, that are usually a separate set of headlights fitted to road vehicles beside the usual low beam/high beam headlights and their feature is that they turn with the steering, so that the driver of the vehicle can see the bend, what he is actually turning into. These type of headlights appeared on production cars in the 1920's and are still around nowadays, but not very popular, although they make night time driving safer. The most famous car which featured these lights was the Citroen DS (1955-1975), introduced on the1968 Paris Motor Show. The headlights can be connected to the steering linkage by means of rods or cables, operated hydraulically by the power steering or nowadays electronically adjusted, even controlled by satellite navigation system.

INTRODUCTION

The present invention relates to headlights of an automobile, more particularly to a direction turning device for headlights of an automobile which enables to turn direction synchronously with the rotation of the steering and hence increasing the safety for driving at night or in the darkness.

In the known technology of the prior art, a headlight of an automobile has a fixed line of emission which is aligned with the front direction of the automobile. Although the effects of "high beam" or "low beam" can be achieved by adjusting the angle of elevation of the headlight, the direction of emission is not adjustable as to the left or right. When the road curves or turns, the corner on time when the car turns, thereby creating a dead angle of illumination and such lack of visibility poses danger in driving at night or in darkness.

Therefore, it is highly desirable to invent a device to solve this problem and such device is of high utility. An object of the present invention is to provide a direction turning device for a headlight of an automobile which renders to emission direction of a headlight of an automobile in synchronization with steering and thus increases the illuminated area upon changes of direction of the automobile when the automobile makes turns.

In ancient Directional headlights, when the steering steers to right or left direction, then both the right and left headlights will steer to the perspective directions. It results in altering the optical axis of the head light to the vehicle speed and the front rood-shape. But according to our project, when the steering steers to right then the right side of the headlight bracket steers to right side and the left side headlight bracket remains stationery by cam mechanism and it is similar for the other side also. Because of this, the optical axis of the headlight is widened and it is useful for the drivers for safety ride.

Functionality: Steering control headlights are designed to improve visibility and safety during nighttime driving, especially on winding roads or sharp turns.

Dynamic Adjustment: The key feature of steering control headlights is their ability to dynamically adjust the direction of the light beam in response to the vehicle's steering angle.

Cornering Illumination: When the driver turns the steering wheel, the headlights swivel or pivot in the direction of the turn, illuminating the area around the curve or corner. This improves visibility and allows the driver to see potential hazards or obstacles on the road ahead, such as pedestrians, cyclists, or animals.

Adaptive Functionality: Some steering control headlights feature adaptive functionality that adjusts the intensity and range of the light beam based on driving conditions, such as vehicle speed, road curvature, and ambient light levels.

1.1 Objective

Improved Visibility: By automatically swiveling in the direction of the vehicle's turn, steering- controlled headlights illuminate the road ahead more effectively, especially around curves and bends. This improves visibility for the driver and helps them anticipate potential hazards or obstacles.

Enhanced Safety: Steering-controlled headlights help drivers see farther into corners and navigate winding roads more confidently, reducing the risk of accidents caused by limited visibility. By illuminating the path ahead more effectively, these headlights contribute to overall road safety, especially during nighttime driving.

1.2 Problem Definition

Headlight Alignment: The headlights are not aligned properly with the direction of travel, causing reduced visibility or glare for other drivers. This misalignment could be due to a fault in the steering-controlled headlight adjustment mechanism or improper installation.

Intermittent Headlight Operation: The headlights intermittently turn on or off while steering, indicating a possible wiring issue, loose connection, or malfunction in the steering column switch or headlight control module.

Headlight Flickering: The headlights flicker or dim when turning the steering wheel, suggesting an electrical problem such as a faulty relay, corroded wiring, or a defective headlight bulb connection.

1.3 Scope of Work

Understand the specific requirements and objectives of the steering control headlight system, including performance criteria, functionality, and integration with existing vehicle systems. Conceptualize and design the steering control headlight system, considering factors such as steering angle input, vehicle speed, lighting conditions, and safety regulations.

Determine the optimal placement of sensors, actuators, and control modules within the vehicle architecture. Select appropriate components, including sensors, actuators, microcontrollers, and communication interfaces, based on the design requirements. Integrate sensors, such as steering angle sensors and vehicle speed sensors, to accurately detect the vehicle's steering angle and speed. Ensure proper calibration and alignment of sensors to provide accurate input data to the control system. Develop control algorithms to translate steering angle and vehicle speed inputs into appropriate adjustments to the headlights.

1.4 Future Scope

Integrate steering control headlights with ADAS technologies such as lane-keeping assistance and adaptive cruise control. Enable automatic adjustment of headlight direction and intensity based on vehicle speed, steering input, and road conditions to optimize visibility and safety.

Implement advanced sensing and recognition systems, such as LiDAR (Light Detection and Ranging) or camera-based systems, to detect and recognize road conditions, traffic, and obstacles. Enable adaptive lighting algorithms that adjust headlight patterns and intensity to optimize visibility and minimize glare for other road users. Utilize connected vehicle technology to enable communication between vehicles and infrastructure (V2X) and enhance situational awareness.

Enable cooperative adaptive lighting systems that coordinate headlight operation with other vehicles to improve visibility and safety in complex traffic environments. Develop energy-efficient lighting technologies, such as LED (Light-Emitting Diode) or OLED (Organic Light- Emitting Diode), to reduce power consumption and extend battery life. Explore renewable energy sources, such as solar or kinetic energy harvesting, to power steering control headlights and reduce dependence on traditional power sources.

HISTORY OF DEVELOPMET

Although the concept of headlights that follow the movements of the steering is still considered nowadays as being innovative, it is not new. The first vehicles fitted with such systems appeared in the 1920s. Pioneers and milestones in the automotive history featuring directional headlights were the 1928 Willys - Knight 70A Touring, the 1930s Czech Tatra and the American 1948 Trucker Sedan. These cars were equipped with a third central headlight mechanically connected to the steering system. The most famous car featuring directional headlights, was the Citroen DS (1955-1975), introduced on the 1968 Paris Motor Show. This car had both headlights not only swiveling with the steering, but they were self-leveling as well, responding to inputs from the suspension. While it was a purely mechanical system operated by cables, the 1970Citroen SM used a sealed hydraulic system with a glycerin based fluid. On present day motorcars two types of directional headlight system are in use:

1. A fixed light that only turns on and off based on steering and vehicle speed.

2. The light is motorized by the use of small electric motors and physically swivels according to the movement of the steering wheel and vehicle speed.

This modern technology first appeared in 2003 on the Porsche Cayenne (fixed) and the Mercedes E-class (motorized). Soon other manufacturers followed them such as the BMW with the adaptive headlights and cornering lights and nowadays most of the main brands use such systems on their vehicles like Acura, Audi, BMW, Cadillac, Ford, Infiniti, Jaguar, Land Rover, Lexus, Mercedes-Benz, Opel, Porsche, Saab, Volkswagen, Volvo and Mazda. Audi is experimenting with a system which uses satellite navigation adjusts the headlights according to the road layout ahead the vehicle.

CONSTRUCTION

The main components used in this project are:

1. Sprockets:

A sprocket is a profiled wheel with metal teeth that meshes with a chain, track or other perforated or indented material. Sprockets are used to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

Choose appropriate materials for the spokes, typically stainless steel or high-tensile steel, to ensure durability, strength, and resistance to corrosion. Consider a lightweight material if reducing the overall weight of the bicycle is a priority. Determine the optimal length and thickness of the spokes based on the size of the bicycle wheel, the rim's dimensions, and the desired tension in the spokes.

Fig: 1.1 Sprockets.

2. Steering System:

The most conventional steering arrangement is to turn the front wheels using a handle operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints to allow it to deviate somewhat from a straight line. Other arrangements are sometimes found on different types of vehicles.

For example, a tiller or rear wheel steering.

3. Headlights:

Understand the requirements and preferences of cyclists, including brightness, beam pattern, battery life, mounting options, and budget constraints. Design the headlight system, considering factors such as brightness (lumens), beam pattern (spot, flood, or combination), light color (white or colored), and power source (battery-powered or dynamo).

Select appropriate LED (Light Emitting Diode) or other light sources based on efficiency, reliability, and durability. Design the housing and optics to ensure optimal light distribution, minimize glare for oncoming traffic, and provide visibility at various distances. Determine the power source for the headlight, such as rechargeable batteries (e.g.. lithium-ion) or a dynamo hub.

4. Nut and Bolt:

Choose materials with appropriate strength and corrosion resistance, such as stainless steel or carbon steel. Consider using materials that are lightweight to minimize the overall weight of the bicycle. Determine the size and thread pitch of the bolts based on the components they will fasten together.

5. Frames:

0.75 Square Inch Pipe

Choose a material with suitable strength, durability, and corrosion resistance for the square pipe, such as steel (e.g., mild steel or stainless steel) or aluminum. Consider the weight of the material to ensure it does not add unnecessary mass to the bicycle's steering assembly.

Determine the appropriate length and wall thickness of the square pipe based on the specific requirements of the steering control headlight system. Ensure that the square pipe is long enough to accommodate the necessary components of the headlight system, such as the light source, wiring, and mounting hardware.

Fig: 1.2 Frames.

6. Chain drive:

Commonly, mechanical energy from a motor or other source applied to a sprocket wheel is conveyed by means of an endless chain to another sprocket wheel for driving a mechanism. Examples of such an arrangement are found in bicycles, motorcycles, and conveyor belts.

WORKING PRINCIPLE

Our project is to the turn the right light bracket to the right, when the vehicle turns to right leaving the left bracket to remain in standstill position, and vice versa.

When the steering steers to the right, a sprocket attached to the steering rod rotates which in turn connected to the other sprocket through a chain. The sizes of the sprockets were designed in such a way that, if the smaller sprocket rotates four full complete rotations the larger sprocket will rotate once. Also the small gear, which is attached to the same shaft as of the larger sprocket, also rotates along with the sprocket.

A larger gear of the former is chosen, which is twice its diameter, is meshed to transmit the motion. So the right light bracket moves according to the movement of the follower. At the same time, the cam at the other end remains in the dwell period, which results in the stand still position of the light brackets.

DESIGN CALCULATIONS

1. Design calculation for chain drive

Speed of rotation, $N_1 = 1000$ rpm

Speed of rotation, $N_2 = 250$ rpm

Centre distance, $a = 800$ mm

Gear ratio, $i = N_1/N_2 = 4$

$i_{std} = 4$

Teethes, $Z_1 = 20$

Teethes, $Z_2 = i \times Z_1 = 80$ teeth

Chain pitch, $a = (30\text{-}50)\,p$.

$a = 30p \Rightarrow p = 26.67 \text{ mm} = P_{max}$

$a = 50p \Rightarrow p = 16 \text{ mm} = P_{min}$

Standard pitch, $P_{std} = 25.4$ mm

So the chain selected is 16A1-R80-> simplex

Length of chain, $l_p = 2a_p + (z_1+z_2)/2 + ((z_2-z_1)/2)^2/a_p)$

$a_p = a_0/p = 800/25.4 = 31.49$

$= 115.87$

$= 116$ links

Actual length = no. of links × pitch = 2946.6 mm

Bearing area = 1.79 mm^2

Centre distance, $a((e+ \sqrt{(e^2-8m)})/4)p$

$e = l_p - (z_1+z_2)/2 = 66$

$m = ((z_2-z_1)/(2*3.14))^2$

$a = 66+ \sqrt{(((66^2-(8*91.18))/4)}p = 801.5 \text{ mm}$

2. Design calculation for chain drive

Speed of rotation, $N_1 = 1000$ rpm

Speed of rotation, $N_2 = 250$ rpm

Centre distance, $a = 1200$ mm

Gear ratio, $i = N1/N2 = 4$

$istd = 4$

Teethes, $z1 = 20$

Teethes, $z2 = i \times z1 = 80$ teethes

Chain pitch, $a = (30\text{-}50)p$

$a = 30p \Rightarrow p = 40\text{mm} = Pmax$

$a = 50p \Rightarrow p = 24\text{mm} = Pmin$

Standard pitch, $pstd = 25.4$ mm

So the chain selected is 16A1-R80-> simplex.

Length of chain,

$lp = 2ap+(z1+z2)/2+((z2-z1)/2)^2/ap$

$ap = a0/p = 1200/25.4 = 47.24$

$lp = (2*47.24)+50+(60/2*3.14)^2/47.24$

$= 144.49$

= 146 links

Actual length = no. of links × pitch

= 3708.4 mm

Bearing area $=1.79\ \text{mm}^2$

Centre distance, $a = ((e+\sqrt{(e^2-8m)})/4)p$

$e = lp-(z1+z2)/2 = 96$

$m=((z2-z1)/(2*3.14)^2)$

$= 91.18$

$a =96+ \sqrt{(((96^2-(8*91.18))/4)}p=1194.5$ mm

3. Rotation reduction ratios

Steering rotation = 7200

Angle of cam to be tilted = 900

So value of angle to be reduced is in ratio 8:1

The reduction between the sprockets is made as 4:1

So the diameter & teeth of the larger sprocket should be four times that of the smaller

Diameter, $d1 = 40$ mm

Teethes, $z1 = 20$

Diameter, $d2 = 160$ mm

Teethes, $z2 = 80$

4. Design calculation for sprockets

Here the rotation reduction ratio is 4:1

So the diameter & teeth of larger sprocket should be four times that of the smaller.

Diameter, d1 = 40 mm [readily available in market]

Teethes, z1 = 20

Diameter, d2 = 160 mm

Teethes, z2 = 80

APPLICATIONS

- Can be used in all heavy vehicles.
- Can be used in tempo and vans.
- Speed-sensitive lighting.
- Weather adaptive lighting.
- Curve lighting.
- Dynamic cornering light.

ADVANTAGES

- Useful for heavy vehicles in hill areas, where hair-pin bends are more.
- Improved visibility around corners.
- Enhanced safety during night driving.
- Automatic adjustment based on driving conditions.
- Modern and advanced feature.
- Increased driving comfort.

DISADVANTAGES

- Higher initial cost.
- Increased complexity in the vehicle's electrical system.
- Maintenance and repair expenses.
- Limited retrofitting options for older vehicles.
- Potential visibility limitations in certain conditions.

LIMITATIONS

- Not mandatory for straight roads.
- Restricted effectiveness in extreme weather conditions.
- Limited range of movement on sharp turns.
- Vulnerable to damage from road debris.
- High repair or replacement cost.

CONCLUSIONS

Before we undertook this project our knowledge about directional headlights was limited. After doing an extensive research for this project we have a wider knowledge of this field in automotive technology, learnt useful information about different types of directional headlights. We have searched the library of the college for relevant books and the internet for additional information.

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