Car headlight steering and follow-up mechanism design

Kang Sang1 and Shaoguo Zhang
Xijing University of Mechanical Engineering, Xi’an, 710123, China
1E-mail: 1037364737@qq.com

Abstract. In order to reduce the driving problem caused by insufficient light when driving and turning, it is necessary to design the following steering headlamp, so that the driver can see the road information in front of him in time and make a timely judgment. This paper firstly determines the overall design of the following steering light, analyzes and selects the following steering structure of the main structure of the headlight, and completes the design of the transmission scheme. Finally, the design can realize the following steering of the headlight.

1. Introduction
The main function of headlights is to get information about the road surface, but at the same time dazzle other drivers when they cannot meet the car. So the light distribution of headlights, industry standards are very strict. Automobile headlamp has always been the research object of automobile designers, because headlamp is the eye of automobile. In this situation[1], it is necessary to design a headlight that can follow the vehicle's steering.

2. The overall scheme design of the headlight system with steering and follow-up
Follow-up headlights are common in high-end small cars and are expensive. The following is a brief overview of the design of the following headlight system.

2.1. function and composition of the system
During driving, when the car body tilts, the system can obtain the information of the road surface according to the sensors at the front and rear, so that the driving computer can control the headlight of the car to make the appropriate pitch illumination Angle. Follow the turn, when the turn will also follow the headlights, so the light will also follow the movement[2], illuminate the front of the turn enough lighting. Auto adaptive intelligent lighting control system mainly consists of a variety of sensors, signal conditioning, driving circuit, motor, fault diagnosis and other parts. It is divided into: headlight control unit、AFS main controller、all-vehicle sensor module.

2.2. basic functions of the system
When driving on the curve and ramp at night, the system analyzes the steering data of the steering wheel and the data of the body Angle. Then the stepper motor gets the control signal and commands the motor to rotate to the specified position. This completes the control of the light Angle along with the direction of the car, and the road surface in the direction of the car will be illuminated[3].

2.3. working principle of the system
The data obtained by the tilt sensor and the steering wheel sensor can determine the driving state of the car, and the detected signal can be input into the MCU in time to judge and process and send out the
corresponding instructions. The relevant instructions can control the headlight to make corresponding adjustments, and the headlight can realize the following steering. In the AFS system, when the vehicle turns left, the left headlight will also turn left, and the right headlight will remain still. Similarly, when turning right, the right headlight rotates right, while the left headlight stays still[4].

2.4. chapter summary
This chapter describes the overall composition of the system. The principle and function of the system are expounded, which provides a theoretical basis for the further study of the system.

3. Mechanism design of headlight following steering

3.1. transmission mode and material selection of steering mechanism
Material selection of steering mechanism is also extremely important. The service life of a car is about 12 years, so the lamp life is generally longer. Therefore, the material selection with good wear resistance should be adopted. Therefore, 45 steel has a long service life. If the use of PVC engineering plastics will not only oxidation for a long time, wear and tear will also lead to its damage, which will increase the cost of its use[5].

3.2. left-right steering design of headlights
The platform designed in this paper needs to meet the corresponding left-right rotation movement when rotating (figure1), in which 1 is the headlamp, 2 is the gear, 3 is the coupling and 4 is the motor. The working principle is the driving device of the rotary platform. The power is transmitted to the big ring of teeth fixed on the frame through the output pinion of the transmission device, so that the rotary table can rotate around the rotary center line. The motor is the main source of power. At the same time, it also needs a large transmission torque. In order to meet the design requirements of the phase, it needs a precise reducer to play the role of deceleration and torsional increase, so that the designed structure can meet the corresponding design requirements[6]. In this paper, when designing the overall scheme of the platform, it is necessary to realize the linkage between the main moving motor of the automobile headlamp regulating mechanism and the feeding movement of the workpiece by using the driving motor. Meanwhile, there is also a strict internal transmission ratio. Therefore, the adoption of gear transmission can meet the strict control of the logarithmic ratio.

3.3. selection analysis of driving motor
Select the power of the drive motor: The slewing platform design can probably will drive motor rated power set to \( P_d = 30 \text{ w} \), the power is enough to meet demand. The synchronous speed of the driving motor of this series shall all meet the requirements of the actual speed characteristics[7]. Through comparative analysis, this paper focuses on the synchronous speed of the driving motor is \( n = 1000 \text{r/min} \). It is mainly based on a series of requirements such as transmission ratio, price, size[8],

![Figure 1. left-right rotary platform transmission.](image-url)
performance and actual needs of motor transmission device of automobile headlamp adjusting mechanism platform in the specific design and calculation, and finally adopts the driving motor of MKC road-rocker model. With high cost performance, can meet the actual work needs.

3.4. design and calculation of transmission mechanism

This section firstly calculates the design of the transmission gear:

1) according to the mechanical design and material mechanics designed, the transmission torque of the transmission gear can be calculated according to the following formula:

\[ T = \frac{9550P}{n} = 23.58N \]  

(1)

2) the load coefficient can also be preliminarily selected according to the knowledge learned: \( K_r = 1.4 \).

3) take the tooth width coefficient according to the mechanical design: \( \phi_d = 1 \).

4) the elastic coefficient of the transmission gear can also be known from the mechanical design: \( E_z = 189.8\sqrt{\text{MPa}} \).

5) for the standard spur gear, the corresponding nodal area coefficient can be selected: \( Z_{Hf} = 2.5 \).

6) preliminarily determine the transmission ratio of the transmission mechanism: \( u = i = 3.48 \)

7) determine the number of teeth of the transmission gear: The number of teeth of the pinion can then be selected, and the calculation of the large gear can be determined according to the following formula, that is, it is desirable. \( z_1 = 29 \). \( z_2 = uz_1 = 3.48 \times 29 = 100.92 \). \( z_2 = 101 \).

8) calculation of the coincidence degree of transmission gear: The calculation of the coincidence degree of the end face of the transmission gear is carried out according to the following formula:

\[ \varepsilon = \left[ 1.88 - 3.2 \left( \frac{1}{z_1} + \frac{1}{z_2} \right) \right] \cos \beta \]  

(2)

The axial coincidence degree of the transmission gear is calculated according to the following formula: \( \varepsilon = 0.318 \phi_d z_1 \tan \beta = 0 \). Then the coincidence coefficient of the transmission gear can be found. \( Z_z = 0.88 \).

9) according to the knowledge of mechanical design, the allowable contact stress of the transmission gear can be calculated according to the following formula:

\[ [\sigma]_{Hf} = \frac{Z_N \sigma_{Hf, \text{lim}}}{S_H} \]  

(3)

According to the mechanical design, it can be found that the ultimate stress of contact fatigue strength of the transmission gear is, respectively, \( \sigma_{Hf, \text{lim}} = 580 \text{MPa} \) \( \sigma_{Hf, \text{lim}2} = 400 \text{MPa} \). It can also be determined that the stress cycles of the pinion gear and the large gear of the transmission mechanism are:

\[ N_1 = 60n_1aL_h = 60 \times 480 \times 1.0 \div 2 \times 8 \times 250 \times 10 = 1.15 \times 10^9 \]  

(4)

The life coefficient of the transmission gear can be checked, so the specific safety coefficient can be taken as, then the contact stress of the transmission gear can be calculated by the following formula \( Z_{N1} = 1.0 \) \( Z_{N2} = 1.1 \) \( S_H = 1.0 \).

\[ [\sigma]_{H1} = \frac{Z_{N1} \sigma_{Hf, \text{lim}1}}{S_H} = \frac{1 \times 580}{1} = 580 \text{MPa} \]  

(5)

\[ [\sigma]_{H2} = \frac{Z_{N2} \sigma_{Hf, \text{lim}2}}{S_H} = \frac{1.1 \times 400}{1} = 400 \text{MPa} \]  

(6)

So the calculation is good. The soft tooth surface of the transmission gear adopts closed drive, so
the gear design is carried out according to the contact fatigue strength of the tooth surface. Then, the dividing circle diameter of pinion is calculated as follows:

\[
d_{ul} = \sqrt{\frac{2Kt}{\varphi_h} \left( \frac{Z_u Z_m Z_e}{\sigma_{ult}} \right)^2 + \frac{2 \times 1.4 \times 58600 
\times 3.48 + 1}{3.48 \times 440} \right)^2 = 57.54 \text{mm}
\]

3.5. chapter summary
This chapter mainly designs the mechanism of left and right rotation of headlight, determines the overall rotation design of the platform, and also analyzes and selects the type of driving motor. Finally, the design and calculation of the transmission mechanism, the determination of the size and the failure mode of the transmission are analyzed. To ensure that the left and right rotation of the headlight can meet the work requirements.

4. conclusion
First of all, this paper analyzes the following steering control of automobile headlamp. The controller of automobile headlamp and the mechanical transmission parts are designed. The following conclusions can be drawn: 1. The following headlights can reduce the traffic accidents caused by insufficient lighting; 2. The main parts of the headlamp, such as the front lamp shade and headlamp assembly, are designed to match the good performance of the car.

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