Simulation troubleshooting and optimization of internal rearview mirror optical dithering problem

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Abstract. In order to solve the optical dither problem of the inside rearview mirror of a certain vehicle, the finite element modeling and modal simulation analysis of the inside rearview mirror were carried out by using MSC NASTRAN software. Based on the results of the simulation analysis, the structure of the mirror rod and the base was optimized to improve the stiffness and modal, and the scheme was engineered and verified, which effectively solved the optical dithering problem of the rearview mirror.

Keywords: Inside rearview mirror, vibration, structural optimization.

1. Introduction
Car rearview mirror is generally divided into inside and outside the car two, the car rearview mirror is a plane mirror, reflecting the real distance. The rearview mirror is the driver sitting in the cab seat directly access to the rear, side and below the car and other external information tools [1]. In order to facilitate the operation of the driver, prevent the occurrence of driving safety accidents, to protect personal safety, all countries have stipulated that the car must be installed on the rearview mirror, and all the rearview mirror must be able to adjust the direction. Now a lot of car factories in order to reduce the cost of the vehicle are in the reduction of design, but for the car rearview mirror is not only not reduced, but also constantly improve the function, its importance is self-evident. The rearview mirror plays an irreplaceable role in the process of use, so the structure stiffness performance of its body becomes more important. If the body stiffness is insufficient, it will produce optical jitter problems, affecting all functions related to vision, especially may produce vertigo; Serious more in the process of driving will produce larger visual jitter; Both of these conditions will affect driving safety [2, 3].

2. Problem Background
Because of the importance of the vehicle rearview mirror, the vehicle manufacturers and suppliers have established various rearview mirror performance and testing standards. The inner rearview mirror assembly is fixed on the vibration tooling according to the real vehicle state, and the electric vibration system is used to sweep the frequency in the range of 20Hz~250Hz with the acceleration of 0.5g. The mirror of the inner rearview mirror is irradiated with the laser. The light spot length reflected on the white board before and after vibration is measured with a ruler, and the torsion Angle is calculated.
3. Analysis and optimization

3.1. Factor Analysis
As shown in Figure 1, the internal rearview mirror optical jitter bench test mainly includes the following six elements: 1. The lens; 2. The lens is connected with the mirror rod; 3. The rod lens; 4. The mirror rod is connected with the base; 5. The base; 6. The base is connected with the platform. Among them, the 1, 2 and 6 items of high, middle and low rearview mirrors are basically the same, and the difference is 3, 4 and 5 items.

![Figure 1. Analysis of influencing factors on the frame state of the inner rearview mirror](image)

3.2. Simulation Analysis
The finite element model of the inner rearview mirror is shown in Figure 2. Based on this model, the 6 degrees of freedom of all nodes in the connection area between the base and the bench is constrained, and the constrained modal analysis is performed by MSC NASTRAN.

![Figure 2. Finite element model and modal analysis of inner rearview mirror boundary conditions](image)

In the post-processing software, the modal analysis result is 81.26Hz, and the actual measurement is 78Hz, with an error of 4%, which meets the accuracy requirements and can guide the structural optimization. The strain energy cloud diagram of modal analysis is shown in Figure 3. It can be seen that the main factors affecting the stiffness of the rearview mirror are the mirror rod and the connection area between the mirror rod and the base (3, 4), while the base (5) itself has no obvious stiffness problem.
3.3. Simulation Optimization

Simulation structure optimization was carried out for the mirror rod and the connection area between the mirror rod and the base to improve the body stiffness, as shown in Table 1. Make appropriate adjustments in consideration of supplier process level and mold repair cycle. The modal analysis results of the engineering scheme and the simulation optimization scheme for the interior and exterior decoration have little difference. The modal analysis result of the engineering scheme is 132Hz, which is acceptable.

| Table 1. Simulation optimization scheme and engineering scheme of the inner rearview mirror |
|---------------------------------------------------------------|
| **Optimization measures** | base | Optimization scheme | Engineering plan |
| **Optimization measures** | ![Base Diagram] | ![Optimization Scheme Diagram] | ![Engineering Plan Diagram] |

Figure 3. Modal analysis strain energy nephogram of the inner rearview mirror
4. Bench verification of engineering scheme

According to the engineering scheme, the mold of the mirror rod of the rearview mirror was modified and the sample was made. Three samples were randomly selected for bench test. The test results are shown in Table 2.

**Table 2. Test results of engineering scheme of inner rearview mirror**

| Torsion Angle | The target | base | The optimized |
|---------------|------------|------|---------------|
|               |            | 1#   | 2#  | 3#  | 1#   | 2#  | 3#  |
| 20Hz-80Hz     | ≤10’       | 5’   | 55’ | 59’ | 5’   | 6’  | 7’  |
| 80Hz-90Hz     | ≤23’       | 38’  | 35’ | 40’ | 21’  | 17’ | 20’ |
| 90Hz-250Hz    | ≤35’       | 5’   | 8’  | 11’ | 24’  | 14’ | 21  |

5. Conclusion

Based on the modal analysis of MSC NASTRAN soft components, the thin and weak region of junction stiffness was detected through the modal strain distribution of the junction structure, which was used as the basis for the optimization of junction structure and modal analysis verification. And then through the hand to strengthen the side of the bench test to judge the process of the side of the effect. Finally, the optimization procedure is completed and the test certificate reaches the standard.

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