Design of Swing Arm Type Actuator and Suspension for Micro Optical Disk Drive

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ABSTRACT

Some micro-optical devices have recently been developed and created with OFH (Optical Flying Head). Many sliders for OFH and optical component systems have been introduced. However, the mechanical system that makes of suspension, swing arm and VCM part has not been showed interesting in it. For embodiment of the micro optical device, the mechanical actuating system is also designed and developed. In this paper, we give an overview of an optical disk actuating system using an OFH that is suitable for use with removable optical media.

1. INTRODUCTION

A lot of information storage devices have been introduced and developed for recently years. The trends of those devices are high capacity, compact size, low power consumption, reliability, and removability with other device. Some micro-optical devices have recently been developed and created with OFH. Among those devices, the swing arm type rotary actuator has fast access time for random access and small size for more simple design than linear type actuator. The swing arm type actuator consists of slider for OFH, suspension, swing arm and rotary VCM (Voice Coil Motor) parts. Many sliders for OFH and optical component systems have been introduced. However, the mechanical system that makes of suspension, swing arm and VCM part has not been showed interesting in it. For embodiment of the micro optical device, the mechanical actuating system is also designed and developed. In this paper, we designed swing arm type rotary actuator using an OFH suitable for micro optical disk drive. Each mechanical part is designed and optimized for optical system characteristics. And, actuator has sufficient servo bandwidth, fast and stable seeking performance.

2. Overview of the actuator system for ODD

The mechanical system is designed for optical disk

drive. Accordingly, each part is suitable for optical characteristics. First, suspension for OFH is designed to make frequencies of lateral and torsional resonance modes higher. The torsion mode is possible to make coma aberration and the sway mode restricts tracking band. At the same time, the suspension has to satisfy with flying stability of slider. Second, swing arm that is similar to E-block in the hard disk drive is designed for lower mass and inertia for fast seeking. This also has benefit for the power consumption for stable seeking motion. Third, coil is designed for magnetic force. The shape and phase of the coil are optimized for large flux density and orthogonal force. Finally, the total actuating system is designed for mass balance. These achieved by optimizing the shape of VCM holder part. The mass balance of entire actuator centered pivot bearing gives stable actuator driving motion. Figure 1 shows the scheme of the actuator system.

Fig. 1 Micro Drive System

3. OFH Slider and Design of optical suspension

Figure 2 shows the scheme of the OFH slider and suspension. It is assumed that the size of the slider is compatible with the standard nano slider, and it holds an optical lens whose diameter is 0.9mm. This suspension consists of four parts: load beam, flexure, hinge structure and base plate. The main characteristics of this suspension are as follows; rectangular hall for optical path in the flexure, T-bar shape and end-lift for the load/unload system, and hinge structure for spring region. The initial model is obtained by sensitivity analysis. 14 parameters are considered, as the design parameters and

the object are five resonance frequencies; cantilever, roll, pitch, 1st torsion and sway mode. Final optimal design is utilized FEM optimization tool of ANSYS. Fig. 3. shows the design parameters. The objective function is to maximize the frequency of the 1st torsion mode. Constraints are cantilever, roll, pitch and sway frequencies. The combination of subprogram method and first order method is utilized. Table 1. shows the results of the parameters comparing with initial model.

Fig. 2. OFH Slider & Suspension

Fig. 3. Suspension design parameter

Table 1 Results of the optimizing

Mode	Initial	Optimal	Exp.
Cantilever	247 Hz	256 Hz	250 Hz
2 nd Bending	5.91 kHz	8.63 kHz	8.76 kHz
1 st Torsion	8.14 kHz	9.48 kHz	9.36 kHz
2 nd Torsion	17.01 kHz	18.80 kHz	18.83 kHz
Sway	19.51 kHz	22.8 kHz	22.28 kHz

4. Design of Swing Arm and VCM Holder

Swing arm is designed considering the couple mode with suspension and decreasing of the mass inertia. As the increment of mass caused by optical components makes vibration problems of swing-arm, resonance is controlled and increased for wide bandwidth. At the same time, total swing arm mass and mass inertia are reduce for fast seeking and power consumption. FEM is employed in optimizing swing arm. Seven parameters are selected design parameter, objective function is to reduce moment of inertia for the tracking direction. Constraints are cantilever and lateral bending resonance frequencies.

VCM holder is designed to get the mass balance of total actuator, and dynamic characteristics of total actuator. Two types of the holder design are considered. Figure 4 shows the swing arm and VCM holder.

Fig. 4. Swing arm type A/B

5. Design of magnetic part for VCM

Within the 1-inch micro drive size, the optimum design of the VCM is significant to achieve the maximum performance. To get the large torque constant, more turns, better magnets, bigger magnets and smaller gap are required. In these characters, the tradeoffs exist. For example, more turns affect less efficient i^2R , more moving mass and more inductance. Better magnets affect more cost and leakage. Bigger magnet affects the volume and weight. Smaller gap affects less room for coils, cooling more difficult and tighter tolerances that are required tough for coils. The VCM is designed using 3-D electro-magnetic analysis, and parameters of magnetic circuit are determined to make large flux density and orthogonal force. For the optimal coil design, coil width, radius and number of turn are selected design parameters. The large flux density enables to achieve low power consumption and the orthogonal force reduces the magnitude of actuator critical mode. Fig. 5 shows the magnetic optimization process and results.

Fig. 5. Yoke thickness iteration and coil & turns

6. CONCLUSION

We designed swing type rotary actuator using an OFH slider, which is suitable for micro optical disk drive. Each mechanical part is designed and optimized for optical system characteristics. And, actuator has sufficient servo bandwidth, fast and stable seeking performance. It makes to realize narrow track density and low power consumption.

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