LINEAR MOTOR SERVO CONTROL SYSTEM WITH DISTURBANCE OBSERVER FOR MAGNETO-OPTICAL DISK DRIVE

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1. Introduction

In a magneto-optical (MO) disk drive, a precision tracking servo system using a linear motor is widely employed for high density recording. The linear motor, which moves an optical head, however, is often restrained from moving by resistive force such as friction. The accuracy of the tracking servo control is then degraded. The accuracy is also degraded by external disturbance such as shock or vibration. Resistive force and disturbance consequently become a great obstruction to high density recording.

We have newly adopted the disturbance observer which utilizes acceleration sensors into the tracking servo system for linear motor control. In this paper, we describe a construction of an observer that is suitable for linear motor control, and suppression results of the influence of resistive force and disturbance.

2. Observer Construction

While the use of a disturbance observer employing a velocity sensor has been reported for rotary motor control [1], we thought it would be more advantageous to use small acceleration sensors for linear motor control.

Figure 1 shows a block diagram of the disturbance observer. Thrust F_1 is calculated with driving current I and thrust F_2 is with acceleration s^2X . Then the difference between F_1 and F_2 is fed back to the linear motor to suppress the influence of resistive force and disturbance.

We used a 5.25" MO disk drive which had a linear motor with slide bearings. Two piezoelectric acceleration sensors were installed. One was in the moving part and another was in the stationary part of the linear motor. True acceleration of the motor was detected as the relative acceleration of the moving part to the stationary part.

Figure 1 : Disturbance Observer Block Diagram

3. Experiments and Results

3.1 Influence of Resistive Force

Figure 2 shows a transfer gain curve from the driving signal to the acceleration of the linear motor without the observer. The gain curve decreases in low frequencies, and it indicates that the linear motor hardly moved because of the resistive force caused by friction of the bearings.

Figure 3 shows a transfer gain curve with the disturbance observer. The gain curve is flattened in the wide frequency range, thus indicating that the observer enabled the linear motor to move smoothly.

When the linear motor and a lens actuator were combined to form a tandem servo system to track disk eccentricity of $\pm 30\mu\text{m}$, displacement of the lens actuator was $\pm 5.4\mu\text{m}$ with the observer, and $\pm 19.3\mu\text{m}$ without the observer. This suggests that the observer enabled the linear motor to track the eccentricity more accurately.

Figure 2 : Linear Motor Transfer Gain Curve
(without Observer)

Figure 3 : Linear Motor Transfer Gain Curve
(with Observer)

3.2 Disturbance Suppression

Both Figure 4 and Figure 5 show the tracking error signal (TES) and displacement of the lens actuator when an external disturbance of 0.9G at 120Hz was applied to the linear motor. In Figure 4, the tracking error due to the disturbance was $\pm 0.025\mu\text{m}$ without the observer and in Figure 5, it was $\pm 0.001\mu\text{m}$ with the observer.

The displacement values of the lens actuator, which were caused by motion of the linear motor due to the disturbance, were $\pm 7.6\mu\text{m}$ and $\pm 0.3\mu\text{m}$ respectively. The observer suppressed the influence of the disturbance.

4. Conclusions

We have succeeded in applying a disturbance observer which utilizes acceleration sensors to the linear motor control of an MO disk drive. The observer sufficiently suppressed the influence of resistive force and disturbance then significantly improving the accuracy and performance of the MO disk drive's tracking servo system.

By employing this observer we have realized a precision tracking servo system for high density recording.

5. Reference

- [1] M. Nagasawa, E. Yokoyama : IEICE Technical Report, Vol.92, No.201, MR92-30(1992)

Figure 4 : Disturbance Influence (without Observer)

Figure 5 : Disturbance Influence (with Observer)