Verification Skip Writes Head-Positioning Error Mechanism Using Skip Writes Problem Detection

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Abstract: - HDD-structure interaction is one of the main issues facing the development of the hard disk drive (HDD) system while as they operate at high rotational speeds. Writing instability of HDD has affected related to difficulty in read-write in a HDD. This paper illustrates studying the skip write problem. The effects of head gimbal assemblies (HGA) trouble to writing on media are considered. In addition, studying the variables that affect to writing problem by head gimbal assemblies (HGA) is accomplished. Finally, comparison between experimental data from HDD activity and mathematics analysis of skip write model is also investigated.

Key-Words: - Hard Disk Drive, HDD, Skip Write Model

1 Introduction
Magnetic Data Recording storage technology, integrated circuit technology, and network technology are referred to as 3 pillars for infrastructure of modern information transferring and storage information are named as 3 key aspects of our information age. Among them storage information gives accumulated effect. The people would like to store as much information collected/received as possible [1].

Technology applying in modern magnetic data storage device systems is the magnetic hard disk drive (HDD). Magnetic HDD includes data storage disk which is mounted on a high speed spindle motor, a read-write head carrying by a slider – suspension system and flies over disk surface at extremely small head-disk space head position actuator and its servo electronics and signal processing system [1]. The magnetic HDD technology is the most successful mechatronics system. On magnetic recording disc drive, which persuade increasing disk rotational speed for high-speed data performance and increase head positioning error due to disk flutter and combination magnetic head read/write error. Therefore, it is necessary to reduce mechanism of head-positioning error caused by disk flutter. The former report proposed the mechanism and equation of the relation between the amplitude of the disk flutter [2-5] and the amplitude of the head-positioning error signal [6]. This paper conducts experiment to verify the proposed mechanism. In the experiment, the amplitude of the head-positioning error was calculated by the proposed mechanism and was compared with the measured head-positioning error signal. The error of calculated head-positioning error was about 10% in the comparison with measured head-positioning error signal. The error of calculated head-positioning error was about 10% in the comparison with measured head-positioning error signal. It was definite that the proposed mechanism was approved. Therefore, the proposed mechanism could predict the amplitudes of head-positioning error signal. The former report defined the flutter transfer ratio, which is the amount of head off-track by unit amplitude of disk flutter, and declared that the head-positioning error could be reduced by making the small flutter transfer ratio [6]. It is necessary to make small radius of the head rolling motion for reducing the flutter transfer ratio. First method to reduce flutter transfer ratio is
construction thickness of the slider to be smaller. It was confirmed that experimentally head-positioning error decreased as the flutter transfer ratio decreased when the thickness of the slider was changed. The second method is making the longitudinal axes of the gimbal beams slant. The effectiveness of this method was confirmed by the simulation results.

1.1 Head-positioning error mechanism caused by Disk Flutter

1.1.1 Head off-track due to disk flutter

The outline of the mechanism stated by the former report is shown as the introductory remarks [6]. The mechanism of the head off-track caused by the disk flutter is shown in Fig.1. The conditions of slider and disk that without disk flutter occurring are illustrated with the light line in Fig. 1. The original positions of head and track are expressed as $A_0$ and $B_0$. Additionally, the conditions of slider and disk with disk flutter occurring are illustrated with dark line in Fig. 1. The original head position $A_0$ moves to $A_1$ by the rolling motion of the slider and the original track position $B_0$ moves to $B_1$ by the disk deflection.

![Fig. 1 Head off-track mechanism due to disk flutter [5]]

2. Method of Skip write positioning error signal detector

2.1 Low Amplitude Skip write detector

For method of detecting and respond to low amplitude –write/skip- write event in a disc drive, the invention involves characterizing gain factor of a variable gain amplifier embedded in the read path of a disc drive during at least two instances in such event. Next the write event is executed. After the write event, the gain factor employed by variable gain amplifier is acquired as the read head passes over the following servo sector. To conclude, the acquired gain factor is compared to the characterization in order to detect a low-amplitude-write/skip-write event. Thus, during execution of a write command, the disc drive alternates between reading servo sectors and recording user data to disc. Whenever the disc drive of the present invention attempts to read data from the disc including instances in which it is attempting to read servo data during execution of a write command variable gain amplifier is used to receive the signal to yield an output signal with approximately constant amplitude. If the signal from head is relatively weak, the variable gain amplifier is obliged to perform relatively strong amplification operation as shown in Fig.2.

![Fig. 2 Flow chart low amplitude skip write detection [7].]
Conversely, if the signal is moderately strong, the amplification operation is reasonably weak. Servo sectors are written during manufacture of the disc drive, and thus are of approximate constant magnetic intensity. Consequently, any variance in the gain factor employed by the aforementioned variable gain amplifier during detection of a servo sector is the result of variance in the elevation of the head. If the gain factor employed by the variable gain.

In some forms of disc drives, several consecutive data sectors (sector in which user data are written) are followed by a servo sector (a sector in which servo data are written for permitting the disc drive to determine whether the head is located over the proper region of the disc. This alternating data and servo sectors pattern is repeated along each track. During execution of writing command, the disc drive reads data in servo sectors to construct definite that it is located over suitable location of disc. Meanwhile, as the head becomes oriented over data sectors, user data is written to the disc.

2.2 VSWR Skip Write detector

An apparatus and coupled method is disclosed to detect a skip write error occurring during data storage device writing process using voltage standing wave ratio (“VSWR”), determined by monitoring voltage reflected by the write element. An alteration in the read/write head fly height is monitored by comparing the instantaneous voltage standing wave ratio to a baseline voltage standing wave ratio. If the read/write head fly height is determined to be outside of predetermined range, a skip write error is assumed resultant in a suspension of writing operation and the institution of rewriting procedure [8]. The present invention offers an apparatus and associated method to monitor the fly height of the read/write head during a write operation. The fly height can be used as an indication of whether the write operation was completed successfully. A magnetic disc drive has been used to illustrate a preferred embodiment of the present invention, however, embodiments of the present invention can be used for various types of storage systems such as magnetic and optical disc drives among others as shown in Fig. 3.

3. Experiment to verify the mechanism of the skip write head-positioning error.

Fig. 3 Flow chart VSWR skip write detection [8].

Fig. 4 Experimental setup [9].

In the experiment, the amplitude of the disk and skip write—positioning error signal were shown at the same time. The measurement of the amplitude of
disk shows data amplitude with head positioning error signal (The head positioning error signal comes from the track center as shown in Fig. 4). The problem statement of Skip writes signatures, there are two methods to do the solution for the problems appeared as above (Low amplitude method and VSWR method).

4. Conclusions
The proposed mechanism of the skip writes head positioning error can be explained by this experiment.

(1) The Low amplitude skip write detector method could detect all defects but it takes extraordinarily elongated time. This method should be practical for poor writing performance.

(2) The VSWR skip write detector method could detect about 97% of all defects but it takes a short time. This method should be exploiting for transient skip write.

At present two techniques could be applied for detecting skip write problem. In the future work, for skip write detection improving, we could combine with mathematics function with the method described previously.

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