TITLE OF THE INVENTION

MAGNETIC DISK APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a magnetic disk apparatus which outputs information used for analyzing reasons for occurrence of a malfunction.

Magnetic disk apparatuses have been spreading widely as external storage devices for computers. In a magnetic disk apparatus, a magnetic head seeks in the radial direction of a medium thereby to record (or read) data on (or from) a rotating magnetic disk. The magnetic disk apparatus has such a mechanical operating part and therefore involves a higher malfunction rate than that of, for example, a semiconductor device. Consequently, artificial countermeasures are needed against malfunctions, e.g., a user must periodically back up data. Taken into consideration this situation, new kind of magnetic apparatus which has a self-diagnosis function has been produced. By the self-diagnosis function of diagnosing malfunctions, a periodical check is performed on parameters indicating factors which induce malfunctions. The factors are, for example, a RAW error rate, number of times of CSS (Contact Start Stops), retried starts, seek performance, and the like. Thus, whether or not the apparatus is in a risky state from which occurrence of a malfunction is predicted is determined. When it is determined that

the apparatus is in this risky state, a warning is issued in advance.

SMART (Self-Monitoring Analysis and Reporting technology) is known as a more progressive self-diagnosis function. The SMART is supported by the ATA (AT Attachment) standard. The ATA standard is an IDE interface which is substantially the standard for connection between a personal computer and magnetic disk apparatuses. This is standardized by ANSI (American National Standard Institute).

One of functions provided by the SMART is a function to obtain event logs. This function is to record logs (history) of various events defined in a magnetic disk apparatus, onto a medium. This function is also used for diagnosis for malfunctions.

To explain the structure more specifically, 255 blocks are assigned to a recording area for logs. Each block includes 16 sectors at most. Among the 255 blocks, 128 blocks are assigned to an area for setting the specification of the ATA standard, 32 blocks are assigned to an area for a host vendor, and 96 blocks are assigned to an area for a device vendor.

In the present situation, two blocks defined by the ATA are used. These two blocks are used to realize a function of recording five commands preceding the time of occurrence of an error and a log of the command status which causes the error, as well as a function of

recording an execution result log of a self-diagnosis (self-test) which a magnetic disk apparatus makes to diagnose its own processing functions. Log information recorded by these functions can be read out by a sub-command which the SMART mechanism actually includes. Also, the host system can write and read original information into and from the log recording area of a medium.

This kind of conventional apparatus involves the following problem. That is, if a malfunction such as an abnormal operation or the like occurs in the side of the host system, information necessary for analyzing the reason for the malfunction cannot always be obtained sufficiently, only by the self-diagnosis function provided by the conventional magnetic disk apparatus. For example, this is a case that a malfunction occurs due to a defect in driver software in the side of the host system or the like.

BRIEF SUMMARY OF THE INVENTION

The present invention has been made in view of the above situation, and has an object of providing a magnetic disk apparatus capable of obtaining information useful for analyzing reasons when a malfunction occurs.

A magnetic disk apparatus according to the present invention comprises: detection means for detecting reception of a subsequent command from a host before

execution of completion of a preceding command issued by the host; preparation means for preparing first information indicating contents of a command received from the host and a reception time of the command; and means for preparing second information indicating a detection result obtained by the detection means, based on the first information prepared by the preparation means.

According to the present invention, it is possible to know later that the a subsequent command is supplied from a host before completion of execution of a preceding command issued from the host.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a block diagram showing a schematic structure of a magnetic disk apparatus according to the first embodiment of the present invention.

FIG. 2 is a view showing a detailed structure of a register group (task file).

FIG. 3 is a flowchart showing operation of executing a command in the magnetic disk apparatus.

FIG. 4 is a block diagram showing a schematic structure of a magnetic disk apparatus according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following, embodiments of the present invention will be explained with reference to the drawings.

(First Embodiment)

FIG. 1 is a block diagram showing the schematic structure of a magnetic disk apparatus according to the first embodiment of the present invention. As shown in this figure, the magnetic disk apparatus according to the present embodiment comprises a record/reproduce medium 1, a read/write circuit 2, a disk data controller 3, a buffer RAM 4, a CPU 5, a host interface 6, ROM & RAM 7, a driver 8 for a VCM (Voice Coil Motor) and a spindle motor, and a disk head 10.

The disk head 10 is attached to a head movement mechanism called a carriage. Also, the disk head 10 is movable in the radial direction of the medium 1 by

operation of the carriage. The disk head 10 is controlled to be positioned above a specified target cylinder (target track) by a servo processing system (head positioning control mechanism).

The carriage is also controlled by the VCM. The VCM is driven by the driver 8. The spindle motor is also driven by the driver 8. The driver 8 is a driver IC (Integrated Circuit) which constructs the motor driver and the VCM driver (called a double driver).

The read/write circuit 2 inputs a read signal from the disk head 10, which is amplified by a head amplifier, and performs signal processing necessary for data reproduction operation. The read/write circuit 2 also performs signal processing necessary for data recording operation, and supplies the disk head 10 with a write current corresponding to write data, through the head amplifier.

Also, the read/write circuit 2 executes reproduce processing of servo data, which is necessary for serve processing of head positioning control, in addition to normal record/reproduce processing of user data. The servo data contains a cylinder address indicating the current position of the disk head 10, and burst data (a burst signal) indicating a position error within a cylinder. A servo circuit not shown extracts the cylinder address from a data pulse outputted from the read/write circuit 2, and maintains it. Also, the

serve circuit performs processing for outputting a sample timing signal for extracting the burst signal, or processing for extracting a sector pulse.

A CPU 5 and the servo circuit construct together a servo processing system for executing head positioning control. This CPU 5 executes not only the head positioning control but also various drive controls for the magnetic disk apparatus, including the control of transfer of read/write data. The CPU 5 executes various drive controls, based on a control program stored in the ROM 7. The ROM 7 is connected to the CPU 5 through an external bus. This ROM 5 stores firmware for diagnosing a malfunction of the magnetic disk apparatus. Also, the ROM 7 stores conditions concerning changes of the output level of data, the number (retry number) of times for which read processing is repeated, and correct reading of data by an error correction function such as ECC or the like. The firmware in the ROM 7 comprises a function to collect command issue history information relating to characterizing points of the present invention. The details thereof will be explained later.

More specifically, the CPU 5 is constructed by a one-chip microprocessor, and includes an A/D converter and a D/A converter, as a signal input/output section. Further, the CPU 5 has a internal read/write memory called a command RAM. In the present embodiment, the

CPU 5 converts the burst signal into digital data with user of the A/D converter. In addition, the CPU 5 converts a control amount necessary for servo processing (e.g., a control amount necessary for head positioning control) with use of the D/A converter into an analogue signal, and outputs it to the driver 8.

The disk data controller 3 constructs an interface between the magnetic disk apparatus and the host system, and serves as a controller which transfers mainly read/write data. This disk controller 3 temporarily stores read data in units of sectors, which is read from the medium 1, and write data to be written into the medium 1, into the buffer RAM 4. The disk data controller 3 and the CPU 5 constructs a system for performing data transfer control. Also, the disk data controller 3 is provided with an error detection circuit. This error detection circuit detects a data error, based on data read from the medium 1, and also has an function to recover an error if the error is within a predetermined narrow area, i.e., an ECC (Error Correction Code) function.

The disk data controller 3 also comprises a register group 12 used to process a command supplied from a host (not shown). This register group 12 is called a task file and comprises a status register 121, a command register 122, and an address register 123, as shown in FIG. 2. Although the register group 12

includes further other registers, explanation thereof will be omitted herefrom. Also, the disk data controller 3 has a storage section 14 for command sequence information. This storage section 14 is prepared especially within a predetermined storage section supported by the log function of the SMART (error prediction). Otherwise, the storage section 14 may be provided in the buffer RAM 4.

The status register 121 of the register group 12 shown in FIG. 2 is a register which shows an execution state of a command written into the command register 122 from a host. In the disk data controller 3 (in the side of the magnetic disk apparatus), the register 121 is set in a busy state during execution of the command, and is set into a ready state upon completion of the execution. These states are expressed by setting/resetting a command execution flag inside the firmware. The host not shown detects a execution state of a command by referring to the status register 121, and can therefore send a command at an appropriate timing during normal operation. However, if any malfunction occurs due to a defect or the like of software installed in the host side, there is a case that subsequent commands are supplied from the host and written into the command register 122 regardless of the status register 121 set in the busy state. This is called command overwrite.

The magnetic disk apparatus according to the present embodiment comprises means for detecting the command overwrite and for recording a detection result included in command issue history information. This is realized as an additional function of the firmware described above.

With reference to the flowchart in FIG. 3, explanation will be made of the operation of command execution in the magnetic disk apparatus according to the present embodiment constructed as described above.

At first, in a step S1, a command is supplied to the disk data controller 3 through the host interface 6. This command is written into the command register 122 in the register group 12. At this time, the contents of a task file (values of respective registers) and a lifetime stamp, corresponding to the command, are temporarily stored as command information into the buffer RAM 4. The lifetime stamp means a value of elapsed time from when the power of the magnetic disk apparatus is turned on.

The command information may be utilized for another log function which the SMART mechanism comprises. The storage area for the command information constructs a ring buffer with a finite length. When the data storage volume is filled, new information is written over the oldest data.

At this time, whether or not command overwrite

occurs is determined on the basis of a command execution flag (in a step S2). That is, occurrence of command overwrite is detected upon execution of the step S2 even though the command execution flag is set. At this time, a subsequent command supplied from the host is written into the command register 122. This detection method is only an example and may be substituted by another detection method.

If command overwrite is detected, the detection result is stored as command overwrite information into the storage section 14. The storage section 14 constructs a ring buffer having a finite length like the command information described previously, and stores a plurality command overwrite information items as logs. When the data storage volume is filled, new information is written over the oldest data. The top area of the storage section 14 has a log index. The log index expresses the registration order of command overwrite information, e.g., which log is the newest or so. Subsequently to the log index, command overwrite information is stored.

The command overwrite information has, for example, a data size of 512 bytes for each item. The contents thereof are the value of a task file of a command which has been issued previously but has not yet executed completely, the value of a lifetime stamp, the value of a task file of a command supplied presently, the value

of a lifetime stamp, and the value of an issue time interval (ms) between these two commands. The data structure (format) of command overwrite information, however, is not limited hitherto.

This kind of command overwrite information is recorded as log data for one detection of command overwrite. However, with respect to command overwrite which is detected next, command overwrite information corresponding to a subsequent area in the storage section 14. When the storage volume of the storage section 14 is filled, new data is written over the oldest data.

Otherwise, if command overwrite does not occur, a command execution flag is set in correspondence with a present command (step S4). Further, the command is executed (step S5). Upon completion of execution of the command, the command execution flag is reset (step S6).

According to the magnetic disk apparatus in the present embodiment as described above, command overwrite information is stored in the storage section 14. Therefore, by reading the stored command overwrite information, it is possible to know later that a subsequent command is supplied from a host before completion of execution of a preceding command which has been issued from the host. Accordingly, information effective for analyzing reasons when a

malfunction occurs.

(Second Embodiment)

FIG. 4 is a block diagram showing a schematic structure of a magnetic disk apparatus according to the second embodiment of the present invention. In this apparatus, the same parts as those of the first embodiment are denoted at the same reference symbols as those of the first embodiment.

The magnetic disk apparatus according to the second embodiment differs from the first embodiment in that command information containing command overwrite information is recorded on a non-volatile recording medium. Particularly in this case, command information is recorded in a medium area 11 especially provided on the record/reproduce medium 1. The present embodiment is constructed such that command information recorded in the medium area 11 of the medium 1 is transferred to the host through the host interface 6, in response to a predetermined request (command).

In the present embodiment, information equivalent to the above-mentioned command overwrite information is stored into the storage section 14, regardless of occurrence of command overwrite, and is also written into the medium area 11 of the medium 1 at an appropriate timing. That is, operation of writing a log is carried out except for the time of receiving a command so that the time required for writing data into

the medium 1 through the read/write circuit 2 might not influence operation of the entire magnetic disk apparatus. A ring buffer is also constructed with respect to the medium area of the medium 1. When the area is filled with recording data, new data is written over the oldest data.

When the host receives transferred of log information recorded in the medium area 11 of the medium 1 of the magnetic disk apparatus, there are a case that both the command information and command overwrite information are displayed and a case that only the command information is displayed (i.e., an issue history of commands).

In case of requesting transfer of log information to the magnetic disk apparatus from the host, there is provided means for instructing whether display of command overwrite information is enabled or disabled. Specifically, a special bit is prepared in a Feature register associated with a transfer request.

In this case, the magnetic disk apparatus according to the present embodiment transfers both of the command information and command overwrite information to the host through the host interface 6, if display of command overwrite information is instructed. Otherwise, if display of command overwrite information is not instructed, only the command information is transferred to the host through the host

interface 6. In the side of the host, supplied information can be displayed with its format unchanged.

According to the magnetic disk apparatus of the second embodiment as described above, functions and effects equivalent to those of the first embodiment can be obtained. In addition, command overwrite information is recorded on a non-volatile storage medium (medium 1), so this information can be obtained permanently. With respect to transfer of the recording information to the host, it is possible to instruct whether display of command overwrite information should be enabled or disabled, so a flexible system structure can be attained.

Note that the present invention is not limited to the embodiments described above but may be variously modified in practice. For example, the present invention is applicable not only to magnetic disk apparatuses but also to other information recording apparatuses.

According to the present invention as has been explained above, it is possible to provide a magnetic disk apparatus capable of obtaining information which is useful for analyzing a reason when a malfunction occurs.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to

the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.



WHAT IS CLAIMED IS:

1. A magnetic disk apparatus comprising:

a recording medium;

a host interface connected to a host;

a controller, connected to the host interface, configured to receive commands issued by the host and process a data transfer between the host and the recording medium based on the received commands;

means for detecting a reception of a subsequent command before completion of execution of a preceding command in the controller; and

means for storing first information indicating that the detecting means detects the reception.

2. The apparatus according to claim 1, wherein said controller comprises a register for storing the command and a status thereof, and said detection means detects said reception of the subsequent command before the preceding command, based on the status stored in the register.

3. The apparatus according to claim 1, further comprising means for storing second information indicating contents of commands received by said controller and a reception time of the commands.

4. The apparatus according to claim 3, wherein said means for storing second information is provided in said controller.

5. The apparatus according to claim 3, wherein

said means for storing second information comprises a memory connected to said controller.

6. The apparatus according to claim 3, further comprising:

means for writing said second information to said recording medium; and

means for reading the second information from the recording medium and sending the second information to the host through the host interface.

7. The apparatus according to claim 6, further comprising means for setting an instruction to said second information instructing whether display of the second information should be enabled/disabled by the host.

8. A method for detecting command-overwrite in a magnetic disk apparatus, comprising:

receiving a preceding command issued by a host;

storing the preceding command in a controller;

processing a data transfer between the host and a recording medium based on the preceding command stored in the controller;

receiving a subsequent command issued by the host;

detecting a reception of the subsequent command before completion of execution of the preceding command; and

storing first information indicating that the detecting step detects the reception.

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9. The method according to claim 8, wherein said controller comprises a register for storing the command and a status thereof, and said detecting step detects said reception of the subsequent command before the preceding command, based on the status stored in the register.

10. The method according to claim 8, further comprising:

storing second information indicating contents of commands received by said controller and a reception time of the commands.

11. The method according to claim 10, wherein said second information is stored in said controller.

12. The method according to claim 10, wherein said second information is stored in a memory connected to said controller.

13. The method according to claim 10, further comprising:

writing said second information to said recording medium; and

reading the second information from the recording medium and sending the second information to the host.

14. The method according to claim 13, further comprising:

setting an instruction to said second information instructing whether display of the second information should be enabled/disabled by the host.



15. A magnetic disk apparatus connected to a host, comprising:

a controller configured to receive and execute a first command;

means for detecting a reception of a second command from the host during execution of the first command in the controller; and

storage means for storing an information indicating that the detecting means detects the reception.