TITLE OF THE INVENTION

DISK DRIVE SYSTEM, AND DISK CONTROLLER AND DISK ACCESS CONTROL METHOD FOR THE DISK DRIVE SYSTEM

BACKGROUND OF THE INVENTION

The invention relates to a disk drive system, and a disk controller and a disk access control method applicable to the disk drive system. The invention particularly relates to a disk drive system which accesses alternate sectors, instead of defective sectors, if there are replaced defective sectors within the access field, and a disk controller and the disk access control method applicable to such disk drive system.

In the disk drive system that uses a magnetic disk or hard disk as recording medium, there are a plurality of concentric tracks provided on the magnetic disk, and each track is divided into many sectors as unit area for storing data.

It is generally known that the magnetic disk cannot be avoided having defective sectors caused by defects or other reasons. Therefore, in the disk drive system, a special alternate track that replaces defective sectors for alternate sectors is provided on the magnetic disk, and the sectors on this alternate track are allocated as sectors alternating defective sectors. In the disk drive system having such alternate sectors as mentioned above, if there is

a replaced alternate sector within the access field, the defective sector is not accessed, and the alternate sector is accessed instead, and data is written in or read from the alternate sector.

An example of the reading and writing of data of the conventional disk drive system will now be described. This example is concerned with a reading method that data is read from the disk upon receipt of the read command from the host system (hereinafter simply called the host).

Upon receipt of the read command from the host, the disk drive system first checks whether there is a defective sector or sectors within the target access field or region designated by the read command, and whether there is an alternate sector or sectors for the defective sector or sectors. If both a defective sector or sectors and an alternate sector or sectors are detected, the magnetic head reads from the first sector up to the sector just before the defective sector within the target access field. Next, the magnetic head is sought up to the alternate track and the alternate sector is read, and then, the magnetic head is sought up to the track in which there is a sector within the target access field. The disk drive system subsequently checks whether there is a defective sector or sectors in the remaining access field, and if a defective sector or sectors are detected, the target

access field is similarly divided into segments by the defective sector, and the reading operation as mentioned above is repeated.

The writing of data into the disk is processed the same as the reading of data from the disk. The disk drive system first checks whether there is a defective sector that has been replaced with an alternate sector within the target access field requested by the host. If there is a defective sector, the target access field is limited from the first sector up to the sector just before the defective sector within the target access field. Then, the alternate sector is accessed, followed by the remaining sectors.

Thus, when there is a defective sector within the target access field, a time for the disk drive system to seek an alternate track having an alternate sector and a time for the disk drive system to seek a track in which there are remaining sectors within the target access field are needed every time a defective sector or sectors are accessed. Moreover, latency or waiting time for the disk drive system to detect an applicable alternate sector on the alternate track is needed. As a result, the disk drive system such as this has a drawback of slow access speed.

As mentioned above, the conventional disk drive system accesses the same number of alternate tracks having alternate sectors as the number of defective

sectors within the access field, and repeats the seeking operation between target tracks, which should be accessed originally, and the alternate track for every access. Also, latency or waiting time for the disk drive system to detect target sectors and alternate sectors is needed. Thus, the conventional disk drive system has another drawback of long total access time.

BRIEF SUMMARY OF THE INVENTION

An objects of the invention is to provide such a disk drive system and the disk access control method that prevents the disk access speed from slowing down by minimizing seeking and waiting during the access operation, wherein, in the case where there is a defective sector within the access field, the alternate sector which has replaced the defective sector, is first accessed, and proper sectors are then accessed by skipping over the defective sector.

Another object of the invention is to provide such a disk controller and a disk drive system equipped with the disk controller that prevents the disk access speed from slowing down, wherein, if a defective sector is accessed, the skipping operation is carried out independently and automatically from the main controller of the disk drive system.

According to the invention, there is provided a disk drive system for storing data, comprising:

a recording disk having a plurality of data tracks in a user area and a at least one alternate track an alternate area, the tracks including normal sectors and some of the defective sectors in the user area, and the defective sectors being replaced to an alternate sector arranged in the alternate area, respectively;

receiving means for receiving an access command to designate an access field in the user area;

determining means for determining, in response to the access command, one of defect detection mode in which there is the defective sector in the access field and no defect detection mode in which there is no defective sector in the access field;

accessing means for accessing the normal sectors in the access field in the no defect detection mode to read data from the normal sectors or write data on the normal sectors; and

controlling means for controlling the accessing means to access the alternate sector relating to the defective sector in the alternate area, thereafter, access the normal sectors in the access field and skip the defective sector after reading data from the alternate sector or writing data on the alternate sector in the defect detection mode.

If there is a replaced defective sector within the requested access field, such disk drive system as described above first accesses an alternate sector to

be replaced with, and then accesses from the first sector within the access field before accessing, more specifically, reading or writing, from the first sector within the access range. If a replaced defective sector is detected, the disk drive system skips over this defective sector.

Upon receipt of the read command from the host, the disk drive system checks whether there is a replaced defective sector within the access field requested by the command. If there is a defective sector, the disk drive system reads the alternate sector prior to reading the first sector within the requested access field. At this time, if there is more than one replaced sector within the access field, the disk drive system reads all alternate sectors.

Thereafter, the reading of data starts from the requested first sector, same as the conventional disk drive system. Data reading proceeds sequentially sector by sector from the first sector, and upon reaching the replaced defective sector, reading of the defective sector is skipped, and proceeds to the next sector.

The same operation as reading takes place when the write command is received from the host. The disk drive system checks whether there is a replaced sector within the requested access field before writing the first sector requested. If there is a defective

sector, the disk drive system first writes the alternate sector, and then proceeds from the first sector requested.

Upon reaching the replaced defective sector, writing of data into the defective sector is skipped, and proceeds to the next sector. The write command herein is a command to write data received from the host within the target access field of the magnetic disk, and data from the host is transferred sequentially from the first sector. Therefore, when the host transfer rate and the disk transfer rate are the same or its difference is a little, writing into the alternate sector cannot be performed first, since data transfer is not completed yet at the time the writing operation starts. However, the host transfer rate is much quicker than the disk transfer rate between the currently available magnetic disk system and the host computer such as personal computer. For the reason, in most cases, data transfer is completely finished before the writing operation starts. It is thus sufficiently feasible to first write data into the alternate sector.

Even if the transfer of all data is not finished before the writing operation starts, writing can be done in the conventional method. Or, it is possible to wait until data transfer is completely finished within the predetermined fixed time, and then start the

writing operation.

As explained above, if there is a replaced defective sector within the access field requested by the host, the conventional disk drive system invites access suspension due to shuttle seeking and rotational delay, resulting in an extended total access time, since access to the alternate sector is carried out midway through the reading/writing operation. On the contrary, the disk drive system of the invention reduces shuttle seeking and rotational delay, resulting in reducing a drop in the access speed, since access suspension due to the replaced defective sector does not occur and all access operation is carried out at one time or finished within one rotation waiting time at most.

Here, it is recommended to provide a buffer memory which has a buffer area for temporarily storing data, that is read out from the magnetic disk, to be transferred to the host, as well as data, that is transferred from the host, to be written into the magnetic disk in order to absorb the speed difference between the disk transfer rate and the host transfer rate.

In this case, it is better to provide a pointer means having a disk pointer (DP), which is First buffer pointer showing a location in the buffer area for the data, when the data, which is read out from the

magnetic disk, is stored in the buffer area as well as when the data to be written into the magnetic disk is extracted from the buffer area, and a host pointer (HP), which is Second buffer pointer showing a location in the buffer area for the data, when the data, which has been read out from the magnetic disk and stored in the buffer area, is extracted from the buffer area and transferred to the host as well as when the data, which is transferred from the host and to be written to the magnetic disk, is stored in the buffer area.

For the system equipped with a buffer memory, it is also better to provide a read-time buffer pointer control means which enables to adjust the setting of the disk pointer (DP) or the host pointer (HP) or both so that the data read out from the destination of replacement by the First access control means and the data read out from sectors, excluding the replaced sector, within the access range by the second access control means are transferred to the host in the sequence as requested by the command through the buffer area, when there is a replaced defective sector within the access field requested by the read command.

Similarly, it is better to provide a write-time buffer pointer control means which enables to adjust the setting of the disk pointer (DP) so that the data to be written into the destination of replacement is extracted from the buffer area by the First access

control means as well as the data to be written into the sector, excluding the replaced sector within the access field, is extracted from the buffer area by the second access control means when there is a replaced defective sector within the access field requested by the write command.

The features of the invention include: a register means of establishing information concerning replaced sectors within the access field on the disk controller which continuously accesses sectors within the access field from the first sector which is set up by the main controller by running the main controller of the disk drive system after all replaced sectors are accessed for their destination of replacements, if there is a replaced defective sector within the access field requested by the host; a sector-matching judgment means of determining whether the access target sector matches with the replaced sector indicated by the established information of the register means prior to accessing the sectors within the access field; and a sector skip means of creating such equivalent status that access to the skipped sector is completed, at least, by skipping over the applicable access target sectors when matching is determined.

With such disk controller as this, it is possible to further reduce a drop in access speed, since access to replaced sectors, which becomes necessary when

executing continuous access from the first sector within the access field after all replaced sectors are accessed by the main controller because of the presence of replaced defective sectors within the requested access field, can be skipped over independently of the main controller and automatically by the disk controller.

Here, it is better to provide, in the disk controller, a means of automatically updating the information showing access target sectors every time skipping is carried, aside from a means of automatically updating the information showing access target sectors every time access to the sectors within the access field is executed.

For such configuration that the buffer memory is connected to the disk controller, it is better to provide a means of updating only the sectors that has skipped the disk pointer (DP) for every skip by the disk controller.

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 schematic block diagram of the magnetic disk system related to one embodiment of the invention;

FIG. 2A is a schematic plan view showing an example of the layout relationship between track and sector on the magnetic disk shown in FIG. 1;

FIG. 2B is a schematic plan view showing an example of the layout relationship between track and sector in cases where there is a replaceable defective sector and there is no replaceable defective sector on the disk shown in FIG. 1;

FIG. 3 shows an example of the data structure in the sector alternate control table, which is stored in the buffer RAM shown in FIG. 1;

FIG. 4 shows an example of the relationship between buffer area that is stored in the buffer RAM shown in FIG. 1 and buffer pointers (host pointer, HP, and disk pointer, DP);

FIGS. 5A, 5B, and 5C show the state transitions of

the buffer area 210 when the read command, which is stored in the buffer RAM shown in FIG. 1, is executed;

FIGS. 6A and 6B are flow charts explaining the operating status during read command execution in the system shown in FIG. 1;

FIG. 7 is an example of the track state diagram showing the track which includes replaced sector and track which includes alternate sector in the disk shown in FIG. 1;

FIG. 8 is an example of the relationship between the buffer area 210 and buffer pointers (host pointer, HP, and disk pointer, DP) during write command execution in the system shown in FIG. 1;

FIGS. 9A and 9B are flow charts explaining the operating status during write command execution in the system shown in FIG. 1;

FIGS. 10A and 10B show the state transitions of the buffer area 210 during read command execution of the magnetic disk system related to another embodiment of the invention; and

FIG. 11 is a flow chart explaining the operating status during read command execution in the magnetic disk system related to another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

One of the preferred embodiments of the magnetic disk system according to the invention will now be

described with reference to the accompanying drawings.

FIG. 1 is a schematic block diagram of a disk storage system, i.e. a hard disk system related to one embodiment of the invention.

In FIG. 1, the numeral 11 indicates a magnetic disk to which data is magnetically recorded as recording medium, and the numeral 12 is a magnetic head which writes data on the disk 11 and reads data from the disk 11. The head 12 is provided on each recording surface of the disk 11. FIG. 1 shows the magnetic disk system equipped with a single disk 11, however, it is obvious that such magnetic disk system that has more than one disk placed with a gap in-between can be constructed.

On the recording surface of the disk 11, a plurality of concentric tracks 110 are provided (the number of tracks illustrated is extremely fewer than the actual one for reasons of drawing purpose). On each track 110, servo blocks (not illustrated) in which servo information used for seeking and positioning of the head 12 is recorded are spaced uniformly. More than one sector (normally, two to five sectors) as recording unit, in other words, data sectors, are placed between servo blocks. The servo blocks are spaced uniformly and arranged in a radial direction from the center to the periphery on the disk 11.

Specified areas of the recording surface of the

disk 11, for instance, the area at the inner region of the disk, is allocated to the system area 111 for storing system control information. Another areas of the recording surface at the inner region of the disk are allocated to an alternate track zone or area which is a destination of replacement for the defective sector. The system control information includes a sector alternate table on which sector alternate control information showing correspondences between defective sector to be replaced and alternate sector.

FIG. 2A shows an example of the positional relationship between track and sector on the recording surface of the disk 11.

In FIG. 2A, track A and track X are shown as track 110. On the track A, sectors starting from sector number 0 to sector number N are allocated. The track A is the track 110, called user area, which user uses to record data, and the sector on the track A can be accessed by an address from the host. Also, on the track X, sectors starting from sector number 0 to sector number M are allocated. The track X is the track within the alternate field, in other words, the alternate track 110. The sectors on the track X are the so-called alternate sectors to be used as destination of replacements for the defective sectors.

FIG. 2B shows an example of the sector alternation. FIG. 2B shows an example in which the

sector with the sector number of 3, in other words, the sector 3 of the track A in FIG. 2A (hereinafter called the sector A-3; the sector Z of the track Y is generally called the sector Y-Z) has a defect and is replaced with the sector X-1 (the sector with the sector number of 1 of the track X).

With reference to FIG. 1 again, the disk 11 is rotated at high speed by a spindle motor (hereinafter called the SPM) 13. The head 12 is connected to a rotary head actuator 14 as a mechanism that moves the head. By rotations of the actuator 14 of which rotation and angle are restricted, the head 12 moves in the radial direction of the disk 11 by which the head 12 is sought on the target track and positioned. The actuator 14 has a voice coil motor (hereinafter called the VCM) 15, which becomes the drive unit of the actuator 14, and is operated by the VCM 15.

The SPM 13 and the VCM 15 are connected to a motor driver 16. The motor driver 16 supplies control current into the SPM 13 to run the SPM 13, and also supplies control current into the VCM 15 to actuate the VCM 15. Servo-values that determines the levels of control currents which is to be supplied from the motor driver 16 to the SPM 13 and to the VCM 15, respectively, are determined by CPU 22.

After the head 12 is sought on the target track 110 and positioned, it scans the target track 110 on

the rotating magnetic disk 11. Also, the head 12 sequentially reads the servo information in the servo blocks uniformly spaced on the track 110 by scanning. The head 12 also reads data from the target sector by scanning, and writes data into the target sector.

The head 12 is connected to a head amplifier circuit 17 which is mounted on the flexible printed wiring board (FPC). The head amplifier circuit 17 designates one of heads 12 to be active according to the control from the CPU 22, and controls input/output of the read/write signal between heads 12. The head amplifier circuit 17 amplifies the analog read signal from the head 12 in a reading mode. The head amplifier circuit 17 converts a recording signal from a read/write circuit 18 to a writing data, and outputs the writing data to the head 12.

The read/write circuit 18 has many functions; an automatic gain control (AGC) function of amplifying the analog read signal, which is read from the disk 11 by the head 12 and amplified by the head amplifier circuit 17, into a constant voltage; a decoding function of performing the signal processing necessary to decode from the read signal amplified by the AGC function to the data in NRZ code, or equivalently, a read channel; an encoding function of performing the signal processing necessary to write data into the disk 11, that is, a write channel; a pulsing function of pulsing

the read signal and outputting pulsed read data so that the servo information from the read signal can be extracted; and a function of extracting burst data in the servo information according to the burst timing signal from a gate array 19, about which is described below. The burst data is sent to the CPU 22 and used as positional control to position the head 12 at the target location of the target track.

The gate array 19 has a function of generating various timing signals, including the burst-timing signal, in order to gain the servo information from the read pulse that is output from the read/write circuit 18, and another function of extracting a cylinder code in the servo information. The cylinder code is sent to the CPU 22 and used as seek control to move the head 12 to the target track.

Hard disk controller (HDC) 20 has an interface control function of controlling the communication of commands, such as the write command between hosts, and the read command, and data; a disk control function of controlling data transfer from and to the disk 11; and a buffer control function of controlling a buffer RAM 21, about which is described below. The HDC 20 has a built-in automatic access circuit 200 that implements an automatic access function of automatically accessing more than one sector. Details of the operation of the automatic access circuit 200 and registers Y-1, Y-2,

Z-1, and Z-2 of the automatic access circuit 200 are described in the following paragraph "Another embodiment of the invention".

To the HDC 20, the buffer random access memory (RAM) 21 is connected. In the buffer RAM 21, a buffer area 210, which temporarily stores the write data transferred from the host and written on the disk 11, and the read data read from the disk 11 and transferred to the host, is provided.

In the buffer RAM 21, an area is provided for storing copy of the sector alternate control information, which is stored in the system area 111 of the disk 11, as a sector alternate control table 211. In a normal state, the sector alternate control table 211 on the buffer RAM 21 is used to access alternate sectors because of high-speed access operation.

An example of the data structure of the sector alternate control table 211 is described with reference to FIG. 3.

The entry information in each entry of the sector alternate control table 211 consists of address information about the address of the defective sector and the address of the alternate sector to be replaced with the defective sector. Generally, an alternate area having alternate track or tracks is prepared on the disk and the alternate sectors are allocated in the alternate track. Therefore, in the alternate control

table 211, the address information of the alternate sector is described as offset address showing offset from the start position of the alternate area or the track to the applicable alternate sector. Thus, to add the base address designating the start position of the alternate area and the offset address to be replaced with the defective sector indicates the position of the alternate sector on the disk. Describing the address of the alternate sector with using offset address helps minimize the volume of data necessary to designate an address.

In FIG. 1, the CPU 22 executes a control of the hard disk system (HDD) in accordance with the control program, including the seeking/locating control of the head 12 based on the cylinder code, which is extracted by the gate array 19, as well as the burst data, which is extracted by the read/write circuit 18; and the disk access control or the read/write access control by the HDC 20 in accordance with the read/write command from the host.

With regard to the disk access control, the head under the control of the CPU 22, if there is a replaced defective sector within the access field requested by the command from the host, first accesses the alternate sector to be replaced, and then accesses proper sectors. At the time of accessing the replaced defective sector, the head skips over the defective

sector and goes to the next sector.

The CPU 22 is connected to the Read Only Memory (ROM) 23 for storing the control programs, the Random Access Memory (RAM) 24 having work space for the CPU 22, and the Electrically Erasable and Programmable Read Only Memory (EEPROM) 25 or an erasable and nonvolatile memory for storing control parameters for the magnetic disk system. These ROM 23, RAM 24, EEPROM 25 and CPU 22 may be formed on one chip.

Two kinds of buffer pointers to control the buffer area 210 in the buffer RAM 21 will now be described with reference to FIG. 4.

Normally, there are two kinds of buffer pointers for controlling the buffer area 210.

One of the buffer pointers is called host pointer (HP). The host pointer shows the address of the buffer area 210 in which read data is stored. This address is referenced when the read data transferred from the disk 11 to the host is read out from the buffer area 210 in the buffer RAM 21. The host pointer also shows the address of the buffer area 210 in which write data is to be stored. This address is referenced when the write data transferred from the host to the disk 11 is written in the buffer area 210.

The other buffer pointer is called disk pointer (DP). The disk pointer shows the address of the buffer area 210 in which read data is to be stored.

This address is referenced when read data transferred from the disk 11 is written in the buffer area 210. Or, the disk pointer shows the address of the buffer area 210 in which write data is stored. This address is referenced when write data transferred from the host to the disk 11 for disk writing is read out from the buffer area 210.

These pointers (HP and DP) are counted up to add or counted down to subtract. These pointers can express in various units: the number of bytes, words or sectors, and designate data for one sector. In the embodiment of the invention, the host pointer (HP) and the disk pointer (DP) are described as buffer pointers, which change by data length, for instance, the number of words, of the buffer RAM 21 having the buffer area 210, by counting up. Also, the data length of the buffer area 210 is set at two bytes (16 bits), i.e., one word is two bytes. In this case, the host pointer (HP) and the disk pointer (DP) are increased by one by an automatic access circuit 200 at a time when one word is read from the buffer area 210 or is written in the buffer area 210. Therefore, when data for one sector (512 bytes = 256 words) is read or written, the pointers are added by 100h (the letter h at the end shows that the hexadecimal numbering system is used).

FIG. 4 shows the disk pointer (DP) after data for one sector (512 bytes) is read from the disk 11 and is

stored in the buffer area 210 when the pointer at 0h is set before reading the data for one sector. After reading data for one sector from the track 110, the disk pointer (DP) changes one sector, i.e., 512 bytes (256 words), and the reading of the pointer changes from 0h to 100h. Reading data from the track 110 is sequentially transferred to and stored on the buffer area 210 and the disk pointer (DP) is counted up automatically from the set disk pointer (DP) in accordance with the data transfer by the automatic access circuit 200.

FIG. 4 also shows the host pointer (HP) after data for one sector (512 bytes) is transferred to the host from the buffer area 210 with the setting of the pointer at 0h. Normally, data of each sector is read from the track 110 and stored in the order of transfer to the host on the buffer area 210. Therefore, once the host pointer (HP) starts being counted up sequentially by the means of the automatic access circuit 200, data is transferred in sequence to the host. The host pointer (HP) and the disk pointer (DP) are set and initialized by the CPU 22.

Here, let's assume that the host issues a command to the hard disk system in FIG. 1 to read the disk of the size of six sectors from the sector number 0 in the track A (sector A-0) as shown in FIG. 2B. Here, the host pointer (HP) and the disk pointer (DP) are counted

up by the number of words (one word = 2 bytes).

With the conventional disk access control method or the disk read control method, upon receipt of a command from the host, checking is carried out whether there is a replaced defective sector within the access field. Here, since the sector A-3 is replaced with the sector X-1 as shown in FIG. 2B, the head first reads the sectors A-0, A-1 and A-2, and then the head seeks up to the track X and reads the alternate sector X-1 after a lapse of a latency or waiting time to detect the alternate sector X-1. Thereafter, the head again seeks the track A to check whether there is a replaced defective sector within the remaining access field. In an example shown in FIG. 2B, since there is no defective sector within the remaining access field, the head reads the sectors A-4 and A-5 after a lapse of a latency or waiting time.

With the conventional disk access control method as described above, sectors just before the replaced defective sector are accessed, and alternate sectors are sought every time a defective sector is detected and remaining sectors within the requested access field are sought, requiring shuttle seeking operation and also a latency or waiting time for sector reading after seeking.

With the conventional disk access control method, however, data is read from the track 110 in the order

of transfer to the host. Hence, if the host pointer (HP) and the disk pointer (DP) are first set at the same reading, and the disk pointer (DP) is counted up sequentially the number of data it reads as well as the host pointer (HP) is counted up sequentially, then, data can be transferred to the host in the order as requested.

Next, disk access, that is, the disk read control method according to a preferred embodiment of the present invention will be described referring to the transition diagram of the buffer state shown in FIGS. 5A, 5B and 5C and the flow chart shown in FIGS. 6A and 6B, based on an example that a read command is given by a host, designating disk read for 6 sectors from the sector A-0 in the track shown in FIG. 2B which is referred with the above conventional method.

When the CPU 22 receives a read command from a host through the HDC 20, it checks whether there is a replaced defective sector within the access field requested by the relevant command for 6 sectors beginning with the sector A-0, that is, the access field from A-0 to A-5, referring to the alternate control table 211 (Step S1). Here, the sector A-3 is a defective sector and replaced by a sector X-1.

In this way, if there is a replaced defective sector within the requested access field, the CPU 22

sets both the buffer pointers of the host pointer (HP) and the disk pointer (DP) so that their values are made identical (Step S2). Here, it is set as host pointer (HP) = disk pointer (DP) = 0h.

Then, the CPU 22 determines the position of the replaced defective sector at the number counted from the first requested sector and changes the disk pointer (DP) and a position on the buffer area 210 in which the replaced sector is stored when the read is executed sequentially from the first sector (Step S3). Here, as the sector A-3 is replaced by the sector X-1, the sector X-1 is read first. As this sector is the fourth sector from the first, the disk pointer (DP) is counted up to 300h corresponding to three sectors from 0h (3 × 512 bytes = 3 × 256 words), as shown in FIG. 5A.

Next, the CPU 22 seeks the head 12 to the alternate track where the alternate sector is located, by controlling the VCM 15 with the motor driver 16, and has the alternate sector read by controlling the automatic access circuit 200 in the HDC 20 (Steps S4 and S5). Here, the track X is sought, and the sector X-1 is read.

Then, the CPU 22 checks whether there is a replaced defective sector within the remaining access field, that is, in the sectors A-4 and A-5 (Step S6). If, differently from the above example, many sectors have been replaced, disk pointers are changed for each

of them (Step S3), and the alternate sector is read (Step S5). Here, if a plurality of sectors have been replaced, each of the alternate sectors are located on the same track in general, and the seek operation becomes unnecessary and continuous access is enabled, except for the case where the first alternate sector is to be accessed.

The flow chart in FIG. 6A shows that the seek operation (Step S4) is executed every time even for the second access to the replaced and after. However, since the current track (cylinder) position and the target track (cylinder) position are checked before starting seek in the seek operation, when each of the alternate sectors are on the same track, each of the alternate sectors are detected on the same track at the second access to the alternate sector and after, and the sector read operation (Step S5) is started. That is, the seek operation is not actually executed at the second access to the alternate sector and after, but the alternate sector is accessed continuously to the access to the first alternate sector.

Read data from the alternate sector is stored in order from the start position of the disk pointer (DP) in the buffer area 210. Thus, as in this example, when the data for one sector from the alternate sector X-1 for the sector A-3 is read (512 bytes = 256 words), the relevant data is stored from the position 300h moved

from the disk pointer (DP) = 0h by three sectors up to 400h.

After that, the CPU 22 returns the disk pointer (DP) to the original position (0h) (Step S7 shown in FIG. 6B).

Then, the CPU 22 seeks the head to the track where the first sector in the requested access field is located (Step S8), and then, continuously reads from the first sector to the sector immediately before the replaced sector by the automatic access circuit 200 (Step S9).

Here, the head is given seek to the track A, and three sectors A-0, A-1, and A-2 are read. At the time the read data of these three sectors is stored in the buffer area 210, the disk pointer (DP) is counted up by three sectors to 300h. The data of the replaced sector A-3 next to the sector A-2 has been already read and stored from the position of 300h in the buffer area 210. Thus, the CPU22 does not read the replaced sector A-3 by the head but counts up the disk pointer (DP) for the one sector (Step S10). By this, the disk pointer (DP) becomes 400h. The relationship between the store position of the read data from each sector in the buffer area 210 and the disk pointer (DP) is shown in FIG. 5C.

Similarly, for the remaining access field, if there is a replaced defective sector (Step S11),

the CPU 22 continuously reads from the first sector to the sector immediately before the relevant replaced defective sector in the remaining access field with the automatic access circuit 200 (Step S12), the relevant replaced defective sector is not read, and only the disk pointer (DP) is updated (Step S10).

If there is no replaced defective sector (Step S11), the CPU 22 reads the remaining sector with the automatic access circuit 200 (Step S13) and completes disk access according to the requested read command, that is, disk read. In this example, as there is no replaced defective sector other than the sector A-3 within the requested access field, A-4 and A-5 are read, and the disk read is completed.

The above example is described for the case where, if the replaced defective sector is normal, the read data of the alternate sector replaced by the defective sector is stored in the area of the buffer area 210 where the read data of the normal sector should have been stored. In this way, the data can be transferred to the host according to the requested order only by sequentially counting up the host pointer (HP).

However, it does not necessarily need to apply such a storing method. This storing method for read data and a modification of the transferring method for read data to the host will be described below.

First, the read order of each sector when there is

an alternate sector within the access field requested by the host is the same as the above explanation. Thus, before reading the first sector within the access field, the alternate sector of the replacement destination of the replaced defective sector is read. This data is stored in the exclusive area of the buffer area 210. If a plurality of defective sectors has been replaced, the read data of the corresponding plural alternate sectors are sequentially stored one by one in the continuous areas of the above exclusive area.

After that, read is started from the first sector and continued through the end with skipping the replaced areas. This read data is sequentially stored by one sector in the continuous areas starting from the position of the buffer area 210 indicated by the disk pointer (DP) = 0h, for example.

In parallel with the processing of storing the read data from each of the above sectors into the buffer area 210, processing is executed to transfer the read data stored in the above buffer area 210 to the host. Data transfer from the buffer area 210 to the host according to the requested order is executed using the host pointer (HP).

Here, the host pointer (HP) is basically counted up sequentially, but for transfer of the data of the replaced sector, the host pointer (HP) is changed so that the data stored in the exclusive area of the

buffer area 210 is transferred. And when the data of the replaced sector is transferred, the host pointer (HP) is returned to a value before the change, and when there is another replaced detective sector, the host pointer (HP) is sequentially counted up again until the data of the next replaced sector is transferred, and data transfer to the host is continued. Even in this way, the same effect as the above example can be obtained.

Next, a disk write control method of accessing the disk when receiving a write command from the host will be explained.

First, tracks on the disk 11 at a write command processing is shown in FIG. 7. In this example of the tracks, sectors numbered as 3 and 5 of the track A, that is, the sectors A-3 and A-5 are replaced by sectors numbered as 1 and 3 of the track X, that is, the sectors X-1 and X-3.

FIG. 8 shows an example of the state in a buffer area at the write command processing, in which the disk pointer (DP) and the host pointer (HP) are shown. As explained above, at the time of disk write, the host pointer (HP) determines the address of the relevant buffer area 210 when writing the write data transferred from the host to the disk 11 into the buffer area 210, while the disk pointer (DP) shows the address of the relevant buffer area 210 when reading the write

data from the host out of the buffer area 210 and transferring it to the disk 11. However, the host pointer (HP) and the disk pointer (DP) are updated not by word but by byte in this case. Thus, when the data length of the buffer area 210 is 2 bytes (16 bits) as with the above, an increase is given by 2 to the host pointer (HP) at each time a single writing of the write data (1 word = 2 bytes) into the buffer area 210 is completed and to the disk pointer (DP) at each time a single reading of the write data (1 word = 2 bytes) from the buffer area 210 for the disk write. Thus, the host pointer (HP) and the disk pointer (DP) are increased by 200h when writing or reading of data corresponding to one sector (512 bytes) to and from the buffer area 210.

Accordingly, after the data corresponding to one sector in the state that the host pointer (HP) = disk pointer (DP) = 0 has been written, the host pointer (HP) and the disk pointer (DP) become the host pointer (HP) = disk pointer (DP) = 200h as shown in FIG. 8.

Here, in the track shown in FIG. 7, suppose that a write command requesting disk write of six sectors from the sector numbered as 1 of the track A, that is, the sector A-1 is given by the host to the magnetic disk system in FIG. 1. Here, the host pointer (HP) and the disk pointer (DP) are counted up by byte as mentioned above.

Also, suppose that all the write data has been transferred to the buffer area 210, in which the host transfer rate of the write data from the host to the buffer area 210 is sufficiently higher than the disk transfer rate of write data from the buffer area 210 to the disk 11, and the magnetic disk system receives the write command from the host and starts the write operation.

In the conventional disk access control method, when a write command is received from the host, it is checked whether there is a replaced sector within the access field. Here, as the sector A-3 has been replaced to the sector X-1 and the sector A-5 to the sector X-3, respectively, data is written into the sectors A-1 and A-2. Next, the track X is given seek, the data is written into the sector X-1 after a latency or waiting time till the sector X-1 is detected has been elapsed, and the track A is given seek again. After that, it is checked whether there is a replaced sector within the remaining access field. Here, the sector A-5 is a defective sector and replaced by the alternative sector. Thus, after the latency or waiting time till detection of the sector A-4 has elapsed, data is written into the sector A-4, and the track X is given seek again. And the data is written into the sector X-3 after the latency or waiting time till detection of the sector X-3, and after that, the track

A is given seek. After that, it is checked whether there is a replaced defective sector within the remaining access field. Here, as there is no defective sector, data is written into the sector A-6 after the latency or waiting time till detection of the sector A-6 has been elapsed.

In this way, the conventional disk write control method needs seek to the alternate sector, reciprocating seek with the remaining sectors in the requested access field and waiting each time accessing the sector immediately before the defective sector to be replaced as with the above mentioned disk read.

However, with the conventional method that access is made in the order of sectors to write into, if the host pointer (HP) and the disk pointer (DP) are set at the same value at first, it is only necessary to sequentially count up the data transferred from the host, and the received data can be written into the requested sector if the disk pointer (DP) is counted up sequentially.

Next, the disk write control method applied in this preferred embodiment will be described referring to the flow chart in FIGS. 9A and 9B based on the example that a write command designating disk write for six sectors from the sector A-1 is given by the host in the track state in FIG. 7 as with the above conventional method.

When the above write command is received from the host, the CPU 22 checks whether there is a replaced defective sector in the access field for six sectors starting from the sector A-1 requested by this command, that is, the sectors A-1 to A-6 (Step S21). Here, suppose that the sectors A-3 and A-5 are defective sectors, and that these sectors A-3 and A-5 have been replaced by alternative sectors.

As in this example, if there is a replaced defective sector within the requested access field, the CPU 22 checks if the write data requested by the CPU 22 has been transferred from the host or not (Step S22). If not, the disk write in the above-mentioned conventional method is executed (Step S33). However, in this preferred embodiment, the disk transfer rate is high, and all the write data has been transferred to the buffer area 210 when the magnetic disk system receives the write command from the host and starts write operation.

In this way, when the requested write data has been transferred from the host, the CPU 22 makes a change so that the disk pointer (DP) points to the first position of the data in the buffer area 210 to write into the alternate sector (Step S23). Here, the disk pointer (DP) is changed so that it points to the first of data of A-3. It can be so configured that moving to the above Step S23 is made after waiting for

a predetermined certain period of time till transfer has been completed even when the data has not been transferred from the host.

Next, the CPU 22 seeks the head 12 to the track where the alternate sector is located (Step S24). Here, the alternate sector X-1 of the sector A-3 is sought. And the CPU 22 writes the data into the alternate sector X-1 by controlling the automatic access circuit 200 in the HDC 20 (Step S25).

Then, the CPU 22 checks if there is a replaced defective sector in the remaining access field (here, sectors A-4 to A-6) (Step S26). If there is another replaced defective sector, the CPU 22 adjusts the disk pointer (DP), changes it so that the disk pointer (DP) points to the first position of the data to write into the alternate sector in the buffer area 210 (Step S23), and writes the data into the alternate sector (Step S25). Here, the disk pointer (DP) is changed so that it indicates the data position of the sector A-5, and the data is written into the sector X-5. The above plural write operations into the alternate sectors eliminates the need of actual seek operation, as these alternate sectors are generally on the same track, and is executed continuously.

If there is no other replaced sector, the CPU 22 seeks the head 12 to the track where the first sector in the requested access field is located (Step S27).

In this example, the track A is sought.

Then, the CPU 22 sets the disk pointer (DP) at the initial value of the host pointer (HP) (Step S28) and writes the data from the first sector to the one immediately before the replaced defective sector using the automatic access circuit 200 (Steps S29 and S30). Here, the data is written into the sectors A-1 and A-2.

And when coming to the turn of the replaced sector, the CPU 22 advances the disk pointer (DP) by one sector and skips the write into the disk 11 by one sector at the same time (Step S32). Here, the sector A-3 is skipped at the above Step S32.

Then, similarly for the remaining access field, the write operation is executed from the first sector of the relevant remaining access field to the one immediately before the replaced defective sector (Step S30). Here, the sector A-4 is processed at the above Step S30. If there is a replaced defective sector within the remaining access field (Step S29), the disk pointer (DP) is advanced by one sector when coming to the turn of the sector, and the write into the disk 11 is skipped by one sector (Step S32). Here, the sector A-5 is processed at the above Step S32.

Then, when there is no longer replaced defective sector within the remaining access field, the remaining data is written (Step S30), and when the entire write operations are done (Step S31), the disk access (disk

write) according to the requested write command is completed. In this example, the data is written into the sector A-6 and the processing is completed.

In this preferred embodiment, explanation goes that the buffer pointers (HP) and (DP) operate by word when executing the read command and by byte when executing the write command, but it is to show that a variety of updating methods can be applied to the buffer pointers, and the read and write are generally updated either by byte, word or sector.

[Another preferred embodiment]

Next, another preferred embodiment of the present invention will be described. As the basic configuration of the magnetic disk system of this preferred embodiment is the same as the magnetic disk system of the above-preferred embodiment, FIG. 1 will be used to explain another preferred embodiment for convenience.

In this preferred embodiment, the operation to skip access to a desired sector is executed not by control of the CPU 22 but automatically by the HDC 20.

The HDC 20 is conventionally provided with the function of automatic access to a plurality of sectors. The automatic access circuit 200 realizes this automatic function. For example, by designating parameters such as access start sector number, the number of access sectors, host pointer (HP), disk pointer (DP), etc. and activating the automatic access

circuit 200, access to consecutive sectors for the designated number of sectors starting with the designated sector in the track can be made automatically. However, in the conventional automatic access circuit, the host pointer (HP) and the disk pointer (DP) changed sequentially, the disk access only dealt with consecutive sectors, and the skipping access to the desired sector could not be done automatically.

Then, in this new automatic access circuit 200 in FIG. 1 to which this preferred embodiment is applied, a function to skip access to a desired sector is added. Thus, two pairs of registers of Y-1 and Y-2 and registers Z-1 and Z-2 are provided in the automatic access circuit 200.

In the registers Y-1 and Z-1, the CPU 22 sets the sector numbers of the replaced defective sectors, and the registers Y-2 and Z-2 are used to set the number of consecutive alternate sectors starting with the sector indicated by the registers Y-1 and Z-1. The number of pairs of the above registers should not necessarily two.

The host pointer (HP) and the disk pointer (DP) are up counters operating by byte and updated automatically each single data reading/writing for the buffer area 210. Here, if access to the buffer RAM 21 having the buffer area 210 is made by 16 bits, that is, 2 bytes, the host pointer (HP) and the disk pointer

(DP) are increased by 2 at a single access. Thus, data reading/writing of one sector (512 bytes) makes 200h increase.

Next, the disk access accompanied by skipping of sector access executed using the new automatic access circuit 200 will be explained referring to the buffer state transition diagram in FIG. 10 and the flow chart in FIG. 11 based on the example that a read command is given by the host in the track state in FIG. 7, requesting disk read of six sectors from the sector numbered as 1 of the track A, that is, the sector A-1.

First, in this preferred embodiment, the replaced sectors A-3 and A-5 contained in the requested access field are detected, and the sectors X-1 and X-3 at the destination of replacement are read first. When the relevant alternate sectors are not consecutive as in this example, this read operation of the alternate sectors X-1 and X-3 is implemented by setting parameters for the read from the above sector in the automatic access circuit 200 for each single sector by control of the CPU22 and by executing the read of the corresponding alternate sector each time by the automatic access circuit 200. At that time, the CPU 22 writes the read data for one sector from the alternate sector at the position on the buffer area 210 where the data of the replaced sector corresponding to the above alternate sector should be stored by changing

the setting of the disk pointer (DP) each time. The operation up till now is the same as the operation at the time of read in the above-preferred embodiment (Steps S1 to S6 in FIG. 6A).

The state of the buffer area 210 when the read operation of the alternate sectors X-1 and X-3 is completed is shown in FIG. 10A using an example with the disk pointer (DP) = 0 as the initial value. Here, the data read from the alternate sector X-1 of the third sector A-3 in the requested access field is stored from the disk pointer (DP) = 400h to 600h, and the data read from the alternate sector X-3 of the fifth sector A-5 within the above access field is stored from the disk pointer (DP) = 800h to A00h.

When the CPU 22 completes all the read operations of the alternate sectors of the replaced defective sectors existing in the access field requested by the host, the disk read of the remaining sectors in the access field, that is, the sectors A-1 to A-6 excluding the replaced sectors A-3 and A-5 is executed by the automatic access circuit 200.

Before starting this disk read, the CPU 22 sets the sector numbers of the replaced sectors in the access field and the number of alternate sectors indicating how many consecutive sectors have been replaced in the register in the automatic access circuit 200.

Here, in the access field (A-1 to A-6), there are two replaced defective sectors A-3 and A-5, and there are no consecutive replaced sectors. In this case, the CPU 22 sets A-3 and 1 for the pair of the registers Y-1 and Y-2 and A-5 and 1 for the pair of the registers Z-1 and Z-2, for example. If the replaced sectors are A-3 and A-4, A-3 and 2 are set for the pair of the registers Y-1 and Y-2, for example. Nothing is set for the pair of the registers Z-1 and Z-2, but it remains at an initial value (null value, for example).

After that, the CPU 22 sets parameters such as the access start sector number (showing A-1), the number of access sectors (showing six sectors of A-1 to A-6), the host pointer (HP), disk pointer (DP) (here, host pointer (HP) = disk pointer (DP) = 0), etc. in the automatic access circuit 200 and activates the above automatic access circuit 200 (automatic function) (Step S41).

When activated by the CPU 22, the automatic access circuit 200 conventionally executes read operation each time the head 12 reaches each sector in the access field for the designated number of access sectors starting at the first sector indicated by the access start sector number. The automatic access circuit 200 has a function to keep and update the sector number of the sectors currently to be accessed (sector number to be accessed) and updates the above sector number to be

accessed at each sector access sequentially from the access start sector number.

On the contrary, in this preferred embodiment, the automatic access circuit 200 compares the current sector number to be accessed kept by itself with the sector number of the replaced sectors set in the registers Y-1 and Z-1 before starting the read operation of one sector and checks if it matches either of the sector number of the replaced sectors (Step S42). Here, the sector number to be accessed is checked if it matches either of A-3 or A-5.

In response to the above check, when the automatic access circuit 200 detects that there is a sector number of the replaced sector matching the sector number to be accessed, that is, when the sector to be accessed is a replaced sector, the state is realized where access to that sector (continuously replaced sector starting with the sector to be accessed) has been completed (Step S46), without accessing the relevant sector (access to the continuously replaced sector when there is another replaced defective sector continuous to the relevant sector, that is, when there is continuously replaced defective sector starting from the sector to be accessed). In concrete, the sector number to be accessed is incremented by the number of replaced sectors to which the relevant access has been completed so as to indicate the sector next to the

replaced sector whose access has been completed (that is, normal sector which has not been replaced), and the disk pointer (DP) is increased by the number of continuous alternate sectors (the number of 512 bytes × continuous alternate sectors), that is, by 200h × the number of continuous alternate sectors. Here, a set value of the register i-2 constituting a pair with the register i-1 (i is Y or Z) matching the sector number to be accessed is used as the number of continuous alternate sectors.

In this example, the sectors replaced within the access fields of A-1 to A-6 are 2 sectors of A-3 and A-5. Thus, when the sector numbers to be accessed are A-3 and A-5, matching (with the set values of the registers Y-1 and Z-1) is detected at the above Step S42, and as the number of continuously replaced sectors (set values of the registers Y-2 and Z-2) is 1, the sector number to be accessed is incremented by 1 and the respective next sectors A-4 and A-6 are shown, while the disk pointer (DP) is increased by 200h, which is one sector.

In the meantime, when the sector numbers to be accessed are A-1, A-2, A-4, and A-6, mismatch is detected at the above Step S42. In this case, the automatic access circuit 200 makes an access to the sector with the sector number to be accessed (Step S43). In this case, the automatic access circuit 200

makes an access to the sector with the sector number to be accessed (Step S43). Here, the disk pointer (DP) is sequentially counted up. And each time an access to one sector is completed, the sector number to be accessed is incremented by one (Step S44).

Each time the automatic access circuit 200 updates the sector number to be accessed at Step S44 or S46, the sector number to be accessed after the update is compared with the value of the access start sector number set by the CPU 22 at start-up of the automatic access circuit 200 (automatic function) plus the number of access sectors (Step S45), and if matched, it is stopped as determined as all the accesses have been completed.

By the above, after the access to the alternate sector of the replaced defective sector contained in the access field requested by the host, access including skip of the replaced sectors from A-1 to A-6 in the relevant access field (and update of the disk pointer (DP) of the alternate sectors) can be automatically executed not by control of the CPU 22 but by the automatic access circuit 200 (in the HDC 20).

Processing when a write command is given by the host is the same as above preferred embodiment, and first, write operation is executed to the alternate sector of the replaced sectors contained in the requested access field, and then, the write operation

may be done including skip of the replaced sector of each sector in the above access field (and update of the disk pointer (DP)) by the automatic access circuit 200.

In the preferred embodiment described above, the case where the present invention is applied to the magnetic disk system has been explained, but in the present invention, read/write of data to and from the magnetic disk is executed by sector, and the present invention may be applied to the disk drive system in general where arbitrary sectors on the track secured in the prescribed alternate area of the relevant magnetic disk is allocated as the destination of replacement of the defective sector on the relevant magnetic disk.

As described above in detail, according to the present invention, in the disk access to the requested access field including the replaced sectors, as an access is made to the sector at the destination of replacement first, and then, accesses are made to normal sectors and an access is skipped at the access to the replaced sectors and moved to the next sector, seek or waiting for rotation to the destination of replacement in the requested access field during continuous access can be avoided, and reduction in disk access speed can be suppressed.

Also, according to the present invention, the skip operation during the access to the above-replaced

sector can be automatically executed independently of the main control part of the disk drive system in the disk controller, and reduction in the disk access speed can be further effectively prevented.

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 disk drive system for storing data, comprising:

a recording disk having a plurality of data tracks in a user area and a at least one alternate track in an alternate area, the tracks including normal sectors and some of the defective sectors in the user area, and the defective sectors being replaced to an alternate sector arranged in the alternate area, respectively;

receiving means for receiving an access command to designate an access field in the user area;

determining means for determining, in response to the access command, one of defect detection mode in which there is the defective sector in the access field and no defect detection mode in which there is no defective sector in the access field;

accessing means for accessing the normal sectors in the access field in the no defect detection mode to read data from the normal sectors or write data on the normal sectors;

controlling means for controlling said accessing means to access the alternate sector relating to the defective sector in the alternate area, thereafter, access the normal sectors in the access field and skip the defective sector after reading data from the alternate sector or writing data on the alternate sector in the defect detection mode.



2. A disk drive system according to claim 1, further comprising a buffer memory in which a buffer area for temporarily storing data read from the disk and to be transferred externally and data transferred from the external to write on the disk.

3. A disk drive system according to claim 2, wherein said controlling means includes buffer control means for controlling said buffer memory to transfer data read out from the normal sectors in the access field and the alternate sector in the alternate area in the order requested by the command, through the buffer area to an external unit, in the defect detection mode.

4. A disk drive system according to claim 2, wherein the access command includes a write command and said disk drive system further comprises activating means for activating said controlling means in the defect detection mode after transferring data to be written on the disk into the buffer area from the external unit in response to the write command.

5. A disk drive system according to claim 4, wherein said controlling means includes buffer control means for controlling said buffer memory to transfer data to be written on the alternate sector in the alternate area from the buffer area to the disk and, thereafter, transfer the data to be written on the normal sectors in the access field from the buffer area to the disk.



6. A disk drive system according to claim 1, further comprising:

a buffer memory in which a buffer area for temporarily storing data read out from the disk to be transferred to an external unit and data transferred from the external unit to be written into the disk; and

a first buffer pointer showing the position of the relevant data on the buffer area when the data read out of the disk is stored in the above buffer area and when the data to be written into the disk is taken out of the buffer area, and

a second buffer pointer showing the position of the relevant data on the area when the data read out of the magnetic disk and stored in the buffer area is taken out of the relevant buffer area to be transferred to the external unit and when the data transferred from the external unit to be written into the disk is stored in the buffer area.

7. A disk drive system according to claim 6, wherein the access command includes a read command and said controlling means includes buffer pointer setting means for setting at least one of the values of the above first and the second buffer pointers so that the data read out from the alternate sector or sectors in the alternate area and the data read out from the normal sectors in the access field are transferred in the order requested by the command through the buffer



area to the external unit in accordance with a read command in the defect detection mode.

8. A disk drive system according to claim 6, wherein the access command includes a write command, said disk drive system further comprises activating means for activating said controlling means in the defect detection mode after transferring data to be written on the disk into the buffer area from the external unit in response to the write command and said controlling means includes buffer control means for controlling said buffer memory to transfer data to be written on the alternate sector in the alternate area from the buffer area to the disk and, thereafter, transfer the data to be written on the normal sectors in the access field from the buffer area to the disk.

9. A disk controller applied to the disk drive system in which a disk has at least one alternate track in an alternate area and a plurality tracks in a user area, the tracks including a plurality of normal sectors and some of defective sectors, the defective sectors in the user area being replaced to an alternate sector in the alternate area, the alternate sector corresponding to the defective sector in an access field which is designated by an access command are accessed in response to the access command in a defect detection mode in which the defective sector is detected in the access field and, thereafter, the

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sectors in the access field are continuously accessed, said disk controller comprising:

registering means for registering information relating to the defective sector in the access field, which is to be replaced with the alternate sector;

determining means for determining one of the defect detection mode and no defect detection mode in which no defective sector is detected in the access field and designating the alternate sector corresponding to the defective sector with reference to the information before the sectors in the access field is accessed; and

skipping means for skipping the access of the defective sector in the access field in the defect detection mode in accordance with the designation of alternate sector.

10. A disk controller according to claim 9, further comprising:

storing means for storing information relating to the sector which is currently accessed in the access field;

first updating means for updating the information so as to be related to the next sector each time after an access of the sector is completed; and

second update means for updating the information so as to be relate to the sector which is to be accessed after skipping the access of the defective

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sector.

11. A disk controller according to claim 10, further comprising:

a buffer memory in which a buffer area for temporarily storing data read from the disk and to be transferred externally and data transferred from the external to write on the disk;

a first buffer pointer showing the position of the relevant data on the buffer area when the data read out of the disk is stored in the above buffer area and when the data to be written into the disk is taken out of the buffer area, and

a second buffer pointer showing the position of the relevant data on the area when the data read out of the magnetic disk and stored in the buffer area is taken out of the relevant buffer area to be transferred to the external unit and when the data transferred from the external unit to be written into the disk is stored in the buffer area.

wherein said skipping means includes

a buffer pointer update means for updating the first buffer pointer each time after skipping the access of the defective sector.

12. A disk access control method applied to a disk drive system in which a disk has at least one alternate track in an alternate area and a plurality tracks in a user area, the tracks including a plurality of normal

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sectors and some of defective sectors, the defective sectors in the user area being replaced to an alternate sector in the alternate area, the alternate sector corresponding to the defective sector in an access field which is designated by an access command are accessed in response to the access command in a defect detection mode in which the defective sector is detected in the access field, said disk access method comprising steps of:

determining one of the defect detection mode and no defect detection mode in which no defective sector is detected in the access field, in response to the access command;

accessing the sectors continuously in the access field in the no defect detection mode;

accessing the alternate sector in the alternate area in the defect detection mode, which corresponds to the defective sector in the access field;

accessing the normal sectors continuously in the access field so as to skip the defective sector in the access field after accessing the alternate sector.

13. A disk access control method applied to a disk drive system in which a disk has at least one alternate track in an alternate area and a plurality tracks in a user area, the tracks including a plurality of normal sectors and some of defective sectors, the defective sectors in the user area being replaced to an alternate

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sector in the alternate area, the alternate sector corresponding to the defective sector in an access field which is designated by an access command are accessed in response to the access command in a defect detection mode in which the defective sector or sectors is detected in the access field, said disk drive system further comprising a buffer memory in which a buffer area for temporarily storing data read from the disk and to be transferred to an external unit and data transferred from the external unit to write on the disk, said disk access method comprising steps of:

determining one of the defect detection mode and no defect detection mode in which no defective sector or sectors is detected in the access field, in response to the access command;

accessing the sectors continuously in the access field in the no defect detection mode and transferring data read out of the sectors to the buffer area;

accessing the alternate sector in the alternate area in the defect detection mode, which corresponds to the defective sector in the access field, and transfer data read out of the alternate sector to the buffer area;

accessing the normal sectors continuously in the access field so as to skip the defective sector in the access field after accessing the alternate sector, and transfer data read out of the normal sectors to the

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buffer area; and

controlling said buffer memory to transfer data in the order requested by the command to the external unit.

14. A disk access control method applied to a disk drive system in which a disk has at least one alternate track in an alternate area and a plurality tracks in a user area, the tracks including a plurality of normal sectors and some of defective sectors, the defective sectors in the user area being replaced to an alternate sector in the alternate area, the alternate sector corresponding to the defective sector or sectors in an access field which is designated by an access command are accessed in response to the access command in a defect detection mode in which the defective sector is detected in the access field, said disk drive system further comprising a buffer memory in which a buffer area for temporarily storing data read from the disk and to be transferred to an external unit and data transferred from the external unit to write on the disk, said disk access method comprising steps of:

controlling a transfer of data between the external unit and the buffer area;

determining one of the defect detection mode and no defect detection mode in which no defective sector is detected in the access field, in response to the access command;

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accessing the sectors continuously in the access field in the no defect detection mode and transferring data from the buffer area to the normal sectors after the transfer controlling step;

accessing the alternate sector in the alternate area in the defect detection mode, which corresponds to the defective sector in the access field, and transfer data from the buffer area to the alternate sectors after the transfer controlling step;

accessing the normal sectors continuously in the access field so as to skip the defective sector in the access field after accessing the alternate sector, and transfer data from the buffer area to the normal sectors after the transfer controlling step.

