MAGNETIC DISK UNIT AND METHOD FOR CONTROLLING THE SAME

The present invention relates to a magnetic disk unit employing a sector servo system which performs position control of a head in accordance with servo information disposed in each sector, and more particularly, to a magnetic disk unit and method for controlling the same which can skip the servo information.

Prior Art

In a magnetic disk unit employing a sector servo system, which is generally used today, there is provided in sectors of each cylinder servo information containing a track number and a signal for correcting a position between tracks. When no command comes from a host computer, a magnetic disk unit usually performs position control of its head so that the head is held on a certain track in accordance with servo information in each sector. This state is called an idle state. When a command comes from the host computer in this state, the command must be immediately executed.

When a small magnetic disk unit is practically used, the ratio of the idle state is very large. In particular, the consumption power of a magnetic disk unit used in a battery-driven notebook type personal computer presents a great problem. In view of this, in a recent sector servo type magnetic disk unit, the power of write or read circuitry is turned on only for each servo sector and is turned off for each data sector, the remaining section of each sector to reduce power consumption during the idle state. Specifically, the power of the write or read circuitry is switched at a fixed duty ratio so as to reduce the consumption power.

Problems to be solved by the Invention

The power off ratio of the write or read circuitry, however, is limited to about 40-50%. This is because the duty ratio is limited by the length ratio between the servo sector and the data sector.

Therefore, it is an object of the present invention to provide a magnetic disk unit and method for controlling the same to remarkably reduce the power consumption.

Means for solving the Problems

To accomplish the above-mentioned object, the present invention provides a magnetic disk unit employing a sector servo system which performs positioning of a head in accordance with servo information disposed in each sector, said magnetic disk unit comprising: position control means for controlling positioning of said head in response to various commands and said servo information; first servo information processing means for processing said servo information supplied by said head, extracting a track number from said servo information, and supplying said track number to said position control means; second servo information processing means for processing said servo information supplied by said head, extracting from said servo information an offset amount from a track center, and supplying said offset amount to said position control means; data write and read means for supplying a write signal to said head, or for receiving a read signal from said head; identifying means for identifying a particular operation mode of said magnetic disk unit other than a write or read operation, and generating a signal representing said particular operation mode; and selection means for controlling, in response to said signal, said first and second servo information processing means so as to selectively supply said servo information to said position control means, wherein said position control means controls the position of said head on the basis of said servo information selected by said selection means.

In addition, the magnetic disk unit may further comprise means for interrupting an operation of at least a part of the data write and read means and the second servo information processing means except when the selection means supplies the servo information to the position control means.

In addition, the present invention provides a method for controlling a magnetic disk unit employing a sector servo system for positioning a head in accordance with servo information disposed in each sector, the method comprising the steps of: processing the servo information supplied from the head; identifying a particular operation mode of the magnetic disk unit other than a write or read operation, and generating a signal representing the particular operation mode; acquiring the servo information selectively in response to the signal; and

controlling positioning of the head on the basis of the servo information selected.

Effects

The present invention does not use the complete servo information from all the sectors in the idle state, but selects the servo information from every two or more sectors so that the position control of the head is performed with a minimum number of the servo information. Consequently, the power consumption can be reduced by the amount needed for computation for position control.

In addition, since the power of the write or read circuitry and some of the electric circuits of the servo system is turned off from the selected servo information to the next selected servo information, the consumption power is further reduced by that amount.

Brief Description of the Drawings

Fig. 1 is a block diagram showing an arrangement of an embodiment of a magnetic disk unit according to the present invention;

Fig. 2 is a diagram illustrating the timing of the power control signal PWPS of the above embodiment in comparison with the power control signal PWPS of the conventional example;

Fig. 3 is a block diagram illustrating a method for setting the parameters of the above embodiment in comparison with that of the conventional example;

Fig. 4 is a flowchart illustrating the basic operation of the sector skipping control of the above embodiment; and

Fig. 5 is a flowchart illustrating the autoskipping operation in the sector skipping control of the above embodiment.

Embodiment

Fig. 1 shows an embodiment of the present invention. In this figure, reference numeral 1 designates a magnetic disk. A plurality of

tracks 3 are concentrically disposed on the magnetic disk 1. Further, 50 sectors are radially formed on the magnetic disk 1, as shown in Fig. 2(C). At the top of each sector, there is provided servo information 5, which is followed by a data region 7. The servo information 5 contains digital servo information indicating a track number and analog servo information indicating an offset amount from the center of each track.

The reading of the servo data 5, and the writing and reading of the data in the data region 7 are performed by a head 11. Specifically, the head 11 is driven in the radial direction of the magnetic disk 1 by a voice coil motor 13 so that the head 11 is moved on a designated track and accesses an addressed sector.

The output signal of the head 11 is amplified by a signal amplifier 21. The output of the signal amplifier 21 is subjected to noise removal with a filter 23, and is supplied to a signal processing circuit 25. The signal processing circuit 25 comprises a peak detector 26, a VFO (variable frequency oscillator) 27 and a code converter 28. The circuit 25 converts the read signal into digital data and sends it to a hard disk controller (not shown) connected to a line 28A. A write signal, on the other hand, is sent from the hard disk controller to the code converter 28, and then to the signal amplifier 21, so that it is converted from digital data to an analog signal, and is fed to the head 11.

The servo information 5 read by the head 11 is separately processed by two circuits. That is, the digital servo information including the track number is supplied through the peak detector 26 of the signal processing circuit 25 to a servo digital data processing circuit 31 to be detected and processed there; and the analog servo information containing the offset information is sent from the filter 23 to a servo analog information processing circuit 33 to be detected and processed there. The outputs of these circuits 31 and 33 are sent to an MPU (micro-processing unit) 35. The MPU 35 performs seek and following control of the head 11 in response to a write or read command, and supplies a D/A converter 41 with the output obtained by computation based on the command and the servo information 5. The output of the D/A converter 41 is supplied to the voice coil motor 13 through a notch filter 43 and a motor driver 45, thus moving the head 11.

An ROM 36 and an RAM 38 are connected to the MPU 35. The ROM 36 stores a microcode 37. The microcode 37 is transferred from the ROM 36 to the RAM 38 when the power is turned on, and performs sector skipping control described below. The RAM 38 contains a group of registers used during the sector skipping control.

The MPU 35 is connected to a host computer 53 through an interface circuit 51, and receives various commands therefrom. A keyboard 55 is connected to the host computer 53.

Next, the power system of such an arrangement is explained. The MPU 35 detects the termination of processing of a write or read command sent from the host computer 53. Then, finding that the next command has not yet arrived at the interface 51 from the host computer 53, the MPU 35 sends to the servo digital data processing circuit 31 via a 16-bit bus, a signal representing the initiation of the idle state, and parameters A', B' and C' for the idle state, which will be described later. The servo digital data processing circuit 31, responding to the signal representing the initiation of the idle state, generates, by using the parameters, a power control signal PWPS based on the servo information 5. The signal PWPS, which turns on and off the power of respective circuits, is supplied to power on/off terminals, such as power save terminals, of the signal amplifier 21, the filter 23, the signal processing circuit 25, and the servo analog information processing circuit 33. Here, the signal amplifier 21, the filter 23 and the signal processing circuit 25 function as a data write and read means, whereas the servo analog information processing circuit 33 functions as a means for processing the analog servo information.

Fig. 2 illustrates, in comparison with a conventional system, the timing of generating the power control signal PWPS when the head 11 is held on the same track. As shown in Fig. 2(A), the conventional system generates the power control signal PWPS for each sector in synchronism with a sector signal produced for each sector. In contrast with this, this embodiment does not generate the power control signal PWPS for each sector, but generates the power control signal PWPS for every other sectors as shown in Fig. 2(B). Assuming that the on-state duration of the power control signal PWPS is T1, and the period of the sector signal is T1+T2, the duty ratio of the power control signal of the conventional system is given by 100T1/(T1+T2), whereas the duty ratio of the

embodiment is given by 100T1/2(T1+T2). In other words, the duty ratio of the embodiment is half that of the conventional system.

The above-mentioned control is carried out by the microcode 37. The microcode 37 performs this control by using the following three parameters which are set in the registers placed in the RAM 38.

A. A parameter for determining the timing (period) of reading the servo information 5.

B. A feedback parameter for performing the stable servo control.

C. A parameter for determining the duty ratio of the power control signal PWPS.

The conventional system uses without change the three parameters A, B, and C which have been already set in the registers, when the system shifts from the write or read mode to the idle mode, as shown in Fig. 3(A). The system of the present invention, on the other hand, simultaneously replaces the three parameters A, B, and C with parameters A', B', and C' for the idle mode by using the microcode 37 so that a new duty ratio is established when the system enters the idle state from the write or read mode, as shown in Fig. 3(B). Thus, the power control signal PWPS as shown in Fig. 2(B) is generated, and at the same time, the servo control is stabilized.

When the interface 51 detects the arrival of a write or read command from the host computer 53, it sends a signal representing this to the MPU 35. In response to this signal, the MPU 35 sends the signal representing the termination of the idle state, and the original parameters A, B, and C to the servo digital data processing circuit 31 via the 16-bit bus. The servo digital data processing circuit 31 holds the power control signal PWPS at the high level so that the recovery to the normal write or read operation on an identical track is achieved. More specifically, when a write or read command comes from the host computer 53, the microcode 37 replaces the three parameters A', B', and C' with the original parameters A, B, and C, again, and returns to the control for the write or read mode.

Fig. 4 is a flowchart illustrating the control operation of the microcode 37 when 1-sector skipping control is carried out. Here, the 1-sector skipping control refers to the position control of the head 11 by using the servo information 5 from every other sector. Receiving the information from the interface 51 that a write or read command comes from the host computer 53 at step SP1, the microcode 37 turns off the skipping servo at step SP2. On receiving the information that the command has been completed at step SP3, the microcode 37 performs the 1-sector skipping control in conjunction with the servo digital data processing circuit 31 at step SP4. Specifically, the microcode 37 substitutes the parameters, and the servo digital data processing circuit 31 carries out the 1-sector skipping control in accordance with the parameters. As a result, the servo digital data processing circuit 31 generates the power control signal PWPS as shown in Fig. 2(B). The power control signal PWPS is supplied to power on/off terminals, such as power save terminals, of the signal amplifier 21, the filter 23, the signal processing circuit 25, and the servo analog information processing circuit 33, thus achieving the power save control.

Fig. 5 is a flowchart illustrating an autoskipping operation in which the 1-sector skip or n-sector skip is automatically selected in accordance with the duration of the idle state. Here, n is an integer equal to or greater than two, which represents the number of sectors to be skipped. For example, when n=2, the servo information is read every three sectors to be used for position control.

At step SP11 of Fig. 5, a user enters an autoskipping command from the keyboard 55. The microcode 37 enters into a wait state until the MPU 35 terminates the command execution from step SP12 to SP13. When the command execution has been completed, the microcode 37 decides whether the next command comes or not, and returns to step SP12 when the next command comes. Thus, the autoskipping operation is not carried out while commands continually come.

On the other hand, when the next command does not come, the autoskipping operation is started. In this case, the microcode 37 starts time count by clearing a timer at step SP15. This is performed so as to take timing Tn to start the n-sector skip. Subsequently, at step SP16, an autoskip is tested whether it is ON or OFF. If it is ON, n-sector skip is started at step SP18 after the time Tn has elapsed.

When the autoskip is not ON at step SP16, or when the time Tn has not yet elapsed at step SP17, the 1-sector skip is started at step SP19. Subsequently, the microcode 37 decides whether the next command comes or not at step SP20, and carries out n-sector skip or 1-sector skip until the next command comes. After detecting the next command at step SP20, the microcode 37 turns off the skipping servo control at step SP21, and returns to step SP12. Thus, the 1-sector skip or n-sector skip is automatically selected and executed in accordance with the elapsed time until the next command comes so that more effective power save control is achieved.

The sector skipping control is performed by detecting the idle state. In the idle state, the average time Tavr until the head 11 reaches the initial position of a target sector is equal to half the rotating time of the magnetic disk 1: when the number of rotation of a spindle is 3,600 r.p.m., it is expressed by

Tavr = 16.66/2 = 8.33 msec.

In the sector skipping control, write or read becomes possible after five sectors has passed since the write or read command arrived. Accordingly, the time due to this delay is expressed by

Tdly = 0.333 5 = 1.665 msec.

where 0.333 is a time in which one sector passes. The sum of these times becomes about 10 msec.

Since the probability that two commands immediately before and after the idle state access the same track is very small, the seek operation is usually executed before the command immediately after the idle state is performed. In this case, the access time is identical regardless of the presence or absence of the sector skip.

According to the present invention, during the seek operation in which the head moves from one track to another, the servo digital data processing circuit 31 generates the power control signal PWPS as shown in Fig. 2(A), thus saving the power consumption during the seek operation. While the head is moving across the tracks, it is necessary to read only the servo information of each sector of each track, but not necessary to read from or write on the data region 7 of each track. To achieve this, when the current operation is the seek operation, the MPU 35 sends a

signal representing the seek operation to the servo digital data processing circuit 31 via the 16-bit bus. The servo digital data processing circuit 31, in response to that signal, sends the power control signal PWPS as shown in Fig. 2(A) to the signal amplifier 21, the filter 23, the signal processing circuit 25 and the servo analog information processing circuit 33. By this, these circuits are kept ON only while the power control signal PWPS is at the high level, and sends the servo information of each track to the MPU 35. In contrast, while the power control signal PWPS is at the low level, these circuits are kept OFF. In the above-mentioned conventional technique, however, the power control signal PWPS as shown in Fig. 2(A) is used only while the head is held on an identical track, and is not used during the seek operation. This is different from the seek operation of the present invention, which uses the power control signal PWPS during the seek operation.

The present invention applied to a 2.5 inch, 50 sector, 3,600 r.p.m. hard disk unit employing 1-sector skipping control, can reduce the total consumption power by about 20% in comparison with a conventional hard disk unit.

Advantages of the Invention

As described above, the present invention carries out the positioning of the head by using the sector skipping control in the idle state where the head is held on an identical track and no write or read operation is executed. More specifically, in the idle state, the present invention does not use the servo information from all the sector, but selects the servo information from every other sectors or from every three or more sectors so that the head positioning can be performed with only a minimum number of the servo information. The power of electric circuitry of write or read system and the servo system which are not needed in the idle state is interrupted, from the arrival of the selected servo information to the arrival of the next selected servo information, by the power control signal generated in accordance with the timing of the sector. As a result, the consumption power can be reduced by that amount. In addition, the consumption power can be further reduced by the amount needed for computing for position control.

CLAIMS

1. A magnetic disk unit employing a sector servo system which performs positioning of a head in accordance with servo information disposed in each sector, said magnetic disk unit comprising:

position control means for controlling positioning of said head;

first servo information processing means for processing said servo information supplied by said head, extracting a track number from said servo information, and supplying said track number to said position control means;

second servo information processing means for processing said servo information supplied by said head, extracting from said servo information an offset amount from a track center, and supplying said offset amount to said position control means;

data write and read means for supplying a write signal to said head, or for receiving a read signal from said head;

identifying means for identifying a particular operation mode of said magnetic disk unit other than a write or read operation, and generating a signal representing said particular operation mode; and

selection means for controlling, in response to said signal, said first and second servo information processing means so as to selectively supply said servo information to said position control means,

wherein said position control means controls the position of said head on the basis of said servo information selected by said selection means.

2. The magnetic disk unit as claimed in claim 1, wherein said particular operation mode is an idle mode in which writing or reading of data is not executed.

3. The magnetic disk unit as claimed in claim 1 or 2, further comprising means for interrupting an operation of at least a part of said

data write and read means and said second servo information processing means except when said selection means supplies said servo information to said position control means.

4. The magnetic disk unit as claimed in any one of claims 1 - 3, wherein said selection means selects said servo information from every other sector.

5. The magnetic disk unit as claimed in any one of claims 1 - 3, wherein said selection means selects said servo information from every three or more sectors.

6. A method for controlling a magnetic disk unit employing a sector servo system for positioning a head in accordance with servo information disposed in each sector, said method comprising the steps of:

processing said servo information supplied from said head;

identifying a particular operation mode of said magnetic disk unit other than a write or read operation, and generating a signal representing said particular operation mode;

acquiring said servo information selectively in response to said signal; and

controlling positioning of said head on the basis of said servo information selected.

7. The method for controlling a magnetic disk unit as claimed in claim 6, wherein said particular operation mode is an idle mode in which writing or reading of data is not executed.

8. The method for controlling a magnetic disk unit as claimed in claim 6 or 7, further comprising the step of interrupting an operation of at least a part of a circuit needed for writing or reading data and of a circuit needed for reading said servo information except when said servo information is selected.

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9. The method for controlling a magnetic disk unit as claimed in any one of claims 6 to 8, wherein said servo information is selected from every other sectors.

10. The method for controlling a magnetic disk unit as claimed in any one of claims 6 to 8, wherein said servo information is selected from every three or more sectors.