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Hard Disk Drive, Hard-Disk-Drive Optimization Method, Hard-Disk-Drive Manufacturing Method and Program therefor

[Technical Field to which the Invention Pertains]

The present invention relates to a hard disk drive used as a data storage medium, and more particularly to a hard disk drive, an optimization process of which is individually executed at the time of, for example, manufacturing.

[0002]

[Prior Art]

A hard disk drive (HDD) broadly used as a data storage medium for computers, and the like, comprises a magnetic head that reads user data stored in a magnetic disk or writes user data to the magnetic disk. The magnetic head is mounted to an actuator moved by a VCM (Voice Coil Motor). When the magnetic head reads/writes user data, the actuator is driven to move and position the magnetic head at a specific track (destination track). Movement of the magnetic head to a given location is controlled according to servo information stored in the magnetic disk.

[0003]

On a magnetic disk such as a hard disk, a plurality of data tracks are formed in the shape of a concentric circle, and servo tracks where identification data and a burst pattern are stored beforehand are formed in a radial

direction of the magnetic disk. The above-mentioned servo information includes the identification data and the burst pattern. The identification data is information indicating a track address of each data track. On the basis of the identification data read by the read head, a read head and a write head can judge a position of a data track. In addition, the burst pattern is constituted of a plurality of burst pattern lines in which signal-stored areas are arranged at constant intervals in a radial direction of the magnetic disk, and the phases of the signal-stored areas are different from one another. According to a signal (Position Error Signal: PES) that is output from the read head in response to the burst pattern, it is possible to detect deviation, i.e., how much a position of the read head or write head deviates from a target data track.

[0004]

This servo information is written to the magnetic disk in the manufacturing process before shipping the hard disk drive as a product. In order to correctly read or write user data, it is necessary to write reference servo information with accuracy. In recent years, the self servo write (SSW) method performed by a hard disk drive itself is proposed and is also put into practical use (refer to Patent documents 1 and 2).

[0005]

[Patent document 1]

Japanese Patent Laid-open No. 11-45405 (pages 9-10)
[Patent document 2]

Japanese Patent Laid-open No. 2002-8331 (page 3)
[0006]

[Problems to be Solved by the Invention]

Unlike usual electrical machinery and apparatus, a hard disk drive is provided with much know-how such as how to write the servo information. When manufacturing the hard disk drive, a long time is spent in executing an optimization/inspection process of the hard disk drive that has just been assembled. This optimization/inspection process includes, for example, the following processes:

- (1) a writing process of servo information;
- (2) a pretest process to optimize coefficients of various kinds of servo systems and channel systems; and
- (3) a function/reliability verification test process on the basis of a long-run test.

[0007]

However, because each of the processes requires a dedicated inspecting apparatus, an investment in the inspecting apparatuses becomes huge when manufacturing a large amount of hard disk drives. Accordingly, the investment in the inspecting apparatuses increases the cost impact, which exerts a direct influence also on a decision of a scale of production. Moreover, also in a case where the self servo write method as described in the above-

mentioned patent documents 1 and 2 is adopted, the necessity of the inspecting apparatuses arises in like manner.

[0008]

The present invention has been made to solve the technical problems as described above, and an object of the present invention is to enable optimization/inspection of a new hard disk drive by use of a hard disk drive that has already been optimized/inspected.

Another object of the present invention is to achieve the optimization of a hard disk drive even if there is no expensive inspecting apparatus.

Still another object of the present invention is to minimize a new investment in mass production manufacturing facility for hard disk drives so as to reduce the running cost at the time of the mass production.

A further object of the present invention is to regenerate a hard disk drive regardless of where it is.

[0009]

[Means for Solving the Problems]

For the purpose of achieving the objects, the present invention makes it possible to clone or reproduce a hard disk drive by incorporating DNA used for reproduction into each hard disk drive, and then by performing optimization and/or inspection by a new hard disk drive (baby hard disk drive) itself according to information

supplied by a finished hard disk drive (parent hard disk drive).

According to one aspect of the present invention, there is provided a hard disk drive comprising:

recognizing means for recognizing that the hard disk drive is a baby hard disk drive in which an optimization/inspection process has not yet been completed;

command transmitting means, based on the recognition of the recognizing means, for transmitting a command requesting a growth program to a parent hard disk drive;

growth-program receiving means, based on the recognition of the recognizing means, for receiving from the connected parent hard disk drive as a result of the request command transmitted by the command transmitting means the growth program required to perform the optimization/inspection process by the baby hard disk drive itself; and

execution means, based on the growth program received by this growth-program receiving means, for executing the own optimization/inspection process, and thereby allowing the baby hard disk drive to grow up into a parent hard disk drive.

[0010]

Here, the hard disk drive may characteristically further comprise a storing means for storing in a memory (on a hard disk, or the like) the growth program executed

by this execution means. In this case, when a new baby hard disk drive in which an optimization/inspection process has not yet been completed is connected thereafter to the hard disk drive comprising the storing means, this hard disk drive as a parent hard disk drive can preferably supply the baby hard disk drive with the growth program stored in the storing means. In addition, the parent hard disk drive may characteristically execute part of the optimization/inspection process to be executed by the execution means. In this case, the execution means can excellently reduce the amount of processing of the optimization/inspection process to be executed by the baby hard disk drive itself with the support of the MPU included in the parent hard disk drive. It should be noted that the above-mentioned term "connected" includes a state in which irrespective of a wired connection or a radio connection, some communication such as an exchange of a command can be executed.

[0011]

According to another aspect of the present invention, there is provided a hard disk drive comprising:

a ROM for storing a basic program that receives a growth program for performing self-optimization; and

a MPU that receives the growth program according to the basic program stored in the ROM, and that performs the self-optimization by the received growth program.

Here, the basic program stored in the ROM includes a function of checking whether or not information specific to the hard disk drive is stored in a predetermined memory, or whether or not servo information is written to the disk, and of thereby recognizing a state in which optimization of the hard disk drive itself has not yet been performed. In addition, the MPU recognized its own state according to this basic program.

[0012]

Additionally, the basic program stored in this ROM includes a function of transmitting a command requesting a growth program to a parent hard disk drive to be connected. Moreover, after the optimization processing ends, the MPU stores the growth program in a predetermined memory area, for instance, on the magnetic disk, or the like.

[0013]

According to still another aspect of the present invention, from the viewpoint of the parent hard disk drive, there is provided a hard disk drive comprising:

connection means that is adapted to be connected to an unfinished hard disk drive (baby hard disk drive) where servo information is not written to a disk;

storing means for storing a program by which this unfinished hard disk drive writes by itself servo information to its own disk;

receiving means for receiving a request command for

the program from the unfinished hard disk drive; and
supplying means, according to the request command received by the receiving means, for supplying the program stored in the storing means to the unfinished hard disk drive.

The hard disk drive is characterized in that this program includes a function of executing optimization/inspection processing, and that the parent hard disk drive further comprises an execution means for executing part of the optimization/inspection processing of the unfinished hard disk drive.

[0014]

According to further aspect of the present invention, there is provided a hard-disk-drive optimization method whereby using a first hard disk drive (parent hard disk drive) where optimization processing has already been completed, the optimization processing is executed for a second hard disk drive (baby hard disk drive) where the optimization processing has not yet been completed, the hard-disk-drive optimization method comprising the steps of:

recognizing by the second hard disk drive itself that the second hard disk drive is a hard disk drive in which the optimization processing has not yet been completed;

issuing, based on the recognition, to the first hard

disk drive a command for requesting information used for optimization;

supplying the information used for optimization, which is included in the first hard disk drive, from the first hard disk drive to the second hard disk drive;

executing, based on the supplied information used for optimization, various kinds of processes by the second hard disk drive itself so that the second hard disk drive grows up into an optimized hard disk drive; and

after the second hard disk drive completes the optimization processing, supplying the information used for optimization from the second hard disk drive to a third hard disk drive in which the optimization processing has not yet been completed.

In this connection, the above-mentioned "completion of the optimization processing" does not merely indicate that the optimization processing is completely completed. As long as the second hard disk drive is in a state of being able to supply the information used for optimization to the third hard disk drive that is a new baby hard disk drive, there is no problem.

[0015]

Here, the hard-disk-drive optimization method is characterized in that the information used for optimization, which is supplied from the first hard disk drive, includes a growth program by which the second hard disk drive

executes various kinds of optimization processes by itself. In addition, this information includes a test code possessed by the first hard disk drive.

Moreover, the hard-disk-drive optimization method is characterized in that the first hard disk drive executes by itself part of the optimization processing which the second hard disk drive should execute by itself.

[0016]

According to still a further aspect of the present invention, there is provided a hard-disk-drive manufacturing method for manufacturing a second hard disk drive by use of a first hard disk drive which has already been manufactured, the hard-disk-drive manufacturing method comprising the processes of:

making a connection between the first hard disk drive and the second hard disk drive;

supplying information, by which the second hard disk drive writes servo information to a disk of the second hard disk, from the first hard disk drive to the second hard disk drive;

according to the supplied information, writing servo information to the disk by the second hard disk drive itself;

supplying information, by which the second hard disk drive performs inspection by itself, from the first hard disk drive to the second hard disk drive; and

according to the supplied information, performing inspection on the second hard disk drive by itself.

[0017]

In addition, the present invention can be treated as a program executed by a computer (MPU) that is built into a hard disk drive.

In this case, this program allows the computer to implement the functions of:

recognizing by a baby hard disk drive itself that the baby hard disk drive is a hard disk drive in which an optimization/inspection process has not yet been completed;

requesting, based on this recognition, another hard disk drive (parent hard disk drive) to transmit to the baby hard disk drive a growth program that is required for performing the optimization/inspection process on the baby hard disk drive by itself; and

receiving, based on this request, a growth program supplied from the another hard disk drive.

[0018]

Here, in the function of recognizing by a hard disk drive itself that an optimization/inspection process to be performed on the hard disk drive has not yet been completed, such recognition can be made by, for instance, checking whether or not information specific to the hard disk drive is stored, or checking whether or not servo information is written to a disk.

[0019]

According to yet another aspect of the present invention, there is provided a program allowing a computer built into a parent hard disk drive to implement the functions of:

receiving, from another hard disk drive (baby hard disk drive) where an optimization/inspection process has not yet been completed, a request for a growth program by which the another hard disk drive executes the optimization/inspection process by itself;

reading out the growth program stored in a memory;
and

supplying the another hard disk drive with the read growth program.

Additionally, if part of the optimization/inspection process of the another hard disk drive is executed, it is possible to further implement a function of reducing the amount of processing in the another hard disk drive.

[0020]

On the other hand, a program according to the present invention allows a computer built into a hard disk drive to implement the functions of:

writing servo information to its own disk by use of information exported from another hard disk drive; and

executing by itself an inspection process by use of the information exported from the another hard disk drive.

[0021]

It should be noted that other than the case where the programs are provided in a state in which they are stored beforehand in a ROM, or the like, a mode in which the program is provided from outside through a given storage medium or network can also be considered.

[0022]

[Mode for Carrying out the Invention]

A preferred embodiment to which the present invention is applied will hereinafter be described in detail with reference to the accompanying drawings.

Fig. 1 is a block diagram illustrating a main configuration of a hard disk drive (HDD) 10 to which this embodiment is applied. The hard disk drive 10 comprises the following: a magnetic disk 11 that is a storage medium for storing data; a spindle motor 12 for rotating the magnetic disk 11; a magnetic head 13 for reading/writing data from/to the magnetic disk 11; an actuator 14 that is a driving mechanism of the magnetic head 13; and a voice coil motor (VCM) 15 for generating driving force that moves the magnetic head 13 to a given location by the actuator 14.

[0023]

The hard disk drive 10 is a data storing and reproducing unit in which the magnetic head 13 performs a seek operation on the magnetic disk 11 rotated and driven by the spindle motor 12, and in which the magnetic head 13

remains at a given track (location) to write data to the magnetic disk 11 or to read data written to the magnetic disk 11. While one or more magnetic disks 11 are placed as the need arises, one magnetic disk 11 is provided as illustrated in Fig. 1 by way of example. When the hard disk drive 10 is operating, the magnetic disk 11 is driven to rotate around the spindle shaft of the spindle motor 12. On the other hand, when the hard disk drive 10 is not operating, the magnetic disk 11 stops rotating (at rest). Two magnetic heads 13 are held at the front end of the actuator 14 and act respectively on the top and bottom surfaces of the magnetic disk 11. The two magnetic heads 13 write/read data to/from the magnetic disk 11.

[0024]

The hard disk drive 10 comprises, as a control portion, a voice coil motor (VCM) driver 16, a digital-to-analog converter (DAC) 17, a read/write channel 18, and a hard disk controller (HDC) 19. The voice coil motor (VCM) driver 16 drives the voice coil motor (VCM) 15. The digital-to-analog converter (DAC) 17 controls a driving electric current of the voice coil motor (VCM) 15 and performs its feed forward control. The read/write channel 18 performs code modulation of data to be written and then outputs the data to a head amplifier, and detects data from an output signal of the head amplifier and then performs code demodulation. The hard disk controller (HDC) 19

functions as an interface of the hard disk drive 10.

[0025]

Moreover, the hard disk drive 10 further comprises, as the control portion, a MPU (Micro Processing Unit) 20, a ROM 21, an EEPROM (Electrically Erasable and Programmable ROM) 22, and a DRAM (Dynamic RAM) 23. The MPU (Micro Processing Unit) 20 performs the total control of the hard disk drive 10, including positioning control of the magnetic head 13, interface control, initialization and settings of each peripheral LSI, and defect control. The ROM 21 stores ROM codes as a basic program for executing basic functions of the hard disk drive 10. The EEPROM (Electrically Erasable and Programmable ROM) 22 is a memory where data can be rewritten or erased afterward by electrical operation, and stores parameters specific to the hard disk drive 10. The DRAM (Dynamic RAM) 23 temporarily stores a program to be executed by the MPU 20, the result of operation, and the like. Incidentally, when assembly of mechanical parts has just been completed, a program is not stored in this EEPROM 22. After the hard disk drive grows up by cloning itself and consequently an optimization/inspection process ends, parameters specific to the disk are stored in the EEPROM 22.

[0026]

The actuator 14 is driven by the voice coil motor (VCM) 15 that is controlled by the MPU 20 through the

digital-to-analog converter (DAC) 17 and the voice coil motor (VCM) driver 16. At the time of data writing, to begin with, the read/write channel 18, which performs data reading and writing operations, converts data to be written, which is transmitted from a host computer through the HDC 19, into a writing signal (electric current), and then supplies the writing signal to the magnetic head 13. According to the writing electric current, the magnetic head 13 writes the data to the magnetic disk 11. On the other hand, at the time of data reading, the read/write channel 18 converts a reading signal (electric current) read from the magnetic disk 11 into digital data, and then outputs the digital data to the host computer through the HDC 19.

[0027]

As described above, the HDC 19 has functions as an interface of the hard disk drive 10. One of the functions is to receive the data to be written, transmitted from the host computer, and also transmit the data to the read/write channel 18. In addition, another is to transmit the read data, which is transmitted from the read/write channel 18, to the host computer. Further, the HDC 19 has a function of transmitting the data to the MPU 20 in response to an instruction command from the host computer. Here, in this embodiment, as a substitute for this host computer, if the hard disk drive 10 itself is a baby HDD, a parent HDD is

connected to the hard disk drive 10 as another hard disk drive 10, and if the hard disk drive 10 itself is a parent HDD, a baby HDD is connected as another hard disk drive 10. Between the hard disk drives 10, for example, a command is exchanged, and a growth program is sent and received. To be more specific, besides the function of sending back of data and receiving of data upon receipt of a read/write command, which was conventionally implemented, the hard disk drive 10 has a function of communicating with the other hard disk drive 10 connected.

[0028]

The ROM 21 previously stores a program for executing basic functions. The basic functions include:

- (1) a function of judging that the hard disk drive itself is a baby;
- (2) a function of being able to transmit (send) a command; and
- (3) a function of being able to receive a program.

In this case, the "baby" indicates a state in which a HDD is only mechanically assembled into a unit. In other words, it indicates a clean HDD before testing, in which know-how required as a HDD is not yet provided. To be more specific, the baby indicates a state in which a process of optimization/inspection is not completed; that is to say, a verification test of function/reliability is not performed. Here, the verification test of function/reliability is

based on a pretest and a long-run test in which servo information is written and coefficients of various kinds of servo systems and channel systems are optimized. It should be noted that the "optimization/inspection" means "optimization and/or inspection".

[0029]

Fig. 2 is a diagram illustrating the optimization/inspection process of the hard disk drive 10. The optimization on the basis of device-specific information is first performed on the hard disk drive 10 that has been mechanically assembled, and then the inspection is performed before the manufacturing of the hard disk drive 10 as a product is completed. Accordingly, the undermentioned processing can be considered as a manufacturing method of the hard disk drive 10. Fig. 2 illustrates a state in which a bus connection is made between a parent HDD 51 which is a first hard disk drive 10 and a baby HDD 52 which is a second hard disk drive 10 by use of a cable 53.

A configuration by means of a radio connection, instead of using the cable 53, is also possible. Incidentally, once the baby HDD 52 which is the second hard disk drive 10 grows up, the baby HDD 52 as a parent supplies information to a third hard disk drive 10 which is a baby.

[0030]

The baby HDD 52 is a HDD that is only assembled as described above. If the baby HDD 52 is expressed in other words, it is an unfinished hard disk drive. On the other hand, the parent HDD 51 is a grown-up hard disk drive 10 where its own optimization/inspection process is already completed and thereby much know-how is already provided. Thus, if the parent HDD 51 is expressed in other words, it is a finished hard disk drive. However, it is not always required that the optimization/inspection process be completely finished. The parent HDD 51 have only to grow up to such an extent that it can transmit a growth program to the baby HDD 52 to help cloning. This parent HDD 51 stores some parameters unique to itself in the EEPROM 22 shown in Fig. 1. The parameters includes, for instance, track density (tpi, track per inch), and write current and bias current which are matched with properties of a head and a disk. Further, the magnetic disk 11 stores in a given area a growth program by which the baby HDD 52 performs the optimization/inspection process by itself using microcodes and other codes.

[0031]

In this embodiment, a new proposal is given to the concepts of development, manufacture, and application of the hard disk drive 10.

This new proposal realizes the following functions:
 (1) the HDD (parent HDD 51) itself extracts an electrical

design drawing including both its own hardware and software;

(2) the HDD (parent HDD 51) then exports the design drawing to another HDD (baby HDD 52); and

(3) the HDD (baby HDD 52) to which the design drawing is exported makes itself according to the design drawing.

This means, what is called in the biological world, DNA transplantation. Furthermore, it means cloning of a HDD, that is to say, reproduction (organic birth) of a HDD.
[0032]

As described above, there are, for example, the following specific examples of the optimization/inspection process:

- (1) a writing process of servo information;
- (2) a pretest process in which coefficients of various kinds of servo systems and channel systems are optimized; and
- (3) a function/reliability verification test process on the basis of a long-run test.

Each of the processes is executed according to information (code information, etc.) imported from the parent HDD 51.

[0033]

Next, a HDD reproduction method (optimization method) to which this embodiment is applied will be described.

Fig. 3 is a flowchart illustrating processing executed in the MPU 20 of the parent HDD 51 that is the first hard disk drive 10. To begin with, a bus connection is made, by use of the cable 53, between the parent HDD 51 and the baby HDD 52 that is the second hard disk drive 10. Then, in the parent HDD 51, the processing is started by switching the power supply on. The parent HDD 51 is first subjected to usual start-up processing (step 101) and waits for a command from the baby HDD 52 (step 102). Upon receipt of a growth-program request command received from the baby HDD 52 connected to the parent HDD 51 (step 103), the parent HDD 51 calls a growth program from the magnetic disk 11, and then transmits (supplies) the growth program to the baby HDD 52 through an I/O bus of the cable 53 (step 104). Subsequently, as the need arises, the MPU 20 executes part of function optimization processing and/or functional verification processing in the baby HDD 52 (step 105). After that, usual processing is executed (step 106), and then the processing ends. Incidentally, the processing performed in parallel by the parent HDD 51 and the baby HDD 52 in the step 105 will be described in detail later.

[0034]

Fig. 4 is a flowchart illustrating processing executed in the MPU 20 of the baby HDD 52 that is the second hard disk drive 10. In the first place, the baby HDD 52 judges whether or not this HDD itself is a baby HDD

that has just been mechanically assembled, and whether or not this HDD itself is a clean HDD (step 201). Although the judgments can be made by several methods, they are basically made by checking whether or not the baby HDD 52 has information to be included in a grown-up HDD. This checking function is executed by reading ROM codes from the ROM 21 where basic functions of the hard disk drive 10 are stored.

[0035]

A first method of judgment made in this step 201 could conceivably check whether or not the EEPROM 22 which stores device-specific information is empty (all 0). If the EEPROM 22 is judged to be empty (null), this HDD can be recognized as a baby. Once the HDD grows up, several parameters unique to each drive are already stored in the EEPROM 22, which will therefore never result in misjudgment as to whether the HDD is a baby or not. In addition, a second method could conceivably check whether or not servo information is written on a surface of the magnetic disk 11. If it can be judged that no servo information is written, this HDD can be recognized as a baby. Once the HDD grows up, servo information is already written to the magnetic disk 11. Therefore, if this is checked, misjudgment as to whether or not the HDD is a baby will never occur.

[0036]

In this manner, if it is recognized that the HDD is

not a baby in step 201, usual start up is executed (step 207), and subsequently usual processing is executed (step 208) before the processing ends. If it is recognized that the HDD is a baby in step 201, a request command which requests a growth program for cloning is transmitted to the parent HDD 51 (step 202). The request command is a special command that the parent HDD 51 can identify. As described above, the baby HDD 52 is required to have beforehand a function of issuing a command. It is desirable that this interface logic be given to the baby HDD 52 on the sending side instead of the parent HDD 51 on the receiving side.

[0037]

Next, the baby HDD 52 receives the growth program through the I/O bus (cable 53) (step 203). This growth program is transferred from the parent HDD 51 to the baby HDD 52 as if DNA were inherited. The received growth program is temporarily stored in the DRAM 23 of the baby HDD 52 that is the second hard disk drive 10. After that, the MPU 20 reads the growth program stored in the DRAM 23, and then executes the program (step 204). To be more specific, through the execution of the growth program, the baby HDD 52 grows up successively. This growth program has several stages. Various kinds of programs, microcodes, and various kinds of commands are sent out from the parent HDD 51 at any time. Upon end of predetermined steps, the baby HDD 52 receives the next program. This is similar to a

case in which a man or a woman raises a learning level from a baby to an adult stepwise.

As a matter of course, it is also possible to configure the baby HDD 52 in such a manner as to receive all growth programs from the beginning.

[0038]

The execution of the growth programs is completed in this manner, and thus all of the processes including export, optimization, test, and inspection are achieved, ending the cloning (step 205). At this time, in preparation for becoming a parent in future to export function information to the next baby (third hard disk drive 10), for instance, the baby HDD 52 stores the growth program in an area (reserved area of a disk) specially reserved in the magnetic disk 11 (step 206) before the series of processing for growth ends. In this area, microcodes used to maintain performance of the HDD, and the like, are also stored. The above describes the case where the growth program is stored in a specific area of the magnetic disk 11 that is a memory. However, if a sufficient memory area is ensured in storing the program, it is also possible to store the growth program in a different memory such as the EEPROM 22.

[0039]

Next, the execution of the growth program described in step 204 will be detailed. The growth program is constituted of several subprograms, and these subprograms

have the following functions:

- (1) recognition of the HDD itself;
- (2) optimization of parameters; and
- (3) verification of performance/reliability.

Education corresponding to each of the functions is executed stepwise.

[0040]

To begin with, in the subprogram for recognizing the HDD itself shown in item (1), a model of the baby HDD 52 is recognized from among some models. For example, by checking a pre-amplifier signal, the following contents are recognized: the number of the magnetic heads 13; the number of disks; and the like. Judging from individual differences in mechanical and physical properties, such as properties of the magnetic head 13 and the magnetic disk 11, properties of itself are recognized.

[0041]

A program required to write servo information is output from the parent HDD 51, and the same microcodes (including test codes) as those possessed by the parent HDD 51 are exported. In the subprogram for optimizing parameters, shown in (2), both writing of servo information and magnetic recording are executed. In accordance with the properties of mechanical parts such as the magnetic head 13 and the magnetic disk 11, various kinds of parameters are determined.

[0042]

Subsequently, a program for verifying performance and reliability in the baby HDD 52 and various kinds of command groups are sent from the parent HDD 51 at any time, and then the verification of performance/reliability shown in item (3) is executed. As a result, the inspection process of performance/reliability is totally achieved. Incidentally, if the parameters to be verified do not reach designed values expected at the beginning, resulting in unexpectedly poor performance, it is also possible to decrease the performance to some degree by reviewing the designed values. For example, when a capacity of 40 GHz is required as a designed value, if only a capacity of 30 GHz is obtained because of the performance of the magnetic head 13, or the like, the design and the test are performed again with the capacity of 30 GHz. In this manner, according to this embodiment, because the optimization/inspection process is totally started from a baby state, it is possible to easily perform the redesign and the retest in accordance with the performance of the own HDD.

[0043]

Next, the processing described in step 105 of Fig. 3 will be described in detail in which the parent HDD 51 executes part of the function optimization processing and/or the function verification processing in the baby HDD

52.

As described above, the MPU 20 of the baby HDD 52 performs operation during the cloning. However, even if the function of the MPU 20 is improved, performing the processing only by the MPU 20 of the baby HDD 52 will lead to an increased load of the MPU 20. If a reduction in load of the MPU 20 in the baby HDD 52 is tried for this reason, a range of the operation is limited, leading to insufficient optimization. As a result, properties and reliability of the finished hard disk drive 10 become poor. In addition, to make up for this, if the hard disk drive 10 which is the baby HDD 52 is equipped with a powerful MPU 20, an increase in cost cannot be avoided. It is not desirable to incur a heavy expenditure for the purpose of the functional enhancement that is not directly related to the use of a customer. For this reason, in this embodiment, this problem is solved by performing parallel processing between the baby HDD 52 and the parent HDD 51 in such a manner that the parent HDD 51 helps the baby HDD 52 perform the growth processing.

[0044]

More specifically, in this embodiment, the "function optimization program" and the "functional verification program" possessed by the parent HDD 51 is exported to the clean baby HDD 52 which has just been assembled. Then, operation is performed in the baby HDD 52 according to the

programs. At the same time, some batch processing parts among the operation groups are passed to the parent HDD 51 where the MPU 20 of the parent HDD 51 performs the batch processing. This enables improvement in performance of operation. For example, a function of FFT (Fast Fourier Transform) usually performed to optimize the function of the baby HDD 52, and the like, can usually be handled by batch processing. Accordingly, it is desirable that the parent HDD takes charge of the functions.

[0045]

It should be noted that if this way of thinking is extended, cloning processing for the hard disk drive 10 as the next baby of the baby HDD 52 can be started before a test for cloning processing of the baby HDD 52 itself ends. To be more specific, because the respective cloning tests for a parent and a baby can be performed in parallel, this can also be applied to applications improving productivity to a large extent.

[0046]

Thus, in this embodiment, the know-how possessed by the parent HDD 51 is exported to the baby HDD 52 connected to the parent HDD 51, and thus the baby HDD 52 can execute by itself the optimization/inspection process, such as writing of servo information so as to grow up. In the above-mentioned description, mainly the case where the baby HDD 52 is manufactured is taken as the example. However,

if such an idea is further extended, for instance, the following mode can also be conceived: after the parent HDD 51 is installed at a customer's site, the know-how is exported at the customer's site, and then instead of using the parent HDD 51, the baby HDD 52 is used as the hard disk drive 10 of the customer. Moreover, for example, the following mode can also be employed: if the hard disk drive 10 is connected to a PC (personal computer), the baby HDD 52 is directly connected to the PC, and then using a communication function of the PC, know-how is imported, and a growth program is received from a connected-to server of a network such as the Internet.

[0047]

[Effects of the Invention]

As described above, according to the present invention, on the basis of information obtained from a hard disk drive whose optimization/inspection has already been performed, a new hard disk drive can perform the optimization/inspection by itself.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a block diagram illustrating a main configuration of a hard disk drive (HDD) to which an embodiment is applied.

[Fig. 2]

Fig. 2 is a diagram illustrating an

optimization/inspection process of the hard disk drive.

[Fig. 3]

Fig. 3 is a flowchart illustrating processing executed by a MPU of a parent HDD that is a first hard disk drive.

[Fig. 4]

Fig. 4 is a flowchart illustrating processing executed by a MPU of a baby HDD that is a second hard disk drive.

[Explanation of Reference Numerals]

10 ... Hard disk drive (HDD), 11 ... Magnetic disk, 12 ... Spindle motor, 13 ... Magnetic head, 14 ... Actuator, 15 ... Voice coil motor (VCM), 16 ... Voice coil motor (VCM) driver, 17 ... Digital-to-analog converter (DAC), 18 ... Read/write channel, 19 ... Hard disk controller (HDC), 20 ... MPU, 21 ... ROM, 22 ... EEPROM, 23 ... DRAM, 51 ... Parent HDD, 52 ... Baby HDD, 53 ... Cable

Fig. 1

16 VCM driver

12 Spindle motor

18 Read/write channel

To another HDD or a host computer

Fig. 2

51 Parent HDD

52 Baby HDD

53 Cable

Fig. 3

Power on

S101 Start up

S102 Wait for a command.

S103 Receive a request command for a growth program.

S104 Transmit the growth program.

S105 Execute part of function optimization/function
verification processing of the baby HDD.

S106 Execute usual processing.

End

Fig. 4

S201 Is a HDD recognized as a baby HDD?

S202 Transmit a command requesting a growth program for
executing cloning processing.

S203 Receive the growth program.

S204 Execute the growth program.

S205 Finish the growth program to complete the cloning processing.

S206 Store the growth program in preparation for the next cloning.

End

S207 Usual start up

S208 Usual processing

End

Claims.**1. A hard disk drive comprising:**

recognizing means used for recognizing that an optimization/inspection process to be performed on the hard disk device has not yet been completed;

growth-program receiving means, based on the recognition of the recognizing means, for receiving from a parent hard disk drive connected to the hard disk drive a growth program necessary for performing the optimization/inspection process on the hard disk drive itself; and

execution means, based on the growth program received by the growth-program receiving means, for executing the optimization/inspection process on the hard disk drive itself.

2. A hard disk drive according to claim 1, further comprising command transmitting means, based on the recognition of the recognizing means, for transmitting a command requesting the growth program to the parent hard disk drive.

3. A hard disk drive according to claim 1, further comprising storing means for storing in a memory the growth program executed by the execution means;

wherein, if the hard disk drive is thereafter connected to another hard disk drive in which the optimization/inspection process has not yet been completed, the growth program stored in the storing means is supplied to the another hard disk drive.

4. A hard disk drive according to claim 1, wherein:
the parent hard disk drive takes charge of a predetermined part of the optimization/inspection process to be executed by the execution means.

5. A hard disk drive comprising:
a ROM for storing a basic program that receives a growth program for performing self-optimization; and
a MPU for receiving the growth program according to the basic program stored in the ROM, and performing the self-optimization by the received growth program.

6. A hard disk drive according to claim 5, wherein:
the basic program stored in the ROM includes a function of recognizing that the hard disk drive is in a state in which the self-optimization has not yet been

performed; and

the MPU recognizes its own state according to the basic program.

7. A hard disk drive according to claim 5, wherein:
the basic program stored in the ROM includes a function of transmitting a command requesting the growth program to a parent hard disk drive to be connected.

8. A hard disk drive according to claim 5, wherein:
after the optimization ends, the MPU stores the growth program in a predetermined memory.

9. A hard disk drive comprising:
connection means adapted to be connected to an unfinished hard disk drive where servo information is not written to a disk;

storing means for storing a program by which the unfinished hard disk drive writes servo information to the disk; and

supplying means for supplying the unfinished hard disk drive with the program stored in the storing means.

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

receiving means for receiving a request command for

the program from the unfinished hard disk drive;

wherein the supplying means supplies the program on the basis of the request command received by the receiving means.

11. A hard disk drive according to claim 9, wherein:
said program includes a function of executing optimization/inspection processing, and the hard disk drive further includes execution means for executing part of the optimization/inspection processing on the unfinished hard disk drive.

12. A hard-disk-drive optimization method, using a first hard disk drive where optimization processing has already been completed, for executing the optimization processing on a second hard disk drive where the optimization processing has not yet been completed, said method comprising the steps of:

supplying information used for optimization, which is included in the first hard disk drive, from the first hard disk drive to the second hard disk drive; and

allowing, according to the supplied information used for optimization, the second hard disk drive to execute various kinds of processes so as to grow up into an optimized hard disk drive.

13. A hard-disk-drive optimization method according to claim 12, further comprising the steps of:

recognizing by the second hard disk drive itself that the optimization processing to be performed on the second hard disk drive has not yet been completed; and

issuing, according to the recognition, a command requesting the information used for optimization to the first hard disk drive.

14. A hard-disk-drive optimization method according to claim 12, further comprising the step of:

after the second hard disk drive has completed the optimization processing, supplying the information used for optimization from the second hard disk drive to a third hard disk drive in which the optimization processing has not yet been completed.

15. A hard-disk-drive optimization method according to claim 12, wherein:

the information used for optimization, which is supplied from the first hard disk drive, includes a growth program by which the second hard disk drive executes various kinds of optimization processes.

16. A hard-disk-drive optimization method according to claim 15, wherein:

the information used for optimization, which is supplied from the first hard disk drive, includes a test code possessed by the first hard disk drive.

17. A hard-disk-drive optimization method according to claim 12, wherein:

the first hard disk drive executes part of the optimization processing to be executed by the second hard disk drive.

18. A hard-disk-drive manufacturing method for manufacturing a second hard disk drive by use of a first hard disk drive which has already been manufactured, said method comprising the steps of:

making a connection between the first hard disk drive and the second hard disk drive;

supplying information, by which the second hard disk drive writes servo information to a disk of the second hard disk itself, from the first hard disk drive to the second hard disk drive; and

according to the supplied information, writing the servo information to the disk by the second hard disk drive itself.

19. A hard-disk-drive manufacturing method according to claim 18, further comprising the steps of:

supplying information, by which the second hard disk drive performs inspection on the second hard disk itself, from the first hard disk drive to the second hard disk drive; and

according to the supplied information, performing the inspection on the second hard disk drive by itself.

20. A program allowing a computer built into a hard disk drive to implement the functions of:

recognizing that an optimization/inspection process to be performed on the hard disk drive has not yet been completed;

requesting, based on the recognition, another hard disk drive to supply a growth program that is required to perform the optimization/inspection process by the hard disk drive itself; and

receiving, based on the request, the growth program supplied from said another hard disk drive.

21. A program according to claim 20, wherein:

the recognizing function recognizes that the optimization/inspection process to be performed on the hard disk device has not yet been completed, by checking whether or not information specific to the hard disk drive is stored, or by checking whether or not servo information is written to a disk of the hard disk device.

22. A program allowing a computer built into a hard disk drive to implement the functions of:

receiving, from another hard disk drive in which a optimization/inspection process has not yet been completed, a request for a growth program by which the another hard disk drive executes the optimization/inspection process by itself;

reading out the growth program stored in a memory;
and

supplying the another hard disk drive with the read growth program.

23. A program according to claim 22, further implementing the function of:

executing a part of the optimization/inspection process of the another hard disk drive.

24. A program allowing a computer built into a hard disk drive to implement the functions of:

writing servo information to a disk of the hard disk drive by use of information exported from another hard disk drive; and

executing an inspection process on the hard disk drive by use of the information exported from the another hard disk drive.