

DESCRIPTION

INFORMATION PROCESSING DEVICE

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to an information processing device.

BACKGROUND ART

[0002] Conventionally, in a hard disk drive, when there is an area where it is difficult to read data, adjustments, such as adjusting the start timing of the read processing and adjusting the bias current of the magnetic head, are performed and data reading is performed while making multiple retries. When data reading is successful, an alternate sector is formed in an unused area and the data is written on there to avoid loss of data. In addition, technology has also been developed to avoid the loss of data by predicting breakdowns in the hard disk drive and performing automatic mirroring of data.

CITATION LIST

Patent Literature

[0003] Patent Document 1: Japanese Patent Application Laid-open No. 2017-37626

Patent Document 2: Japanese Patent Application Laid-open No. 2000-20248

SUMMARY OF INVENTION

Problem to be Solved by Invention

[0004] However, in a case that a hard-to-read data area arises by peeling of magnetic material or foreign matter adhering on a platter in a hard disk drive, the damage may widely spread when operation is continued in a state where it is difficult to normally read data. An increase in the number of the alternate sectors due to continuation of operation may cause an excess of the allowable capacity of the alternate area and, in

some cases, cause a delay of the processing operation, frequent occurrence of errors, operation freeze, abnormal noise, and the like. Generally, no method is usually employed from the very start to utilize the total capacity of the hard disk drive, and the hard disk drive is instead utilized with unused areas still remaining in operation that gradually uses up the unused areas. Whereupon, if it is possible to provide an information processing device that is capable of managing data by using unused areas on the hard disk drive, it is possible to effectively avoid the loss of data, to prevent the wide spread of damage, and to usefully improve reliability of the hard disk drive.

Means for Solving Problem

[0005] An information processing device includes, for example, an area assignment unit, an information acquisition unit, a copy processing unit, and an output unit. The area assignment unit is configured to: execute read and write processing of data on a first area being a part of a total area; form an alternate sector for transferring the data to an unused area in the first area when the read and write processing of data in the first area fails; and assign at least one auxiliary area, which corresponds to capacity of the first area, for a second area being an unused area other than the first area, the assignment being performed on a hard disk drive that performs the read and write processing of data on the alternate sector. The information acquisition unit is configured to acquire history information in which a number of the alternate sectors formed in the first area is recorded. The copy processing unit is configured to cause the hard disk drive to: copy data in the first area onto any one of the auxiliary areas, which is unused, when an increase in the alternate sectors due to the read and write processing is equal to or larger than a predetermined threshold; and execute the read and write processing on the auxiliary area as the first area where the copying has been completed. The output unit is configured to output utilization information representing a usage status of the auxiliary area.

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is an explanatory drawing illustratively and schematically illustrating a hard disk drive and a platter included in the hard disk drive to which an information processing device according to an embodiment is applicable;

FIG. 2 is a block diagram illustratively and schematically illustrating in detail a structure of the information processing device according to the embodiment;

FIG. 3 is an illustrative flowchart for explaining a processing procedure when assigning an auxiliary area in the information processing device according to the embodiment;

FIG. 4 is an illustrative flowchart for explaining a processing procedure including warning processing in the information processing device according to the embodiment;

FIG. 5 is an illustrative flowchart for explaining in detail area switching processing in the flowchart of FIG. 4; and

FIG. 6 is an illustrative flowchart for explaining in detail another case of area switching processing in the flowchart of FIG. 4.

DESCRIPTION OF EMBODIMENTS

[0007] Exemplary embodiments will be described with reference to the accompanying drawings. The structure according to an embodiment described below, and functions and results (advantageous effects) brought about by the applicable structure are mere examples and are not limited by the content described below.

[0008] FIG. 1 is an illustrative schematic drawing illustrating a hard disk drive 10 (hereafter, referred to as an HDD 10) and a platter 12 included in the hard disk drive to which an information processing device according to the embodiment is applicable. The platter 12 is a storage medium part that is formed by that, a disk-shaped base material of aluminum alloy, glass, ceramics, or other materials is uniformly coated or vapor-deposited with fine magnetic material on the surface. The platter 12 is clamped

to a rotating shaft (spindle) (not illustrated) by way of a support hole 12a formed in the center of the platter 12. The platter 12 rotates at high speed by the rotational drive of the rotating shaft. The platter 12 is housed together with a swing arm 14 including a magnetic head 14a at the tip, a drive mechanism including the spindle, and other items, in a sealed state within a case 10a of the HDD 10. The magnetic head 14a performs data read and write operation on the platter 12 in a state of floating several nanometers from the platter 12 that is rotating at high speed. In order to increase the storage capacity, the HDD 10 in some cases includes recording layers formed on the top and rear surfaces of the platter 12, and is in some cases formed in a multilayer structure with a plurality of platters 12 arranged by way of gaps in the rotation direction. The magnetic head 14a (swing arm 14) is in this case installed on each recording layer.

[0009] The HDD 10 performs, in the platter 12, data read and write processing onto a first area where accessible data in all storage areas is already recorded. In the HDD 10, when the data reading and writing is repeated during operation, an area where it is difficult to read and write data may arise on the first area. In this case, the HDD 10 adjusts the start timing in the read processing and the bias current of the magnetic head 14a and the like, and performs data reading while making multiple retries. After failing in the read and write processing of data, when a retry results in a success of reading data, the HDD 10 forms an alternate sector for transferring the data to an unused area in the first area. The HDD 10 then avoids losing data by continuing the read and write processing of data onto the alternate sector. However, even in a case of continuing the read and write processing of data after transferring the data to the alternate sector, when the same first area is repeatedly accessed after sustaining damage due to impacts or foreign matters on the platter 12, re-accessing might possibly cause further spread of the damage. Whereupon, the information processing device according to the present embodiment transfers all data to a part of a second area being unused other than the first area (one of the auxiliary areas subdividing the second area), and performs read and write processing on that area serving as the first area. In other words, loss of data and

the spread of damage is avoided by continuing the read and write processing after switching the access area to an area (auxiliary area) having no damage (low probability of damage). In the HDD 10 serving as the processing object for the information processing device according to the present embodiment, a part of an area in the usable total capacity, for example, an area corresponding to a few to a few dozen percent of the total capacity is used as the initial usage area where the application data, the numerical data, and the like are stored. The remaining area can be utilized as an auxiliary area capable of being accessed while avoiding loss of the application data, the numerical data, and the like stored in the first area. However, if the user does not wish to perform an area switching processing to avoid loss of data as described above, the total area can be used as a storage area for storing optional data whenever needed.

[0010] FIG. 2 is a block diagram illustratively and schematically illustrating in detail the structure of an information processing device 16 capable of performing the area switching processing according to the embodiment.

[0011] The information processing device 16 may be configured by hardware and may perform the above-described type of area switching processing while connected to the HDD 10 by way of a predetermined interface, or may perform the above-described type of the area switching processing on software installed in a system (for example, a personal computer) equipped with the HDD 10. In the case illustrated in FIG. 2, as one example, the information processing device 16 is configured by hardware and is connected to the HDD 10. In this case, a display/input unit 18 is connected to the information processing device 16 by way of a predetermined interface to input assignment conditions for the area switching processing and the like by the user, and to display various types of information, such as warnings output from the information processing device 16. When the HDD 10 is connected to a personal computer or a similar device, and a display part and an input unit are included in the personal computer side, the display/input unit 18 can be omitted and the functions of the personal computer side can be utilized.

[0012] The information processing device 16 as described above includes a controller 20, a storage unit 22, and the like to transfer the data of the first area to an unused auxiliary region having no damage (or where probability of damage is low) and perform functions to switch the access area and continue the read and write processing. When the information processing device 16 is configured by hardware, a selection switch 24 (for example, a DIP switch or toggle switch) is connected to the information processing device 16 to switch whether or not to assign an unused auxiliary area (second area) to which data in the first area where read and write processing can be performed currently on is to be transmitted. In this case, a mode that does not utilize the area switching function (data transfer function) of the present embodiment can be selected. The second area can be utilized as a storage area for other data, and the HDD 10 can be set to be utilized by the conventional method. Instead of the selection switch 24, validation and invalidation of the area switching function in the present embodiment may be switched in accordance with a switching command that is input by using the display/input unit 18.

[0013] The controller 20 includes an area assignment unit 26, an information acquisition unit 28, a copy processing unit 30, an output unit 32, and the like. The copy processing unit 30 includes a comparison unit 30a, a copy execution unit 30b, and the like. The storage unit 22 is capable of storing input information that the user input by way of the display/input unit 18 and the like, and capable of storing the information (number of alternate sectors) acquired by the information acquisition unit 28. The storage unit 22 is capable of storing thresholds (for example, area switching thresholds described below and R/W check thresholds) used by the comparison unit 30a to determine whether the copy execution unit 30b performs copying of data on the HDD 10, and capable of storing information copy record results (area switching count H) on the copy execution unit 30b, and the like.

[0014] During an initial setting of the information processing device 16, the area assignment unit 26 recognizes, as the first area, an area on the HDD 10 that is configured by a used area already containing data and an area used for an alternate

sector when a data reading defect occurs. The area assignment unit 26 recognizes, as the second area, an unused area other than the first area. Then, the area assignment unit 26 assigns, for the second area, at least one, for example, n auxiliary areas corresponding to capacity of the first area. A total area 34 of the platter 12 on the HDD 10 illustrated in FIG. 1 has, for example, a capacity of 1 TB (terabyte). The area that stores application data, numerical data, image data, and the like, and the used area that is already obtained as the area for the alternate sector are recognized as a first area 34a. It is assumed that 100 GB (gigabytes) out of the total area 34 of the platter 12 are used as the first area 34a. In this case, the remaining 900 GB are recognized as a second area 34b. The area assignment unit 26 performs the assignment by subdividing the second area 34b into, for example, 9 (assignment number $n = 9$) auxiliary areas 36 (100 GB each) each corresponding to the capacity of the first area 34a (for example, 100 GB).

[0015] When assigning a plurality of auxiliary areas 36 for the second area 34b on the platter 12 of HDD 10, the area assignment unit 26 assigns the auxiliary areas 36 so as to be adjacent to each other in the radius direction by using, as a minimum unit, tracks each extending along the circumference, as illustrated in FIG. 1. In this case, it is possible to shorten the movement distance of the magnetic head 14a due to area switching. For example, the movement amount of the magnetic head 14a can be shortened to a minimum by that, the area switching is performed between the areas adjacent to each other in the radial direction. As a result, the wear on the drive section and the consumption of lubricant oil by the platter 12 can be suppressed and the operating time of the HDD 10 can be extended.

[0016] In the case in FIG. 1, an area initially obtained as a usage area (first area 34a) is located at the outermost circumference of the platter 12. However, the first area 34a is an area that can be accessed for read and write processing. When the area switching is performed as described above, the auxiliary area 36 to which data is transmitted is treated as the first area 34a in subsequent processing. In the assignment of the auxiliary area 36 performed by the area assignment unit 26 during the initial setting, the area is

not physically assigned on the platter 12 but is assigned virtually on the information processing device 16 so that the position information as to record data on the platter 12 side can be recognized on the information processing device 16 side. The assignment number n of the auxiliary area 36 assigned by the area assignment unit 26 can be determined such that the capacity of an auxiliary area 36 during the assignment is equal to or larger than the capacity of the first area 34a. Therefore, the area assignment unit 26 may automatically determine the assignment number n depending on a usage status of the HDD 10. In another embodiment, for example, the area assignment may be performed by designating, by a user with the display/input unit 18, the capacity of the auxiliary area 36 and the assignment number n such that the capacity to be designated is equal to or larger than the capacity of the first area 34a in the initial setting.

[0017] The information acquisition unit 28 acquires required information from history information that is recorded as needed based on the operating state of the HDD 10. Self-Monitoring, Analysis and Reporting Technology (SMART) information gathered during operation as a standard function of the HDD 10 can be used as the history information. Beside the frequency of errors occurring up to now such as the number of the alternate sectors occurring, worst record, and the like, the SMART information includes, for example, information on the power supply ON/OFF count, the power supply ON time, and the magnetic head 14a seek time. The information acquisition unit 28 acquires, from the HDD 10, information relating to the number of the alternate sectors out of the SMART information and stores the acquired information in the storage unit 22. The information acquisition unit 28 reads out the number of the alternate sectors from the HDD 10 when the area assignment unit 26 assigns the auxiliary area 36, and stores the readout information in the storage unit 22. The information acquisition unit 28 also reads out the latest number of the alternate sectors from the HDD 10 in, for example, a predetermined processing cycle during operation of the HDD 10, and stores the readout information in the storage unit 22. In this case, while the number of alternate sectors, which has been stored in the storage unit 22, is

treated as a previous value, the number of alternate sectors, which is newly read out, is stored in the storage unit 22 as the latest value. Accordingly, the previous value and the latest value are stored in the storage unit 22.

[0018] The copy processing unit 30 causes the HDD 10 to execute copy processing to copy data in the first area 34a onto any one of the unused areas in the auxiliary areas 36 when an increase in the number of the alternate sectors acquired by the information acquisition unit 28 is equal to or larger than a predetermined threshold. The comparison unit 30a calculates, for example, the difference between the previous value and the latest value of the number of the alternate sectors stored in the storage unit 22 by the information acquisition unit 28. In other words, the number of the alternate sectors, which mainly occurs within the first area 34a due to the read and write processing performed by the HDD 10, can be calculated between the time of storing the previous number of the alternate sectors and the time of storing the latest number of the alternate sectors. The comparison unit 30a then compares the calculated difference with the area switching threshold previously stored in the storage unit 22. The area switching threshold is a threshold previously determined by testing or the like. For example, the relation between the number of the alternate sectors occurring in the same area (for example, the currently accessible first area 34a) on the platter 12 and the frequency of occurrence of delays or errors in processing speed on the HDD 10 can be acquired through testing or the like. The area switching threshold is determined based on the number of occurrence of alternate sectors, which is seen as being allowable for normal operation of the HDD 10. The area switching threshold is preferably set by taking the gain margin into account. When the comparison unit 30a determines that the difference in the alternate sectors is equal to or larger than the area switching threshold, that is, when it determines that occurrence of any further alternate sectors in the currently accessible first area 34a may possibly cause a drop in reliability in the HDD 10 along with the increased risk of data loss, the copy execution unit 30b copies the data in the first area 34a onto an unused auxiliary area 36. When the data in the first area 34a is

copied onto the unused auxiliary area 36, the copy execution unit 30b increments, by "+1", the area switching count H indicating the copy record results, and stores the incremented value into the storage unit 22.

[0019] Before copying the data in the first area 34a onto the auxiliary area 36, the copy execution unit 30b may execute read and write check processing (R/W check), which is a function of the HDD 10, on the auxiliary area 36 on which copying is to be performed, that is, for example, the auxiliary area 36 adjacent to the first area 34a that is currently accessible. When the result of the R/W check indicates that the read and write error check (for example, the number of the alternate sectors) is below a predetermined threshold (R/W check threshold), that is, for example, when a read and write error count is below 10 times, the copy execution unit 30b may copy the data in the first area 34a onto the auxiliary area 36. In this way, the copy execution unit 30b checks beforehand the possibility of the alternate sectors occurring in the auxiliary area 36, and excludes, from data transfer candidates, those auxiliary areas 36 having the number of the alternate sectors that might possibly exceed the area switching threshold at an early stage (switching areas to another auxiliary area 36 becomes necessary). Consequently, the copy execution unit 30b is able to reduce the risk of losing data and able to lower the delay of the processing in the HDD 10 and the error occurrence frequency. As a result, it is possible to contribute to improvement of the reliability of the HDD 10.

[0020] Moreover, irrespective of a possible increase in the number of the alternate sectors, when a copy request command input by the user with the display/input unit 18 and the like is received, the copy execution unit 30b may automatically copy data in the first area 34a onto any one of the auxiliary areas 36, which is unused. By this, data can be transferred even when the user senses an unusual event in the HDD 10 based on his/her past experience or the like, and it is possible to contribute to improvement of the reliability of the HDD 10. Moreover, even in a case where data transfer is required due to operational reasons, data can be swiftly transferred, and it is possible to contribute to the HDD 10 usage convenience.

[0021] The output unit 32 outputs utilization information representing the usage status of the auxiliary areas 36 and causes the display/input unit 18 to display the utilization information. As described above, the capacity of the total area 34 of the HDD 10 is finite, so that the number of times that the copy execution unit 30b can copy data in the first area 34a onto the unused auxiliary area 36 is also finite. Therefore, when the copy execution unit 30b finishes executing a copy command on the final unused auxiliary area 36, that is, when the area switching count H reaches the assignment number n for the auxiliary areas 36 assigned by the area assignment unit 26, the output unit 32 outputs a stop warning that advises swiftly stopping the currently operating HDD 10 and performing countermeasures. In this case, the possibility that loss of data might immediately occur in the auxiliary area 36 where data is copied by the copy execution unit 30b is low. Therefore, it is possible for the user to avoid the loss of data by performing an HDD 10 replacement operation (operation to shift the data to a different HDD 10) in compliance with the stop warning that is output. When the area switching count $H + 1$ reaches an assignment number n for the auxiliary areas 36 assigned by the area assignment unit 26, that is, when the number of the unused auxiliary areas 36 remaining after area switching reaches 1, the output unit 32 may output a data backup advisory warning for data from the HDD 10 as a preliminary notification. In this case, it is possible for the user to perform replacement work preparations including obtaining a new HDD 10 in compliance with the output data backup advisory warning to reliably avoid loss of data while also feeling reassured there is still time to take action. The output unit 32 may display information based on the number of the remaining unused auxiliary areas 36, for example, may perform countdown display of the number of the remaining unused auxiliary areas 36.

[0022] While FIG. 2 is a function block diagram illustrating the required functions of the information processing device 16, those functions may be consolidated or dispersed as needed when the same functions can be achieved.

[0023] The procedure of the area switching processing by the information processing

device 16 structured in this way will be described with referring to the flowcharts in FIG. 3 to FIG. 6. While the flowcharts in FIG. 3 to FIG. 6 are examples, the processing sequence and processing content may be changed as needed when the same functions can be achieved.

[0024] The processing procedure at the time of assigning the auxiliary areas 36 in the information processing device 16 will be first of all described while referring to the flowchart in FIG. 3.

[0025] When the user inputs, by using the display/input unit 18, an operation start command to execute a data loss avoidance function for data in the HDD 10 via the information processing device 16, the area assignment unit 26 assigns the auxiliary area 36 for the platter 12 (S100). The area assignment unit 26 acquires the capacity (for example, the capacity obtained as the area for storing the application data, the numerical data, the image data, and the like, and the area for alternate sectors) of the usage area obtained as the first area 34a in the HDD 10, which is input from the display/input unit 18. The area assignment unit 26 determines the assignment number n for the auxiliary areas 36 based on the capacity of the first area 34a and the capacity of the second area 34b other than the first area 34a. The area assignment unit 26 assigns, for the second area 34b, n auxiliary areas 36 that correspond to the capacity of the first area 34a.

When assigning the auxiliary area 36, the user may use the display/input unit 18 to input the assignment number n , or may obtain the capacity of the first area 34a from the HDD 10 and calculate the assignment number n that the second area 34b can be assigned.

[0026] Subsequently, the information acquisition unit 28 reads out the number of the alternate sectors in the total area 34 of the platter 12 from the SMART information stored in the HDD 10 (S102). The information acquisition unit 28 stores, in the storage unit 22, the current number of the alternate sectors that is read out in a predetermined area (S104). The controller 20 then permits the start of the read and write processing on the first area 34a on the HDD 10 (S106).

[0027] FIG. 4 is an illustrative flowchart for explaining the procedure of the processing

including the warning processing in the information processing device 16. The flowchart in FIG. 4 is repeatedly performed at a predetermined processing cycle during operation in the information processing device 16. The processing in the flowchart in FIG. 4 can for example also be performed, for example: when the power of the HDD 10 is turned on; when the power is turned on to the system connected to the HDD 10; at the time set on the timer or the like; and when the user has input maintenance commands for optimizing the HDD 10 by utilizing the display/input unit 18.

[0028] Upon starting the processing in the flowchart in FIG. 4, the information acquisition unit 28 reads out the number of alternate sectors in the total area 34 of the platter 12 in the current status from the SMART information stored in the HDD 10 and stores, in the storage unit 22, the readout number as the latest value for the number of the alternate sectors (S200). Next, the comparison unit 30a reads out the number of the alternate sectors (previous value) of the auxiliary area 36 stored in the storage unit 22 and the current number of the alternate sectors (latest value) stored at S200, and calculates the difference between these two values (S202).

[0029] The comparison unit 30a checks whether there is an automatic interrupt processing to perform a switching request to the auxiliary area 36. When there is no interrupt processing (No at S204), the comparison unit 30a compares the difference calculated at S202 with the area switching threshold read out from the storage unit 22 (S206). The request for the interrupt processing can be performed for example by utilizing the display/input unit 18. When the comparison unit 30a determines, from the comparison results, that the difference is smaller than the area switching threshold (Yes at S206), the number of the alternate sectors occurring at the current stage is determined not to cause a problem even if the read and write processing continues within the currently accessible first area 34a. As a result, the controller 20 outputs, to the HDD 10, a command for allowing the read and write processing on the HDD 10 (S208).

[0030] When there is interrupt processing at S204 (Yes at S204) or when the difference calculated at S202 is equal to or larger than the area switching threshold at S206 (No at

S206), the copy execution unit 30b checks whether the area switching count H stored in the storage unit 22 reaches the assignment number n for the auxiliary area 36 (S210).

When the area switching count H has reached the assignment number n for the auxiliary area 36 (Yes at S210), it means that there are no more unused auxiliary areas 36 on the platter 12. In this case, the output unit 32 outputs a stop warning advising that the currently operating HDD 10 should be swiftly stopped (S212). In this case, the possibility that loss of data might immediately occur in the currently accessible first area 34a is low. The controller 20 therefore outputs, to the HDD 10, a command to permit performing the read and write processing on the HDD 10 (S208) and temporarily ends the procedure. In this case, the user performs the HDD 10 replacement operation (operation to shift the data to a different HDD 10) in compliance with the stop warning that is output and can in this way definitely avoid the possibility of data loss occurring in the near future.

[0031] In S210, when the area switching count H has not reached the assignment number n for auxiliary areas 36 (No at S210), the copy execution unit 30b adds "1" to the area switching count H stored in the storage unit 22 and checks whether the area switching count $H + 1$ has reached the assignment number n for the auxiliary areas 36 (S214). In other words, the copy execution unit 30b checks whether the remaining unused auxiliary areas 36 are now "1". When the area switching count $H + 1 =$ assignment number n (Yes at S214), that is, the current area switching count H has reached a count of $n - 1$, the output unit 32 outputs a data backup advisory warning for data in the HDD 10 as a preliminary notification (S216). In this case, there is one remaining unused auxiliary area 36, so that the copy execution unit 30b performs area switching processing that copies all data in the first area 34a to the unused auxiliary area 36 (S218). At S216, when a data backup advisory warning is output, one unused auxiliary area 36 is remaining and the copying of data onto the auxiliary area 36 can definitely be performed. In other words, there is still a surplus remaining until the HDD 10 must be quickly replaced. The user can perform replacement work preparations

including procuring a new HDD 10 in compliance with the output data backup advisory warning to reliably avoid loss of data while feeling there is still time to take action.

[0032] In S214, when the area switching count $H + 1$ has not reached the assignment number n (No at S214), there are two or more unused auxiliary areas 36 remaining, and the processing shifts to S218 by skipping the processing at S216.

[0033] The area switching processing at S218 will be described in detail while referring to the flowchart in FIG. 5. First of all, the copy execution unit 30b copies all data in the currently accessible first area 34a onto the unused auxiliary area 36 (S300). For example, in FIG. 1, all data is copied onto the auxiliary area 36 radially adjacent to the first area 34a. In FIG. 5, for simplifying the description, it is assumed that the currently accessible first area 34a is an area $P_{(M)}$. In addition, the unused adjacent auxiliary area 36 is assumed to be $P_{(M+1)}$. Here, M is a subscript for identifying areas on the platter 12 and, in FIG. 1, an area corresponding to the first area 34a when assigning the auxiliary area 36 is assumed to be $M = 0$, and the auxiliary areas 36 are assumed to be $M = 1, M = 2, \dots, M = n$ toward the inner circumferential side. For example, when the first area 34a is at the outermost circumference of the platter 12 (the area switching has still not been performed), all data in the area $P_{(M=0)}$ (all data of the first area 34a) is copied onto $P_{(M=0+1=1)}$ serving as the adjacent auxiliary area 36. Therefore, the area $P_{(M=1)}$ after the first copying becomes the first area 34a in the next area switching.

[0034] Next, the information acquisition unit 28 reads out the number of the alternate sectors in the total area 34 of the platter 12 from the SMART information stored in the HDD 10 after copying (S302). The information acquisition unit 28 stores the readout number of the alternate sectors after copying onto a predetermined area of the storage unit 22 (S304). Then, in order to record results that all data in the area $P_{(M)}$ is copied onto the area $P_{(M+1)}$, the copy execution unit 30b adds "1" to the area switching count H (S306), and temporarily ends the procedure.

[0035] When the area switching processing is completed, the operation returns to the flowchart in FIG. 4, and the controller 20 permits the start of the read and write

processing on the area $P_{(M+1)}$ (copy-completed new auxiliary area 36) on the HDD 10 (S208) and temporarily ends the procedure.

[0036] FIG. 6 is an illustrative flowchart for explaining the procedure of another case of area switching processing. In the area switching processing, the read and write check processing (R/W check) is executed in advance on an area to which data is to be copied and, when the read and write error count (number of the alternate sectors) is below a predetermined number, data copying of the first area 34a (area $P_{(M)}$) is executed onto the auxiliary area 36 (area $P_{(M+1)}$).

[0037] First of all, the copy execution unit 30b executes the R/W check in the area $P_{(M+1)}$ serving as the next area on which copying is to be performed (S400). The information acquisition unit 28 reads out, from the SMART information stored in the HDD 10, the number of the alternate sectors in the total area 34 of the platter 12 after the R/W check and stores it in the storage unit 22 (S402). Then, the copy execution unit 30b calculates the difference between the number of the alternate sectors before the R/W check stored in the storage unit 22 and the number of the alternate sectors after the R/W check stored at S402 (S404). The copy execution unit 30b then compares the difference calculated at S404 with the R/W check threshold that is read out from the storage unit 22 (S406). As a result of the comparison, when the comparison unit 30a determines that the difference is smaller than the R/W check threshold (Yes at S406), all data in the area $P_{(M)}$ is copied onto the R/W check completed area $P_{(M+1)}$ (S408). In other words, the copy execution unit 30b causes the HDD 10 to perform data copying on the basis of the determination that a state will not arise where the number of the alternate sectors immediately exceeds the area switching threshold due to copying onto the area $P_{(M+1)}$, and copying must be performed again onto another auxiliary area 36.

[0038] Next, the information acquisition unit 28 reads out the number of the alternate sectors in the total area 34 of the platter 12 from the SMART information stored in the HDD 10 after copying (S410). The information acquisition unit 28 stores the readout number of the alternate sectors after copying in a predetermined area of the storage unit

22 (S412). Then, in order to record results of copying the data in the area $P_{(M)}$ onto the area $P_{(M+1)}$ (results of copying data in the first area 34a to the auxiliary area 36), the copy execution unit 30b adds "1" to the area switching count H (S414) and temporarily ends the procedure.

[0039] In S406, the comparison unit 30a may determine, from the comparison results that, the difference is not smaller than the R/W check threshold (No at S406), in other words, may determine that the area $P_{(M+1)}$ on which the R/W check has been executed is possibly damaged and is not appropriate for copying the data of the area $P_{(M)}$. In this case, the copy execution unit 30b checks whether $M + 1 = n$ (S416). In other words, the copy execution unit 30b checks whether the area on which the R/W check has been performed in the current processing is the last unused auxiliary area 36. When it is not $M + 1 = n$ (No at S416), the copy execution unit 30b performs $M = M + 1$ (S418) and shifts to S400. In addition, the copy execution unit 30b executes a R/W check on the next unused auxiliary area 36 (for example, $P_{(M+1+1=2)}$) and again performs the processing from S400 onward. A search can therefore be made for another area to safely copy data in the area $P_{(M)}$, and the risk of loss of data in the area $P_{(M)}$ (data in the first area 34a) can be further reduced.

[0040] In S416, when $M + 1 = n$ (Yes at S416), that is, when the area $P_{(M+1)}$ on which the R/W check has been executed is the last unused area 36 and there is the possibility of damage, the copy execution unit 30b determines prohibition of copying of data in the area $P_{(M)}$ (S420). Since read-write errors appear in the final remaining auxiliary area 36 and any further copying is impossible, the output unit 32 outputs a stop warning for advising swiftly stopping the currently operating HDD 10 (S422), and temporarily stops the procedure. In this case, the possibility that loss of data might immediately occur in the currently accessed area $P_{(M)}$, that is, the first area 34a is low. Therefore, in FIG. 4, the processing shifts to S208, the controller 20 outputs a command to the HDD 10 for permitting the read and write processing on the HDD 10 and temporarily ends the procedure in FIG. 4. When a stop warning for the HDD 10 is output at S422, loss of

data can be avoided by that, the user performs the HDD 10 replacement task (operation to shift the data to a different HDD 10) in accordance with the stop warning in the same manner as when a stop warning is output at S212.

[0041] In this way, the risk of data loss can be reduced and contribution can be made to improving the reliability of the HDD 10, by checking the possibility of forming alternate sectors in the auxiliary area 36 in advance and by excluding, from data transfer candidates, alternate areas 36 having the number of the alternate sectors that might possibly exceed the area switching threshold at an early stage (switching area to another alternate area 36).

[0042] In the above-described embodiment, an example is described, in which the information processing device 16 is configured by hardware. Alternatively, the same functions can also be achieved by a processing module by way of a CPU of a system (for example, a personal computer) connected to the HDD 10. In this case, the software for implementing the information processing device 16 can be acquired by way of a storage medium and communication lines and installed in a CPU to achieve the same effects.

[0043] Some embodiments of the present invention are described; however, the above embodiments and modifications are at most merely examples and are not intended to limit the scope of the present invention. The above-described embodiments can be achieved in a variety of forms, and various omissions, substitutions, and changes can be made without departing from the spirit and scope of the present invention. The above-described embodiments and their modifications are included in the spirit and scope of the present invention and also in the invention described in the accompanying claims and their equivalents.

CLAIMS

1. An information processing device comprising:
 - an area assignment unit configured to
 - execute read and write processing of data on a first area being a part of a total area,
 - form an alternate sector for transferring the data to an unused area in the first area when the read and write processing of data in the first area fails, and
 - assign at least one auxiliary area, which corresponds to capacity of the first area, for a second area being an unused area other than the first area, the assignment being performed on a hard disk drive that performs the read and write processing of data on the alternate sector;
 - an information acquisition unit configured to acquire history information in which a number of the alternate sectors formed in the first area is recorded;
 - a copy processing unit configured to cause the hard disk drive to
 - copy data in the first area onto any one of the auxiliary areas, which is unused, when an increase in the alternate sectors due to the read and write processing is equal to or larger than a predetermined threshold, and
 - execute the read and write processing on the auxiliary area as the first area where the copying has been completed; and
 - an output unit configured to output utilization information representing a usage status of the auxiliary area.
2. The information processing device according to claim 1, wherein the area assignment unit is configured to determine whether or not to assign the auxiliary area, the determination being performed in accordance with a state of a selection switch that switches whether the auxiliary area is to be assigned or not.
3. The information processing device according to claim 1 or 2, wherein, when a

copy request command is received in a case that the increase in the auxiliary sectors is below the threshold, the copy processing unit causes the hard disk drive to copy data in the first area onto any one of the auxiliary areas, which is unused, and execute the read and write processing on the auxiliary area as the first area.

4. The information processing device according to any one of claims 1 to 3, wherein, before causing the hard disk drive to execute the copying, the copy processing unit causes the hard disk drive to

execute read and write check processing on the auxiliary area on which copying is to be performed, and

execute the copying of the data when a number of read and write errors is below a predetermined threshold.

5. The information processing device according to any one of claims 1 to 4, wherein, when the area assignment unit assigns a plurality of auxiliary areas for the second area, the area assignment unit assigns the auxiliary areas in a radius direction by using, as a minimum unit, tracks each extending along circumference of a platter of the hard disk drive.