Description

BACKGROUND OF THE INVENTION

The present invention relates generally to information recording/reproducing apparatus, and more particularly to such an information recording/reproducing apparatus for verifying or confirming the information recorded on a disc-like recording medium such as a magentic desc and an optical disc.

Recently, in accordance with high-speed operation and high performance of computers are required high-speed operation and high performance of peripheral equipment. Particularly, it is strongly required for secondary storages such as a magentic disc drive and an optical disc drive to reduce the access time concurrently with ensuring high reliability so as to increase the data transfer speed and the capacity. Thus, recent approaches involve increasing the rotational speed of the recording medium, reducing the weight of the recording/reproducing head and increasing the track pitch and the frequency for densification or increase in the recording density. Here, with a view to improving the reliability on writing data on the recording medium, it is general to perform a write-and-verify operation to read out the written data in order to check whether the data is normally readable, whether the number of data errors such as bit inversion is below a standard value and whether the read-out data are correct. One example of the conventional write-and-verify operations will be described hereinafter. There is a problem which arises with such a write-and-verify operation, however, in that difficulty is encountered to quickly perform the switching operation between the verifying operation and the recording operation, thereby requiring standby for rotation of the recording medium to entirely decrease the performance of the information recording/reproducing apparatus.

US-A- 4 611 314 discloses an information recording/reproducing device according to the preamble of Claim 1. In this prior art device data is written to a disc during a first rotation of the disc, then the written data is reproduced during a second rotation of the disc and the whole of the reproduced data is immediately checked for errors.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an information recording/reproducing apparatus which is capable of eliminating the standby for rotation of the recording medium.

In accordance with the present invention, there is provided an information recording/reproducing apparatus comprising: recording means for recording information on a disc-like recording medium rotatable by rotating means; reproducing means for reproducing the information recorded on the disc-like recording medium by the recording means; and control means for controlling the recording means and the reproducing means so as to record the information on the disc-like recording medium and reproduce the information recorded thereon for verification of the recorded information, the control means dividing the information to be recorded into two or more portions so that the first division portion is successively recorded over a first group of a plurality of blocks successively formed circumferentially on the disc-like recording medium and then reproduced for the verification before the second division portion is successively recorded over a second group of blocks which are consecutive to the first group of blocks and then reproduced for the verification, the recording and reproduction being continuously effected up to the last division portion, wherein in verification, with respect to the first division portion to the division portion immediately before the last division portion, only final one or more blocks of the blocks of the just recorded division portion are not verified immediately but, after the recording for a subsequent division portion, verified together with the blocks of the subsequent division portion other than final one or more blocks, and with respect to the last division portion all blocks thereof are verified together with previously recorded and non-verified blocks.

Preferably, the control means determines the number of the immediately non-verified blocks of each of the division portions so that a time required for rotation of the disc-like recording medium corresponding to the immediately non-verified blocks is longer than a time required for the next recording preparation after completion of the verification.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram showing an information recording/reproducing apparatus equipped with a conventional verification function;

Fig. 2 is a graphic illustration for describing operation of the Fig. 1 information recording/reproducing apparatus;

Fig. 3 is a block diagram showing an arrangement of an information recording/reproducing apparatus according to an embodiment of the present invention which includes an improved data verification function;

Fig. 4 is a graphic illustration for describing an operation of the Fig. 3 information recording/reproducing apparatus; and

Fig. 5 is a flow chart for a better understanding of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Prior to describing a feature of the present invention, a conventional write-and-verity operation for an information recording/reproducing apparatus will be described hereinbelow with reference to Fig. 1 for a better understanding of this invention, Fig. 1 showing a general arrangement of an optical disc system. In Fig. 1, a controller illustrated at numeral 3 includes a buffer memory 4 for once storing data transfered through a host interface 2 from a host computer 1. After start of storage of the data in the buffer memory 4, the stored data are successively supplied to an EDAC 5 in units of data corresponding to one sector of a disc-like recording medium 8 where an error correction code is added thereto. The EDAC 5 acts as a bit error detection and correction circuit in which a predetermined bit is inserted into the data in accordance with an adequate calculation equation so as to find the error bit position when an error such as the bit inversion occurs on reproduction. Subsequently, the data from the EDAC 5 are supplied through a MODEM 6 to a drive unit 7 so as to be written on the recording medium 8. The MODEM 6 function as a modulation and demodulation circuit to perform the modulation for recording to the optical disc and perform the demodulation of the signal read out from the optical disc to the original data before the recording. The optical disc, being the recording medium, has thereon a spiral track or coaxial tracks, each track corresponding to one revolution of the optical disc being divided with equal angles into sectors each of which is the minimum recording block (element) and the one-time-recording data being recorded over a plurality of sectors. A sector address and a track address for indicating the sector position on the optical disc are in advance recorded at the head portion of each of the sectors. For performing the write-and-verify operation, the data stored in the buffer memory 4 are required to be left until the verification is completed for the sector in which the data is written, and in response to generation of a problem due to the verification, the data left in the buffer memory 4 are again transferred to the drive unit 7 so as to be written in a different sector of the recording medium 8. Fig. 2 shows a line of sectors on which data are written. For example, in the case that all data to be recorded is 50 Kbytes, the capacity of the buffer memory 4 is 32 Kbytes and the capacity of each of the sectors on the recording medium 8 is 0.5 Kbytes, of this 50 Kbytes, the 32 Kbyte data are first transferred thereto from the host computer 1 in Fig. 1, then followed by interruption of the transferring operation. The 32 Kbyte data stored in the buffer memory 4 are successively transferred to the drive unit 7 so as to be recorded in sectors m to m+63 of the recording medium 8 as illustrated by a in Fig. 2. Subsequently, the controller 3 causes the drive unit 7 to move in a radial direction of the recording medium 8 to perform the seeking operation in which the read-out address is checked whether it is coincident with a target address set at the front side of the record-started sector m, as illustrated by b in Fig. 2. The drive unit 7 reads out the data in the sectors m to m+63 as illustrated by c in Fig. 2. The read-out data are transferred to the controller 3 which in turn, checks the qualities (bit error, level of the read-out signal) of the read-out data for each sector. If there is a problem, the data of buffer memory 4 corresponding to the sector are again transferred to the drive unit 7 to be written in an area disposed as a substitute for the sector. Thereafter, the portion of the buffer memory 4 corresponding to the sector is released. On the other hand, if no problem, the portion of the buffer memory 4 is directly released. To the released buffer memory 4, the next data are transferred from the host computer 1. After completion of the verification for the sectors m to m+63, the controller 3 causes the drive unit 7 to seek the front side of the sector m+64 as illustrated by d in Fig. 2. Here, during the standby for rotation as illustrated by e in Fig. 2, a preparation is made for the next recording operation. Thereafter, the remaining 18 Kbyte data are similarly transferred through the EDAC 5 and the MODEM 6 to the drive unit 7 so as to be recorded in sectors after the sector m+63 as illustrated by f in Fig. 2. Subsequently, in response to a command from the controller, the drive unit 7 seeks the front side of the sector m+64 as illustrated by g in Fig. 2 to read out the recorded data for verification as illustrated by h in Fig. 2. In Fig. 2, illustrations corresponding to the standby for rotation between the seeking b, g and the verification c, h are omitted for brevity.

According to the above-described write-and-verify operation, a quick switching operation to the recording for the sectors after the sector m+63 after the completion of the verification for the sectors m to m+63 becomes difficult because of generation of standby for rotation, generally one and more revolutions. Actually, the undesirable seeking operation and standby operation as illustrated by d and e in Fig. 2 are required. The number of the undesirable operations increases as the data amount increases and the capacity of the buffer memory 4 becomes smaller.

Referring now to Fig. 3, there is illustrated an information recording/reproducing apparatus according to an embodiment of the present invention which has a write-and-verify function, where parts corresponding to those in Fig. 1 showing a conventional information recording/reproducing apparatus are marked with the same numerals and the detailed description thereof will be omitted for brevity. In Fig. 3, the information recording/reproducing apparatus includes a controller 3 comprising a buffer memory 4, an EDAC 5, a MODEM 6 and a verification buffer memory 9. The buffer memory 4 is coupled to a host computer 1 and has a capacity of 32 Kbytes, for ex-

ample. A write-and-verify operation will be described hereinbelow with reference to Fig. 4, for example, under the condition that all data to be recorded is 50 Kbytes. Of this 50 Kbyte data, the 32 Kbyte data are initially transferred from the host computer 1 and then stored in the buffer memory 4 before transferred through the EDAC 5 and the MODEM 6 to a drive unit 7. The drive unit 7 operates a recording/reproducing means, not shown, so as to record the data in sectors m to m+63 of a disc-like recording medium 8, driven by means of a driving mechanism 8', as illustrated by A in Fig. 4. Subsequently, the controller 3 causes the drive unit 7 to seek the front side of the sector m of the recording medium 8 as illustrated by B in Fig. 4 to successively verify the data from the sector m as illustrated by C in Fig. 4. Here, if in this system the time required from completion of the verification to completion of preparation for the next recording operation is coincident with the time required for rotation of the recording medium corresponding to one sector, the controller 3 performs the verification for the data up to the sector m+62, but not performing the verification for the data of the sector m+63. During the passage of the sector m+63, a preparation for recording data in the sectors after the sector m+63 is made as illustrated by D in Fig. 4. At this time, the data recorded in the sector m+63 are transferred into the verfication buffer memory 9 and the portion of the buffer memory 4 corresponding to the data in the sector m+63 is released. Thereafter, when the recording medium 8 rotates up to a position which allows recording data into the sector m+64, the remaining 18 Kbyte data are recorded over 36 sectors as illustrated by E in Fig. 4. Subsequently, the drive unit 7 seeks the front side of the sector m+63 as illustrated by F in Fig. 4 to verify the the sector m+63 and the 36 sectors, in which the data are recorded later, as illustrated by G in Fig. 4. In Fig. 4, illustrations for the standby to be made between the seeking B, F and the verification C, G are omitted.

Fig. 5 is a flow chart showing the above-described operation to be executed in the controller 3, where A to G respectively correspond to the processes A to G in Fig. 4. In Fig. 5, the operation starts with a step 101 to divide the information to be recorded into a plurality of portions, then followed by a step 102 to set as a target sector the first sector m in which the first portion is recorded. The step 102 is followed by a step 103 to seek for the target sector and then followed by a checking step 104. If not, the operational flow returns to the step 103. On the other hand, if so, the operational flow advances to a step 105 to record data corresponding to the set sectors ($\leqq$ 64). After the execution of the step 105, control goes to a step 106 to check whether the recorded data correspond to the first portion. If the answer of the step 106 is affirmative, control goes to a step 107 to set the first sector m as the target sector, then followed by a step 108 for the seeking operation. If the answer of the step 106 is negative, control goes to a step 109 to set as the target sector the head sector of the previously non-verified sectors, the followed by the step 108. After the step 108, control goes to a checking step 110. If the answer of the step 110 is negative, the operational flow returns to the step 108. On the other hand, if the answer of the step 110 is affirmative, control proceeds to a step 111 to check whether the data to be recorded correspond to the final portion. If the answer of the step 111 is negative, the operational flow goes to a step 112 in which the verifying operation is made for the sectors except for the last sector or successive n sectors including the last sector and further for the sectors which have not been verified previously. The step 112 is followed by a step 113 to set as a target sector the head sector of the sectors corresponding to the next portion, then followed by a step 114 to check the target sector. If the answer of the step 114 is affirmative, the operational flow returns to the step 105. If the answer of the step 111 is affirmative, control goes to a step 115 to verify the sectors corresponding to the final portion and further verify the previously non-verified sectors.

With the above-described operation, where the necessary time between the verification completion and the next-recording preparation completion needs the time for rotation corresponding to n sectors, the verifying operation is performed up to the sectors m+64-n and the data corresponding to the remaining n sectors are transferred to the buffer memory 9 so as to be verified together with the next data portions. In the case that the amount of data is large, the above-operation is repeatedly effected before the finally recorded data and the previously non-verified data are together verified, thereby not requiring the seeking operation and the standby at the time of start of recording after the verification to reduce the recording time.

It should be understood that the foregoing relates to only a preferred embodiment of the present invention.

Claims

1. An information recording/reproducing apparatus comprising:

recording means (7) for recording information on a disc-like recording medium (8) rotatable by rotating means;

reproducing means (7) for reproducing the information recorded on said disc-like recording medium (8) by said recording means (7); and

control means (3) for controlling said recording means (7) and said reproducing means (7) so as to record the information on said disc-like recording medium (8) and reproduce the in-

ample. A write-and-verify operation will be described hereinbelow with reference to Fig. 4, for example, under the condition that all data to be recorded is 50 Kbytes. Of this 50 Kbyte data, the 32 Kbyte data are initially transferred from the host computer 1 and then stored in the buffer memory 4 before transferred through the EDAC 5 and the MODEM 6 to a drive unit 7. The drive unit 7 operates a recording/reproducing means, not shown, so as to record the data in sectors m to m+63 of a disc-like recording medium 8, driven by means of a driving mechanism 8', as illustrated by A in Fig. 4. Subsequently, the controller 3 causes the drive unit 7 to seek the front side of the sector m of the recording medium 8 as illustrated by B in Fig. 4 to successively verify the data from the sector m as illustrated by C in Fig. 4. Here, if in this system the time required from completion of the verification to completion of preparation for the next recording operation is coincident with the time required for rotation of the recording medium corresponding to one sector, the controller 3 performs the verification for the data up to the sector m+62, but not performing the verification for the data of the sector m+63. During the passage of the sector m+63, a preparation for recording data in the sectors after the sector m+63 is made as illustrated by D in Fig. 4. At this time, the data recorded in the sector m+63 are transferred into the verfication buffer memory 9 and the portion of the buffer memory 4 corresponding to the data in the sector m+63 is released. Thereafter, when the recording medium 8 rotates up to a position which allows recording data into the sector m+64, the remaining 18 Kbyte data are recorded over 36 sectors as illustrated by E in Fig. 4. Subsequently, the drive unit 7 seeks the front side of the sector m+63 as illustrated by F in Fig. 4 to verify the the sector m+63 and the 36 sectors, in which the data are recorded later, as illustrated by G in Fig. 4. In Fig. 4, illustrations for the standby to be made between the seeking B, F and the verification C, G are omitted.

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With the above-described operation, where the necessary time between the verification completion and the next-recording preparation completion needs the time for rotation corresponding to n sectors, the verifying operation is performed up to the sectors m+64-n and the data corresponding to the remaining n sectors are transferred to the buffer memory 9 so as to be verified together with the next data portions. In the case that the amount of data is large, the above-operation is repeatedly effected before the finally recorded data and the previously non-verified data are together verified, thereby not requiring the seeking operation and the standby at the time of start of recording after the verification to reduce the recording time.

It should be understood that the foregoing relates to only a preferred embodiment of the present invention.

Claims

1. An information recording/reproducing apparatus comprising:

recording means (7) for recording information on a disc-like recording medium (8) rotatable by rotating means;

reproducing means (7) for reproducing the information recorded on said disc-like recording medium (8) by said recording means (7); and

control means (3) for controlling said recording means (7) and said reproducing means (7) so as to record the information on said disc-like recording medium (8) and reproduce the in-

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formation recorded thereon for verification of the recorded information, said control means (3) dividing the information to be recorded into two or more portions so that the first division portion is successively recorded over a first group of a plurality of blocks successively formed circumferentially on said disc-like recording medium (8) and then reproduced for the verification before the second division portion is successively recorded over a second group of blocks which which are consecutive to said first group of blocks and then reproduced for the verification, the recording and reproduction being continuously effected up to the last division portion, characterized in that the apparatus is adapted so that in verification, with respect to the first division portion to the division portion immediately before the last division portion, only final one or more blocks of the blocks of the just recorded division portion are not verified immediately but, after the recording for a subsequent division portion, verified together with the blocks of the subsequent division portion other than final one or more blocks, and with respect to the last division portion all blocks thereof are verified together with previously recorded and non-verified blocks.

2. An appratus as claimed in claim 1, wherein said control means (3) determines the number of the immediately non-verified blocks of each of the division portions so that a time required for rotation of said disc-like recording medium (8) corresponding to the immediately non-verified blocks is longer than a time required for preparing the next recording operation after completion of the verification.

3. An apparatus as claimed in claim 1, wherein said control means (3) includes memory means (9) to temporalily store data corresponding to the immediately non-verified blocks till the next verification.

Patentansprüche

1. Eine Informations-Aufzeichnungs/Wiedergabe-Vorrichtung mit:
Aufzeichnungsmitteln (7) zum Aufzeichnen von Informationen auf einem plattenartigen Aufzeichnungsmedium (8), das durch Rotationsmittel drehbar ist;
Wiedergabemitteln (7) zum Wiedergeben der auf dem plattenartigen Aufzeichnungsmedium (8) durch die Aufzeichnungsmittel (7) aufgezeichneten Informationen; und
Steuerungsmitteln (3) zum Steuern der Aufzeichnungsmittel (7) und der Wiedergabemittel (7), um die Informationen auf dem plattenartigen Aufzeichnungsmedium (8) aufzuzeichnen und die darauf aufgezeichneten Informationen wiederzugeben zur Verifikation der aufgezeichneten Informationen, wobei die Steuerungsmittel (3) die aufzuzeichnenden Informationen in zwei oder mehr Abschnitte unterteilen, so daß der erste Teilabschnitt sukzessive über eine erste Gruppe einer Vielzahl von Blöcken, die sukzessive in Umfangsrichtung auf dem plattenartigen Aufzeichnungsmedium (8) ausgebildet sind, aufgezeichnet und dann wiedergegeben wird zur Verifikation, bevor der zweite Teilabschnitt sukzessive über eine zweite Gruppe von Blöcken, die sich an die erste Gruppe von Blöcken anschließt, aufgezeichnet und dann wiedergegeben wird zur Verifikation, und die Aufzeichnung und die Wiedergabe kontinuierlich bewirkt werden bis zum letzten Teilabschnitt,
dadurch gekennzeichnet,
daß die Vorrichtung so ausgebildet ist, daß bei der Verifikation bezüglich des ersten Teilabschnitts bis zu dem Teilabschnitt unmittelbar vor dem letzten Teilabschnitt lediglich ein letzter Block oder mehrere letzte Blöcke der Blöcke des gerade aufgezeichneten Teilabschnitts nicht sofort, sondern nach der Aufzeichnung für einen nachfolgenden Teilabschnitt zusammen mit anderen Blöcken des nachfolgenden Teilabschnitts außer dem letzten Block oder mehreren letzten Blöcken verifiziert werden, und bezüglich des letzten Teilabschnitts alle Blöcke davon zusammen mit zuvor aufgezeichneten und nichtverifizierten Blöcken verifiziert werden.

2. Eine Vorrichtung wie in Anspruch 1 beansprucht, worin das Steuerungsmittel (3) die Anzahl der nicht sofort verifizierten Blöcke jedes der Teilabschnitte bestimmt, so daß eine Zeit, die für eine den nicht sofort verifizierten Blöcken entsprechende Rotation des plattenartigen Aufzeichnungsmediums (8) erforderlich ist, länger ist als eine Zeit, die zum Vorbereiten des nächsten Aufzeichnungsvorgangs nach Vollendung der Verifikation erforderlich ist.

3. Eine Vorrichtung wie in Anspruch 1 beansprucht, worin das Steuerungsmittel (3) Speichermittel (9) einschließt, um vorübergehend Daten, die den nicht sofort verifizierten Blöcken entsprechen, bis zur nächsten Verifikation zu speichern.

Revendications

1. Appareil d'enregistrement/reproduction d'informations, comportant :
des moyens d'enregistrement (7) pour en-

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registrer une information sur un support d'enregistrement en forme de disque (8) pouvant tourner grâce à des moyens de rotation ;

des moyens de reproduction (7) pour reproduire l'information enregistrée sur ledit support d'enregistrement en forme de disque (8) par lesdits moyens d'enregistrement (7) ; et

des moyens de commande (3) pour commander lesdits moyens d'enregistrement (7) et lesdits moyens de reproduction (7) de façon à enregistrer l'information sur ledit support d'enregistrement en forme de disque (8) et à reproduire l'information enregistrée sur celui-ci pour la vérification de l'information enregistrée, lesdits moyens de commande (3) divisant l'information à enregistrer en deux ou plusieurs parties de telle sorte que la première partie divisée soit enregistrée successivement en un premier groupe d'une pluralité de blocs formés successivement de façon circonférentielle sur ledit support d'enregistrement en forme de disque (8), puis ensuite reproduite pour la vérification avant que la deuxième partie divisée soit successivement enregistrée en un deuxième groupe de blocs qui sont consécutifs audit premier groupe de blocs, puis ensuite reproduite pour la vérification, l'enregistrement et la reproduction étant effectués de façon continue jusqu'à la dernière partie divisée, caractérisé en ce que l'appareil est adapté pour que, lors de la vérification, en ce qui concerne les parties de la première partie divisée à la partie divisée immédiatement avant la dernière partie divisée, seul le ou les blocs finaux des blocs de la partie divisée qui vient d'être enregistrée ne soient pas vérifiés immédiatement, mais soient, après l'enregistrement pour une partie divisée suivante, vérifiés en même temps que que les blocs de la partie divisée suivante autre que le ou les blocs finaux, et, en ce qui concerne la dernière partie divisée, tous les blocs de celle-ci soient vérifiés en même temps que les blocs précédemment enregistrés et non vérifiés.

2. Appareil selon la revendication 1, dans lequel lesdits moyens de commande (3) déterminent le nombre des blocs non vérifiés immédiatement de chacune des parties divisées, de telle sorte qu'un temps nécessaire pour la rotation dudit support d'enregistrement en forme de disque (8) correspondant aux blocs non vérifiés immédiatement soit plus long qu'un temps nécessaire pour préparer l'opération d'enregistrement suivante après l'achèvement de la vérification.

3. Appareil selon la revendication 1, dans lequel lesdits moyens de commande (3) comportent des moyens formant mémoire (9) pour mémoriser temporairement des données correspondant aux blocs non vérifiés immédiatement jusqu'à la vérification suivante.