



159159



G00002

- 1 -

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR HEAD POSITIONING CONTROL IN A
DISK DRIVE

BACKGROUND OF THE INVENTION

5 The present invention relates generally to a disk drive and, in particular, to a head positioning control technique.

 In general, in a hard disk drive, head positioning control is performed to position a
10 magnetic head to a target position (a target track or a target cylinder) on a disk medium. The magnetic head has a structure such that a read head comprised of, for example, a GMR (a giant magnetoresistive element) or a TMR (a tunnel MR) and write head are
15 mounted on the same slider as a separate unit. The read head is comprised of a read only head for reading recorded data from a disk medium. The write head is comprised of a head for writing data onto the disk medium.

20 In the disk drive, the magnetic head is usually mounted on a rotary type actuator and, by the driving of the actuator, moved to a target position on the disk medium. There, the read head and write head in the magnetic head are positioned in a different
25 position. Upon the recording and reproduction of data, therefore, it is necessary to adjust the moving of the magnetic head so that the magnetic head is

positioned on the same track on the disk medium. That
is, it is necessary to position the write head on a
target track upon the recording of data and to
position the read head on the target track upon the
5 reproduction of data.

The amount of movement involved upon the
adjustment of this movement is called as an offset.
The offset value is uniquely determined according to
the distance between the read head and the write head
10 and the radial position of the magnetic head over the
disk medium. That is, the offset value is calculated
from the distance between the read head and the write
head and the skew angle (differing dependent upon the
radial position) of the actuator.

15 Generally, at the time of manufacturing a disk
drive, the offset value is measured or calculated in
track units and stored as a fixed value in a memory (a
flash EEPROM, etc.) in the disk drive. A
microprocessor (CPU) in the drive reads out the offset
20 value from the memory at the time of performing head
positioning and uses this value to adjust the head
under the head position control. Or, the CPU performs
an approximate calculation from the offset value on a
plurality of reference measuring tracks and calculates
25 an offset value of a corresponding track.

As a method of the manufacture of the disk drive,
a disk medium with servo data recorded thereon by a

dedicated servo track writer is incorporated in the disk drive. In such a disk drive, a so-called disk runout is generated in the incorporating process. The disk runout is synchronized with the rotation of a spindle motor which rotates the disk medium.

If there is any disk runout, the physical radial position of the magnetic head varies even on the same track during one rotation of the disk medium and there is also a variation in the offset involved. If, in the disk drive involving a disk runout, any head positioning control is made with the use of a fixed value, which is an offset value in the track unit, there exists a positioning portion at a position displaced toward the inner or outer circumference side of the track on the magnetic head during one rotation of the track on the magnetic head.

In a disk drive, generally, the track over which recording is performed by the write head is made wider than the track over which reproduction is performed by the read head. For this reason, even if some positional displacement of the read head occurs, no lowering of the quality of the reproduction signal occurs at a data read mode. In recent years, the difference between the recording track width and the reproduction track width is made smaller due to an increased tendency toward a higher recording density of the disk drive, so that an allowable positional

variation in one circumference of the track is becoming smaller.

In order to solve such a problem, a method is proposed to correct an offset value in one
5 circumference of the track (for example, see JPN PAT APPLN KOKAI publication No. 2005-216378). According to this method, an offset value in one circumference of a track is corrected with the use of the absolute value and phase parameters of a runout amount relative
10 to each track. A method of measuring the runout amount relative to any track comprises, for example, of measuring the runout amount with an actuator fixed to a track of a measuring target.

As a method of measuring a runout amount, another
15 method is also proposed which comprises, with a head fixed to a given radial position from a rotation center on a disk medium, measuring a runout amount based on a time interval of a clock mark reproduction signal which is output from the head (for example, see
20 JPN PAT APPLN KOKOKU Publication 3198490).

As set out above, it is possible to, at a manufacturing step for example, measure a runout amount relative to any given track in the disk drive with a disk medium incorporated therein and correct an
25 offset value on one circumference of the track based on the runout amount. That is, it is possible to store a correction offset value (sometimes generally

referred to as offset information) on one
circumference of each track in a memory of the disk
drive.

5 If any external impact (shock), etc., acts on a
disk drive (a product) during or after its shipment,
there sometimes arises a positional displacement
(sometimes referred to as a disk shift) of a disk
medium fixed to a spindle motor. Upon the occurrence
of a disk shift, there occurs a variation in a disk
10 runout amount and phase, and any correct offset value
which was stored in the memory of the disk will become
invalid. When, in such disk drive, the magnetic head
is positioned on a target track on the disk medium, it
becomes impossible to effect a moving adjustment of
15 the magnetic head in one circumference of the track.
In the disk drive of a high recording density level,
therefore, a reproduction signal becomes lower in
quality at a data read mode and, in the worst case,
the reproduction of the recorded data becomes
20 impossible.

BRIEF SUMMARY OF THE INVENTION

It is accordingly the object of the present
invention to provide a disk drive which can correct
existing offset information according to a variation
25 of a disk runout amount involved upon the occurrence
of a disk shift and, at all times, realize highly
accurate head positioning control.

In one aspect of the present invention, there is provided a disk drive comprising a magnetic head including a write head configured to write data on a disk medium and a read head configured to read the data from the disk medium; an actuator configured to have the magnetic head mounted thereon; memory means for storing offset information for, when the magnetic head is positioned to a target position on the magnetic head, adjusting an offset set based on a positional relation between the write head and the read head; control means for, at a time of a data read/write operation, driving the actuator under control with the use of the offset information stored in the memory means and positioning the write head or read head to a target position on the disk medium; measuring means for measuring a disk runout amount and phase at an operation other than the write operation; and offset information updating means for generating correction offset information according to a result of measurement by the measuring means and updating the offset information of the memory means by the correction offset information.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the

detailed description of the embodiments given below,
serve to explain the principles of the invention.

FIG. 1 is a block diagram showing a main section
of a disk drive relating to an embodiment of the
5 present invention;

FIG. 2 is a view for explaining a track format
relating to the present embodiment;

FIG. 3 is a view for explaining a track format
relating to the present embodiment;

10 FIG. 4 is a view showing the characteristics of a
disk runout amount relating to the present embodiment;

FIG. 5 is a view for explaining the contents of
offset information relating to the present embodiment;

15 FIG. 6 is a flowchart for explaining a process of
an offset information correction operation relating to
the embodiment;

FIG. 7 is a view showing an error profile
associated with a correction operation relating to the
present embodiment; and

20 FIG. 8 is a view showing an error profile
associated with a correction operation relating to the
present embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The embodiment of the present invention will be
25 explained below with reference to the drawing.

[Structure of Disk Drive]

FIG. 1 is a block diagram showing a main section

of a disk drive relating to the present embodiment.

A disk drive 100 has, as shown in FIG. 1, a disk medium 1, a spindle motor (SPM) 2 for rotating the disk medium 1 and a rotary type (or a swing arm type) actuator 4 with a magnetic head 3 mounted on it.

The disk medium 1 is comprised of, for example, a magnetic recording medium for recording data by a magnetic recording system. The magnetic head 3 is of such a type as to have a structure with a read head 3R and write head 3W separately mounted on the same slider. The read head 3R is comprised of, for example, a GMR element and serves as a read only head for reproducing recorded data from the disk medium 1. The write head 3W is used to magnetically record data on the disk medium 1.

The actuator 4 is driven by a voice coil motor (VCM) 5 to allow it to swing over the disk medium 1 in a radial direction. The actuator 4 is comprised of a mechanism configured to, under control of a later-described CPU, position the magnetic head 3 at a target position (target track or target cylinder) on the disk medium 1.

The disk drive 100 comprises a head amplifier 6, a read/write (R/W) channel 7, a microprocessor (CPU) 8, a memory 9, a VCM driver 10 and a disk controller (HDC) 11. The head amplifier 6 amplifies a read signal which is output from the read head 3R.

The read/write channel 7 includes a signal processing circuit for processing the read signal which is output from the read head 3R and reproducing the recorded data. Further, the read/write channel 7 allows the write data which is output from the disk controller 11 to be encoded and a write signal which is supplied to the write head 3W to be output. The read/write channel 7 includes a servo decoder 17 which detects the servo data from a read signal which is output from the head amplifier 4. The servo data is, as will be described later, data for use in the positioning control of the magnetic head 3- see FIG. 2.

The microprocessor (CPU) 8 constitutes a main control unit of the disk drive 100 and performs head positioning control with the use of the servo data which is output from the servo decoder 17. Further, the CPU 8 controls data read/write operations under the cooperation of the disk controller 11. The disk controller 11 constitutes an interface between the disk drive 100 and the host system 200 and performs read/write data transfer control, etc.

The CPU 8 implements the head poisoning control by controlling the VCM driver 10 based on a position error between the position of the magnetic head 3 and the target position (access target track or cylinder). The VCM driver 10 contains a D/A converter for

supplying a drive current to a VCM 5 under control of the CPU 8 (under an operation control amount). The VCM driver 10 controls the rotation drive of the actuator 4 under control of the CPU 8.

5 The memory 9 includes a flash EEPROM accessed by the CPU 8 and volatile memory such as a DRAM and SRAM. The flash EEPROM stores parameters for calculating an offset value relating to a target position (target track or target cylinder) as well as a default value
10 of the disk runout amount and so on. The volatile memory stores, at any time, a disk runout amount and offset value calculated by the CPU 8. At a
15 positioning time of the read/write head (3R, 3W), the CPU 8 performs a position correction with the use of the calculated offset value.

(Track Format)

 The disk medium 1 has a large number of concentric tracks each used as a data storage area. Each track (or cylinder) 20 has, as shown in FIG. 2, a
20 servo sector 21 storing the servo data and data sector 22 storing the user data. In actuality, a track of one circumference on the disk medium 1 is such that, as shown in FIG. 3, a plurality of servo sectors 21 are arranged at predetermined intervals and that one
25 or a plurality of sectors 22 are provided between the respective servo sectors.

 The servo data includes, as shown in FIG. 2, a

servo mark 23, address data 24, servo burst data 25,
etc. The servo mark 23 is data which recognizes it as
being a servo sector 21. The address data 24 is a
code for detecting a track (cylinder) address and
5 sector address. The servo burst data 25 is data for
detecting a position error (an error relative to a
track center) of the head 3. The CPU 8 decides the
position of the magnetic head 3 over the disk medium 1
with the use of the servo data read out by the read
10 head 3R.

[Head Positioning Control and Offset Information
Updating]

In the disk drive 100 of the present embodiment,
at a time of a manufacturing process for example, a
15 disk runout amount relative to any given track is
measured after a disk medium 1 is incorporated, and
offset information corresponding to one circumference
of the track is calculated based on the disk runout
amount and is stored in a flash EEPROM of a memory 9.
20 This offset information is comprised of an offset
value (OFn) corresponding to a respective sector
address (sector number Sn) at each track (a track
number Tn of address data) as shown in FIG. 5. The
sector address (sector number Sn) is data for
25 identifying the servo sector 21 in the track.

Here, as a general method for measuring the disk
runout amount in any given track, an actuator 4 is

physically fixed by pushing it against a stopper in the disk drive 100 and the servo data is read out by a read head 3R from the one circumference of the track. The disk runout amount and phase are then calculated from a variation amount of the servo data. By such measuring method, it is possible to measure the disk runout amount corresponding to one circumference of any given track, as shown in FIG. 4.

In the disk drive shipped as a product as set out above, the offset information corresponding to one circumference of the track is calculated based on the disk runout amount measured at a time of manufacturing and, as shown in FIG. 5, stored in the flash EEPROM of the memory 9. As set out above, if any external shock, etc., acts on a disk drive shipped as a product, a disk shift occurs and the already measured disk runout amount and phase vary, so that the offset value (OFn) becomes ineffective.

According to the present embodiment, when any external shock acts on the disk drive 100, for example, during shipment as a product, the CPU 8 assumes it as generating a disk shift, directly measures a disk runout amount and phase shift amount corresponding to one circumference of the track and performs a correction operation on the offset information stored in the memory 9, as explained in more detail with reference to FIGS. 6 to 8.

When a given external shock is detected, for example, by an acceleration sensor provided in the disk drive 100, the CPU 8 performs a correction operation for correcting the offset information (See a flowchart of FIG. 6). Here, if a normal data read/write operation is performed, the CPU 8 performs a correction operation after the read/write operation has been finished.

The CPU 8 measures a disk runout amount and phase shift amount corresponding to one circumference of the track, that is, the respective servo data, on any given track of the disk medium 1- step S1. Stated in more detail, the CPU 8 performs the reproduction of the servo data by the read head 3R before and after the measurement target track while off-tracking the magnetic head 3. The CPU 8 calculates the disk runout amount and phase by measuring a reproduction error generation amount corresponding to the servo sector.

Here, it is desirable to avoid any error measurement caused by noise at a time of measurement by performing an error correction at a proper correction intensity level.

FIGS. 7 and 8 are views showing an error profile relating to the measurement operation. FIG. 7 shows an error profile as a result of measurement and FIG. 8 shows an error profile after correction. In FIGS. 7 and 8, the abscissa shows a servo sector number and

the ordinate shows a variation amount corresponding to a disk runout amount.

In FIG. 7, reference numeral 70 shows a reference level at a variation amount = zero and reference
5 numeral 73 corresponds to a center line of a measurement target track. Here, attention should be given to an area 75 where, for example, the number of reproduction error occurrences is about 0 to 2. This area 75 corresponds to a track state range over which
10 the disk runout occurs. The area 76 near to the area 75 corresponds to a neighboring area where the number of reproduction error occurrences is about 2 to 6. On the other hand, an outside 74 of the area 75 corresponds to, for example, "the number of
15 reproduction occurrences" is about 6 to 8, and an outside track area where a reproduction error correction cannot be made.

In the result of measurement, the difference between a maximum level 72 and minimum level 70 on a
20 resultant envelope means a variation amount caused by the disk runout. By specifying the peak position of the envelope it is possible to recognize the phase corresponding to the servo sector number.

The CPU 8 calculates a correction offset value
25 (OFCn) by adding the measured variation amount and phase to the offset value (OFn) on the measurement target track - step S2. That is, the offset value of

the respective servo sector is so corrected as to be positioned to a near center of the track width per sector. By the correction of the offset information, any local error generation due to the off-tracking is inhibited, to obtain a broader error generation margin. FIG. 8 shows a correction profile in the so-corrected case as set out above.

The CPU 8 updates the already existing offset information by storing in the memory 9 the correction offset value (OFCn), that is, a corrected offset value per servo sector, in step S3. The CPU 8 converts the variation amount and phase resulting from the disk runout to an offset value and stores in the memory 9 a correction offset value (OFCn), that is, a value obtained by correcting the existing offset value stored in the memory 9 on the basis of the offset value above-see FIG. 5.

The CPU 8 informs the occurrence of the disk shift and updating of the offset information to the host-system 200 through the disk controller 11. By doing so, the host system 200 can recognize the occurrence of an external impact, such as a shock, on the disk drive 100.

Where, on the drive disk of the present embodiment, an external force, such as a shock, acts, after it is shipped as a product, and a disk shift occurs on the disk medium 1 fixed on the spindle motor

2, the CPU 8 directly measures the disk runout amount and phase in track units and, based on the result of this measurement, performs update processing on the offset information for correcting the existing offset
5 information. By doing so, the CPU 8 can, even if the existing record track varies due to the occurrence of the disk shift, make an accurate positioning adjustment on that record track with the use of the correction offset value.

10 Stated in more detail, as shown in FIG. 7, when the already existing record track varies due to a disk shift, for example, data corresponding to a servo sector number 54 is read out by the read head 3R, it follows that, for the existing offset information, the
15 read head 3R is position-adjusted to an area indicated by the reference numeral 74. In this case, an uncorrectable read error is involved due to a shifting off the track area 75.

 By the use of the updated correction offset
20 information (correction offset value OFCn), on the other hand, the CPU 8 can position-adjust the read head 3R within a range of the track area 75. Thus, a read signal which is read out by the read head 3R is reproduced as a read error suppressed data. In other
25 words, even where any disk shift subsequently occurs due to any external shock, it is possible to correctly read out recorded data.

Here, as shown in FIG. 5, the CPU 8 sets in the memory 9 a flag (F) representing the occurrence of a disk shift and, by doing so, can recognize the storing of the correction offset information properly
5 corresponding to the disk shift. That is, by setting the correction offset value as a runout learned value at each sector address it is possible to adjust it against a variation of the disk runout amount. Since a disk shift may occur a plurality of times, an
10 appropriate number of bits is desirably prepared so that any specific disk shift occurrence time can be recorded as a correction offset value.

In the present embodiment, the position adjustment using the correction offset information may
15 be made at any of a data reproduction or write time.

According to the present invention, it is possible to correct the existing offset information according to a variation of a disk runout amount resulting from the occurrence of a disk shift and, by
20 doing so, realize a highly accurate head positioning control at all times.

[Other Embodiments]

Although in the present embodiment the offset information has been explained as being stored in the
25 flash EEPROM of the memory 9, the present invention is not restricted thereto and it may be recorded on a disk medium 1 at a specific area (system area).

Incidentally, there is sometimes the case where the offset information cannot be read out from on the disk medium 1 when a disk shift occurs. In any case, however, no problem occurs because updating is performed.

(Measuring Method of Disk Runout Amount and Phase)

The measuring method of the disk runout amount and phase may comprise dividing one circumference of a measurement target track into appropriate sectors and, while off-tracking a read head 3R, measuring a reproduction error generation amount, an error rate or a gain control value (AGC value) for adjusting an input signal for a read/write channel. The method comprises detecting a best point from a result of measurement and measuring a disk runout amount and phase from a maximal value and minimal value by joining each best point of these sectors.

Another measuring method may comprise, while off-tracking a read head 3R as set out above, predicting an error rate value with the use of parameters representing a signal quality as a statistical amount and obtaining a best point. This measuring method is already known (see T. Perkins and Z.A. Kerin, "A Window-Margin-Like Procedure for Evaluating PRML Channel Performance", IEEE Trans. Magn., Vol. 32, No. 2, pp1109-1114 (1995), for example). This measuring method is generally utilized as the function

included in the read/write channel in the field of a disk drive.

Further measuring methods may also be used which, from a result of measurement made on a variation of intervals of servo sectors, presumes the disk runout amount and phase. In general, if there is no disk runout, then all the sector intervals should be equal to each other. However, there exists a disk runout and, hence, a longer material and shorter interval portion occur. The disk runout amount can be calculated from a radius value which can be calculated from this time variation portion and track number.

In more detail, the CPU 8 detects a servo mark 23 included in respective servo sectors from a measurement target track and measures a time interval of a generating servo gate. The CPU 8 presumes a disk runout amount and phase based on the variation portion of the time interval of the servo gate as a result of the measurement.

This measurement method can be checked at any time in the case where the magnetic head 3 is on-tracked. It is, therefore, possible to, relative to a track on which recording is made under a present disk shift condition, periodically confirm the correction offset value and quickly detect a variation in the runout amount.

(Read Re-try Operation)

In disk drives in general, if a read error (reproduction error) occurs at a data read operation, the CPU 8 executes a re-try operation and re-executes a read operation on the same track. If the read error cannot be recovered by the re-try operation, the CPU 8 may perform the updating of the offset information in the present embodiment. By doing so, it is possible to suppress the read error caused by the generation of the disk shift. Here, if the CPU 8 applies correction offset information different from initially applied offset information during a re-try operation and, by doing so, obtains a coincidence with an offset value involved upon the recording of data on a read target track, then the CPU 8 allows a read operation. Immediately after the occurrence of a disk shift, the previously recorded tracks constitute a large proportion and, with a corresponding offset value first set as a default value, a correction offset value for a newly recording portion is used at a re-try operation time.

By doing so, newly recorded data tracks are sequentially increased and, when its ratio exceeds 50%, the CPU 8 can also replace the default value with a correction offset value. In this case, it is desirable to set a replacement unit against the default value, for example, per zone or per sub-zone.

By thus applying a plurality of such correction offset values at the re-trying operation time, it is possible to handle such a situation even in the case where the recording time is made over a time range before and
5 after the disk shift in one track.

(Track for Testing)

In the present embodiment, upon the occurrence of a disk shift, the measurement of the disk runout amount and phase is performed on any given track on
10 the disk medium. In this case, the CPU 8 may set a specific track on the disk medium 1 as a testing track and perform the measurement of the disk runout amount and phase on the testing track. In actual use, the testing track is a specific track provided in a system
15 area on the disk medium.

According to this method, for a respective measurement, a faster comparison is made with a result of a previous measurement and it is possible to achieve a high degree of accuracy. If the testing
20 track is a specific track included in the system area, it is possible to avoid erasing of recorded data on an adjacent track to a measurement target track at a measuring time.

(Notice of Back-up)

25 In the present embodiment, the CPU 8 performs processing of a notice to the host system 200 relating to the occurrence of the disk shift and updating of

the offset information. Here, if a disk shift occurs due to a shock, etc., to the disk drive 100, there is a possibility that such a disk shift exceeds an allowable value.

5 In such a case, if the disk drive is operated over a long period of time, this adds a further inconvenience. It is therefore desirable to provide a notice function to the disk drive 100 to the effect that a warning be given to the host system 200 against
10 the occurrence of a disk shift and a prompt backup be taken on the user side.

 Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to
15 the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit of scope of the general inventive concept as defined by the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A disk drive comprising:

a magnetic head including a write head configured to write data on a disk medium and a read head

5 configured to read out the data from the disk medium;

an actuator configured to have the magnetic head mounted thereon;

a memory unit configured to store offset information for, when the magnet head is positioned to
10 a target position over the disk medium, adjusting an offset based on a positional relation between the write head and the read head;

a controller configured to, at a data read/write operation time, drive the actuator under control with
15 the use of the offset information stored in the memory unit and position the write head or read head to the target position over the disk medium;

a measuring unit configured to measure a disk runout amount and phase of the disk medium at an
20 operation time other than the data read/write operation; and

an offset information updating unit configured to generate correction offset information according to a result of measurement by the measuring unit and update
25 the offset information of the memory means by the correction offset information.

2. A disk drive according to claim 1, wherein

the memory unit stores the offset information of the track unit on the disk medium and the offset information is an offset value set at each plurality of sectors; and the offset information updating unit
5 updates, for each track unit, the correction offset information constituted by a correction offset value generated based on a result of measurement performed by the measuring unit for each sector.

3. A disk drive according to claim 1, further
10 comprising a detection unit configured to detect the occurrence of a disk shift on the disk medium.

4. A disk drive according to claim 3, wherein the measuring unit and offset information updating unit are operated when the occurrence of the disk
15 shift is detected by the detection unit.

5. A disk drive according to claim 3, wherein the detection unit detects the occurrence of the disk shift when a read error occurring at a time of a data read operation cannot be recovered.

20 6. A disk drive according to claim 1, further comprising a noticing unit configured to notice the updating of the offset information by the offset information updating unit.

25 7. A disk drive according to claim 1, further comprising a unit configured to decide whether or not a result of measurement made by the measurement unit is an abnormal value upon comparison with a reference

value; and a unit configured to, when the result of comparison is an abnormal value, make a notice to that effect.

8. A disk drive according to claim 1, wherein
5 the memory unit is comprised of the disk medium.

9. A disk drive according to claim 1, wherein
the measuring unit measures the disk runout amount and
phase based on a result of measuring the intervals of
a plurality of servo sectors arranged on each track on
10 the disk medium.

10. A disk drive according to claim 1, wherein
the measuring unit and offset information updating
unit are operated when the read error cannot be
recovered by a re-trying operation which is done when
15 a read error is generated at a time of a data read
operation.

11. A disk drive according to claim 1, wherein,
at a time of a re-trying operation, the controller
selectively uses correction offset information
20 corresponding to a newly recorded sector, or offset
information corresponding to a before-updating sector,
at the read operation time.

12. A head positioning control method for use in
a disk drive comprising a magnetic head including a
25 write head configured to write data on a magnetic
medium and a read head configured to read out the data
from the disk medium, an actuator having the magnetic

head mounted thereon, and a memory unit configured to store offset information for, when the magnetic head is positioned to a target position over the disk medium, adjusting an offset which is set based on a positional relation between the write head and the read head, the method comprising:

- 5 measuring a disk runout amount and phase of the disk medium at a time of an operation other than a data read/write operation;
- 10 generating correction offset information according to a result of measurement by the measuring; and
- updating the offset information of the memory unit by the correction offset information.