

DESCRIPTION

RAID DEVICE

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to a RAID device.

BACKGROUND ART

[0002] Conventionally, as a technique for improving the reliability and availability of a computer, a technique called RAID (redundant arrays of inexpensive disks or redundant arrays of independent disks) 1 to RAID 6, RAID 10, or the like (hereinafter simply referred to as RAID) has been known.

[0003] In such a conventional technique, in a case where trouble occurs in any of storages, data stored in the failed storage can be restored by executing a rebuild process after replacing the failed storage with normal one.

CITATION LIST

Patent Literature

[0004] Patent Document 1: JP 2014-170370 A

Patent Document 2: JP 2014-123258 A

Patent Document 3: JP 2013-200764 A

SUMMARY OF INVENTION

Problem to be Solved by Invention

[0005] However, in the conventional technique, it is not easy for a user to grasp the progress degree of the rebuild process.

Means for Solving Problem

[0006] A RAID device according to an embodiment includes an execution unit and a

control unit. The execution unit executes a rebuild process of restoring data stored in one or more storage devices of a plurality of storage devices by using data stored in another storage device. The control unit controls a light emitting unit to cause the light emitting unit to emit light in different modes in accordance with a progress degree of the rebuild process.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is a diagram illustrating an example of an overall configuration of a computer according to a first embodiment;

FIG. 2 is a diagram illustrating an example of an external appearance of the computer according to the first embodiment;

FIG. 3 is a diagram illustrating an example of changes in a blinking cycle of an LED according to the first embodiment;

FIG. 4 is a flowchart illustrating an example of a procedure of a calculation process of a progress degree of a rebuild process according to the first embodiment;

FIG. 5 is a diagram illustrating an example of changes in the number of blinks of an LED per unit time according to a first modification;

FIG. 6 is a diagram illustrating an example of an overall configuration of a computer according to a second embodiment;

FIG. 7 is a diagram illustrating an example of changes in the number of blinked LEDs according to the second embodiment;

FIG. 8 is a diagram illustrating an example of an overall configuration of a computer according to a third embodiment;

FIG. 9 is a diagram illustrating an example of an external appearance of the computer according to the third embodiment;

FIG. 10 is a diagram illustrating an example of changes in blinking of a bar graph LED according to the third embodiment;

FIG. 11 is a diagram illustrating an example of an overall configuration of a computer according to a fourth embodiment;

FIG. 12 is a diagram illustrating an example of changes in blinking of a circular bar graph LED according to the fourth embodiment;

FIG. 13 is a diagram illustrating an example of an overall configuration of a computer according to a fifth embodiment;

FIG. 14 is a diagram illustrating an example of a display of a progress degree of a rebuild process according to the fifth embodiment; and

FIG. 15 is a flowchart illustrating an example of a procedure of a calculation process of a progress degree of a rebuild process according to a sixth embodiment.

DESCRIPTION OF EMBODIMENTS

[0008] (First Embodiment)

FIG. 1 is a diagram illustrating an example of an overall configuration of a computer 1 according to the present embodiment. As illustrated in FIG. 1, the computer 1 includes storages 2a and 2b, a RAID card (RAID controller card) 3, a main board 10, light emitting diodes (LEDs) 4a and 4b, and an LED control board 5. The computer 1 further includes a display device, such as a display (not illustrated), and an input device, such as a keyboard and a mouse, and has a hardware configuration using an ordinary computer. The computer 1 is an example of a RAID device in the present embodiment.

[0009] The storages 2a and 2b are storage devices, each being a hard disk drive (HDD), a solid-state drive (SSD) or the like. Hereinafter, the storages 2a and 2b are simply referred to as a storage 2 unless particularly distinguished from each other.

[0010] A RAID card 3 is an expansion card attached to the computer 1 and includes a RAID controller 31. The RAID controller 31 has a hardware configuration including a control device such as a processor and a storage device such as a flash memory. The RAID controller 31 includes an acquisition unit 32, an execution unit 33, a calculation unit 34, a transmission unit 35, and a reception unit 36. The function of the RAID controller 31 may be implemented by a software program or may be implemented by a hardware circuit.

[0011] The execution unit 33 controls the storage 2 by using a RAID 1 technique and executes the rebuild process. The rebuild process is a process which, when any of the storages 2 fails and is replaced with a new storage 2, restores data stored in the failed storage 2 by copying data to the replaced storage 2 from another storage 2 that does not fail.

[0012] The acquisition unit 32 acquires status information of the storage 2, a rebuild state, and an address at which the rebuild process has ended. The status information is information representing whether the status (operating state) of the storage 2 is normal or abnormal due to occurrence of trouble. The rebuild state is information representing whether or not the rebuild process is in progress in the storage 2. The address at which the rebuild process ends is an address that indicates a storage region in which data is completely copied from another storage 2 among the storage regions of the newly replaced storage 2 when the rebuild process is in progress.

[0013] The calculation unit 34 calculates the progress degree of the rebuild process when the rebuild process is in progress in the storage 2. The progress degree of the rebuild process is a numerical value indicating the ratio (percentage) of addresses, at which the rebuild process has ended, in the entire address space per storage 2. The entire address space per storage 2 is preset in a storage unit (not illustrated) or the like of the RAID controller 31. In the present embodiment, the progress degrees of the rebuild process of both the storage 2 as the data copy destination and the storage 2 as the copy source indicate the same value.

[0014] The transmission unit 35 transmits, to the LED control board 5, the progress degree of the rebuild process calculated by the calculation unit 34. In a case where the status information of the storage 2 represents abnormal, the transmission unit 35 transmits, to the LED control board 5, the matter that the status information of the storage 2 represents abnormal. The transmission unit 35 transmits a data read/write command to the storage 2 on the basis of a command from the main board 10.

[0015] The reception unit 36 receives the command to read and write data from the main board 10 to the storage 2.

[0016] The main board 10 is a board on which a central processing unit (CPU) 11, a read only memory (ROM), a random-access memory (RAM), and the like are mounted.

[0017] The LEDs 4a and 4b are examples of the light emitting unit in the present embodiment and are installed in the housing of the computer 1 in a state where the light emission can be visually recognized from the outside. Hereinafter, the LEDs 4a and 4b are simply referred to as an LED 4 unless particularly distinguished from each other. The LED 4 of the present embodiment is installed in each storage 2 one by one. The LED 4 lights (emits light) or turns off (switch off the light) under the control of the LED control board 5.

[0018] In a case where the rebuild process is in progress on the storage 2, the LED control board 5 causes the LED 4, which is associated with the storage 2 on which the rebuild process is in progress, to emit light in different modes in accordance with the progress degree of the rebuild process. In other words, the LED control board 5 displays the progress degree of the rebuild process by causing the LED 4 to emit light in the different modes in accordance with the progress degree of the rebuild process. More specifically, the LED control board 5 of the present embodiment changes the blinking cycle of the LED 4a in accordance with the progress degree of the rebuild process of the storage 2a, and changes the blinking cycle of the LED 4b in accordance with the progress degree of the rebuild process of the storage 2b. Details of the blinking cycle of the LED 4 will be described later.

[0019] When the status of the storage 2 is abnormal, the LED control board 5 causes the LED 4 to emit light in the mode different from a case where the rebuild process is in progress. In the present embodiment, in a case where the status of any of the storages 2 is abnormal, the LED control board 5 lights the LED 4 associated with the relevant storage 2.

[0020] In the present embodiment, although the power for the LED 4 to emit light is supplied from the main board 10 to the LED 4 through the LED control board 5, the power supply unit is not limited thereto.

[0021] FIG. 2 is a diagram illustrating an example of the external appearance of the

computer 1 according to the present embodiment. A drive bay 21a houses the storage 2a, and a drive bay 21b houses the storage 2b. The LED 4a is installed near the drive bay 21a, and the LED 4b is installed near the drive bay 21b. In the present embodiment, as an example, the LEDs 4a and 4b are installed below the drive bays 21a and 21b, respectively.

[0022] FIG. 3 is a diagram illustrating an example of changes in the blinking cycle of the LED 4 according to the present embodiment. The LED control board 5 of the present embodiment gradually changes the blinking cycle such that the lighting time of the LED 4 becomes shorter as the progress degree of the rebuild process becomes higher. Specifically, compared to a case where the progress degree of the rebuild process is "0 to 10%", the lighting time of the LED 4 is shorter in a case where the progress degree of the rebuild process is "11 to 50%". Further, compared to a case where the progress degree is "11 to 50%", the lighting time of the LED 4 is shorter in a case where the progress degree is "51 to 99%". The rebuild process ends when the progress degree reaches 100%, so that the blinking ends and the LED 4 turns off. The change in the blinking cycle illustrated in FIG. 3 is an example, and the present invention is not limited thereto.

[0023] FIG. 4 is a flowchart illustrating an example of a procedure of a calculation process of the progress degree of the rebuild process according to the present embodiment. The RAID controller 31 executes the processes of this flowchart while the computer 1 is in operation.

[0024] The acquisition unit 32 acquires the status information and the rebuild state from each storage 2 (S1). The transmission unit 35 determines whether or not the statuses of the storages 2a and 2b acquired by the acquisition unit 32 are "normal" (S2).

[0025] In a case where the status of any of the storages 2 is "abnormal" (S2 "No"), the transmission unit 35 transmits, to the LED control board 5, the matter that the status of the relevant storage 2 is "abnormal" (S3). For example, the transmission unit 35 transmits, to the LED control board 5, information that identifies the storage 2 having an "abnormal" status out of the plurality of storages 2. In this case, the LED control

board 5 controls and lights the LED 4 that is associated with the storage 2 having an "abnormal" status.

[0026] On the other hand, in a case where the status of the storage 2 is "normal" (S2 "Yes"), the acquisition unit 32 determines whether or not the storage 2 is in the rebuild process, on the basis of the rebuild state acquired in the process of S1 (S4). In a case where any of the storage 2 is not in the rebuild process (S4 "No"), the process ends.

[0027] In a case where any of the storages 2 is in the rebuild process (S4 "Yes"), the acquisition unit 32 acquires, from the storage 2, the address at which the rebuild process ends (S5). Then, the calculation unit 34 calculates the progress degree of the rebuild process on the basis of the entire address space per storage 2 and the address acquired by the acquisition unit 32, at which the rebuild process has ended (S6).

[0028] The transmission unit 35 transmits the calculated progress degree of the rebuild process to the LED control board 5 (S7). In this case, the LED control board 5 causes the LED 4 to blink at the blinking cycle in accordance with the progress degree of the transmitted rebuild process.

[0029] On the basis of the progress degree calculated in the process of S6, the transmission unit 35 determines whether or not the rebuild process ends (S8). When the progress degree of the rebuild process is less than 100%, the transmission unit 35 determines that the rebuild process does not end (S8 "No"), and the processes of S5 to S7 are repeated.

[0030] On the other hand, when the progress degree of the rebuild process is 100%, the transmission unit 35 determines that the rebuild process ends (S8 "Yes"), and transmits to the LED control board 5 the matter that the rebuild process ends (S9). In this case, the LED control board 5 brings the blinking of the LED 4 to an end.

[0031] In recent years, there is a tendency that the time required for the rebuild process becomes longer due to an increase in the capacity of the storage or the like, and there is a growing need to grasp the progress degree of the rebuild process. Further, even if the progress degree of the rebuild process is displayed on the relevant display of the computer 1, the progress degree cannot be grasped in a case where a user is not in front

of the display due to work or the like. Thus, it may take time and effort to confirm the progress degree. In general, in a case where the computer 1 is used in a data center, a plant, or the like, a monitoring screen of the plant or the like is already displayed on the display (not illustrated) of the computer 1. Therefore, in a case where the rebuild process is executed, it may be difficult to further display the progress degree of the rebuild process on the display.

[0032] In contrast, according to the computer 1 of the present embodiment, the LED control board 5 controls the LED 4 to cause the LED 4 to emit light in the different modes in accordance with the progress degree of the rebuild process, so that the user can easily grasp the progress degree the rebuild process.

[0033] The computer 1 of the present embodiment causes the LED 4 to blink during execution of the rebuild process and changes the blinking cycle of the LED 4 in accordance with the progress degree of the rebuild process. Therefore, according to the computer 1 of the present embodiment, the user can easily grasp the execution and the progress degree of the rebuild process even from a distant position.

[0034] While the computer 1 is an example of the RAID device in the present embodiment, the RAID device may be the RAID card 3 or the RAID controller 31 installed in the RAID card 3. Further, a configuration may be adopted such that a chipset mounted on the main board 10, a dedicated circuit, a CPU 11, or the like has the functions of the RAID controller 31 or the LED control board 5 of the present embodiment. The functions of the LED control board 5 of the present embodiment may be implemented by a software program executed by the CPU 11 or the RAID controller 31.

[0035] In the present embodiment, the acquisition unit 32 of the computer 1 acquires whether or not the rebuild process is in progress from the storage 2. Alternatively, for example, a configuration may be adopted such that the status of whether or not the rebuild process is in progress is determined on the basis of the signal to start the rebuild process received by the reception unit 36 from the main board 10.

[0036] Further, in the present embodiment, while the configuration of the RAID 1 in

which the computer 1 includes two storages 2 is described as an example, the present invention is not limited to the number of the storages 2 and the applied type of the RAID.

[0037] (First Modification)

The computer 1 of the first embodiment changes the blinking cycle of the LED 4 in accordance with the progress degree of the rebuild process. The change in the light emission mode of the LED 4 is not limited to this.

[0038] FIG. 5 is a diagram illustrating an example of changes in the number of blinks of the LED 4 per unit time t_1 according to this modification. The LED control board 5 of the present modification changes the number of blinks of the LED 4 per predetermined unit time t_1 step by step in accordance with the progress degree of the rebuild process. As illustrated in FIG. 5, compared to a case where the progress degree of the rebuild process is "0 to 10%", the number of blinks of the LED 4 per unit time t_1 is greater in a case where the progress degree is "11 to 50%". Further, compared to a case where the progress degree is "11 to 50%", the number of blinks of the LED 4 per unit time t_1 is greater in a case where the progress degree is "51 to 99%". The number of blinks illustrated in FIG. 5 is an example, and the present invention is not limited thereto.

[0039] (Second Embodiment)

The computer 1 of the first embodiment shows the progress degree of the rebuild process by the change in the blinking cycle of the LED 4. In contrast, in the second embodiment, the progress degree of the rebuild process is shown by changing the number of blinked LEDs 4.

[0040] FIG. 6 is a diagram illustrating an example of an overall configuration of a computer 201 according to the present embodiment. The computer 201 includes the storages 2a and 2b, the RAID card 3, the main board 10, LEDs 4c to 4h (light emitting units), and an LED control board 205. The storages 2a and 2b, the RAID card 3, and the main board 10 have the same functions as in the first embodiment.

[0041] In addition to the functions of the first embodiment, the LED control board 205 of the present embodiment displays the progress degree of the rebuild process by

changing the number of blinked LEDs 4 out of the plurality of LEDs 4 installed in the storages 2, in accordance with the progress degree of the rebuild process for each storage 2. In a case where the status of any of the storages 2 is abnormal, the LED control board 205 lights all three LEDs 4 associated with the storage 2 being in the abnormal status.

[0042] FIG. 7 is a diagram illustrating an example of changes in the number of blinked LEDs 4 according to the present embodiment. The LED control board 205 changes the number of LEDs 4 to be blinked out of the LEDs 4c to 4e, in accordance with the progress degree of the rebuild process of the storage 2a. In the example of FIG. 7, in a case where the progress degree of the rebuild process of the storage 2a is "0 to 10%", the LED control board 205 causes the LED 4c to blink out of the LEDs 4c to 4e. When the progress degree of the rebuild process reaches "11 to 50%", the LED control board 205 causes the LEDs 4c and 4d to blink. When the progress degree of the rebuild process reaches "51 to 99%", the LED control board 205 causes all the three LEDs 4c to 4e to blink. The number of the LEDs 4c to 4e illustrated in FIG. 7 is an example, and the present invention is not limited thereto. Further, similarly to the example illustrated in FIG. 7, the LED control board 205 changes the number of LEDs 4 to be blinked out of the LEDs 4f to 4h in accordance with the progress degree of the rebuild process of the storage 2b.

[0043] The procedure of the process executed by the RAID controller 31 according to the present embodiment is the same as the procedure of the first embodiment described with reference to FIG. 4.

[0044] As described above, the computer 201 according to the present embodiment changes the number of blinked LEDs 4 out of the plurality of LEDs 4 associated with each storage 2, in accordance with the progress degree of the rebuild process for each storage 2. Therefore, according to the computer 201 of the present embodiment, the user can grasp the progress degree by the number of the turning-on LEDs 4. Thus, it is not required for the user to continue visually recognizing the LED 4, and it is possible for the user to grasp the progress degree of the rebuild process in a shorter time.

[0045] (Third Embodiment)

In the second embodiment, the progress degree of the rebuild process is shown by changing the number of blinked LEDs 4. In contrast, in the third embodiment, the progress degree of the rebuild process is displayed by a bar graph LED (LED level meter) in which a plurality of LEDs is arranged in a bar graph shape.

[0046] FIG. 8 is a diagram illustrating an example of an overall configuration of a computer 301 according to the present embodiment. The computer 301 includes the storages 2a and 2b, the RAID card 3, the main board 10, bar graph LEDs 304a and 304b, and an LED control board 305. The storages 2a and 2b, the RAID card 3, and the main board 10 have the same functions as in the first embodiment.

[0047] The bar graph LEDs 304a and 304b (hereinafter, referred to as a bar graph LED 304 unless particularly distinguished from each other) are light emitting units having a bar graph shape by arranging a plurality of LEDs in a straight line. The bar graph LED 304 is installed in each storage 2.

[0048] The LED control board 305 displays the progress degree of the rebuild process by changing the number of the blinked LEDs out of the plurality of LEDs included in the bar graph LED 304 in accordance with the progress degree of the rebuild process for each storage 2. When the status of any of the storages 2 is abnormal, the LED control board 305 lights the bar graph LED 304 associated with the storage 2 having the abnormal status.

[0049] FIG. 9 is a diagram illustrating an example of the external appearance of the computer 301 according to the present embodiment. As illustrated in FIG. 9, the bar graph LED 304a is installed in front of the drive bay 21a in which the storage 2a is housed. Further, the bar graph LED 304b is installed in front of the drive bay 21b in which the storage 2b is housed. The bar graph LEDs 304a and 304b may be located near the drive bays 21a and 21b, respectively. The present invention is not limited to the installation positions of the bar graph LEDs 304a and 304b are not limited to ones illustrated in FIG. 9.

[0050] FIG. 10 is a diagram illustrating an example of changes in blinking of the bar

graph LED 304a according to the present embodiment. The LEDs included in the shaded portion of the bar graph LED 304a in FIG. 10 blink, and the LEDs in the other portion turn off. In a case where the storage 2a is in the rebuild process, the LED control board 305 causes the plurality of LEDs included in the bar graph LED 304a to blink in order from the bottom as the progress degree of the rebuild process of the storage 2a increases. Thus, the blinking range of the bar graph LED 304a widens as the progress degree of the rebuild process of the storage 2a increases. In FIG. 10, the bar graph LED 304a is described as an example, whereas the same is applied to the blinking change of the bar graph LED 304b.

[0051] The procedure of the process executed by the RAID controller 31 according to the present embodiment is the same as the procedure of the first embodiment described with reference to FIG. 4.

[0052] As described above, according to the computer 301 of the present embodiment, the progress degree of the rebuild process in each storage 2 can be shown in more detail by using the bar graph LED 304.

[0053] (Fourth Embodiment)

The computer 301 according to the third embodiment uses the bar graph LED 304 to display the progress degree of the rebuild process. In contrast, in a fourth embodiment, the progress degree of the rebuild process is displayed by pie chart LEDs in which a plurality of LEDs is arranged in a pie chart shape.

[0054] FIG. 11 is a diagram illustrating an example of an overall configuration of a computer 401 according to the present embodiment. The computer 401 includes the storages 2a and 2b, the RAID card 3, the main board 10, LEDs 414a and 414b, pie chart LEDs 424a and 424b, and an LED control board 405. The storages 2a and 2b, the RAID card 3, and the main board 10 have the same functions as in the first embodiment.

[0055] The pie chart LEDs 424a and 424b (hereinafter, referred to as a pie chart LED 424 unless particularly distinguished from each other) are light emitting units having a pie chart shape by arranging a plurality of LEDs in a circle shape. The pie chart LED 424 is installed in each storage 2. Further, the pie chart LED 424 is also referred to as

a circular bar graph LED.

[0056] The LEDs 414a and 414b (hereinafter, referred to as an LED 414 unless particularly distinguished from each other) are individual LEDs, and are located at the respective centers of the pie chart LEDs 424a and 424b, as an example. The pie chart LED 424 and the LED 414 are installed near the drive bay 21 in which each storage 2 is stored.

[0057] The LED control board 405 changes the number of blinked LEDs out of the plurality of LEDs included in the pie chart LED 424 in accordance with the progress degree of the rebuild process for each storage 2. In a case where the status of any of the storages 2 is abnormal, the LED control board 405 lights the LED 414 associated with the storage 2 being in the abnormal status.

[0058] FIG. 12 is a diagram illustrating an example of changes in blinking of the pie chart LED 424a according to the present embodiment. The LEDs included in the shaded portion of the pie chart LED 424a in FIG. 12 blink, and the LEDs in the other portion turn off. In a case where the storage 2a is in the rebuild process, the LED control board 405 causes the plurality of LEDs included in the pie chart LED 424a to blink in a clockwise order from the upper center as the progress degree of the rebuild process of the storage 2a increases. Therefore, the blinking range of the pie chart LED 424a is widened as the progress degree of the rebuild process of the storage 2a increases.

[0059] In the example of FIG. 12, the status of the storage 2a is normal, so that the LED 414a turns off. In a case where the status of the storage 2a is abnormal, the LED control board 405 turns on the LED 414a. In FIG. 12, the pie chart LED 424a and the LED 414a are described as an example, and the same is applied to the light emission mode of the pie chart LED 424b.

[0060] The procedure of the process executed by the RAID controller 31 according to the present embodiment is the same as the procedure of the first embodiment described with reference to FIG. 4.

[0061] As described above, according to the computer 401 of the present embodiment, the progress degree of the rebuild process in each storage 2 can be shown in more detail

with a small installation area by using the pie chart LED 424.

[0062] (Fifth Embodiment)

In the first to fourth embodiments, although the display of the progress degree of the rebuild process is completed by the processes of the computers 1, 201, 301, and 401, the display method is not limited to this. In the fifth embodiment, the progress degree of the rebuild process is transmitted to another device by visible light communication, and thereby the progress degree can be displayed on another device.

[0063] FIG. 13 is a diagram illustrating an example of an overall configuration of a computer 501 according to the present embodiment. The computer 501 includes the storages 2a and 2b, the RAID card 3, the main board 10, the LEDs 4a and 4b, an LED control board 5, and a modulation circuit 6. The storages 2a and 2b, the RAID card 3, the main board 10, the LEDs 4a and 4b, and the LED control board 5 have the same functions as in the first embodiment.

[0064] In a case where the LED control board 5 causes the LED 4 to blink, the modulation circuit 6 modulates the blinking cycle of the LED 4 into a cycle representing the progress degree of the rebuild process for each storage 2, on the basis of a visible light communication protocol. The modulation circuit 6 may be provided on the LED control board 5 or the main board 10. The function of the modulation circuit 6 may be implemented by a software program.

[0065] By modulating the blinking cycle through the modulation circuit 6, the light output from the LED 4 serves as a signal representing the numerical value of the progress degree of the rebuild process on the basis of the visible light communication protocol. The visible light communication signal can be read by a device such as a smartphone or a tablet personal computer (PC), in which an application for reading data on the basis of the visible light communication protocol is installed in advance.

[0066] FIG. 14 is a diagram illustrating an example of a display of the progress degree of the rebuild process according to the present embodiment. An application for performing visible light communication is installed in a smartphone 7 illustrated in FIG. 14. The smartphone 7 interprets, by the above-mentioned application, the progress

degree of the rebuild process for each storage 2 from the light of the LED 4 captured by the camera mounted on the smartphone 7.

[0067] In the present embodiment, the smartphone 7 displays, on a display 71, a captured image as a background and displays the progress degree of the rebuild process while superposing on the displayed captured image. In the example illustrated in FIG. 14, the progress degree of the rebuild process of the storage 2a represented by the light of the LED 4a and the progress degree of the rebuild process of the storage 2b represented by the light of the LED 4b are both "11%". In this case, in the smartphone 7, the read progress degree value "11%" is displayed in the vicinity of each of the LEDs 4a and 4b on the image displayed on the display 71. The display mode illustrated in FIG. 14 is an example, and the present invention is not limited to this.

[0068] The procedure of the process executed by the RAID controller 31 according to the present embodiment is the same as the procedure of the first embodiment described with reference to FIG. 4.

[0069] As described above, in the computer 501 of the present embodiment, the LED 4 blinks at the cycle representing the progress degree of the rebuild process on the basis of the visible light communication protocol, so that the progress degree of the rebuild process can be displayed in a numerical value, such as a percentage, on the display 71 of the smartphone 7 or the like. Therefore, according to the computer 501 of the present embodiment, the user can grasp a more detailed progress degree. Further, according to the computer 501 of the present embodiment, within a range where visible light reaches, the user can easily grasp the progress degree of the rebuild process even at a distance where it is difficult to determine the blinking cycle of the LED 4 or the like with naked eyes.

[0070] In general, in a case where the blinking speed of the LED 4 in visible light communication is high, the LED 4 is visible to the naked eyes as if it continues lighting. Thus, it may be possible to employ a configuration that enables the naked eyes to recognize the blinking of the LED by slowing the blinking speed down.

[0071] (Sixth Embodiment)

In the sixth embodiment, as well as the status or the progress degree of the rebuild process for each storage 2 is displayed by the light emission of the LED 4 similarly to the first to fourth embodiments, an access frequency for each storage 2 is displayed by changing the light emission color of the LED 4.

[0072] Similarly to the first embodiment, the computer 1 of the present embodiment includes the storages 2a and 2b, the RAID card 3, the main board 10, the LEDs 4a and 4b, and the LED control board 5. The main board 10 and the storages 2a and 2b have the same functions as in the first embodiment.

[0073] In addition to the function of the first embodiment, the LED 4 of the present embodiment is a multi-color type LED that can emit a plurality of different colors of light. Specifically, the LED 4 of the present embodiment is a two-color LED capable of emitting red and green light. Alternatively, the LED 4 may be an RGB full color LED or the like.

[0074] The RAID card 3 of the present embodiment includes the RAID controller 31 that is the same as in the first embodiment. The RAID controller 31 includes the acquisition unit 32, the execution unit 33, the calculation unit 34, the transmission unit 35, and the reception unit 36 as in the first embodiment. The acquisition unit 32, the execution unit 33, and the reception unit 36 have the same functions as in the first embodiment.

[0075] In addition to the functions of the first embodiment, the calculation unit 34 of the present embodiment calculates the access frequency for each storage 2. The access frequency is a frequency of data reading/writing (access) executed by the CPU 11 mounted on the main board 10 to the storages 2a and 2b within a predetermined time.

[0076] More specifically, the calculation unit 34 totals, for each storage 2, the number of times of the data reading/writing executed for a predetermined time. In a case where the totaled number is equal to or more than a predetermined number, the calculation unit 34 calculates the access frequency at the relevant predetermined time as being "high". In a case where the totaled number is less than the predetermined number, the calculation unit 34 calculates the access frequency as being "low".

[0077] In addition to the functions of the first embodiment, the transmission unit 35 of the present embodiment transmits, to the LED control board 5, the access frequency for each storage 2 calculated by the calculation unit 34.

[0078] In addition to the function of the first embodiment, the LED control board 5 of the present embodiment causes the LED 4 to emit light in different modes in accordance with the access frequency for each storage 2. Specifically, in a case where the access frequency for each storage 2 is "high", the LED control board 5 causes the LED 4 associated with the relevant storage 2 to blink in red during execution of the rebuild process. On the other hand, in a case where the access frequency for each storage 2 is "low", the LED control board 5 causes the LED 4 associated with the relevant storage 2 to blink in green during execution of the rebuild process.

[0079] In general, in a case where the access frequency from the CPU 11 to the storage 2 is high, it takes a long time to end the rebuild process. For example, in a case where another process is in progress in parallel during the execution of the rebuild process, when the access frequency of the storage 2 is increased by the other process, the time until the rebuild process is ended may be lengthened.

[0080] In a case where the status of any of the storages 2 is abnormal, the LED control board 5 lights, in red, the LED 4 associated with the relevant storage 2. The light emission color of the LED 4 in the present embodiment is an example, and the present invention is not limited to this.

[0081] FIG. 15 is a flowchart illustrating an example of a procedure of a calculation process of the progress degree of the rebuild process according to the present embodiment. The processes from the acquisition of the status information and the rebuild state of the storage 2 of S1 to the transmission of the progress degree of the rebuild process of S7 are the same as those in the first embodiment.

[0082] After the transmission unit 35 transmits the progress degree of the rebuild process in progress to the LED control board 5 (S7), the calculation unit 34 calculates the access frequency ("high" or "low") for each storage 2 (S61).

[0083] Then, the transmission unit 35 transmits the access frequency for each storage 2

calculated by the calculation unit 34 to the LED control board 5 (S62). In a case where the transmitted access frequency for each storage 2 is "high", the LED control board 5 causes the LED 4 associated with the relevant storage 2 to blink in red. In a case where the transmitted access frequency for each storage 2 is "low", the LED control board 5 causes the LED 4 associated with the relevant storage 2 to blink in green.

[0084] The processes from the process of determining the end of the rebuild process of S8 executed after the process of S62 to the process of transmitting the end of the rebuild process of S9 are the same as in the first embodiment.

[0085] As described above, the computer 1 according to the present embodiment causes the LED 4 to emit light in different modes in accordance with the progress degree of the rebuild process, and further causes the LED 4 to emit light in different modes in accordance with the access frequency for each storage 2. Therefore, according to the computer 1 of the present embodiment, the user can more accurately estimate the time required to end the rebuild process on the basis of the access frequency for the storage 2 in which the rebuild process is in progress and the progress degree of the rebuild process.

[0086] Furthermore, according to the computer 1 of the present embodiment, by grasping the access frequency for the storage 2 in which the rebuild process is in progress is high, it is possible for the user to determine to temporarily stop the rebuild process and execute again the rebuild processing after the execution of the other process ends.

[0087] In the present embodiment, the access frequency is shown in two levels of "high" and "low". Alternatively, for example, the number of times of reading and writing for each storage 2 within a predetermined time may be used as the value of the access frequency.

[0088] In the present embodiment, a configuration is adopted in which the LED control board 5 causes the LED 4 to blink in different colors in accordance with the access frequency during the execution of the rebuild process. Alternatively, a configuration may be adopted in which the LED 4 lights in different colors in accordance with the

access frequency even during the period other than the execution of the rebuild process.

[0089] In the present embodiment, a configuration in which the LED 4 is caused to blink in different colors in accordance with the access frequency is combined with the configuration of the first embodiment. The configuration may be combined with the relevant configurations of the second to fifth embodiments.

[0090] As described above, according to the first to sixth embodiments, the RAID device is provided in which the user can easily grasp the progress degree of the rebuild process.

[0091] A calculation program of the progress degree of the rebuild process executed by the computer 1 of the present embodiment is provided to be pre-installed in the ROM or the like. Further, the calculation program of the progress degree of the rebuild process executed by the computer 1 of the present embodiment may be configured to be provided in the state of being recorded as an installable format or executable format of file in a computer-readable recording medium such as a CD-ROM, a flexible disk (FD), a CD-R, a digital versatile disk (DVD).

[0092] The calculation program of the progress degree of the rebuild process executed by the computer 1 of the present embodiment may be configured to be stored in a computer connected to a network such as the Internet and provided by being downloaded via the network. Further, the calculation program of the progress degree of the rebuild process executed by the computer 1 of the present embodiment may be provided or distributed via a network such as the Internet.

[0093] The calculation program of the progress degree of the rebuild process executed by the computer 1 of the present embodiment has a module configuration including the above-described units (the acquisition unit, the execution unit, the calculation unit, the transmission unit, and the reception unit). As an actual hardware, the CPU (processor) reads and executes the calculation program of the progress degree of the rebuild process from the ROM to load the above units onto a main storage device, and the acquisition unit, the execution unit, the calculation unit, the transmission unit, and the reception unit are generated on the main storage device.

[0094] Although several embodiments of the present invention have been described, these embodiments are provided as examples and are not intended to limit the scope of the invention. These new embodiments can be implemented in other various forms, and various omissions, replacements, and changes can be made without departing from the spirit of the invention. These embodiments and modifications thereof are included in the scope and the gist of the invention and are also included in the invention described in the claims and an equivalent range thereof.

CLAIMS

1. A RAID device comprising:
 - an execution unit configured to execute a rebuild process of restoring data stored in one or more storage devices of a plurality of storage devices by using data stored in another storage device; and
 - a control unit configured to control a light emitting unit to cause the light emitting unit to emit light in different modes in accordance with a progress degree of the rebuild process.
2. The RAID device according to claim 1, wherein the control unit changes a blinking cycle of the light emitting unit in accordance with the progress degree.
3. The RAID device according to claim 1, wherein the control unit changes a number of blinks of the light emitting unit per unit time in accordance with the progress degree.
4. The RAID device according to claim 1, wherein
 - more than one light emitting unit is installed in each of the storage devices, and
 - the control unit changes, in accordance with the progress degree of each storage device, a number of light emitting units to be blinked out of the more than one light emitting unit.
5. The RAID device according to claim 4, wherein the more than one light emitting unit is arranged in a bar graph shape or a pie chart shape, for each storage device.
6. The RAID device according to claim 1, further comprising a modulation unit configured to modulate, based on a visible light communication protocol, a blinking cycle of the light emitting unit into a cycle representing the progress degree.

7. The RAID device according to any one of claims 1 to 6, further comprising a calculation unit configured to calculate an access frequency being a number of times of access from a processor to the storage device within a predetermined time,
wherein the control unit further causes the light emitting unit to emit light in different modes in accordance with the access frequency.