US008700839B2

(12) **United States Patent**
**Chang et al.**

(10) **Patent No.: US 8,700,839 B2**
(45) **Date of Patent: Apr. 15, 2014**

(54) **METHOD FOR PERFORMING STATIC WEAR LEVELING ON FLASH MEMORY**

(75) Inventors: **Yuan-Hao Chang**, Tainan (TW); **Jen-Wei Hsieh**, Taipei (TW); **Tei-Wei Kuo**, Taipei (TW); **Cheng-Chih Yang**, Taipei (TW)

(73) Assignee: **Genesys Logic, Inc.**, Taipei (TW)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1298 days.

(21) Appl. No.: **11/963,262**

(22) Filed: **Dec. 21, 2007**

(65) **Prior Publication Data**

US 2008/0162796 A1 Jul. 3, 2008

(30) **Foreign Application Priority Data**

Dec. 28, 2006 (TW) ..... 95149542 A

(51) **Int. Cl.**

| | |
|---|---|
| ***G06F 12/00*** | (2006.01) |
| ***G06F 13/00*** | (2006.01) |
| ***G06F 13/28*** | (2006.01) |
| ***G06F 12/02*** | (2006.01) |
| ***G06F 3/06*** | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***G06F 12/0246*** (2013.01); ***G06F 12/00*** (2013.01); ***G06F 3/0688*** (2013.01); *G06F 2212/1036* (2013.01); *G06F 2212/7201* (2013.01); *G06F 2212/2022* (2013.01); *G06F 2212/7202* (2013.01); *G06F 2212/7205* (2013.01); *G06F 2212/7211* (2013.01); *G06F 2212/222* (2013.01)

USPC ..... **711/103**; 711/111; 711/112; 711/114; 711/154; 711/165; 711/170; 711/E12.002; 711/E12.008; 711/E12.059; 711/E12.078; 365/185.11; 365/185.33; 714/763; 714/773; 707/824

(58) **Field of Classification Search**

USPC ..... 711/104, E12.008, 103, 111, 112, 114, 711/154, 165, 170, E12.002, E12.059, 711/E12.078

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,479,638 A * 12/1995 Assar et al. ..... 711/103
5,485,595 A * 1/1996 Assar et al. ..... 711/103

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1840722 A2 * 10/2007 ..... G06F 3/06
JP 2003256289 A * 9/2003 ..... G06F 12/16

(Continued)

OTHER PUBLICATIONS

Endurance Enhancement of Flash-Memory Storage Systems: An Efficient Static Wear Leveling Design, Chang et al, DAC 2007, Jun. 4-8, 2007m pp. 212-217 (6 pages).*

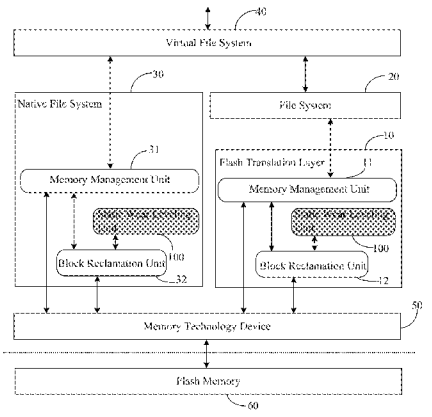
(Continued)

*Primary Examiner* — Arpan P. Savla
*Assistant Examiner* — Daniel C Chappell
(74) *Attorney, Agent, or Firm* — Kirton McConkie; Evan R. Witt

(57) **ABSTRACT**

A method for performing a static wear leveling on a flash memory is disclosed. Accordingly, a static wear leveling unit is disposed with a block reclamation unit of either a flash translation layer or a native file system in the flash memory, and utilizes less memory space to trace a distribution status of block leveling cycles of each physical block of the flash memory. Based on the distribution record of the block leveling cycles, the number of the leveling cycles less than a premeditated threshold would be found while the system idles. Then the static wear leveling unit requests the block reclamation unit to level the found blocks. Before leveling the from one block to another block which is leveled frequently, whereby accurate wear leveling cycles for the blocks can be averaged extremely.

**3 Claims, 6 Drawing Sheets**



(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 6,000,006 | A * | 12/1999 | Bruce et al. | 711/103 |
| 6,081,447 | A * | 6/2000 | Lofgren et al. | 365/185.02 |
| 6,230,233 | B1 * | 5/2001 | Lofgren et al. | 711/103 |
| 6,426,893 | B1 * | 7/2002 | Conley et al. | 365/185.11 |
| 6,594,183 | B1 * | 7/2003 | Lofgren et al. | 365/185.33 |
| 6,732,221 | B2 * | 5/2004 | Ban | 711/103 |
| 6,831,865 | B2 * | 12/2004 | Chang et al. | 365/185.33 |
| 6,850,443 | B2 * | 2/2005 | Lofgren et al. | 365/185.29 |
| 6,865,122 | B2 * | 3/2005 | Srinivasan | 365/200 |
| 6,973,531 | B1 * | 12/2005 | Chang et al. | 711/103 |
| 6,985,992 | B1 * | 1/2006 | Chang et al. | 711/103 |
| 7,012,835 | B2 * | 3/2006 | Gonzalez et al. | 365/185.11 |
| 7,120,729 | B2 * | 10/2006 | Gonzalez et al. | 711/103 |
| 7,224,607 | B2 * | 5/2007 | Gonzalez et al. | 365/185.11 |
| 7,353,325 | B2 * | 4/2008 | Lofgren et al. | 711/103 |
| 7,394,692 | B2 * | 7/2008 | Chen et al. | 365/185.11 |
| 7,441,067 | B2 * | 10/2008 | Gorobets et al. | 711/103 |
| 7,518,919 | B2 * | 4/2009 | Gonzalez et al. | 365/185.11 |
| 7,523,013 | B2 * | 4/2009 | Gorobets et al. | 702/177 |
| 7,523,249 | B1 * | 4/2009 | Estakhri et al. | 711/103 |
| 7,552,272 | B2 * | 6/2009 | Gonzalez et al. | 711/103 |
| 7,631,138 | B2 * | 12/2009 | Gonzalez et al. | 711/103 |
| 7,636,258 | B2 * | 12/2009 | Kux et al. | 365/185.18 |
| 7,688,643 | B2 * | 3/2010 | Lofgren et al. | 365/185.28 |
| 7,743,203 | B2 * | 6/2010 | France | 711/103 |
| 7,778,077 | B2 * | 8/2010 | Gorobets et al. | 365/185.09 |
| 8,060,718 | B2 * | 11/2011 | Freitas et al. | 711/165 |
| 8,065,469 | B2 * | 11/2011 | Mothilal | 711/103 |
| 8,082,386 | B2 * | 12/2011 | Kao et al. | 711/103 |
| 8,200,891 | B2 * | 6/2012 | Mukaida et al. | 711/103 |
| 8,200,892 | B2 * | 6/2012 | Mukaida | 711/103 |
| 8,205,036 | B2 * | 6/2012 | Chen et al. | 711/103 |
| 8,301,826 | B2 * | 10/2012 | Gonzalez et al. | 711/103 |
| 8,407,408 | B2 * | 3/2013 | Mothilal | 711/103 |
| 2003/0177302 | A1 * | 9/2003 | Pistilli | 711/103 |
| 2003/0227804 | A1 * | 12/2003 | Lofgren et al. | 365/200 |
| 2005/0102466 | A1 * | 5/2005 | Chen et al. | 711/103 |
| 2005/0114589 | A1 * | 5/2005 | Lofgren et al. | 711/103 |
| 2006/0075395 | A1 * | 4/2006 | Lee et al. | 717/168 |
| 2008/0320214 | A1 * | 12/2008 | Ma et al. | 711/103 |
| 2009/0043831 | A1 * | 2/2009 | Antonopoulos et al. | 707/205 |
| 2009/0089489 | A1 * | 4/2009 | Mukaida et al. | 711/103 |
| 2009/0122949 | A1 * | 5/2009 | Reid et al. | 377/15 |
| 2009/0241010 | A1 * | 9/2009 | Yano et al. | 714/764 |
| 2010/0037001 | A1 * | 2/2010 | Langlois et al. | 711/103 |
| 2010/0262875 | A1 * | 10/2010 | Hetzler et al. | 714/719 |
| 2010/0318719 | A1 * | 12/2010 | Keays et al. | 711/103 |
| 2011/0138109 | A1 * | 6/2011 | Liu et al. | 711/103 |
| 2011/0145474 | A1 * | 6/2011 | Intrater | 711/103 |
| 2011/0283044 | A1 * | 11/2011 | Olds et al. | 711/102 |
| 2012/0191927 | A1 * | 7/2012 | Gorobets et al. | 711/156 |
| 2012/0198137 | A1 * | 8/2012 | Mothilal | 711/103 |
| 2012/0246393 | A1 * | 9/2012 | Hashimoto | 711/103 |
| 2012/0271991 | A1 * | 10/2012 | Allen et al. | 711/103 |
| 2012/0303919 | A1 * | 11/2012 | Hu et al. | 711/165 |
| 2013/0036253 | A1 * | 2/2013 | Baltar | 711/103 |

FOREIGN PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| JP | 2007133683 | A * | 5/2007 |
| TW | 200406771 | | 5/2004 |
| TW | 200421349 | | 10/2004 |
| WO | WO 2007112555 | A1 * | 10/2007 |

OTHER PUBLICATIONS

Rejuvenator: A static wear leveling algorithm for NAND flash memory with minimized overhead, Murugan et al, 2011 IEEE 27th Symposium on Mass Storage Systems and Technologies (MSST), May 23-27, 2011, pp. 1-12 (12 pages).*

Improving Flash Wear-Leveling by Proactively Moving Static Data, Chang et al, IEEE Transactions on Computers, vol. 59, iss. 1, Jan. 2010, pp. 53-65 (13 pages).*

A Group-Based Hybrid Wear-Leveling Algorithm for Flash Memory Storage Systems, Liu et al, 2012 Third International Conference on Digital Manufacturing and Automation (ICDMA), Jul. 31, 2012-Aug. 2, 2012, pp. 58-61 (4 pages).*

Wear Leveling in Single Level Cell NAND Flash Memories, STMicroelectronics, AN1822 Application note, Nov. 2004.

* cited by examiner

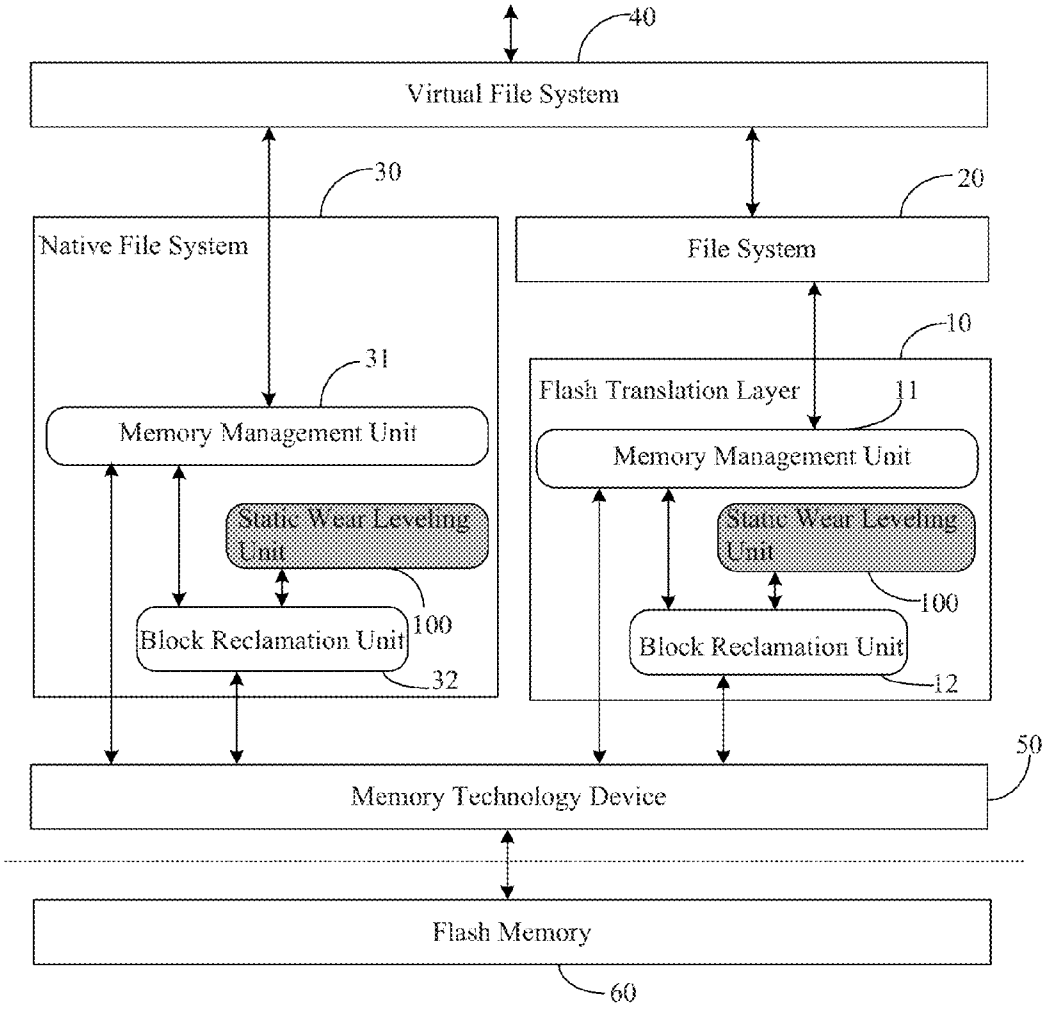

40
Virtual File System
30
20
Native File System
File System
10
31
Flash Translation Layer
11
Memory Management Unit
Memory Management Unit
Static Wear Leveling Unit
Static Wear Leveling Unit
100
100
Block Reclamation Unit
Block Reclamation Unit
32
12
50
Memory Technology Device
Flash Memory
60

FIG. 1

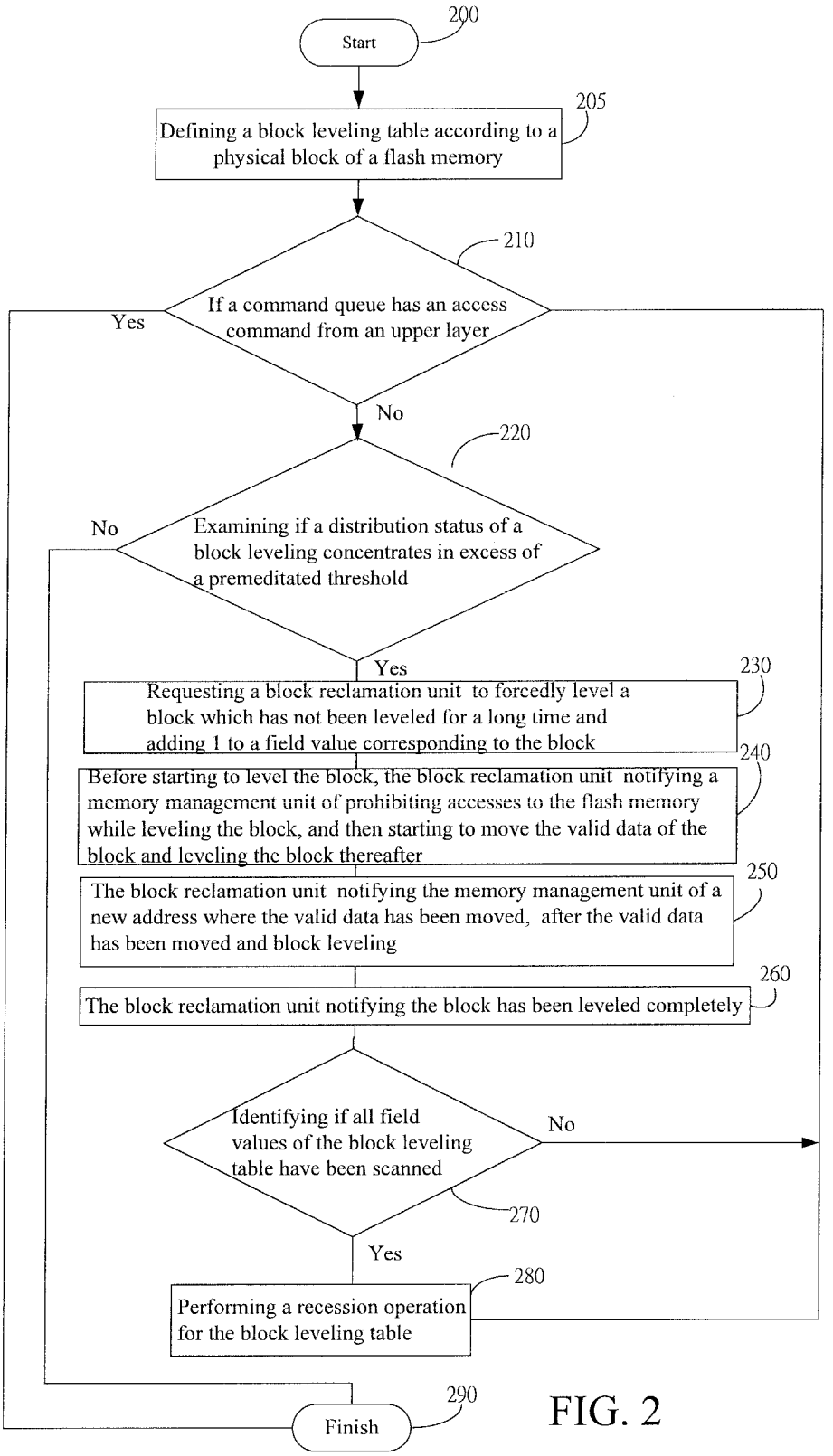

200
Start
205
Defining a block leveling table according to a physical block of a flash memory
210
If a command queue has an access command from an upper layer
Yes
No
220
Examining if a distribution status of a block leveling concentrates in excess of a premeditated threshold
No
Yes
230
Requesting a block reclamation unit to forcedly level a block which has not been leveled for a long time and adding 1 to a field value corresponding to the block
240
Before starting to level the block, the block reclamation unit notifying a memory management unit of prohibiting accesses to the flash memory while leveling the block, and then starting to move the valid data of the block and leveling the block thereafter
250
The block reclamation unit notifying the memory management unit of a new address where the valid data has been moved, after the valid data has been moved and block leveling
260
The block reclamation unit notifying the block has been leveled completely
Identifying if all field values of the block leveling table have been scanned
No
270
Yes
280
Performing a recession operation for the block leveling table
290
Finish

FIG. 2

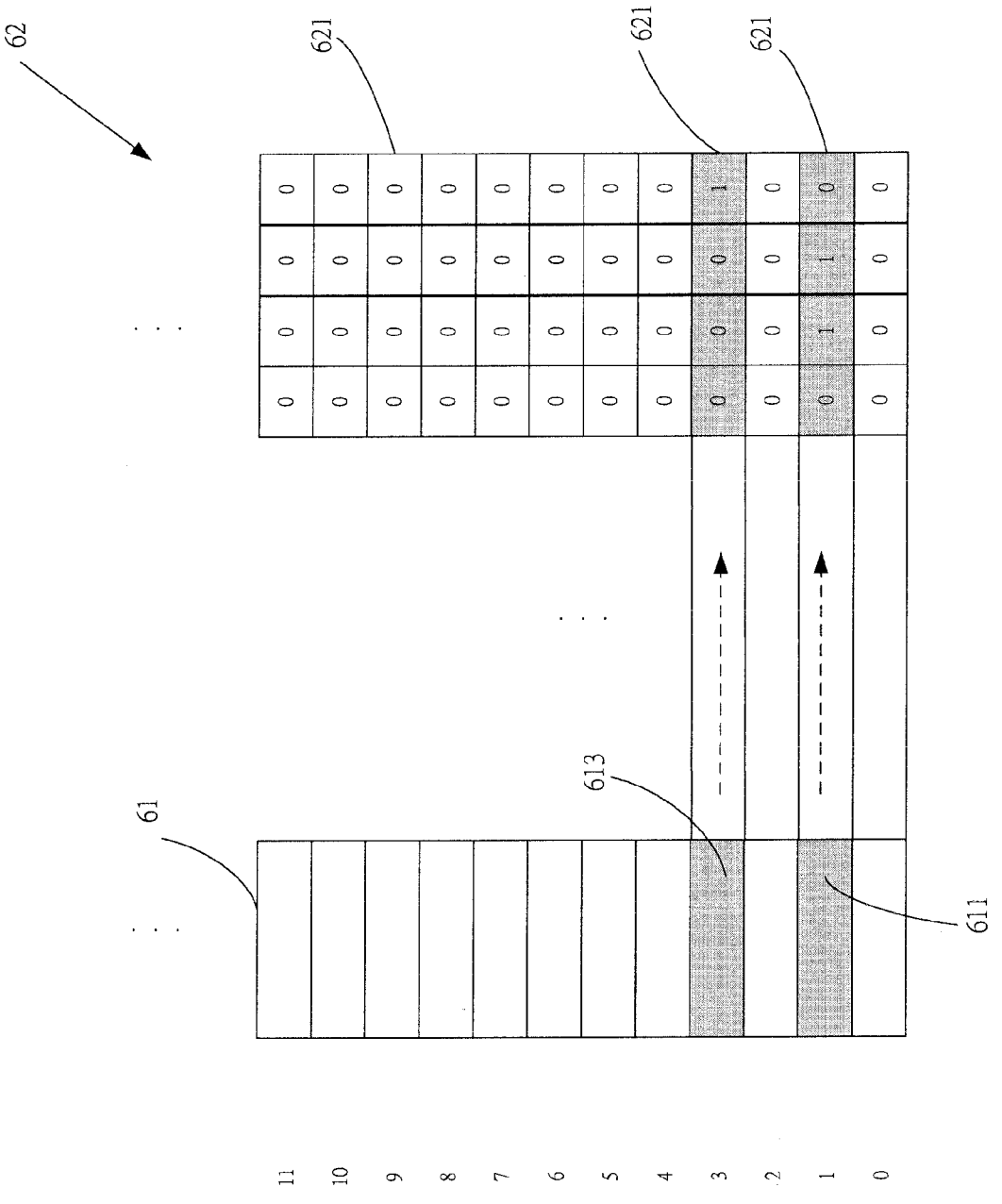



FIG.3

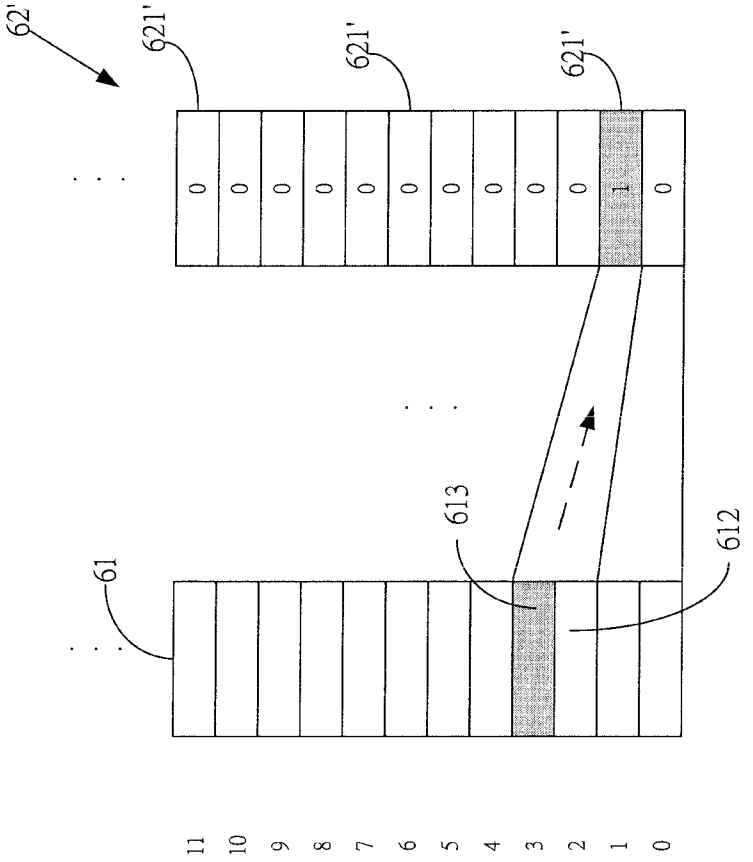



FIG. 4

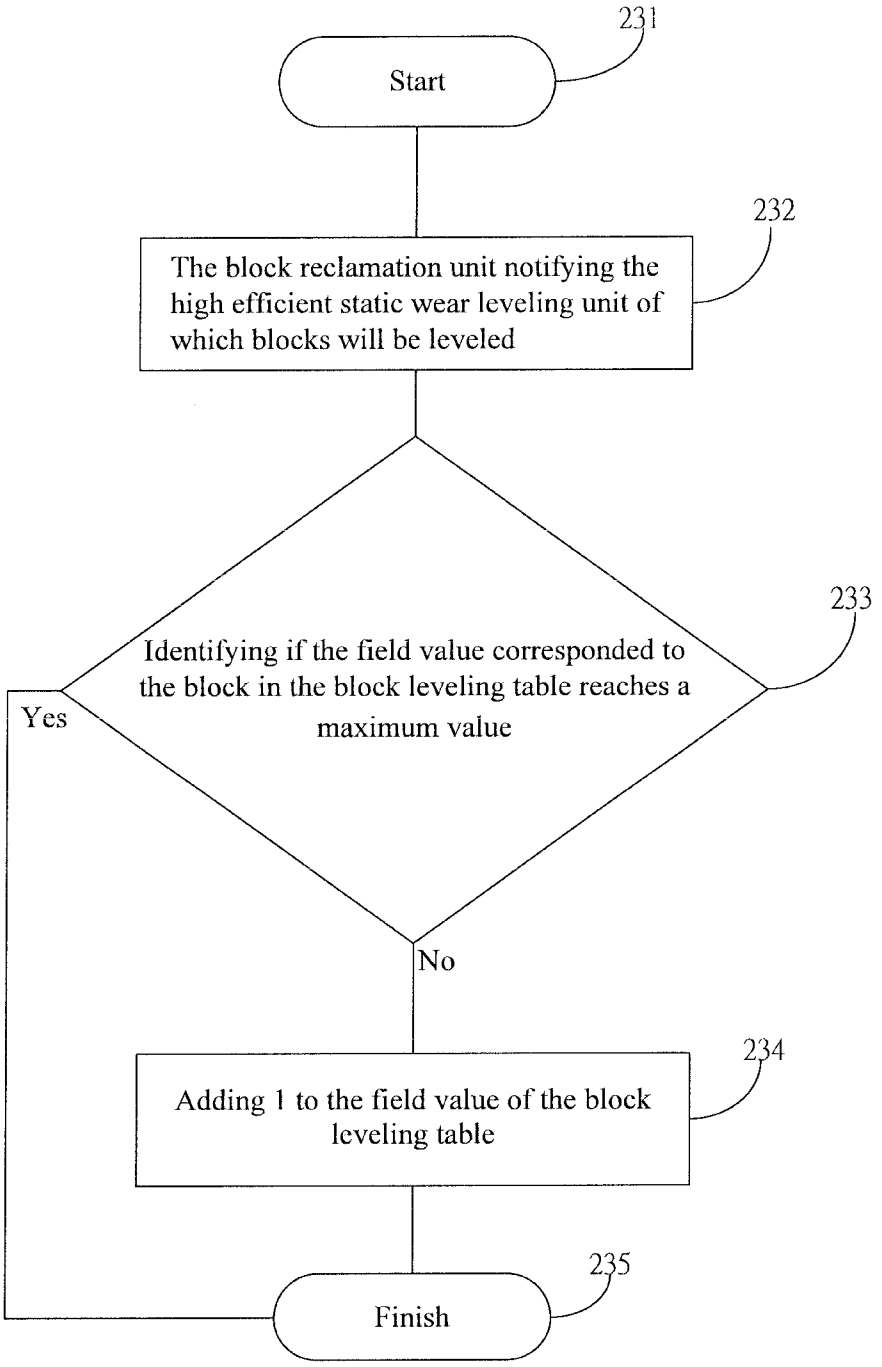

231
Start
232
The block reclamation unit notifying the high efficient static wear leveling unit of which blocks will be leveled
233
Identifying if the field value corresponded to the block in the block leveling table reaches a maximum value
Yes
No
234
Adding 1 to the field value of the block leveling table
235
Finish

FIG. 5

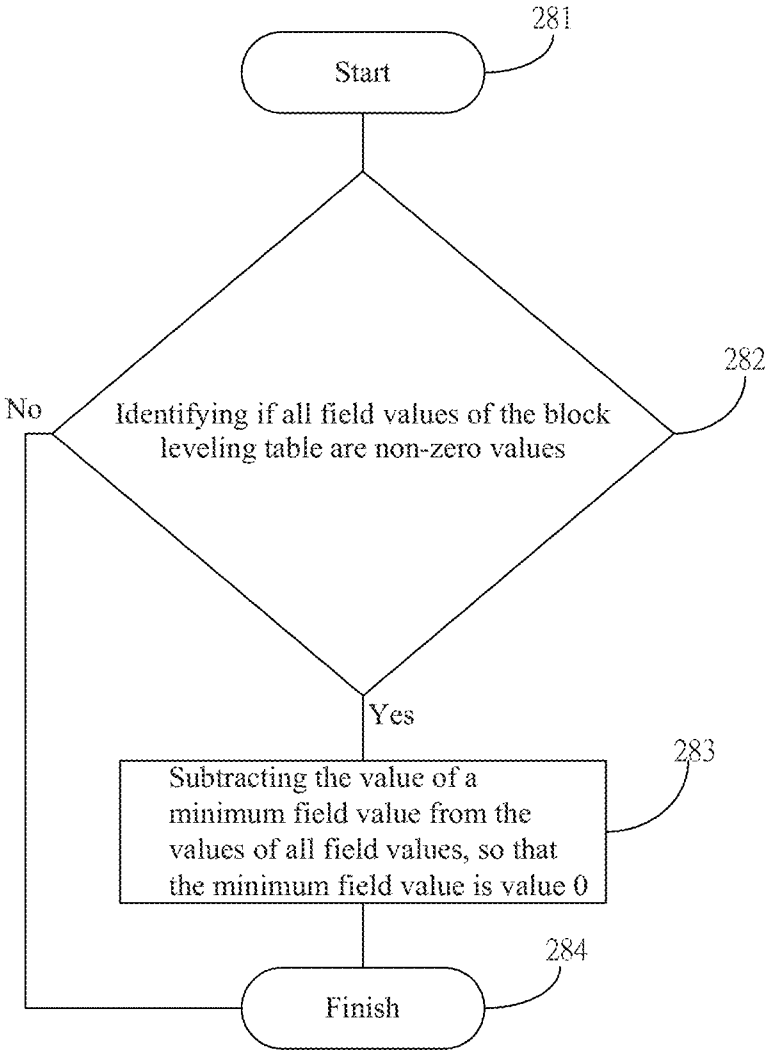

281
Start
282
Identifying if all field values of the block leveling table are non-zero values
No
Yes
283
Subtracting the value of a minimum field value from the values of all field values, so that the minimum field value is value 0
284
Finish

FIG. 6

# METHOD FOR PERFORMING STATIC WEAR LEVELING ON FLASH MEMORY

## FIELD OF THE INVENTION

The present invention generally relates to a method for performing a static wear leveling on a flash memory, and more particularly, to a wear leveling method used for a memory block leveling of a flash memory with accurate wear leveling cycles.

## BACKGROUND OF THE INVENTION

In a present flash memory data access management technique, a data stored in a flash memory block could not be read out correctly after block leveling of approximate one hundred thousand cycles. Such a matter that a flash memory block could not be read correctly due to excessive leveling cycles is generally called 'Write-through'. Since the flash memory has a limited service life, it is a significant topic to create how to procrastinate Write through of the block for prolongating the flash memory service life. For solving the problem, the conventional method approaches the wear leveling cycles of every block as equivalent as possible by evenly distributing the data into every block of the flash memory with utilizing of a Wear Leveling Scheme.

The conventional Wear Leveling Scheme comprises a Dynamic Wear Leveling Scheme and a Static Wear Leveling Scheme. The implementation of the Dynamic Wear Leveling Scheme is to update data or write a data into a free block of a system, wherein the free block is formed by leveling the block whose data are overdue. Therefore, advantages of the Dynamic Wear Leveling Scheme includes a simplified design, low cost, and block leveling cycles more than the predetermined amount. However, drawbacks of the Dynamic Wear Leveling Scheme are that the block which stores frequently updated data is leveled frequently and the block which stores rarely updated data is leveled infrequently; Therefore the leveling cycles of all blocks are not equalized.

In addition, an implementation of the Static Wear Leveling Scheme is to keep traces of the leveling cycles of every block. In other words, the Static Wear Leveling Scheme levels the less leveling-cycle block when the system needs extra free blocks. Therefore, the advantage of the Static Wear Leveling Scheme completely achieves the wear leveling for the blocks. However, the drawbacks of the Static Wear Leveling Scheme are higher system management expense, such as moving surplus data and consuming memory spaces required for traces of the leveling cycles of every block.

## SUMMARY OF THE INVENTION

To solve the foregoing drawbacks, an objective of the present invention is to provide a method for performing a static wear leveling on a flash memory, and this static wear leveling is capable of achieving the complete wear leveling under a less system management expense.

Another objective of the present invention is to provide a method for performing a static wear leveling on a flash memory, which only needs to dispose at least one static wear leveling unit having higher transplantation and versatility for a conventional flash translation layer or a block reclamation unit of a native file system.

In accordance with an aspect of the present invention, the method for performing the static wear leveling unit on the flash memory additionally disposes at least one highly efficient static wear leveling unit to a conventional flash translation layer or a block reclamation unit of a native file system, wherein the highly efficient static wear leveling unit traces a distribution status of the block leveling by using less memory spaces. Therefore, the static wear leveling unit examines a distribution record of the block leveling for finding out the block whose leveling cycles are less than a predetermined threshold when the system is idle, and then sends a request to the block reclamation unit to level the block. The data of such a block which is rarely updated would be compelled to move from a block to another block which is leveled frequently. This could average the leveling cycles of the blocks extremely to approach the effects of lower cost, higher transplantation and wear leveling.



## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** illustrates a system schematic diagram which caches an address translation layer of a flash memory by utilizing a method for performing a static wear leveling on a flash memory according to the present invention;

FIG. **2** illustrates a flow chart of caching an address translation layer of a flash memory in method according to the present invention;

FIG. **3** illustrates a diagram of a first embodiment for a block leveling table in the method according to the present invention;

FIG. **4** illustrates a diagram of a second embodiment for a block leveling table in the method according to the present invention;

FIG. **5** illustrates a flow chart of a maintenance operation for a block leveling table in the method according to the present invention;

FIG. **6** illustrates a flow chart of a recession operation for a block leveling table structure in the method according to the present invention;

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please refer to FIG. **1**. FIG. **1** illustrates a system schematic diagram which caches an address translation layer of a flash memory by utilizing a method for performing a static wear leveling on a flash memory according to the present invention. The conventional system communicates with a file system **20** such as FAT or EXT2 via a flash translation layer **10**. In addition, the conventional system also can directly communicate with a virtual file system **40** via a native file system **30** such as JFFS2 or YAFFS2 and access a flash memory **60** via a MTD (Memory Technology Device) **50**.

The flash translation layer **10** comprises a memory management unit **11** and a block reclamation unit **12**; likewise the native file system **30** also comprises a memory management unit **31** and a block reclamation unit **32**. Accordingly, the flash translation layer **10** and the native file system **30** are upwardly linked to the virtual file system **40** via the memory management unit **11** and the memory management unit **31**, respectively. In addition, the memory management unit **11** and the memory management unit **31** are downwardly linked to the block reclamation unit **12** and the block reclamation unit **32**, respectively, and thereby manage and perform a block leveling operation on the flash memory **60**.

The basic concept of the method according to the present invention is additionally dispose a static wear leveling unit **100** into either the block reclamation unit **12** of the flash translation layer **10** or the block reclamation unit **32** of the native file system **30**. By utilizing the flash translation layer **10** or the native file system **30** alternatively, the method of the present invention can achieve the effects of higher transplantation and wear leveling. In addition, the static wear leveling unit **100** can be implemented by a hardware circuit or software.

Please refer to FIGS. **2**, **3** and **4**. FIG. **2** illustrates a flow chart of caching an address translation layer of a flash memory in the method according to the present invention, as an operation of the static wear leveling unit **100** shown in FIG. **1**. Accordingly, the flow chart comprises the following steps from (**200**) to step (**290**).

After the system starts in step **200**, step (**205**) defines a block leveling table according to the physical block **61** of the flash memory **60**. In other words, as shown in FIG. **3** or **4**, the defined block leveling table **62** or **62'** is dependent on the number of the leveling cycles for the physical block **61** of a flash memory **60**. In FIG. **3**, the block leveling table **62** exhibits an one-to-multiple mode that a physical block **61** corresponds to a 4-bit field **621** value, wherein the first physical block **611** has been leveled for 6 cycles and the third physical block **613** has been leveled once as pointed by arrows in FIG. **3**.

As shown in FIG. **4**, the block leveling table **62'** exhibits a multiple-to-one mode that more than one physical block **61** corresponds to a 1-bit field value **621'**, wherein the second physical block **612** is a physical block without level and the third physical block **613** has been leveled. However, the block leveling table **62'** only provides that at least one physical block of both the second physical block **612** and the third physical block **613** has been leveled. Even though the accuracy of the mode is imperfect, the data still can be compelled to move and level only when the second physical block **612** and the third physical block **613** both corresponding to the same field value **621'** are never leveled.

However, if one of the second physical block **612** and the third physical block **613** has been leveled, then a data updated frequently would be written into other physical blocks **61**. Oppositely, if a data rarely updated is finally written into the physical blocks **61**, it means the data stored in the second physical block **612** and the third physical block **613** both are rarely updated and to be compelled to move. In addition, the block leveling table **62** or the block leveling table **62'** are stored in the static wear leveling unit **100** or the flash memory **60**, alternatively.

In step (**210**) the static wear leveling unit **100** examines if its command queue receives an access command from an upper layer as at least one of the flash translation layer **10** and the native file system **30**. If the static wear leveling unit receives any access command, then end the follow-up steps. Otherwise, the static wear leveling unit **100** operates after a specific period when the virtual file system **40** of the native file system **30** do not send any request to access the flash memory.

In step (**220**), at least one static wear leveling unit **100** examines if a distribution status of the block leveling concentrates in excess of a premeditated threshold. If yes, progressing the step (**230**), and otherwise, ending the follow-up steps.

In step (**230**), the static wear leveling unit **100** requests the block reclamation unit **12** or **32** of the flash translation layer **10** or the native file system **30** to force leveling a block which has not been leveled for a long time and add 1 to the field **621** or the field **621'** corresponding to the physical block **61**. It means that the physical block **61** corresponding to which value is 0 in the field **621** or the field **621'** of the block leveling table **62** or the block leveling table **62'** should be leveled by the block reclamation unit **12** or **32** in the flash translation layer **10** or the native file system **30**.

After adding 1 into the field **621** or **621'** whose value is 0, in the step **230**, a maintaining operation is performed for the block leveling table **62** or the block leveling table **62'**.

In step (**240**), before the block reclamation unit **12** or **32** requested by the static wear leveling unit **100** in the flash translation layer **10** or the native file system **30** starts to level the physical block **61** of the flash memory **60**, the block reclamation unit **12** or **32** notifies a memory management unit **11** or **31** to prohibit any access to the flash memory while leveling the block **61**, and then start to move the valid data stored in the physical block **61** that the static wear leveling unit **100** wants to level. Next, the static wear leveling unit **100** starts to level the physical block **61** whose valid data have been moved out.

In step (**250**), the block reclamation unit **12** or **32** notifies the memory management unit **11** or **31** of a new physical address where the valid data of the physical block **61** has been moved after the block reclamation unit **12** or **32** moves the valid data and then levels the physical block **61** so that the memory management unit **11** or **31** can update a corresponding relationship between the new physical address of the physical block **61** and a logical address of the valid data.

In step (**260**), the block reclamation unit **12** or **32** linked to the static wear leveling unit **100** notifies the memory management unit **11** or **31** that the physical block **61** has been leveled completely.

In step **270**, the static wear leveling unit **100** identifies if all field values of the block leveling table **62** or **62'** have been scanned by examining if all values in the field **621** or **621'** of the block leveling table **62** or **62'** appear 1. If yes, the next step **280** is performed; Otherwise the process goes back to step (**210**).

Step **280** performs a recession operation for the block leveling table **62** or **62'** and the process goes back to step (**210**). And, the system finish implements in FIG. **290**.

Please refer to FIG. **5**. FIG. **5** illustrates a flow chart of a maintaining operation for a block leveling table in the method according to the present invention, as mentioned in the step (**220**) in FIG. **2**. The flow chart comprises the steps from (**231**) to (**235**) as the followings.

The maintaining operation starts in step (**231**). In the next step (**232**), at least one of the block reclamation unit **12** or **32** in the flash translation layer **10** and the native file system **30** notifies the static wear leveling unit **100** of leveling the physical block which will be leveled in the flash memory **60**.

Step (**233**) identifies if the field value corresponded to the block in the block leveling table reaches a maximum value by examining if all values of the field **621** or **621'** for the block leveling table **62** or **62'** appear 0. If yes, the process goes to Step (**235**) to finish; Otherwise it goes to the step (**234**)

Step (**234**) adds 1 into the field **621** or **621'** whose value appears 0 for the block leveling table **62** or **62'**. Therefore in the flash memory **60**, an accurate leveling cycle of the physical block **61** can be examined.

Please refer to FIG. **6**, FIG. **6** illustrates a flow chart of a recession operation for a block leveling table in the method according to the present invention, as mentioned above in the step (**255**) of FIG. **2**. The flow chart comprises the following steps from (**281**) to (**284**).

The recession operation starts in the step (**281**). The next step (**282**) identifies if all values of the fields **621** or **621'** in the block leveling table **62** or **62'** appear non-zero by examining

if all values of the fields **621** or **621'** appear 1. If yes, the process goes to the step **283**; Otherwise it goes to the step **284** to finish.

Step (**283**) subtracts the values of the field **621** from the value of a minimum field **621** for the block leveling table **62** or subtracts the values of the field **621'** from the value of a minimum field **621'** for the block leveling table **62'**. Therefore, the value of the minimum filed **621** of the block leveling table **62** or the minimum filed **621'** of the block leveling table **62'** appears 0. The step (**284**) finishes the operation.

In conclusion, a basic concept of the static wear leveling unit **100** of the present invention is to trace the distribution status of each physical block **61** in the flash memory **60** by utilizing less memory space. By examining a record regarding to the leveling distribution, the static wear leveling unit **100** can find out the physical block **61** whose leveling cycles are less than the threshold when the system is idle (as the command queue does not receive any access command from the upper layer for a long time). Such a physical block **61** still stores data and hasn't been leveled for a long time. In addition, the static wear leveling unit **100** sends a request for leveling the physical block **61** to the block reclamation unit **12** or **32**. Therefore, the data rarely updated is compelled to move from a physical block **61** to another physical block **61** which is leveled frequently so that the leveling cycles for the physical block **61** are averaged extremely for a long period.

In addition, since the static wear leveling unit **100** only communicates with the block reclamation unit **12** or **32**, it only needs to add an interface into the block reclamation unit **12** of the flash translation layer **10** or the block reclamation unit **32** of the native file system **30** to communicate with the static wear leveling unit **100** without modifying other parts of the system. Therefore, the original operation scheme built with the memory management unit **11** of the flash translation layer **10**, the memory management unit **31** of the native file system **30**, the block reclamation unit **12** of the flash translation layer **10**, and the block reclamation unit **32** of the native file system **30** are all preserved.

As mentioned above, FIG. **1** to FIG. **6** illustrating the method for performing the static wear leveling on the flash memory according to the present invention should be understood by a person skilled in the art, the foregoing preferred embodiments of the present invention are illustrative rather than limiting of the present invention. It is intended that they cover various modifications and similar arrangements be included within the spirit and scope of the appended claims, the scope of which should be accorded the broadest interpretation so as to encompass all such modifications and similar structure.

What is claimed is:

**1**. A method for performing a static wear leveling on a flash memory, which is performed by at least one static wear leveling unit linked to a block reclamation unit of either a flash translation layer or a native file system having a memory management unit, wherein the block reclamation unit is linked to the flash memory for performing a leveling operation on a physical block of the flash memory, the method comprising the steps of:

(A) defining a block leveling table whose fields are used for traces of block leveling cycles of the physical block of the flash memory, then proceeding to step (B);

(B) examining if an access command has been received from at least one of the flash translation layer and the native file system, wherein if the access command is received, proceeding to step (M), and otherwise, proceeding to step (C);

(C) examining if a distribution status of the block leveling cycles concentrates block leveling cycles in excess of a premeditated threshold, wherein if the distribution status concentrates block leveling cycles to be in excess of the premeditated threshold, proceeding to step (D), and if the distribution status is smaller than the premeditated threshold, proceeding to step (M);

(D) requesting the block reclamation unit of either the flash translation layer or the native file system to force leveling of the physical block corresponding to a field whose value appears 0 in the block leveling table, proceeding to step (E);

(E) adding 1 into the field of the block leveling table whose value appears 0 and performing a maintaining operation, wherein the maintaining operation of the step (E) further comprises the steps of:

(E1) notifying the static wear leveling unit for leveling the physical block which is to be leveled by using at least one of the block reclamation unit of the flash translation layer and the native file system;

(E2) identifying if the field value corresponding to the physical block in the block leveling table reaches a maximum value by examining if the field value in the physical block of the block leveling table appears 0, wherein if the maximum value is not reached, proceeding to step (E3), and if the maximum value is reached, proceeding to step (E4);

(E3) adding 1 into the field of the block leveling table whose value appears 0 for performing the maintaining operation, and proceeding to step (E4); and

(E4) finished with the maintaining operation, proceeding to step (F);

(F) before the block reclamation unit starts to level the physical block of the flash memory, notifying the memory management unit to prohibit access to the flash memory, then proceeding to step (G);

(G) moving a valid data stored in the physical block which is to be leveled, then proceeding to step (H);

(H) the block reclamation unit starts to level the physical block whose valid data have been moved out, then proceeds to step (I);

(I) notifying the memory management unit of a new physical address to which the valid data of the physical block is moved after leveling the physical block for updating a corresponding relationship between the new physical address of the physical block to which the valid data has been moved and a logical address of the valid data, then proceeding to step (J);

(J) notifying the memory management unit that the physical block is leveled completely, then proceeding to step (K);

(K) identifying if all values of the fields in the block leveling table appear 1, then proceeding to step (L); and

(L) performing a recession operation in the block leveling table and then returning to step (B), wherein the recession operation further comprises the steps of:

(L1) identifying if all values of the fields in the block leveling table appear non-zero, wherein if all values of the fields appear non-zero, proceeding to step (L2), and otherwise, proceeding to step (L3);

(L2) subtracting the values of the fields of the block leveling table from the value of a minimum field of the block leveling table to achieve the value of the mini-

mum field of the block leveling table appearing 0, and proceeding to step (L3); and

(L3) finished with the recession operation; and

(M) finished with the method for performing a static wear leveling.

**2**. The method of claim **1**, wherein the block leveling table is a multi-bit value in step (B).

**3**. The method of claim **1**, wherein the block leveling table is a single-bit value in step (B).

* * * * *