Abstract: A holographic storage medium includes a hologram including data recorded in a plurality of pages in a superimposed fashion by interference of a signal beam and a reference beam, and an additional page recorded between two adjacent pages in the plurality of pages, wherein a portion of the data is recorded to a region of the additional page having a relatively small selectivity compared to other regions of the additional page without recording on the other regions.
Description

HOLOGRAPHIC STORAGE MEDIUM, RECORDING AND/OR REPRODUCING APPARATUS, AND RECORDING AND/OR REPRODUCING METHOD

Technical Field

[1] Aspects of the present invention relate to a holographic storage medium with an increased recording capacity, recording and/or reproducing apparatuses used with the holographic storage medium, and recording and/or reproducing methods used with the holographic storage medium.

Background Art

[2] In optical holography, data is not stored on a surface of a recording medium, but is stored in a volume thereof. A signal beam interferes with a reference beam within the recording medium to generate a plurality of interference gratings referred to as a data page. The interference gratings change the optical characteristics of the reference beam, causing overlapping to occur. This process is referred to as multiplexing. When data is read from the recording medium, a single reference beam is incident on the recording medium under the same conditions as the conditions used during the data recording to generate a diffraction beam having the stored data page. The diffraction beam is detected by a detection array, which extracts a stored plurality of data bits from a measured intensity pattern. The data page contains the data bits, which are also referred to as pixels. As such, when the data pages overlap in the volume of the recording medium, data storage capacity is increased.

[3] Referring to FIGs. IA, data is recorded to a holographic storage medium 100 using a signal beam S to carry the data and a reference beam R. During recording of the hologram 100, as illustrated in FIG. IA, the reference beam R and the signal beam S interfere with each other to generate an interference pattern, which is transferred to the holographic storage medium 100. During reproduction of data from the holographic storage medium 100, as illustrated in FIG. IB, the original reference beam R is radiated onto the recorded as a hologram on the holographic storage medium 100, and the recorded hologram recorded on the holographic storage medium 100 diffracts the reference beam to output the signal beam S. However, when the reference beam R used to reproduce data is different from an original beam used during the recording of data, the intensity or direction of a reproduced beam is different from the intensity or direction of the original recorded beam. Generally, as such a difference increases, the intensity of radiation is reduced by a shape defined by a sine function.

[4] FIG. 2 is a view illustrating angles according to regions of a signal beam S when data
is recorded on the holographic storage medium 100. Referring to FIG. 2, the signal beam S and a reference beam R are incident on the holographic storage medium 100. The signal beam S is modulated by an optical modulator, such as a spatial light modulator (SLM) 210, and focused in a shape of a page on the holographic storage medium 100. The SLM 210 has a surface with a flat shape. Angles of the signal beam S incident on the holographic storage medium 100 are different according to regions of the SLM 210. The SLM 210 is classified into a, b, c and d regions illustrated in FIG. 2 along a scanning direction of the reference beam R. An incidence angle and selectivity (i.e., a Bragg selectivity angle) of the signal beam S of each region may be calculated. The results are shown in Table 1.

<table>
<thead>
<tr>
<th>region</th>
<th>incidence angle (°)</th>
<th>selectivity (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>35.86</td>
<td>0.11</td>
</tr>
<tr>
<td>b</td>
<td>28.62</td>
<td>0.12</td>
</tr>
<tr>
<td>c</td>
<td>21.38</td>
<td>0.14</td>
</tr>
<tr>
<td>d</td>
<td>14.14</td>
<td>0.16</td>
</tr>
</tbody>
</table>

The incidence angle, at which the signal beam S is incident on the holographic storage medium 100, is an angle of the signal beam S with respect to a normal direction of the holographic storage medium 100 (i.e., a direction perpendicular to a recording surface of the holographic storage medium 100). The incidence angle is 35.86 ° in a region 'a' of the SLM, 28.62 ° in a region 'b,' 21.38 ° in a region 'c,' and 14.14 ° in a region 'd.' Thus, there is an angle difference of about 7.24 ° between adjacent regions. This angle difference is used because the signal beam S passes through an objective lens (not shown) having a numerical aperture (NA) before the signal beam S is incident on the holographic storage medium 100.

When a beam is incident at an angle greater than a predetermined angle with respect to the central axis, the beam is refracted outwards. The NA of the objective lens is proportional to a sine of the predetermined angle. When the beam is incident on the objective lens at an angle less than or equal to the predetermined angle, the beam is not refracted outwards, and instead is totally reflected so as to be spread within the objective lens. When the selectivity of the signal beam S each region is calculated, the smaller the incidence angle is, the greater the selectivity is. That is, the selectivity of the signal beam S varies according to the region of the SLM. Generally, high selectivity is desirable in order to reduce crosstalk. However, as the selectivity is
increased, the incidence angle at which data can be recorded is decreased, preventing high density recording and multiplexing of data to the holographic storage medium 100.

[9] FIG. 3 is a view illustrating the case where a page 300 is divided into regions. Referring to FIG. 3, a signal beam S is modulated by the SLM 210 to have a shape of the page 300 and is divided into A, B, C and D regions along a scanning direction of a reference beam R. FIG. 4 is a graph illustrating the selectivity measured in the regions A, B, C, and D illustrated in FIG. 3. Referring to FIG. 4, the selectivity varies according to the region, similar to the results shown in Table 1.

Disclosure of Invention

Technical Problem

[10] Thus, crosstalk values are different according to the region of the page 300. Maximum selectivity is selected and a recording interval is determined based on the selected maximum selectivity in order to minimize crosstalk between pages. As a result, realization of high density data recording is difficult.

Technical Solution

[11] Aspects of the present invention provide a holographic storage medium with an increased recording capacity, recording and/or reproducing apparatuses to be used with the holographic storage medium, and recording and/or reproducing methods to be used with the holographic storage medium.

Advantageous Effects

[12] According to aspects of the present invention, additional pages 520 are recorded without generating crosstalk between original pages 510 and 530 in a holographic storage medium 200. Thus, aspects of the present invention provide a holographic storage medium with an increased recording capacity.

Description of Drawings

[13] FIGs. 1A and 1B illustrate recording and reproducing operations in optical holography, respectively;

[14] FIG. 2 is a view illustrating angles according to regions of a signal beam when data is recorded on a holographic storage medium;

[15] FIG. 3 is a view illustrating the case where a page is divided into regions;

[16] FIG. 4 is a graph illustrating selectivity measured in the regions illustrated in FIG. 3;

[17] FIGs. 5A, 5B, and 5C are reference views illustrating a recording method according to an embodiment of the present invention;

[18] FIG. 6 is a view illustrating a book in which a plurality of pages are recorded in a superimposed fashion, according to an embodiment of the present invention;

[19] FIG. 7 is a block view illustrating a holographic storage medium recording and/or re-
producing apparatus according to an embodiment of the present invention;

[20] FIG. 8 is a flowchart illustrating a recording method according to an embodiment of the present invention; and

[21] FIG. 9 is a flowchart illustrating a reproducing method according to an embodiment of the present invention.

Best Mode

[22] According to an aspect of the present invention, a holographic storage medium in which a hologram including data is recorded by interference of a signal beam and a reference beam includes a plurality of pages on which the data is recorded in a superimposed fashion, and an additional page recorded between two adjacent pages in the plurality of pages, wherein a portion of the data is recorded to a region of the additional page having a relatively small selectivity compared to other regions of the additional page without recording on the other regions.

[23] According to an aspect of the present invention, a size of the additional page is different from a size of each of the two adjacent pages.

[24] According to an aspect of the present invention, a signal construction of the additional page is the same as a partial signal construction of each of the two adjacent pages, or is different from the partial signal construction of each of the two adjacent pages.

[25] According to an aspect of the present invention, the data recorded on the two adjacent pages comprises user data, and the portion of data recorded on the additional page comprises additional information other than the user data.

[26] According to another aspect of the present invention, a holographic storage medium in which a hologram including data which is recorded by interference of a signal beam and a reference beam includes a book comprising a first page and a second page which each include data and which are recorded to have a maximum selectivity based on the first page, and a third page having a smaller selectivity than the maximum selectivity recorded between the first page and the second page.

[27] According to another aspect of the present invention, a portion of the data is recorded to the third page and is positioned on a region of the third page having a relatively small selectivity compared to other regions of the third page and is not recorded to the other regions.

[28] According to another aspect of the present invention, a holographic storage medium recording apparatus to record data on a holographic storage medium includes a light processing unit to record data by interference of a signal beam and a reference beam on a plurality of pages on the holographic storage medium in a superimposed fashion, and a control unit to control the light processing unit so that an additional page is recorded between two adjacent pages in the plurality of pages, wherein a portion of the data is
recorded to a region of the additional page having a relatively small selectivity compared to other regions of the third page without recording on the other regions.

[29] According to another aspect of the present invention, a holographic storage medium reproducing apparatus to reproduce data recorded to a plurality of pages on a holographic storage medium in a superimposed fashion by interference of a signal beam and a reference beam, includes a light processing unit to reproduce the data from the holographic storage medium; and a control unit to control the light processing unit to reproduce a portion of the data from an additional page recorded between two adjacent pages in the plurality of pages, wherein the portion of data is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

[30] According to another aspect of the present invention, a method of recording data on a holographic storage medium in which data is recorded in a superimposed fashion by interference of a signal beam and a reference beam on a plurality of pages includes recording a portion of the data to an additional page between two adjacent pages in the plurality of pages, wherein the portion of data is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

[31] According to another aspect of the present invention, a method of reproducing data from a holographic storage medium in which data is recorded on a plurality of pages in a superimposed fashion by interference of a signal beam and a reference beam includes reproducing a portion of the data from an additional page recorded between two adjacent pages in the plurality of pages, wherein the portion of data of the additional page is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

Mode for Invention

[32] Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[33] Aspects of the present invention are based on the principle that additional pages may be recorded onto a holographic storage medium without affecting crosstalk between original pages, in order to increase a recording capacity of the holographic storage medium without increasing the crosstalk. Specifically, pages having at least two kinds of sizes are recorded in a manner in which crosstalk is not generated. Thus, the recording capacity of the holographic storage medium is increased in a beneficial manner.
A recording method according to an embodiment of the present invention will be described referring to FIGs. 5A, 5B, and 5C. In a conventional recording method, when selectivity is in the range of 0.1 degrees to 0.038 degrees according to each location of a page, pages are recorded in a superimposed fashion to be spaced at an angle of 0.038 degrees, which corresponds to a maximum selectivity for each page, in order to remove crosstalk between the pages. That is, when an original page 510, illustrated in FIG. 5A, is recorded at a first incident angle, another original page 530 illustrated in FIG. 5C which is adjacent to the original page 510 is recorded at the first incident angle + 0.038 degrees. It is understood that selectivity may be in a different range than 0.1 degrees to 0.038 degrees in other aspects.

According to aspects of the present invention, a page 520 is additionally inserted to be recorded between the two adjacent original pages 510 and 530. The page 520, which is inserted between the original adjacent pages 510 and 530, is referred to as an 'additional page 520' or a 'third page 520' and may be smaller, equal to, or larger than the two adjacent original pages 510 and 530. As shown, the additional page 520 is smaller than the original pages 510 and 530.

Referring to FIG. 5B, the additional page 520 is recorded at the first angle + 0.019 degrees. The additional page 520 is recorded between the page 510, which is recorded at the first angle, and the page 530, which is recorded at the first angle + 0.038 degrees. In other words, the additional page 520 is recorded at another angle which is half the angle of the angle separating the original adjacent pages 510 and 530. With reference to Table 1, such recording would be to regions (a) and (b) of the SLM 210, which therefore has the lower selectivity of 0.11 and 0.12 as compared to regions (c) and (d), which have selectivity of 0.14 and 0.16. Referring to FIG. 5B, the additional page 520 may be embodied to have a different size from the size of the original adjacent pages 510 and 530. Alternatively, the additional page 520 may be embodied to have the same size as the size of the original pages 510 and 530, but a region of the additional page 520 in which data is actually recorded should be smaller than regions of the original pages 510 and 530 in which data is recorded.

Data of the additional page 520 is positioned on a region having a relatively small selectivity compared to other regions in the entire additional page 520. Since the selectivity is small, the additional page 520 does not generate any substantial amount of crosstalk, and therefore does not affect the original adjacent pages 510 and 530. Accordingly, a signal does not deteriorate due to unnecessary crosstalk, and the recording capacity is increased in comparison to a conventional method. The size of the additional page 520, which is inserted between the original pages 510 and 530, may be determined according to the selectivity.

FIG. 6 is a view illustrating a book 600 in which a plurality of pages are recorded in
a superimposed fashion. In the book 600, an additional page 520 is inserted between each of the original pages 510, 530, 550, 570, and 590 according to aspects of the present invention. It is understood that the book 600 may contain more or less pages than the number of pages illustrated in FIG. 6.

Referring to FIG. 6, for example, when a recording capacity of the additional page 520, in which data is to be recorded, is half of the recording capacity of an original page, for example, the original page 510, the recording capacity of data recorded by a recording apparatus to a holographic storage medium 200 is increased by about 50%. Furthermore, although FIG. 6 only illustrates one additional page 520 inserted between the original pages in FIG. 6, other aspects of the present invention are not limited to this, and two or more additional pages 520 may be inserted between each pair of the original pages, for example, the original pages 510 and 530, without affecting crosstalk.

FIG. 7 is a block view illustrating a holographic storage medium recording and/or reproducing apparatus 701 according to an embodiment of the present invention. Referring to FIG. 7, the holographic storage medium recording apparatus 701 includes a light processing unit 710 into which a holographic storage medium 700 is inserted, and a control unit 720 to control the light processing unit 710 to record data on the holographic storage medium 700 and/or to reproduce data to and/or from the holographic storage medium 700.

The light processing unit 710 includes a laser light source 711, such as, for example, a semiconductor laser, a beam splitter 712, a first reflecting mirror 713, a spatial light modulator (SLM) 714, a first lens 715, a second reflecting mirror 716, a second lens 717, a third lens 718 and a detector 719. It is understood that the light processing unit 710 may include elements in addition to those described above and shown in FIG. 7, such as, for example, additional lenses, additional detectors, etc.

The control unit 720 controls the light processing unit 710. In addition, the control unit 720 generates a data page including recording data to transmit the data to the light processing unit 710, and data-processes a signal reproduced from the light processing unit 710. In particular, the control unit 720 controls the light processing unit 710 so that at least one additional page 520 having data recorded in a region with a relatively small selectivity may be recorded between two adjacent pages, such as the two adjacent pages 510 (FIG. 5(a)) and 530 (FIG. 5(c)). Referring back to FIG. 5, the control unit 720 controls the light processing unit 710 so that an angle of a reference beam R used to record an original page 510 may be set at a first angle, an angle of a reference beam R used to record the additional page 520 may be set at another angle equal to the first angle + 0.019 degrees, and an angle of a reference beam R to record a page 530 may be set at the first angle + 0.038 degrees. It is understood that the
variation in degrees between each of the pages 510, 520, and 530 may be more or less than + 0.019 degrees.

The control unit 720 controls the light processing unit 710 so that data is positioned on a region having a relatively small selectivity in the additional page 520, or alternatively, may control the light processing unit 710 so that the size of the additional page 520 is different from the size of the other pages 510 and 530. According to an aspect of the present invention, the control unit 720 positions the data on the region having a small selectivity in the additional page 520 using the method in which the size of the additional page 520 is the same as the size of the original pages 510 and 530, and controls the light processing unit 710 to position data on the region having a relatively small selectivity when the data is positioned on the additional page 520. In order to make the additional page 520 and the original page 510 have different sizes, the SLM 714 can be used to block light from part of the additional page 520, or a shutter (not shown) may be disposed in front of the SLM 714.

The control unit 720 controls the light processing unit 710 so that a signal construction of the additional page 520 may be the same as a partial signal construction of the page 510, or may be different from the signal construction of the page 510. In other words, a method of modulating data to be positioned on the additional page 520, or the ratio of bit 0 to bit 1 on the additional page 520, may be different from the method of modulating data to be positioned on the original page 510 or the ratio of bit 0 to bit 1 on the original page 510.

In addition, the control unit 720 may control the light processing unit 710 so that the original page 510 may be used to record user data, and the additional page 520 may be used to record additional information (i.e., non-user data and/or data used to manage the user data).

When data is recorded on the holographic storage medium 700, the laser light source 711 outputs a laser beam having coherent light. The laser beam is transmitted to be incident on the beam splitter 712, and is divided into a reference beam R and a signal beam S. The signal beam S is incident on the SLM 714. The signal beam S, which represents recording data and is incident on the SLM 714, is spatial-light modulated (amplitude modulated) by the SLM 714. The modulated signal beam S is focused on the holographic storage medium 700 by the first lens 715. Meanwhile, the reference beam R is reflected by the second reflecting mirror 716, and is incident on the holographic storage medium 700 after being focused by the second lens 717. Accordingly, interference fringes, which are generated by overlapping the signal beam S and the reference beam R, are recorded on the holographic storage medium 700 as a minute, dense pattern.

In order to reproduce data recorded on the holographic storage medium 700, an illu-
mination beam (not shown), which is the same as the reference beam R used to record a data page that is to be reproduced, is transmitted to be incident on the holographic storage medium 700. Thus, data is reproduced as diffraction light beams corresponding to the interference fringes recorded on the holographic storage medium 700. Then, the diffraction light beams are focused onto the detector 719 by the third lens 718.

According to an aspect of the present invention, the detector 719 may include one of a charge-coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS). A regenerative signal is output from the detector 719 and is transferred to the control unit 720, at which point the data reproduction operation is complete.

According to an aspect of the present invention, during the reproduction operation, the control unit 720 controls the light processing unit 710 to reproduce at least one additional page 520, which has data recorded to a region having a relatively small selectivity and is recorded between two adjacent original pages 510 and 530, from the holographic storage medium 700. As mentioned earlier, more than one additional page 520 may be recorded between the adjacent original pages 510 and 530.

FIG. 8 is a flowchart illustrating a method of recording data on a holographic storage medium 700, according to an embodiment of the present invention. Referring to FIG. 8, a region having a relatively small selectivity in an original page 510 is determined at operation 810. An additional page 520 including the determined region is recorded between original pages 510 and 530 at operation 820.

FIG. 9 is a flowchart illustrating a method of reproducing data recorded on a holographic storage medium, according to an embodiment of the present invention. Referring to FIG. 9, a reference beam is controlled so as to read an additional page 520 recorded between adjacent original pages 510 and 530 at operation 910. Next, the additional page 520 is reproduced at a predetermined degree of the controlled reference beam at operation 920.

Aspects of the present invention can also be embodied as computer readable codes on a computer readable recording medium. The computer readable recording medium is any data storage device that can store data which can be thereafter read by a computer system. Examples of computer readable recording media include a read-only memory (ROM), a random-access memory (RAM), CD-ROMs, magnetic tapes, floppy disks, optical data storage devices, and a computer signal embodied in a carrier wave comprising a compression source code segment comprising the code and an encryption source code segment comprising the code (such as data transmission through the Internet). The computer readable recording medium can also be distributed over network coupled computer systems so that the computer readable code is stored and executed in a distributed fashion. A functional program, a code and a code segment to achieve the data recording and reproducing methods described above can be un-
derstood by one of ordinary skill in the art.

[52] According to aspects of the present invention, additional pages 520 are recorded without generating crosstalk between original pages 510 and 530 in a holographic storage medium 200. Thus, aspects of the present invention provide a holographic storage medium with an increased recording capacity.

[53] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.
Claims

1. A holographic storage medium in which a hologram including data is recorded by interference of a signal beam and a reference beam, comprising:
   a plurality of pages on which the data is recorded in a superimposed fashion; and
   an additional page recorded between two adjacent pages in the plurality of pages,
   wherein a portion of the data is recorded to a region of the additional page having a relatively small selectivity compared to other regions of the additional page without recording on the other regions.

2. The holographic storage medium of claim 1, wherein a size of the additional page is different from a size of each of the two adjacent pages.

3. The holographic storage medium of claim 1, wherein a signal construction of the additional page is the same as a partial signal construction of each of the two adjacent pages.

4. The holographic storage medium of claim 1, wherein a signal construction of the additional page is different from a partial signal construction of each of the two adjacent pages.

5. The holographic storage medium of claim 1, wherein the data recorded on the two adjacent pages comprises user data, and the portion of data recorded on the additional page comprises additional information other than the user data.

6. A holographic storage medium in which a hologram including data is recorded by interference of a signal beam and a reference beam, comprising:
   a book comprising a, a first page and a second page which each include data and which are recorded to have a maximum selectivity based on the first page, and a third page having a smaller selectivity than the maximum selectivity recorded between the first page and the second page.

7. The holographic storage medium of claim 6, wherein a portion of the data is recorded to the third page and is positioned on a region of the third page having a relatively small selectivity compared to other regions of the third page and is not recorded to the other regions.

8. A holographic storage medium recording apparatus to record data on holographic storage medium, the apparatus comprising:
   a light processing unit to record the data by interference of a signal beam and a reference beam on a plurality of pages on the holographic storage medium in a superimposed fashion; and
   a control unit to control the light processing unit so that an additional page is recorded between two adjacent pages in the plurality of pages, wherein a portion of the data is recorded to a region of the additional page having a relatively small
selectivity compared to other regions of the third page without recording on the other regions.

9. The apparatus of claim 8, wherein the control unit generates the additional page so that a size of the additional page is different from sizes of each of the two adjacent pages.

10. The apparatus of claim 8, wherein the control unit generates the additional page so that a signal construction of the additional page is the same as a partial signal construction of each of the two adjacent pages.

11. The apparatus of claim 8, wherein the control unit generates the additional page so that a signal construction of the additional page is different from a partial signal construction of each of the two adjacent pages.

12. The apparatus of claim 8, wherein the data comprises user data, and the portion of data comprises additional information other than the user data.

13. A holographic storage medium reproducing apparatus to reproduce data recorded to a plurality of pages on a holographic storage medium in a superimposed fashion by interference of a signal beam and a reference beam, the apparatus comprising:

- a light processing unit to reproduce the data from the holographic storage medium; and
- a control unit to control the light processing unit to reproduce a portion of the data from an additional page recorded between two adjacent pages in the plurality of pages, wherein the portion of data is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

14. The apparatus of claim 13, wherein a size of the additional page is different from a size of each of the two adjacent pages.

15. The apparatus of claim 13, wherein a signal construction of the additional page is the same as a partial signal construction of each of the two adjacent pages.

16. The apparatus of claim 13, wherein a signal construction of the additional page is different from a partial signal construction of each of the two adjacent pages.

17. The apparatus of claim 13, wherein the control unit reproduces user data from the two adjacent pages and additional information other than the user data from the additional page.

18. A method of recording data on a holographic storage medium in which data is recorded in a superimposed fashion by interference of a signal beam and a reference beam on a plurality of pages, the method comprising:
recording a portion of the data to an additional page between two adjacent pages in the plurality of pages, wherein the portion of data is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

19 The method of claim 18, wherein the recording comprises generating the additional page so that a size of the additional page is different from a size of each of the two adjacent pages.

20 The method of claim 18, wherein the recording comprises generating the additional page so that a signal construction of the additional page is the same as a partial signal construction of the two adjacent pages.

21. The method of claim 18, wherein the recording comprises generating the additional page so that a signal construction is different from a partial signal construction of each of the two adjacent pages.

22. The method of claim 18, wherein the recording comprises: recording user data on the two adjacent original pages; and recording additional information other than the user data on the additional page.

23. A method of reproducing data from a holographic storage medium in which data is recorded on a plurality of pages in a superimposed fashion by interference of a signal beam and a reference beam, the method comprising: reproducing a portion of the data from an additional page between two adjacent pages in the plurality of pages, wherein the portion of data of the additional page is recorded on a region of the additional page having a relatively small selectivity compared to other regions of the additional page and is not recorded on the other regions.

24. The method of claim 23, wherein a size of the additional page is different from a size of each of the two adjacent original pages.

25. The method of claim 23, wherein a signal construction of the additional page is the same as a partial signal construction of each of the two adjacent original pages.

26. The method of claim 23, wherein a signal construction of the additional page is different from a partial signal construction of each of the two adjacent original pages.

27. The method of claim 23, wherein the reproducing comprises: reproducing user data from each of the two adjacent original pages; and reproducing additional information other than the user data from the additional page.

28. A holographic storage medium on which data is recorded by interference of a signal beam and a reference beam, comprising:
a first page on which data is recorded;
a second page on which the data is recorded and which is positioned at an angle apart from the first page; and
a third page recorded between the first page and the second page and having a portion of the data recorded therein, wherein the portion of data is recorded only at a position within the third page which minimizes crosstalk between the first page and the second page.

[29] 29. The holographic storage medium of claim 28, wherein the third page is positioned apart from the first page at another angle which is approximately half of the angle.

[30] 30. The holographic storage medium of claim 29, wherein the angle is approximately 0.038 degrees, and the another angle is approximately 0.019 degrees.

[31] 31. The holographic storage medium of claim 28, wherein the portion of data is recorded to a region of the third page having a relatively small selectivity compared to other regions of the third page so as to reduce the crosstalk.

[32] 32. The holographic storage medium of claim 28, wherein the data comprises user data, and the portion of data comprises additional information other than the user data.

[33] 33. A holographic storage medium recording and/or reproducing apparatus, comprising:
a light processing unit to record data by interference of a signal beam and a reference beam onto a plurality of pages in a holographic storage medium; and
a control unit to control the light processing unit to record an additional page having a portion of the data between two adjacent pages in the plurality of pages, wherein the portion of data is recorded only at a position within the additional page which minimizes crosstalk between the two adjacent pages.

[34] 34. The holographic storage medium recording and/or reproducing apparatus of claim 33, wherein the two adjacent pages are positioned apart from each other at an angle; and the additional page is positioned in between the two adjacent pages at another angle which is approximately half of the angle.

[35] 35. The holographic storage medium recording and/or reproducing apparatus of claim 34, wherein the angle is approximately 0.038 degrees, and the another angle is approximately 0.019 degrees.

[36] 36. The holographic storage medium recording and/or apparatus of claim 33, wherein the portion of data is recorded to a region of the additional page having a relatively small selectivity compared to other regions of the additional page so as to reduce the crosstalk.
37. The holographic storage medium recording and/or reproducing apparatus of claim 33, wherein the data comprises user data, and the portion of data comprises additional information other than the user data.

38. A holographic storage medium reproducing and/or recording apparatus to reproduce data recorded to a plurality of pages on a holographic storage medium in a superimposed fashion by interference of a signal beam and a reference beam, the apparatus comprising:

- a light processing unit to reproduce the data from the holographic storage medium;
- a control unit to control the light processing unit to reproduce an additional page having a portion of the data recorded between two adjacent pages in the plurality of pages, wherein the portion of data is recorded only at a position within the additional page which minimizes crosstalk between the two adjacent pages.

39. The holographic storage medium reproducing and/or recording apparatus of claim 38, wherein the portion of data is recorded to a region of the additional page having a relatively small selectivity compared to other regions of the additional page so as to reduce the crosstalk.
FIG. 3

FIG. 4

SELECTIVITY OF X AXIS

SELECTIVITY (°)

REGION
**FIG. 8**

START

DETERMINE REGION HAVING RELATIVELY SMALL SELECTIVITY IN PAGE

RECORD ADDITIONAL PAGE INCLUDING DETERMINED REGION BETWEEN PAGES

END

**FIG. 9**

START

CONTROL REFERENCE BEAM SO AS TO READ ADDITIONAL PAGE RECORDED BETWEEN PAGES

READ ADDITIONAL PAGE AT DEGREE OF CONTROLLED REFERENCE BEAM

END
A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 G11B, G03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility Models since 1975
Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) "holographic, hologram, page, crosstalk, selectivity"

B. FIELDS SEARCHED

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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Date of the actual completion of the international search 24 APRIL 2008 (24 04 2008)
Date of mailing of the international search report 24 APRIL 2008 (24.04.2008)

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