POSITIONING AN OPTICAL BEAM

BACKGROUND OF THE INVENTION

The present invention relates generally to positioning an optical beam, and more particularly to tracking movement of a rotary actuator of a disk drive.

Optical mass storage provides a convenient mechanism (i.e., optical disks) for transporting large amounts of data. On a typical read-only optical disk (e.g., a CD-ROM disk), data is represented by the presence or absence of small depressions, or pits, formed in a surface of the disk. When an optical disk drive reads data from the disk, a spindle spins the disk at a predetermined rate and a precisely focused light beam (e.g., a laser beam) is directed to the surface of the disk to scan data from the disk. The surface reflects the beam from the disk, and the pits formed in the surface of the disk modulate the intensity of the beam that is reflected from the disk. The data stored on the disk is reconstructed into a digital representation by monitoring the intensity (high or low) of the beam that is reflected and forming corresponding data consisting of ones and zeros. Some optical disks, such as magneto-optical disks, or phase change disks, can both be read and written by a magneto-optical drive and a phase change drive, respectively. Besides reading and writing data from the disk, the beam may be used for generating signals that allow centering the beam on a desired data track of the disk.

An optical drive may use a rotary actuator to position an optical drive head. The optical drive head may have an objective lens used to direct the beam to the surface of the disk and direct the beam that is reflected

from the disk. The beam is typically generated by an optics module mounted to a base plate of the drive, and a reflective surface of a galvanometer is used to establish beam communication between the optics module and the optical drive head.

An object of the present invention is to provide mounting of the optics module on the rotary actuator, thereby reducing movement of the galvanometer. Another object of the invention is to provide a fixed spatial relationship between the objective lens, the galvanometer and the fixed optics.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the claims.

SUMMARY OF THE INVENTION

In general, in one aspect, the invention features an apparatus for use with an optical disk. The apparatus has a pivotable arm configured to position an optical drive head over a selected portion of the disk. A light source is mounted to the arm and configured to generate a beam of light. A reflector of the disk drive is configured to receive the beam of light and direct the beam to a selected portion of the optical drive head.

Implementations of the invention may include one or more of the following. The reflector may be a mirror having a fixed position. The reflector may be a micro-galvanometer mirror assembly, and the light source may include an optics module. The reflector may include a partially reflecting and partially transmitting surface, the surface positioned to reflect the beam toward the optical drive head. The apparatus may also include a

detector (e.g., a bi-cell detector) positioned to intercept light from the beam transmitted through the surface and provide an indication of the position of the beam on the surface based on the light transmitted through the surface. The apparatus may include a controller (e.g., a tracking servo loop and a galvanometer) connected to receive the indication and position the surface. The apparatus may include an optics module configured to generate the beam of light and a galvanometer having a reflective surface to direct the beam furnished by the fixed optics to the reflector.

An axis of the galvanometer may be concentric with an axis about which the pivotable arm pivots; however, the axis of the galvanometer may be aligned with an axis other than the axis about which the pivotable arm pivots. The optical drive head may be secured to one end of the arm, and the galvanometer may be mounted on a surface of the arm diametrically opposed to said one end of the arm. The beam generated by the light source may be in a plane substantially parallel to a surface of the disk. The beam directed from the reflector to the optical head may be in a plane substantially perpendicular to a surface of the disk. The apparatus may also include an imaging lens located between the light source and the reflector.

In general, in another aspect, the invention features a method for use with an optical disk drive having a pivotable arm connected to position an optical drive head over a selected portion of a disk. The method includes generating a beam of light from a light source mounted to the arm and directing the beam to a selected portion of the optical head.

Implementations of the invention may include one or more of the following. The directing may include using a reflector. The directing may include using a galvanometer configured to position a reflector to direct

the beam. The beam may be in a plane substantially parallel to a surface of the disk, and the directing may include using a galvanometer secured to the arm and mounted to direct the beam toward the optical head.

In general, in another aspect, the invention features an apparatus for use with an optical disk. The apparatus has an arm substantially parallel to a surface of the disk and connected to pivot about an axis located at one end of the arm, the arm configured to position an optical drive head located near another end of the arm over a selected portion of the disk. The apparatus has a light source mounted near the one end of the arm configured to generate a beam of light in a plane substantially parallel to a surface of the disk. The apparatus also has an imaging lens and a galvanometer mounted near the one end of the arm configured to position a first mirror to reflect the beam generated by the light source through the imaging lens and toward the another end of the arm. The apparatus has a second mirror mounted near the another end of the arm configured to reflect the beam reflected by the first mirror into a plane substantially perpendicular to the surface of the disk and toward the optical head.

In general, in another aspect, the invention features an apparatus for use with an optical disk. The apparatus has an arm substantially parallel to a surface of the disk and connected to pivot about an axis located at one end of the arm, the arm configured to position an optical drive head located near another end of the arm over a selected portion of the disk. The apparatus has a light source mounted near said one end of the arm configured to generate a beam of light in a plane substantially parallel to a surface of the disk. The apparatus also has a galvanometer mounted near the another end of the arm configured to position a mirror to

reflect the beam in a plane substantially perpendicular to the surface of the disk and toward the optical drive head.

In general, in another aspect, the invention features a method for use with an optical disk drive having a pivotable arm connected to position an optical drive head over a selected position of a disk. The method includes generating a beam of light via a light source and rotating the light source to track the movement of the arm.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, schematically illustrate the invention and, together with the general description given above and the detailed description given below, serve to explain the principles of the invention.

Figure 1 is a top view of a disk drive actuator.

Figure 2 is a side view of the disk drive actuator of Figure 1.

Figure 3 is a top view of a disk drive actuator of an alternative embodiment.

Figure 4 is a perspective view of a disk drive actuator of an alternative embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figures 1 and 2, in an optical disk drive, an optics module 100 communicates with an optical drive head 107 via a light beam (e.g., a laser) to read data from an upper surface 211 of an optical disk 112. The optics module 100 is mounted on an rotary actuator 103. The actuator 103 has an arm 110, in a plane substantially parallel to the surface 211, used to pivot about a vertical axis 200 and position an optical drive head 107 over a selected region of the surface 211. Because the optics module 100 is mounted on the actuator

103 and rotates with the arm 110, a predetermined spatial relationship is maintained between the optics module 100 and the drive head 107 regardless of the position of the arm 110.

For purposes of reading data from the disk 112, the beam generated by the module 100 travels along three optical paths 106, 108, and 109 to the optical drive head 107 which is positioned by the arm 110 over the upper surface 211 of the disk 112. The optical paths 106 and 108 are in planes substantially parallel to the surface 211. The optical path 109 is in a plane substantially perpendicular to the surface 211. The optical drive head 107 transmits the beam originating from the module 100 to the surface 211 which reflects the beam. The optical drive head 107 directs the beam that is reflected from the surface 211 back to the optical path 109. The beam that is reflected follows optical paths 109, 108, and 106 to the module 100 where data read from the surface 211 is extracted.

For purposes of finely positioning the beam generated by the optics module 100 on the drive head 107 (and on a selected track on the surface 211), a moveable mirror 102 of a galvanometer 104 is positioned to link the optical paths 106 and 108. For each position of the mirror 102, a predetermined spatial relationship exists between the optics module 100 and the mirror 102 as the arm 110 rotates. Therefore, by turning the mirror 102, the galvanometer 104 furnishes fine tracking of the beam communication between the optics module 100 and the surface 211. The coarse tracking of the beam communication between the optics module 100 and the surface 211, on the other hand, is furnished by the pivoting movement of the arm 110.

The optics module 100 is mounted on top of a cylindrical hub 136 of the rotary actuator 103. The hub

136 is coaxial with the axis 200, and the bottom of the hub 136 is mounted to a cylindrical mounting tube 134 which is secured to a drive base plate 135. The actuator arm 110 laterally extends from the side of the hub 136 to cantilever the head 107 over the surface 211. The galvanometer 104 is mounted on the rotary actuator 103 such that the galvanometer 104 rotates by the same angle as the rotary actuator 103. The reflective surface of the galvanometer mirror 102 may be located near the pivoting axis of the galvanometer 104 but may be mounted elsewhere, as described below.

For purposes of controlling movement of the arm 110, the rotary actuator 103 includes a coil 130 located on the side of the hub 136 diametrically opposed to the actuator arm 110. The coil 130 electromagnetically interacts with a magnet 132 (mounted on the drive base plate 135) to control the pivoting of the rotary actuator 103 about the axis 200. The actuator arm 110 includes a resilient flexure 202 which extends downwardly from the actuator arm 110 to position the optical drive head 107 near the surface 211.

As shown in Figure 3, the optical path 108 extends along the arm 110 away from the hub 136. Along the path 108 exists an imaging lens 115 perpendicular to the path 108, and near the end of the actuator arm 110 away from the hub 136, a fixed reflecting mirror 114 links the optical paths 108 and 109.

For purposes of positioning the optical path 109 (i.e., establishing beam communication on a selected portion of the surface 211), a bi-cell detector 166 is mounted to the back of the mirror 114. The mirror 114 is partially transmitting and allows illumination from the beam generated by the optics module 100 to be detected by the detector 166. A galvanometer servo feedback loop (not shown) uses information provided by the detector 166

to control the position of the galvanometer mirror 102 which directs the course of the optical path 109.

The rotary actuator 103 may also include another actuator arm 111, located beneath and substantially parallel with the arm 110, having the same elements discussed above for interacting with a lower surface 210 of the optical disk 112. Another optics module 100 may be mounted to the bottom of hub 136, or alternatively a mirror or prism may be mounted in a manner to permit light communication between the optics module 100 and an optical drive head of the actuator arm 111.

For purposes of generating the beam, the optics module 100 includes a laser module 150 which projects a light beam along the optical path 106 through a collimation lens 152, a polarization/beam splitter 154, and a collimation/correction lens 156. The light beam reflected from the surface 211 passes from the mirror 102 along the optical path 106 through the lens 156 and is diverted by the beam splitter 154 to servo and data detectors 160 of the optics module 100. The data detectors 160 extract the data from the beam reflected from the disk 112.

Other embodiments are within the scope of the present invention. For example, as shown in Figure 3, the galvanometer 104 may alternatively be mounted on top of the hub 136 in a location diametrically opposed to the actuator arm 110 and not at the center of rotation of the rotary actuator 103. In this embodiment, the axis of rotation of the mirror 102 is still parallel to the axis 200, and the mirror 102 extends above the top surface of the hub 136. In this embodiment, the optics module 100 communicates with the drive head 107 via optical paths 108, 109 and 300. Optical path 300 replaces optical path 106, and the mirror 102 links the optical path 106 to the

optical path 108. The beam reflected from the disk 112 follows the optical paths 108-109 and 300.

In another embodiment, as shown in Figure 4, a micro-galvanometer mirror assembly 400 (e.g., a Digital Micromirror Device (DMD) microchip mirror made by Texas Instruments) replaces the fixed reflecting mirror 114. In this embodiment, the galvanometer 104 and its mirror 102 are removed. Furthermore, the optics module 100 is mounted on the hub 136 diametrically opposed to the arm 110. The optics module 100 establishes beam communication with the drive head 107 via the optical path 109 and an optical path 401. The optical path 401 is in a plane substantially parallel to the surface 211 and extends along the arm 110, from the optics module 100, to the micro-galvanometer mirror assembly 400. A partially reflective surface 405 of the assembly 400 links the paths 401 and 109 and furnishes the positioning of the optical path 109 upon the drive head 107. Because the surface 405 is partially transmitting, a bi-cell detector 406 mounted to the back of surface 405 guides the partially reflective surface 405 by providing feedback to a tracking servo loop (not shown). The tracking servo loop interacts with the assembly 400 to turn the surface 405 upon perpendicular axes 402-404 to precisely position the optical path 109.

In summary, an apparatus and method for generating a beam of light from a light source mounted to a rotary actuator and directing the beam to a selected portion of an optical drive head has been described.

The present invention has been described in terms of a preferred embodiment. The invention, however, is not limited to the embodiment depicted and described. Rather, the scope of the invention is defined by the appended claims.

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What is claimed is:

1. An apparatus for use with an optical disk comprising:

a pivotable arm configured to position an optical drive head over a selected portion of the disk;

a light source mounted to the arm configured to generate a beam of light; and

a reflector configured to receive the beam of light and direct the beam to a selected portion of the optical drive head.

2. The apparatus of claim 1 wherein the reflector comprises a mirror having a fixed position.

3. The apparatus of claim 1,

wherein the reflector comprises a micro-galvanometer mirror assembly, and

wherein the light source comprises an optics module.

4. The apparatus of claim 1, wherein the reflector includes a partially reflecting and partially transmitting surface, the surface positioned to reflect the beam toward the optical drive head, the apparatus further comprising:

a detector positioned to intercept light from the beam transmitted through the surface and provide an indication of the position of the beam on the surface based on the light transmitted through the surface; and

a controller connected to receive the indication and position the surface.

5. The apparatus of claim 4 wherein the detector comprises a bi-cell detector.

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6. The apparatus of claim 4 wherein the controller includes a tracking servo loop.

7. The apparatus of claim 1, further comprising:

an optics module configured to generate the beam of light; and

a galvanometer having a reflective surface to direct the beam furnished by the fixed optics to the reflector.

8. The apparatus of claim 7 wherein an axis of the galvanometer is concentric with an axis about which the pivotable arm pivots.

9. The apparatus of claim 7 wherein an axis of the galvanometer is aligned with an axis other than the axis about which the pivotable arm pivots.

10. The apparatus of claim 7, wherein the optical drive head is secured to one end of the arm and the galvanometer is mounted on a surface of the arm diametrically opposed to said one end of the arm.

11. The apparatus of claim 1 wherein the beam generated by the light source is in a plane substantially parallel to a surface of the disk.

12. The apparatus of claim 1 wherein the beam directed from the reflector to the optical head is in a plane substantially perpendicular to a surface of the disk.

13. The apparatus of claim 1 further comprising an imaging lens located between the light source and the reflector.

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14. A method for use with an optical disk drive having a pivotable arm connected to position an optical drive head over a selected portion of a disk, comprising:

generating a beam of light from a light source mounted to the arm; and

directing the beam to a selected portion of the optical head.

15. The method of claim 14 wherein the directing includes using a reflector.

16. The method of claim 14 wherein the directing includes using a galvanometer configured to position a reflector to direct the beam.

17. The method of claim 14,

wherein the beam is in a plane substantially parallel to a surface of the disk, and

wherein the directing includes using a galvanometer secured to the arm and mounted to direct the beam toward the optical head.

18. The method of claim 17 wherein the galvanometer comprises a micro-galvanometer mirror assembly.

19. The method of claim 14 wherein the beam comprises a beam in a plane substantially perpendicular to a surface of the disk.

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20. An apparatus for use with an optical disk comprising:

an arm substantially parallel to a surface of the disk and connected to pivot about an axis located at one end of the arm, the arm configured to position an optical drive head located near another end of the arm over a selected portion of the disk;

a light source mounted near said one end of the arm configured to generate a beam of light in a plane substantially parallel to a surface of the disk;

an imaging lens;

a galvanometer mounted near said one end of the arm configured to position a first mirror to reflect the beam generated by the light source through the imaging lens and toward said another end of the arm; and

a second mirror mounted near said another end of the arm configured to reflect the beam reflected by the first mirror into a plane substantially perpendicular to the surface of the disk and toward the optical head.

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21. An apparatus for use with an optical disk comprising:

an arm substantially parallel to a surface of the disk and connected to pivot about an axis located at one end of the arm, the arm configured to position an optical drive head located near another end of the arm over a selected portion of the disk;

a light source mounted near said one end of the arm configured to generate a beam of light in a plane substantially parallel to a surface of the disk; and

a galvanometer mounted near said another end of the arm configured to position a mirror to reflect the beam in a plane substantially perpendicular to the surface of the disk and toward the optical drive head.

22. The apparatus of claim 21 wherein the galvanometer comprises a micro-galvanometer mirror assembly.

23. The apparatus of claim 21, wherein the mirror has a partially reflecting and partially transmitting surface positioned to reflect the beam toward the optical drive head, the apparatus further comprising:

a detector positioned to intercept light from the beam transmitted through the surface and provide an indication of the position of the beam on the mirror based on the light transmitted through the surface; and

a controller configured receive the indication and interact with the galvanometer to position the mirror.

24. The apparatus of claim 23 wherein the detector comprises a bi-cell detector.

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25. The apparatus of claim 23 wherein the controller includes a tracking servo loop.

26. The apparatus of claim 23 wherein the controller includes a galvanometer.

27. The apparatus of claim 23 wherein the reflector comprises a galvanometer and the controller interacts with the galvanometer to position the mirror based on the indication provided by the detector.

28. A method for use with an optical disk drive having a pivotable arm connected to position an optical drive head over a selected position of a disk, comprising:

generating a beam of light via a light source; and

rotating the light source to track the movement of the arm.

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