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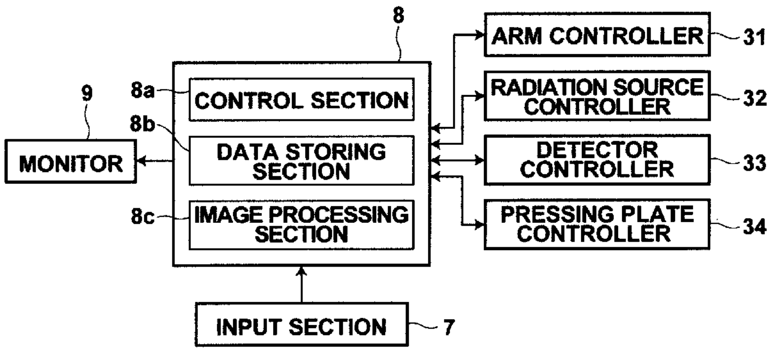
(54) Title: METHOD, APPARATUS, AND PROGRAM FOR DISPLAYING STEREOSCOPIC IMAGES

FIG.3



(57) Abstract: Specification of subjects using a cursor within a stereoscopic image is facilitated in a stereoscopic image display method for displaying the stereoscopic image, which is constituted by a right eye image and a left eye image. An image processing section 8c combines a three dimensional cursor with the stereoscopic image at a position specified by an input means 7 capable of inputting three dimensional positions within the stereoscopic image, and displays the combined image on a monitor 9.

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DESCRIPTION

METHOD, APPARATUS, AND PROGRAM FOR DISPLAYING STEREOSCOPIC IMAGES

Technical Field

The present invention is related to an apparatus, a method, and a program for displaying stereoscopic images employing a right eye image and a left eye image.

Background Art

Conventionally, it is known that stereoscopic viewing of images by combining right eye images and left eye images and utilizing parallax is possible. An image that can be stereoscopically viewed (hereinafter, referred to as "stereoscopic image" or "stereo image") is generated based on a plurality of images of a single subject obtained by imaging from different positions such that parallax exists therebetween.

Generation of such stereoscopic images is utilized not only in the fields of digital cameras and television, but also in the field of radiation imaging. That is, radiation is irradiated onto a patient from different directions, the radiation that passes through the patient is detected with a radiation image detector to obtain a plurality of radiation images having parallax therebetween, and a stereoscopic image is generated based on these radiation images. By generating the stereoscopic image in this manner, a radiation image having a sense of depth can be observed, which is more suited for diagnosis. (Refer to Patent Document 1, for example.)

Prior Art Documents

[Patent Document 1]

Japanese Unexamined Patent Publication No. 2010-110571

Stereoscopic images such as those described above are viewed three dimensionally by causing a pseudo image based on right eye images and left eye images to be projected toward a viewer by utilizing parallax, and are not based on three dimensional image data. Therefore, the boundaries among subjects become vague. For this reason, it is more difficult to specify specific subjects within the stereoscopic images by displaying a three dimensionally movable cursor on the stereoscopic images compared to two dimensional images.

Particularly in the case of radiation images, radiation images are transparent images and the boundaries among subjects become vaguer compared to ordinary photographs. Therefore, it is extremely difficult to specify subjects with a cursor in such images.

The present invention has been developed in view of the foregoing circumstances. It is an object of the present invention to provide an apparatus, a method, and a program for displaying stereoscopic images that employ right eye images and left eye images to display stereoscopic images in which the aforementioned problem is solved.

Disclosure of the Invention

A stereoscopic image display apparatus of the present invention is a stereoscopic image display apparatus that displays a stereoscopic image constituted by a right eye image obtained by imaging subjects and a left eye image obtained by imaging the subjects, the right eye image and the left eye image having parallax with respect to each other, to enable stereoscopic viewing, characterized by comprising:

input means capable of inputting three dimensional positions within the stereoscopic image; and

three dimensional cursor display means, for displaying a three dimensional cursor having transparency at positions specified by the input means.

Here, the "three dimensional cursor" refers to a cursor that can recognize three dimensional shapes which are not contained within a two dimensional plane.

The expression "displays a stereoscopic image... to enable stereoscopic viewing" refers to displaying the images that constitute the stereoscopic image by satisfying all necessary requirements for stereoscopic viewing at the display side. Such requirements may be satisfied by: displaying the constituent images of the stereoscopic image side by side; overlapping the constituent images of the stereoscopic image in different polarized states on a half mirror and displaying them through polarizing glass;

displaying the constituent images of the stereoscopic image with a lenticular display; etc.

The expression "three dimensional cursor having transparency" refers to a cursor that enables a combined portion of the image to be viewed transparently through the cursor when the three dimensional cursor is combined with the stereoscopic image. The degree of transparency may be set at any value other than that which completely precludes the image from being viewed (a degree of transparency of 0%) and that which enables only the image to be viewed (a degree of transparency of 100%).

The stereoscopic image display apparatus of the present invention may be configured such that the shape of the three dimensional cursor is substantially the same as the shapes of portions which are presumed to be specified within the stereoscopic image.

The three dimensional cursor display means may be capable of changing the shape, the size, and the degree of transparency of the three dimensional cursor.

The three dimensional cursor display means may also the three dimensional cursor in a blinking manner.

A stereoscopic image display method of the present invention is a stereoscopic image display method for displaying a stereoscopic image constituted by a right eye image obtained by imaging a subject and a left eye image obtained by imaging the subject, the right eye image and the left eye image having parallax with respect to each other, characterized by comprising:

inputting three dimensional positions within the stereoscopic image with an input means; and

displaying a three dimensional cursor having transparency at positions specified by the input means.

The stereoscopic image display method may be provided as a program that causes a computer to execute the stereoscopic image display method of the present invention.

The apparatus, the method, and the program for displaying stereoscopic images of the present invention are characterized by inputting three dimensional positions within the stereoscopic image, and displaying a three dimensional cursor having transparency at the input specified positions, in a stereoscopic image display apparatus that displays a stereoscopic image constituted by a right eye image obtained by imaging subjects and a left eye image obtained by imaging the subjects, the right eye image and the left eye image having parallax with respect to each other, to enable stereoscopic viewing. Therefore, positions in the depth direction of the stereoscopic image can be more easily understood compared to conventional planar cursors. In addition, a subject is not completely hidden by the cursor when the subject and the cursor overlap each other, but the two are combined and displayed. Therefore, the cursor can be utilized by users to easily specify subjects within the stereoscopic image.

In addition, the shape of the three dimensional cursor may be substantially the same as the shape of a portion which is presumed to be specified within the stereoscopic image. In this case, the portion which is desired to be specified will be displayed clearly as though emphasized if the three dimensional cursor and the desired portion overlap. Therefore, confirmation and specification of the portion will be facilitated.

Further, the shape, the size, and the degree of transparency of the three dimensional cursor may be changed. In this case, the cursor can adapt to the manner of display desired by users, and the utility thereof will be improved.

Still further, the three dimensional cursor may be displayed in a blinking manner. In this case, comparisons between states in which the cursor is present and absent can be easily displayed. Therefore, confirmation and specification of the portion will be facilitated.

Brief Description of the Drawings

Figure 1 is a diagram that schematically illustrates a stereoscopic mammogram display system that employs a stereoscopic image display apparatus according to an embodiment of the present invention.

Figure 2 is a view of an arm member of the stereoscopic mammogram display system of Figure 1 from the rightward direction of Figure 1.

Figure 3 is a block diagram that schematically illustrates the interior of a computer of the stereoscopic mammogram display system of Figure 1.

Figure 4 is a diagram for explaining projection of a three dimensional cursor onto a stereoscopic image.

Figure 5 is a diagram that illustrates an example of a stereoscopic mammogram which is displayed two dimensionally.

Figure 6 is a diagram that illustrates an example of a stereoscopic mammogram which is displayed three dimensionally.

Best Mode for Carrying Out the Invention

Hereinafter, a stereoscopic mammogram display system 1 that employs a stereoscopic image display apparatus according to an embodiment of the present invention will be described. First, the schematic structure of the stereoscopic mammogram display system 1 of the present embodiment will be described. Figure 1 is a diagram that schematically illustrates the stereoscopic mammogram display system 1, Figure 2 is a view of an arm member of the stereoscopic mammogram display system 1 of Figure 1 from the rightward direction of Figure 1, and Figure 3 is a block diagram that schematically illustrates the interior of a computer of the stereoscopic mammogram display system 1 of Figure 1.

As illustrated in Figure 1, the stereoscopic mammogram display system 1 is equipped with: a mammography apparatus 10; a computer 8 connected to the mammography apparatus 10; and a monitor 9 and an input section 7 which are connected to the computer 8.

As illustrated in Figure 1, the mammography apparatus 10 is equipped with: a base 11; a rotating shaft 12 which is rotatable and movable in the vertical direction (the Z direction) with respect to the base 11; and an arm member 13 which is linked to the base 11 via the rotating shaft 12. Note that Figure 2 illustrates the arm member 13 as viewed from the right side of Figure 1.

The arm member 13 is of a C shape. An imaging base 14 is mounted at one end of the arm member 13, and a radiation irradiating section 16 is mounted at the other end of the arm member 13 so as to face the imaging base 14. Rotation and vertical movement of the arm member 13 are controlled by an arm controller 31 built in to the base 11.

A radiation image detector 15, such as a flat panel detector, and a detector controller 33 for controlling readout of electric charge signals from the radiation image detector 15 are provided in the interior of the imaging base 14. In addition, a circuit board with charge amplifiers for converting electric charges read out from the radiation image detector 15 into voltage signals, a correlated double sampling circuit for sampling the voltage signals output from the charge amplifiers, and an A/D converting section for converting the voltage signals into digital signals, etc., is provided in the interior of the imaging base 14.

The imaging base 14 is configured to be rotatable with respect to the arm member 13, such that the orientation of the imaging base 14 can be fixed with respect to the base 11 even when the arm member 13 is rotated with respect to the base 11.

The radiation image detector 15 is capable of repeatedly recording and reading out radiation images. The radiation image detector 15 may be a so called direct type radiation image detector that directly receives radiation and generates electric charges. Alternatively, the radiation image detector 15 may be a so called indirect type radiation image detector that converts radiation to visible light, then converts the visible light to electric charges. In addition, it is desirable for the readout method employed by the radiation image detector 15 to be the so called TFT readout method that reads out radiation image signals by turning TFT's (Thin Film Transistors) ON and OFF, or the so called optical readout method that irradiates readout light to read out radiation image signals. However, the present invention is not limited to these readout methods, and other methods may be employed.

A radiation source 17 and a radiation source controller 32 are provided in the radiation irradiating section 16. The radiation source controller 32 controls the timing at which radiation is irradiated by the radiation source 17, and radiation generating conditions (bulb current, time, bulb current time product, etc.) of the radiation source 17.

A pressing plate 8 for compressing a breast M, a support member 20 that supports the pressing plate 18, and a moving mechanism for moving the support member 20 in the vertical direction (the Z direction) are provided at the central portion of the arm member 13 above the imaging base 14. The position of the pressing plate 18 and a compression pressure are controlled by a pressing plate controller 34.

The computer 8 is equipped with a CPU (Central Processing Unit) and a storage device such as a semiconductor memory, a hard disk, or an SSD. These hardware components constitute a control section 8a, a data storage section 8b, and an image processing section 8c illustrated in Figure 3.

The control section 8a outputs predetermined control signals to each of the controllers 31 through 34, to control the entirety of the system. The specific methods of control will be described later. The data storage section 8b stores radiation image data obtained by the radiation image detector by imaging with each imaging angle. The image processing section 8c administers various image processes onto the radiation image data, in addition to functioning as a cursor display means for displaying a three dimensional cursor within stereoscopic images.

The input section 7 is constituted by a keyboard and a pointing device, such as a mouse, for example. The input section 7 is configured to receive input of movement operations for the three dimensional cursor. The input section 7 is also configured to receive input of imaging conditions and operating commands from an operator.

The monitor 9 is configured to display radiation images for obtained by different imaging directions output by the computer 8 as two dimensional images, to display a stereoscopic image.

Two radiation images based on two sets of radiation image data may be displayed on two screens, a half mirror or polarizing glass may be employed to cause one of the radiation images to enter the right eye of an observer, and the other of the radiation images to enter the left eye of the observer, as a configuration for displaying the stereo image.

Alternatively, two radiation images may be displayed in an overlapping manner, shifted for a predetermined amount of parallax, and viewed through polarizing glass in order to generate a stereo image. As a further alternative, two radiation images may be displayed on a 3D liquid crystal display capable of being stereoscopically viewed as in the parallax barrier method and the lenticular method, to generate a stereo image.

In addition, the apparatus for displaying stereo images and the apparatus for displaying two dimensional images may be configured as separate apparatuses, or may be configured as a single apparatus in the case that the stereo images and two dimensional images can be displayed on the same screen.

Next, the operation of the mammogram display system of the present embodiment will be described. Figure 4 is a diagram for explaining projection of a three dimensional cursor onto a stereoscopic image. Figure 5 is a diagram that illustrates an example of a stereoscopic mammogram which is displayed two dimensionally. Figure 6 is a diagram that illustrates an example of a stereoscopic mammogram which is displayed three dimensionally.

First, an imaging operation will be described.

First, a breast M is placed on the imaging base 14, and is compressed by the pressing plate 18 at a predetermined pressure.

Next, various imaging conditions, including an angle formed by two different imaging directions (hereinafter, referred to as "convergence angle θ") and combinations of imaging angles θ′ that form the convergence angle θ are input via the input section 7. After the imaging conditions are input, an imaging initiation command is input via the input section 7.

After the imaging initiation command is input via the input section 7, imaging of a stereo image of the breast M is performed. Specifically, first, the control section 8a outputs data regarding a convergence angle θ and imaging angles θ′ that form the convergence angle θ to the arm controller 31. Note that in the present embodiment, data regarding the convergence angle θ is set as θ=4°, and the combination of actual imaging angles θ′ is set as θ′=±2°. However, the present invention is not limited to employing these settings, and an operator is capable of setting desired a convergence angle θ via the input section 7.

The arm controller 31 receives data regarding the imaging angles θ′ output by the control section 8a. The arm controller 31 first outputs a control signal to incline the arm member 13 with respect to a direction perpendicular to the detecting surface 15a to realize an imaging angle θ′ of +2° for a right eye image, based on the data regarding the imaging angle θ′.

The arm member 13 rotates +2° in response to the control signal output from the arm controller 31. Next, the control section 8a outputs control signals to the radiation source controller 32 and the detector controller 33 to perform irradiation of radiation and readout of a radiation image. In response to these control signals, the radiation source 17 emits radiation and a radiation image of the breast M obtained by imaging with an imaging angle θ′ of +2° is detected by the radiation image detector 15, radiation image data are read out by the detector controller 33, and the read out radiation image data are stored in the data storage section 8b.

Next, the arm controller 31 outputs a control signal to incline the arm member 13 with respect to a direction perpendicular to the detecting surface 15a to realize an imaging angle θ′ of -2° for a left eye image, based on the data regarding the imaging angle θ′.

The arm member 13 rotates -2° in response to the control signal output from the arm controller 31. Next, the control section 8a outputs control signals to the radiation source controller 32 and the detector controller 33 to perform irradiation of radiation and readout of a radiation image. In response to these control signals, the radiation source 17 emits radiation and a radiation image of the breast M obtained by imaging with an imaging angle θ′ of -2° is detected by the radiation image detector 15, radiation image data are read out by the detector controller 33, and the read out radiation image data are stored in the data storage section 8b.

Next, a stereoscopic image display operation will be described.

First, radiation image signals that represent the right eye radiation image and the left eye radiation image which are stored in the data storage section 8b of the computer 8 are read out from the data storage section 8b of the computer 8, output to the monitor 9, and a stereoscopic image of the breast M is displayed on the monitor 9.

As illustrated in Figure 6, a three dimensional cursor C is displayed on the stereoscopic image. Note that the three dimensional cursor C has transparency, and that the size and the shape of the three dimensional cursor C are not particularly limited.

Specifically, a three dimensional shape such as a sphere, a cube, a polygon, a cylinder, etc., are stored in the data storage section 8b as the shape of the three dimensional cursor C. The shape and the size to be employed as the three dimensional cursor C may be changed according to commands input by the operator.

Alternatively, shapes of portions which are presumed to be specified within the stereoscopic image, such as the shapes of nipples and tumor cells, may be stored in the data storage section 8b. In this case, the shape of the three dimensional cursor C may be selected from among shapes which are stored in advance when viewing the stereoscopic image, and the size of the three dimensional cursor C may be variable based on operator input. If this configuration is adopted, a portion which is desired to be specified will be displayed clearly as though emphasized if the three dimensional cursor and the desired portion overlap completely. Therefore, confirmation and specification of the portion will be facilitated.

In addition, the degree of transparency is not particularly limited, and may be any value. However, if the degree of transparency is within a range from 30% to 60%, the visibility of the three dimensional cursor and the ease with which confirmation of whether the three dimensional cursor is overlapped with a desired subject can be performed can both be achieved.

Here, the process by which the three dimensional cursor C is displayed within the stereoscopic image will be described in detail.

The three dimensional cursor is movable in three dimensions with respect to the display screen of the monitor 9. When a three dimensional position is specified at the input section 7, the image processing section 8C determines a relative position with respect to the detecting surface of the radiation image detector 15, and the three dimensional cursor C is virtually arranged at this position, as illustrated in Figure 4. First, a position at which the three dimensional cursor C is projected onto the detecting surface of the radiation image detector 15 at the imaging angle θ′ for the right eye radiation image is determined. Then, a projected image of the three dimensional cursor C is combined with the right eye radiation image at the determined projection position by image processes, to obtain a right eye radiation image that includes the three dimensional cursor C as illustrated in Figure 5. Similarly, a position at which the three dimensional cursor C is projected onto the detecting surface of the radiation image detector 15 at the imaging angle θ′ for the left eye radiation image is determined. Then, a projected image of the three dimensional cursor C is combined with the left eye radiation image at the determined projection position by image processes, to obtain a left eye radiation image that includes the three dimensional cursor C as illustrated in Figure 5.

A stereoscopic image based on the right eye radiation image and the left eye radiation image, with which the images of the three dimensional cursor C are combined as described above, is displayed on the monitor 9. Thereby, a stereoscopic image that includes the three dimensional cursor C is displayed.

By employing a three dimensional cursor having transparency as the cursor to be displayed on the stereoscopic image in this manner, the position in the depth direction of the stereoscopic image can be more easily understood compared to a case in which an ordinary planar cursor is employed. Further, subjects are displayed, that is, not completely hidden when the subjects and the cursor overlap. Therefore, specification of subjects within the stereoscopic image by users using the cursor is facilitated.

Note that the three dimensional cursor may be displayed in a blinking manner. In this case, comparisons between states in which the cursor is present and absent can be easily displayed. Therefore, confirmation and specification of the portion will be facilitated. Here, the blinking of the three dimensional cursor will cause annoyance if the blinking period is too short, and longer amounts of time will become necessary to perform comparisons if the blinking period is too long. Therefore, it is preferable for the blinking period to be approximately one second. However, the blinking period is not particularly limited, and may be set to any value.

The stereoscopic image display apparatus of the present invention is described as a mammogram display system in the above embodiment. However, the present invention is not limited to stereoscopic mammogram display systems, and may be applied to any stereoscopic image display apparatus capable of displaying stereoscopic images.

Further, various changes and modifications are possible as long as they do not stray from the spirit and the scope of the present invention as claimed.

CLAIMS

1. A stereoscopic image display apparatus that displays a stereoscopic image constituted by a right eye image obtained by imaging subjects and a left eye image obtained by imaging the subjects, the right eye image and the left eye image having parallax with respect to each other, to enable stereoscopic viewing, characterized by comprising:

input means capable of inputting three dimensional positions within the stereoscopic image; and

three dimensional cursor display means, for displaying a three dimensional cursor having transparency at positions specified by the input means.

2. A stereoscopic image display apparatus as defined in Claim 1, characterized by:

the shape of the three dimensional cursor being substantially the same as the shapes of portions which are presumed to be specified within the stereoscopic image.

3. A stereoscopic image display apparatus as defined in Claim 1, characterized by:

the three dimensional cursor display means being capable of changing the shape of the three dimensional cursor.

4. A stereoscopic image display apparatus as defined in any one of Claims 1 through 3, characterized by:

the three dimensional cursor display means being capable of changing the size of the three dimensional cursor.

5. A stereoscopic image display apparatus as defined in any one of Claims 1 through 4, characterized by:

the three dimensional cursor display means being capable of changing the degree of transparency of the three dimensional cursor.

6. A stereoscopic image display apparatus as defined in any one of Claims 1 through 5, characterized by:

the three dimensional cursor display means displaying the three dimensional cursor in a blinking manner.

7. A stereoscopic image display method for displaying a stereoscopic image constituted by a right eye image obtained by

imaging a subject and a left eye image obtained by imaging the subject, the right eye image and the left eye image having parallax with respect to each other, characterized by comprising:

inputting three dimensional positions within the stereoscopic image with an input means; and

displaying a three dimensional cursor having transparency at positions specified by the input means.

8. A program that causes a computer to execute the stereoscopic image display method of Claim 7.

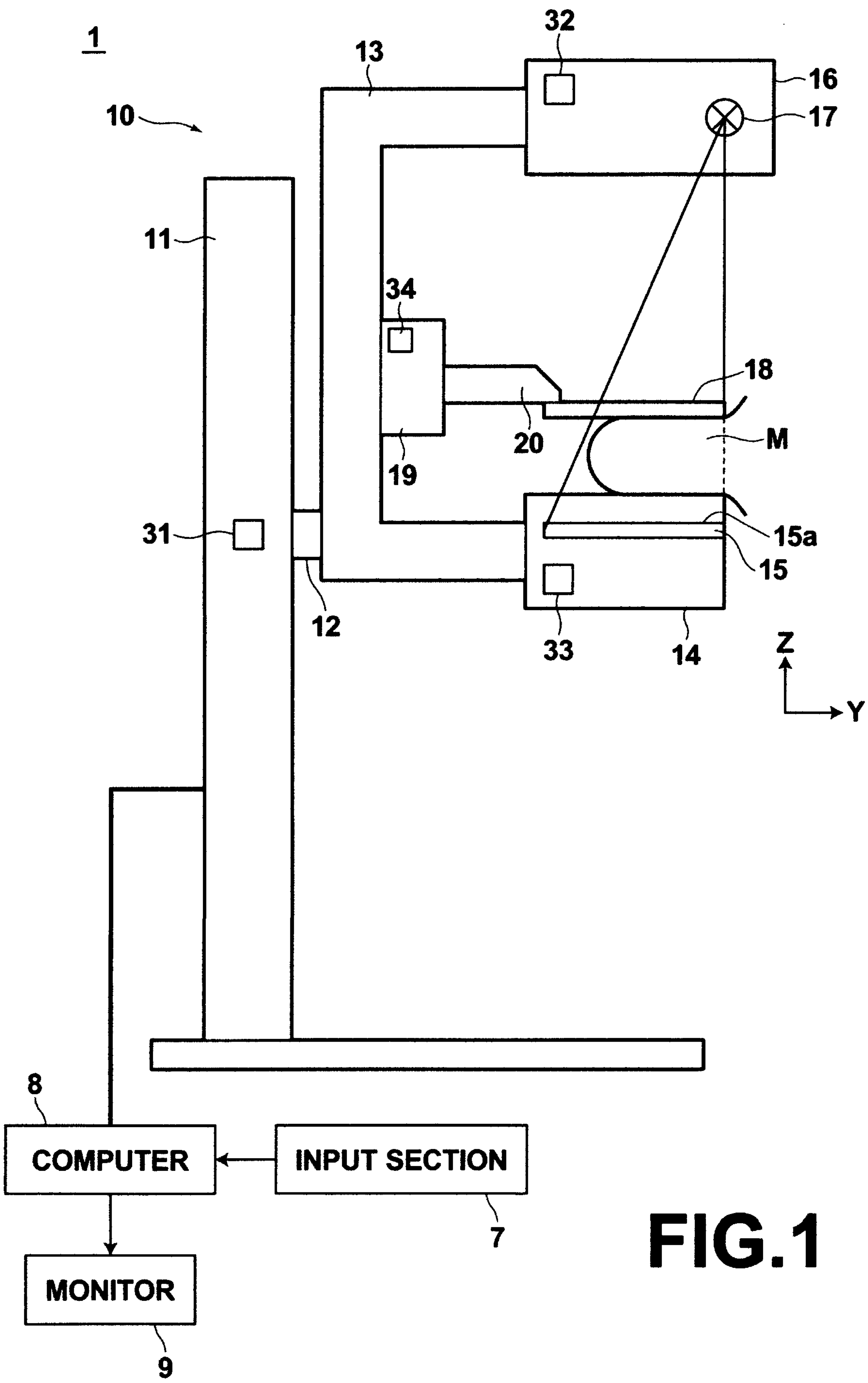

1
10
11
12
13
14
15
15a
16
17
18
19
20
31
32
33
34
M
Z
Y
COMPUTER
INPUT SECTION
MONITOR
8
7
9

FIG.1

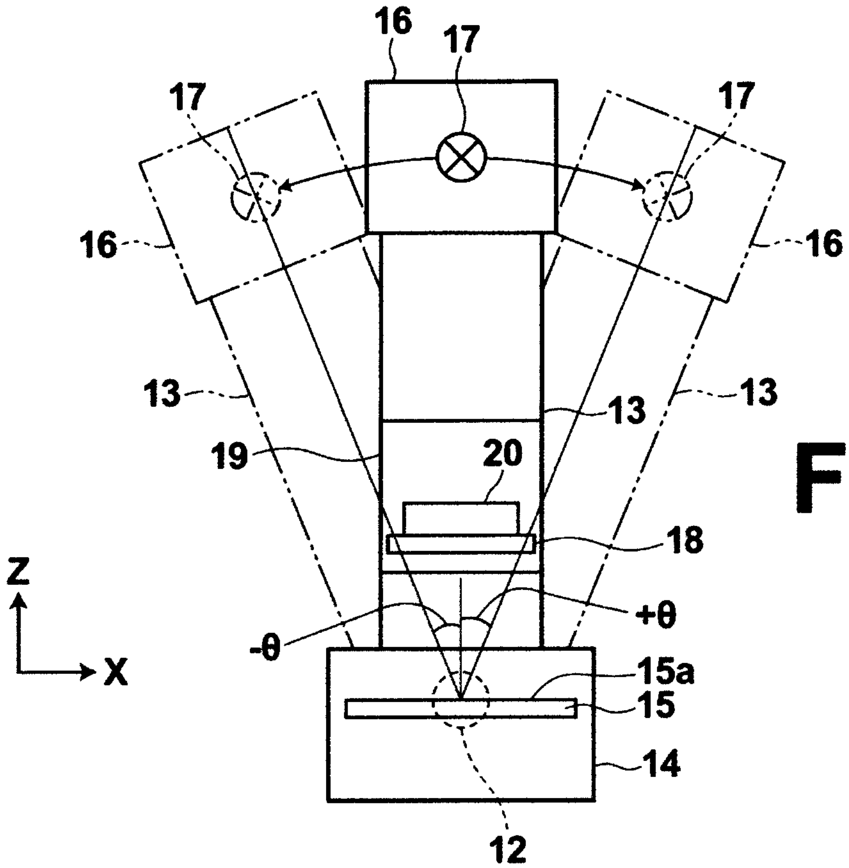

16
17
17
17
16
16
13
13
13
19
20
18
Z
X
+θ
-θ
15a
15
14
12

FIG.2

FIG.3

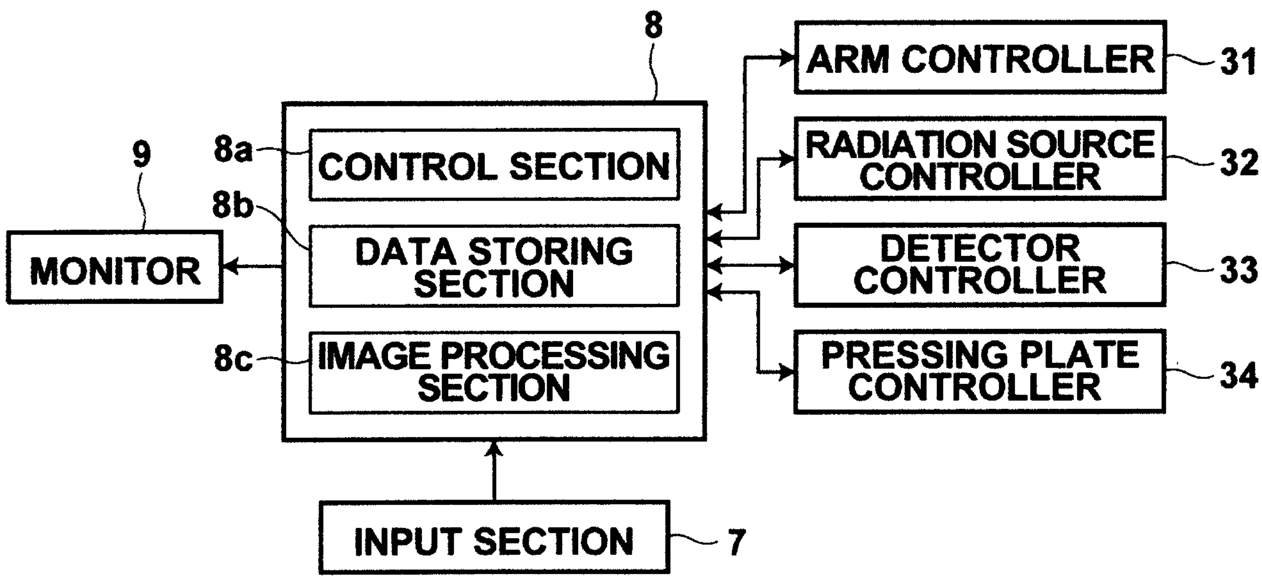

8
ARM CONTROLLER
31
RADIATION SOURCE CONTROLLER
32
9
8a
CONTROL SECTION
8b
DATA STORING SECTION
MONITOR
DETECTOR CONTROLLER
33
8c
IMAGE PROCESSING SECTION
PRESSING PLATE CONTROLLER
34
INPUT SECTION
7

FIG.4

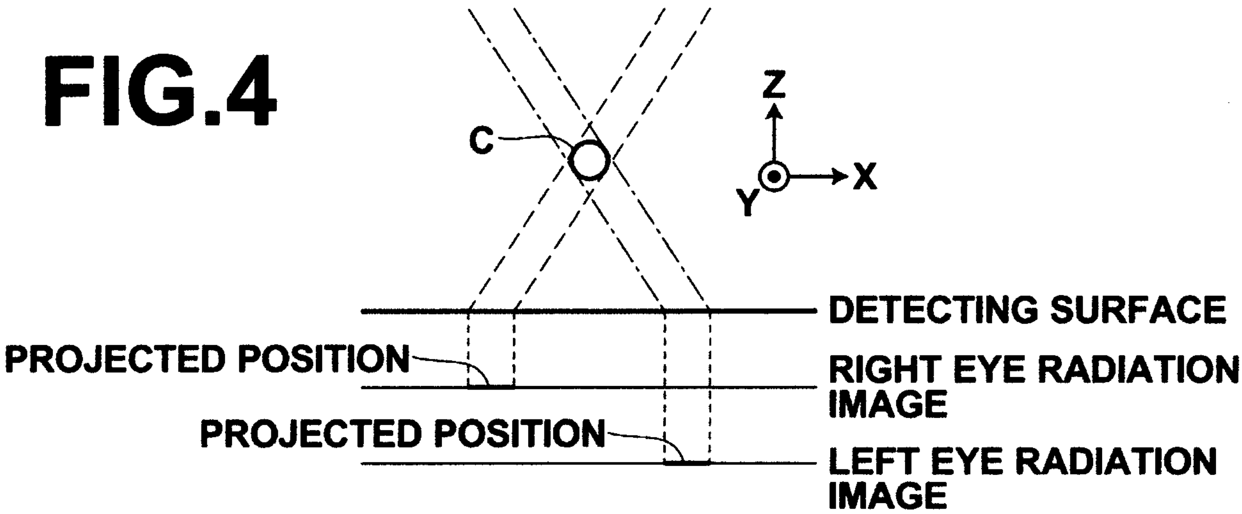


FIG.5

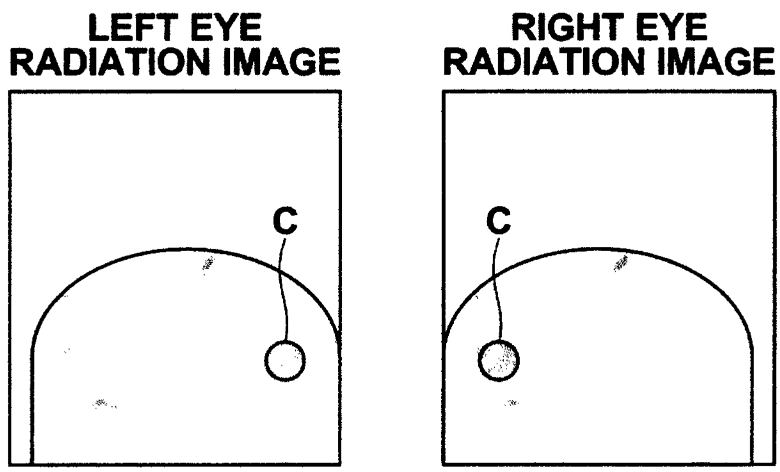
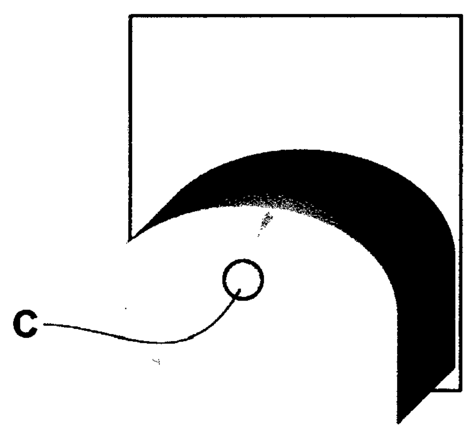


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/076588

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G09G5/36(2006.01)i, A61B6/00(2006.01)i, G09G5/00(2006.01)i, G09G5/08(2006.01)i, G09G5/377(2006.01)i, H04N13/04(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G09G5/36, A61B6/00, G09G5/00, G09G5/08, G09G5/377, H04N13/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2012
Registered utility model specifications of Japan 1996-2012
Published registered utility model applications of Japan 1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 6-27919 A (INTERNATIONAL BUSINESS MACHINES CORPORATION) 1994.02.04, 【0012】,【0045】-【0047】 & US 5162779 A	1,3-8
A	JP 2005-136726 A (CANON KK.) 2005.05.26, 【0022】-【0041】、Fig.2-10 (No Family)	1-8
A	JP 2004-354540 A (SANYO ELECTRIC CO.) 2004.12.16, claim 5 & US 2007/0182730 A1 & WO 2004/107763 A1	1-8
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☐ Further documents are listed in the continuation of Box C.　☐ See patent family annex.

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