PATIENT SUPPORT DEVICE

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Appl. No.: 12/204,617
Filed: Sep. 4, 2008

Abstract

A patient support device for use in a medical facility. The patient support device includes a base and a table assembly coupled to the base. The table assembly includes a lower support and an upper support coupled thereto and movable with respect to the lower support. At least one of the upper support and the lower support includes a bearing layer thereon capable of improving the performance of the patient support device when the upper support moves with respect to the lower support.
FIG. 1
PATIENT SUPPORT DEVICE

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 60/969,904, filed on Sep. 4, 2007, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to a radiation therapy imaging and treatment system. More specifically, the invention relates to a patient support device for use with such a system.

BACKGROUND OF THE INVENTION

[0003] Medical equipment for radiation therapy treats tumorous tissue with high energy radiation. The dose and the placement of the dose must be accurately controlled to ensure both that the tumor receives sufficient radiation to be destroyed, and that damage to the surrounding and adjacent non-tumorous tissue is minimized. Intensity modulated radiation therapy (IMRT) treats a patient with multiple rays of radiation each of which may be independently controlled in intensity and/or energy. The rays are directed from different angles about the patient and combine to provide a desired dose pattern. In external source radiation therapy, a radiation source external to the patient treats internal tumors. The external source is normally collimated to direct a beam only to the tumorous site. Typically, the radiation source includes either high-energy X-rays, electrons from certain linear accelerators, or gamma rays from highly focused radioisotopes, though other types of radiation sources are possible.

[0004] One way to control the position of the radiation delivery to the patient is through the use of a patient support device, such as a couch, that is adjustable in one or more directions. The use of a patient support device is well known in the medical field, with similar patient support devices being used in CT scanning devices and Magnetic Resonance Imagers (MRIs). The patient support device allows the patient to be moved into and out of the field of the radiation to be delivered and in some cases, allow for adjustments of patient position during a radiation treatment.

SUMMARY OF THE INVENTION

[0005] When a patient support device such as a couch is to control the position of the radiation delivery to the patient, there are many variables that need to be accounted for. For example, construction materials and configuration of suitable electronics necessary to operate the couch must be carefully selected to ensure smooth operation of the couch, and precise measurement of couch position (when the couch has multiple movable parts). When these features are thoughtfully considered in the environment of radiation delivery, the patient support device can be a key tool in improving patient outcomes.

[0006] The present invention provides a radiation therapy treatment system that includes an improved patient support device. In one embodiment, the patient support device includes a table assembly coupled to a base. The table assembly includes an upper support and a lower support, the upper support being movable with respect to the lower support. In one embodiment, at least a portion of both the upper and lower supports include a bearing layer, designed to improve the performance of the patient support device during movement of the upper support with respect to the lower support.

[0007] In one embodiment, the present invention provides a radiation delivery system comprising a gantry configured to receive a patient, a radiation source coupled to the gantry and operable to deliver radiation to a patient, and a patient support device movable with respect to the gantry. The patient support device comprises a base, and a table assembly coupled to the base, the table assembly including a lower support and an upper support coupled to the lower support, wherein the upper support is movable with respect to the lower support, and at least one of the upper support and the lower support includes a bearing layer thereon capable of improving the performance of the patient support device when the upper support moves with respect to the lower support.

[0008] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of a radiation therapy treatment system.

[0010] FIG. 2 is a perspective view of a multi-leaf collimator that can be used in the radiation therapy treatment system illustrated in FIG. 1.

[0011] FIG. 3 is a perspective view of a patient support device for use with the system of FIG. 1.

[0012] FIG. 4 is an exploded view of a table assembly of the patient support device of FIG. 3.

[0013] FIG. 5 is a perspective view of an upper support of the table assembly of FIG. 4.

[0014] FIG. 6 is a perspective view of a lower support of the table assembly of FIG. 4.

[0015] FIG. 7 is an assortment of views of a control keypad for use with the patient support device of FIG. 1.

[0016] FIG. 8 is an exploded view of the keypad of FIG. 7.

[0017] FIG. 9 is a front view of the keypad of FIG. 7, illustrating the control buttons in greater detail.

[0018] FIG. 10 is a perspective view of the keypad of FIG. 7, illustrating operation of the buttons by the operator of the patient support device.

[0019] FIG. 11 is a perspective view of the patient support device of FIG. 3, shown in the lowered position.

[0020] FIG. 12 illustrates a riser of the patient support device of FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings.
Although directional references, such as upper, lower, downward, upward, rearward, bottom, front, rear, etc., may be used herein, the drawings, these references are made relative to the drawings (as normally viewed) for convenience. These directions are not intended to be taken literally or limit the present invention in any form. In addition, terms such as "first," "second," and "third" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance.

In addition, it should be understood that embodiments of the invention include hardware, software, and electronic components or modules that, for purposes of discussion, may be illustrated and described as if the majority of the components were implemented solely in hardware. However, one of ordinary skill in the art, based on a reading of this detailed description, would recognize that, in at least one embodiment, the electronic based aspects of the invention may be implemented in software. As such, it should be noted that a plurality of hardware and software based devices, as well as a plurality of different structural components may be utilized to implement the invention. Furthermore, and as described in subsequent paragraphs, the specific mechanical configurations illustrated in the drawings are intended to exemplify embodiments of the invention and that other alternative mechanical configurations are possible.

FIG. 1 illustrates a radiation therapy treatment system 10 that can provide radiation therapy to a patient 14. The radiation therapy treatment can include photon-based radiation therapy, brachytherapy, electron beam therapy, proton, neutron, or particle therapy, or other types of treatment therapy. The radiation therapy treatment system 10 includes a gantry 18. The gantry 18 can support a radiation module 22, which can include a radiation source 24 and a linear accelerator 26 (a.k.a. "LINAC") operable to generate a beam 30 of radiation. Though the gantry 18 shown in the drawings is a ring gantry, i.e., it extends through a full 360° arc to create a complete ring or circle, other types of mounting arrangements may also be employed. For example, a C-type, partial ring, gantry, or robotic arm could be used. Any other framework capable of positioning the radiation module 22 at various rotational and/or axial positions relative to the patient 14 may also be employed. In addition, the radiation source 24 may travel in a path that does not follow the shape of the gantry 18. For example, the radiation source 24 may travel in a non-circular path even though the illustrated gantry 18 is generally circular-shaped. The gantry 18 of the illustrated embodiment defines a gantry aperture 32 into which the patient 14 moves during treatment.

The radiation module 22 can also include a modulation device 34 operable to modify or modulate the radiation beam 30. The modulation device 34 provides the modulation of the radiation beam 30 and directs the radiation beam 30 toward the patient 14. Specifically, the radiation beam 30 is directed toward a portion 38 of the patient. Broadly speaking, the portion 38 may include the entire body, but is generally smaller than the entire body and can be defined by a two-dimensional area and/or a three-dimensional volume. A portion or area desired to receive the radiation, which may be referred to as a target or target region, is an example of a region of interest. Another type of region of interest is a region at risk. If a portion includes a region at risk, the radiation beam is preferably diverted from the region at risk. Such modulation is sometimes referred to as intensity modulated radiation therapy ("IMRT").

The modulation device 34 can include a collimation device 42 as illustrated in FIG. 2. The collimation device 42 includes a set of jaws 46 that define and adjust the size of an aperture 50 through which the radiation beam 30 may pass. The jaws 46 include an upper jaw 54 and a lower jaw 58. The upper jaw 54 and the lower jaw 58 are moveable to adjust the size of the aperture 50. The position of the jaws 46 regulates the shape of the beam 30 that is delivered to the patient 14.

In one embodiment, and illustrated in FIG. 2, the modulation device 34 can comprise a multi-leaf collimator (MLC) 62, which includes a plurality of interfaced leaves 66 operable to move from position to position, to provide intensity modulation. It is also noted that the leaves 66 can be moved to a position anywhere between a minimally and maximally-open position. The plurality of interfaced leaves 66 modulate the strength, size, and shape of the radiation beam 30 before the radiation beam 30 reaches the portion 38 on the patient 14. Each of the leaves 66 is independently controlled by an actuator 70, such as a motor or an air valve so that the leaf 66 can open and close quickly to permit or block the passage of radiation. The actuators 70 can be controlled by a computer 74 and/or controller.

The radiation therapy treatment system 10 can also include a detector 78, e.g., a kilovoltage or a megavoltage detector, operable to receive the radiation beam 30, as illustrated in FIG. 1. The linear accelerator 26 and the detector 78 can also operate as a computed tomography (CT) system to generate CT images of the patient 14. The linear accelerator 26 emits the radiation beam 30 toward the portion 38 in the patient 14. The portion 38 absorbs some of the radiation. The detector 78 detects or measures the amount of radiation absorbed by the portion 38. The detector 78 collects the absorption data from different angles as the linear accelerator 26 rotates around and emits radiation toward the patient 14. The collected absorption data is transmitted to the computer 74 to process the absorption data and to generate images of the patient’s body tissues and organs. The images can also illustrate bone, soft tissues, and blood vessels.

The system 10 can also include a patient support device, shown as a couch 82, operable to support at least a portion of the patient 14 during treatment. While the illustrated couch 82 is designed to support the entire body of the patient 14, in other embodiments of the invention the patient support need not support the entire body, but rather can be designed to support only a portion of the patient 14 during treatment. The couch 82 moves into and out of the field of radiation along an axis 84.

With reference to FIGS. 3-6, the couch 82 includes a table assembly 92 coupled to a base 93 via a platform 95. The table assembly 92 includes an upper support 94 movably coupled to a lower support 98. With particular reference to FIG. 5, the upper support 94 is a substantially flat, rectangular support member on which the patient is supported during treatment. The upper support 94 is movable with respect to the lower support 98 to move the patient into and out of the radiation beam 30 during treatment. In the illustrated embodiment, the upper and lower supports 94, 98 are composed of a carbon fiber composite, though other suitable compositions of the supports are possible.

The upper support 94 has an upper surface 102 and a lower surface 106 that contacts an upper surface 110 of the lower support 98. As shown in the illustrated embodiment, the lower surface 106 includes a bearing layer 114 that is intended to reduce friction between the lower surface 106 and
the upper surface 110 of the lower support 98 when the upper support 94 is moved with respect to the lower support 98. In the illustrated embodiment, the bearing layer 114 is a poly-imide laminate that is coupled to the lower surface 106 using a pressure sensitive adhesive. In the illustrated embodiment, the laminate is Kapton®, available from DuPont. When the upper support 94 moves with respect to the lower support 98, any friction that builds up between the supports can interrupt the operation of the electronics that control the operation of the couch 82 and thus minimizing the friction is one of the goals of the invention. Further, when the supports are composed of a carbon fiber composite, the friction can cause the creation and build-up of carbon dust, which can cause problems with couch operation. Additionally, if the surfaces of the upper and lower supports 94, 98 were to contact each other directly, the contact would result in additional wear and possible warping of the supports themselves, which may not only reduce the precision with which the couch can operate to position a patient, but can also cause couch failure.

With reference to FIG. 4, the lower support 98 includes two channels 118 that are designed to receive and house wiring necessary for the operation of the couch 82. In some embodiments, a retaining member 122 is placed over the wiring within the channels 118 to hold the wiring in place and force the wiring to lie straight within the channels 118 to reduce the possibility of the wiring being pinched between the upper support 94 and the lower support 98. Furthermore, it is desirable to hold the wires in a straight and constant position for image reproducibility. Both the retaining member 122 and the outer sheathing of the wiring itself are composed of radiation resistant material to provide for the protection and proper functioning of the wiring in the high radiation environment of the couch 82. The spacing and design of the channels 118 are selected to separate the power lines from the data lines to prevent interference problems that occur when the two lines are not sufficiently spaced. The upper surface 110 of the lower support 98 is divided into three segments by the channels 118, a middle segment 126 and two outer segments 130. In the illustrated embodiment, there is a bearing layer 134 on the outer segments 130 and the middle segment 126 of the upper surface 110. Preferably, the bearing layer 134 is of the same material as the bearing layer 114. In other embodiments of the invention, the middle segment 126 may be used as a bearing layer.

The couch 82 is movable in the X, Y, and Z directions, as illustrated in FIG. 1. Positioning of the couch 82, and thus the position of the patient, with respect to the gantry 18 and the radiation beam 30 must be precise to ensure that the radiation is delivered to the proper areas of the patient. The movement of the couch 82 is controlled by the couch operator using a control keypad 140. With reference to FIGS. 7-10, the keypad 140 includes elastomeric buttons 144 that operate corresponding portions of a circuit board 148. In order to move the couch 82 in any manner or direction, the user must not only operate the appropriate button 144, but also must depress an enable pad (not shown) on the underside of the keypad 140 to reduce the possibility of accidental movement of the couch 82 by an operator who bumps or brushes against the buttons 144. The ergonomic design of the keypad 140 allows for one-handed operation, as illustrated in FIG. 10. Further enhancing the ergonomic benefits of the keypad 140, there are two symmetrical sets of exterior buttons 152 for moving the couch 82 in the X direction to comfortably allow both right and left handed operation of the keypad 140.

Ease of operation of the couch 82 is the main objective of the keypad 140, which is designed to be intuitive and ergonomic. The smooth, snapproof design includes no exposed metal or electrically conductive materials of any kind, reducing the possibility of shorts in the control mechanism, reducing vulnerability to ESD, and reducing risk of electric shock. The control panel 140 is flush mounted into the side of the couch 82, and has a contiguous, sealed top surface with no joints or seams to be resistant to infiltration of liquids and other contaminants. The specific elastomers chosen for the buttons are highly resistant to cleaners and solvents, and are also resistant to radiation. The keypad 140 also includes an integrated system status beacon (which indicates the status of the system 10 outside the operation of the couch 82), a button 154 for operating the Y-axis clutch, along with a clutch status indicator, and backlit buttons for easy identification. The layout of the buttons 144 is designed to intuitively suggest the movement accomplished by each button. The buttons 144 also provide tactile feedback to the user. Furthermore, the same keypad assembly can fit on either side of the couch 82, and in some cases the couch 82 is provided with a keypad 140 on both sides.

Motion in the Y and Z directions is accomplished via operation of the central buttons 156. The central buttons 156 are dual speed buttons where pushing the button with lesser pressure results in a single contact for slow operation of the couch 82, and pushing the button with additional pressure results in a second electrical contact resulting in faster movement of the couch 82. The dual speed aspect of the buttons 156 allows for greater control of the couch 82, and provides for more efficient couch movement. In turn, greater efficiency in couch movement results in increased patient throughput and reduced fraction delivery time.

The couch 82 also includes support arms 164 that couple the table assembly 92 to a riser 168 of the base 93. As shown in the illustrated embodiment, the couch 82 includes two pairs of support arms 164, with each arm 164 within a pair of arms being parallel to the other. As the table assembly 92 is raised and lowered, a longitudinal axis of each arm 164 within a pair remains parallel to the other arm, and a plane P1 formed by the longitudinal axes of one pair of arms does not intersect a plane P2 formed by the longitudinal axis of the other pair of arms.

The riser 168, as illustrated in FIG. 12, includes several integral leveling feet 172 that allow the riser 168 position with respect to the X, Y, and Z axis position of the gantry 18 (and the floor of the treatment room) to be easily
adjusted to assure that the couch 82 is level with respect to the gantry 18. To adjust the leveling position of the couch 82, the feet 172, shown in the illustrated embodiment as screws, are turned individually to level the position of the couch 82 in all three planes (X, Y, and Z). In the illustrated embodiment, the riser includes six feet 172, though it is understood that other numbers of feet may be used and still fall within the scope of the invention.

What is claimed is:

1. A patient support device for use in a medical facility, the patient support device comprising:
   a base; and
   a table assembly coupled to the base, the table assembly comprising
   a lower support, and
   an upper support coupled to the lower support and movable with respect to the lower support, at least one of the upper and lower supports having a bearing layer thereon capable of improving the performance of the patient support device when the upper support moves with respect to the lower support.

2. The patient support device of claim 1, wherein the upper support includes a lower surface, the lower support includes an upper surface, and wherein the lower surface of the upper support contacts the upper surface of the lower support during movement of the upper support with respect to the lower support.

3. The patient support device of claim 2, wherein the bearing layer is coupled to at least one of the lower surface of the upper support and the upper surface of the lower support.

4. The patient support device of claim 2, wherein the bearing layer is coupled to both the lower surface of the upper support and the upper surface of the lower support.

5. The patient support device of claim 2, wherein the bearing layer is coupled to the entirety of at least one of the lower surface of the upper support and the upper surface of the lower support.

6. The patient support device of claim 1, wherein both the upper and lower supports include a bearing layer thereon.

7. The patient support device of claim 1, wherein the bearing layer is coupled to the entirety of at least one of the upper and lower supports.

8. The patient support device of claim 1, wherein the bearing layer is coupled to only a portion of at least one of the upper and lower supports.

9. The patient support device of claim 1, wherein the bearing layer comprises a Kapton laminate material.

10. The patient support device of claim 1, wherein the bearing layer is coupled to the at least one of the upper and lower supports using a pressure sensitive adhesive.

11. The patient support device of claim 1, wherein the lower support includes at least one channel therein configured to receive wiring.

12. The patient support device of claim 10, wherein the channel includes a radiation resistant retaining member to confine the wiring within the channel.

13. The patient support device of claim 10, wherein the lower support includes two channels, wherein the wiring includes both power lines and data lines, and wherein the spacing of the channels with respect to each other is configured to separate the power lines from the data lines to prevent interference between the power lines and data lines.

14. The patient support device of claim 13, wherein the channels divide the lower support into multiple segments, and wherein all of the segments include a bearing layer thereon.

15. The patient support device of claim 1, wherein the base includes a riser, and wherein the riser includes at least one integral leveling foot that allows the riser position to be adjusted in multiple planes.

16. The patient support device of claim 1, further comprising a control keypad for operation of the patient support device.

17. The patient support device of claim 16, wherein the control keypad allows for one-handed operation of the patient support device by a user, and wherein the keypad is designed to accommodate use by either hand of the user.

18. The patient support device of claim 16, wherein the control keypad includes one or more integral status beacon to indicate the operational status of an external device to which the patient support device is connected.

19. A radiation delivery system comprising:
   a gantry configured to receive a patient;
   a radiation source coupled to the gantry operable to deliver radiation to a patient; and
   a patient support device movable with respect to the gantry, the patient support device comprising
   a base, and
   a table assembly coupled to the base, the table assembly including a lower support and an upper support coupled to the lower support, wherein the upper support is movable with respect to the lower support, and at least one of the upper support and the lower support includes a bearing layer thereon capable of improving the performance of the patient support device when the upper support moves with respect to the lower support.

20. The radiation delivery system of claim 19, wherein the upper support includes a lower surface, the lower support includes an upper surface, and wherein the lower surface of the upper support contacts the upper surface of the lower support during movement of the upper support with respect to the lower support.

21. The radiation delivery system of claim 20, wherein the bearing layer is coupled to both the lower surface of the upper support and the upper surface of the lower support.

22. The radiation delivery system of claim 21, wherein the bearing layer is coupled to the entirety of both the lower surface of the upper support and the upper surface of the lower support.

23. The radiation delivery system of claim 19, wherein the bearing layer comprises a Kapton laminate material.

24. The radiation delivery system of claim 19, wherein the lower support includes two channels therein, each channel configured to receive wiring used to operate the patient support device.

25. The radiation delivery system of claim 24, wherein the wiring includes both power lines and data lines, and wherein the spacing of the channels with respect to each other is configured to separate the power lines from the data lines to prevent interference between the power lines and data lines.

26. The radiation delivery system of claim 24, further comprising a retaining member to restrict the positioning of the wiring within the channels.

27. The radiation delivery system of claim 24, wherein the channels divide the lower support into multiple segments, and wherein all of the segments include a bearing layer thereon.
28. The radiation delivery system of claim 19, wherein the base of the patient support device includes at least one integral leveling foot that allows the patient support device position to be adjusted in multiple planes with respect to the gantry.

29. The radiation delivery system of claim 19, wherein the patient support device further comprises a control keypad that allows a user to move the patient support device with respect to the gantry, and wherein the keypad is designed for one-handed, ambidextrous operation by the user.

30. The radiation delivery system of claim 29, wherein the control keypad includes one or more integral status beacons to indicate the operational status of one or more components of the radiation delivery system.