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(54) **THREE-DIMENSIONAL (3D) EMITTING APPARATUS**

DREIDIMENSIONALE 3D-EMITTIERENDE VORRICHTUNG

APPAREIL D'ÉMISSION EN TROIS DIMENSIONS (3D)

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Description

Technical Field

[0001] The present invention relates to a three-dimensional (3D) emitting apparatus, and more particularly, to a 3D emitting apparatus that may be aimed at a target point accurately and rapidly.

Background Art

[0002] In general, a machine performing a motion similar to a motion of a human using an electrical or magnetic action is referred to as a robot. With the recent development of control technology, robots are utilized in various fields. The robots include, for example, a housekeeper robot at a home, a service robot in a public area, a transfer robot in a production filed, and a worker assistance robot. Such robots perform tasks using a manipulator produced to be capable of performing a motion similar to a motion of an arm or a hand by electrical or mechanical mechanism.
[0003] Such robots may be used for various applications, for example, a three-dimensional (3D) scanner or a 3D printer.
[0004] The 3D scanner refers to a device that measures a 3D shape of an object and obtains 3D shape data.
[0005] An example of the 3D scanner is a contact 3D scanner that measures an overall curved shape of an object by measuring spatial coordinates of each point while in contact with the object along a surface of the object.
[0006] The 3D printer is technology that manufactures an object by outputting successive layers of a material similar to a two-dimensional (2D) printer and laminating the output layers.
[0007] The 3D printer may produce an object rapidly based on digitized drawing data and thus, is mainly used to produce a prototype sample.
[0008] For example, Korean Patent Application KR 2013 0038101, filed on October 8, 2011, discloses "High resolution dental 3D printer by using multiple projection systems".
[0009] US2013/0223597 discloses an x-ray facility comprising at least an x-ray emitter, an x-ray detector and an isocenter disposed along a central beam path between said x-ray emitter and said x-ray detector, support arms, each of said x-ray emitter and said x-ray detector disposed on separate ones of said support arms, and rotary devices, at least one of said rotary devices disposed on each of said support arms, by way of said rotary devices said x-ray emitter and said x-ray detector can be rotated about an axis of rotation intersecting said isocenter and not corresponding to said central beam path, wherein axes of rotation match said rotary devices assigned to one another on different ones of said support arms.
[0010] KR10-1339009 discloses robot system for radiation cancer treatment comprising a base, an armed installed to support a linear accelerator above the base, a detecting means for detecting an output fluctuation of the radiation beam and a position fluctuation of the lesion portion, a controller for driving the arm under a predetermined condition while inputting a signal of the detecting means.
[0011] US8303575 discloses a tool constraint mechanism comprising a manipulator and a remote center mechanism mounted thereon. The manipulator provides at least one degree of freedom for positioning the remote center mechanism, and the remote center mechanism provides at least a further degree of freedom for positioning a tool holder. The holder is suitable for holding a tool which is to be constrained in operation with respect to a remote centre center point, and the orientation of the tool holder is adjustable while maintaining the position of the remote center point fixed with respect to the manipulator.
[0012] US2008/0226036 discloses an X-ray examination device comprising an X-ray source, an X-ray detector, a segmented carrier. The segmented carrier comprises a main arm on which the X-ray source and X-ray detector are mounted, a first auxiliary arm having a first end and a second end, and a second auxiliary arm joined to the first auxiliary arm via a second mechanical coupler providing a first rotational axis.
[0013] US2008/0123813 discloses an apparatus for automatically determining a beam parameter at each of a plurality of treatment node comprising a radiation beam treatment system having a plurality of collimators to deliver a radiation beam to a treatment site, and a radiation treatment planning system operatively coupled to the radiation beam treatment system, the radiation treatment planning system to automatically select multiple collimators of the plurality of collimators to deliver radiation at a plurality of treatment nodes and automatically calculate a beam duration corresponding to a radiation dose to be delivered at each of the plurality of treatment nodes by the multiple collimators.
[0014] US2010/0026789 discloses a mobile console for holding an image acquisition of medical device, primarily for brain surgical approaches comprising a holder fixing said device immovably and a first supporting arm including the holder. The first supporting arm is associated with at least one moving means moving it relative to the table, the first supporting arm and/or moving means are associated with position/trajectory sensors, and said moving means and the position/trajectory sensors being connected to a control unit.
[0015] JP5165527 discloses 3-dimensional printer and printing method using the same comprising a holding device which holds a printing object, a main carriage which mounts a plurality of printer heads, a movement control device

which controls the relative movement of the holder and the carriage in a 3-dimensional space while keeping the mutual positional relationship so that the printing surface in the surface faces the printer head.

Disclosure of Invention

Technical Goals

[0016] An aspect of the present invention provides a three-dimensional (3D) emitting apparatus that may be aimed at a target point rapidly and accurately through relative movements of a robot arm and a table.

[0017] Another aspect of the present invention also provides a 3D emitting apparatus that may increase a directivity with respect to a target point through easy control.

[0018] Still another aspect of the present invention also provides a 3D emitting apparatus that may reduce an overall weight by reducing a number of drive members through a compact design.

[0019] Yet another aspect of the present invention also provides a 3D emitting apparatus that may be configured in a form of a cyberknife, a 3D scanner, or a 3D printer.

Technical solutions

[0020] According to an aspect of the present invention, there is provided a three-dimensional (3D) emitting apparatus including a table on which an object is to be disposed, a robot arm to perform a task on the object, an emitting member provided at an end portion of the robot arm, and a controller to control an operation of the robot arm or a position of the emitting member. The table and the robot arm may move relatively in a vertical or horizontal direction, the emitting member may move along a trajectory of rotation of the robot arm, and the trajectory of rotation is inscribed on a sphere having a center at which a target point is disposed.

[0021] The robot arm includes a first central member, a first link member to rotate around a longitudinal axis of the first central member, a first drive member disposed at one end of the first link member to transmit a torque to the first link member, a second link member connected to another end of the first link member to rotate on a first axis, and a second drive member disposed between the first link member and the second link member to transmit a torque to the second link member.

[0022] The robot arm further includes a third link member connected to a portion of the first central member, the portion differing from a portion to which the first link member is connected, to rotate around the longitudinal axis of the first central member, a third drive member disposed at one end of the third link member to transmit a torque to the third link member, a fourth link member connected to another end of the third link member to rotate on a second axis, and a fourth drive member disposed between the third link member and the fourth link member to transmit a torque to the fourth link member.

[0023] A plurality of emitting members may be provided, and the plurality of emitting members may face an identical target point.

[0024] The first link member, the second link member, the third link member, and the fourth link member may be disposed on concentric spheres having an identical center, extension lines of axes of the drive members intersecting at the identical center.

[0025] The robot arm may be disposed above or below the table, and the 3D emitting apparatus may be configured in a form of a cyberknife that emits radiation from the emitting member toward the object.

[0026] The 3D emitting apparatus may further include an image sensor to convert light emitted from the emitting member and reflected by the object into an electrical image signal, and a data processor to generate a 3D image by combining a plurality of images received from the image sensor. The 3D emitting apparatus may be configured in a form of a 3D scanner that acquires a 3D shape of the object.

[0027] The object may be provided using a fluid material including an ink, an ultraviolet ray may be emitted from the emitting member, and the 3D emitting apparatus may be configured in a form of a 3D printer that irradiates the ultraviolet ray toward the object to harden the object.

[0028] The 3D emitting apparatus may comprise another robot arm, which includes a second central member disposed on an axis identical to the longitudinal axis of the first central member and spaced apart from the center by a distance corresponding to a distance between the first central member and the center, a fifth link member to rotate around a longitudinal axis of the second central member, a fifth drive member disposed at one end of the fifth link member to transmit a torque to the fifth link member, a sixth link member connected to another end of the fifth link member to rotate on a third axis, and a sixth drive member disposed between the fifth link member and the sixth link member to transmit a torque to the sixth link member.

[0029] The other robot arm may further include a seventh link member connected to a portion of the second central member, the portion differing from a portion to which the fifth link member is connected, to rotate around the longitudinal axis of the second central member, a seventh drive member disposed at one end of the seventh link member to transmit a torque to the seventh link member, an eighth link member connected to another end of the seventh link member to rotate on a fourth axis, and an eighth drive member disposed between the seventh link member and the eighth link member to transmit a torque to the eighth link member.

[0030] The longitudinal axis of the first central member, the longitudinal axis of the second central member, the first axis, the second axis, the third axis, and the fourth axis may intersect at the center of the sphere.

[0031] The first axis, the second axis, the third axis, and the fourth axis may be formed to be perpendicular to tangential directions of end portions of the first link member, the second link member, the third link member, the fourth link member, the fifth link member, the sixth link member, the seventh link member, and the eighth link member.

[0032] The first link member and the second link member may be disposed farther away from the center than the third link member and the fourth link member, and the fifth link member and the sixth link member may be disposed farther away from the center than the seventh link member and the eighth link member.

[0033] The lengths of the third link member and the fourth link member may be shorter than a length of the first link member.

[0034] The third link member and the fourth link member may be disposed closer to the center than the second link member, and the fourth link member may be disposed closer to the center than the third link member.

[0035] The lengths of the seventh link member and the eighth link member may be shorter than a length of the fifth link member.

[0036] The seventh link member and the eighth link member may be disposed closer to the center than the sixth link member, and the eighth link member may be disposed closer to the center than the seventh link member.

[0037] The emitting member may be disposed to be perpendicular to tangential directions of end portions of the second link member, the fourth link member, the sixth link member, and the eighth link member.

[0038] The 3D emitting apparatus may further include a position adjustment element to adjust a position of the table.

Brief Description of Drawings

[0039]

FIG. 1 illustrates a three-dimensional (3D) emitting apparatus used as a cyberknife according to an embodiment of the present invention.

FIG. 2 illustrates a disposition of robot arms in a 3D emitting apparatus according to an embodiment of the present invention.

FIG. 3 illustrates a 3D emitting apparatus used as a 3D scanner according to an embodiment of the present invention.

FIG. 4 illustrates a direction of an emitting member in a 3D emitting apparatus according to an embodiment of the present invention.

FIG. 5 illustrates spherical coordinates.

Best Mode for Carrying Out the Invention

[0040] Reference will now be made in detail to 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.

[0041] A three-dimensional (3D) emitting apparatus according to an embodiment of the present invention may include a table on which an object is to be disposed, a robot arm to perform a task with respect to the object, an emitting member disposed at an end portion of the robot arm, and a controller to control an operation of the robot arm or a position of the emitting member.

[0042] The table and the robot arm may move relatively in a vertical or horizontal direction, the emitting member may move along a trajectory of rotation of the robot arm, and the trajectory of rotation may be provided in a form of a sphere having a center at which a target point is disposed.

[0043] A plurality of robot arms may be provided, emitting members corresponding to a number of the robot arms may be provided, and the plurality of emitting members may face an identical target point.

[0044] The robot arm may include a plurality of link members and a plurality of drive members, the plurality of link members may be disposed on concentric spheres having an identical center, and extension lines of axes of the plurality of drive members may be positioned at the center.

[0045] The foregoing describes a general configuration of a 3D emitting apparatus, and the 3D emitting apparatus may be applicable to various fields.

[0046] For example, the 3D emitting apparatus may be applicable to a cyberknife, a 3D scanner, or a 3D printer.

[0047] Hereinafter, a 3D emitting apparatus applied to a cyberknife, a 3D scanner, and a 3D printer will be described in detail.

[0048] FIG. 1 illustrates a 3D emitting apparatus 10 used as a cyberknife according to an embodiment of the present invention, and FIG. 2 illustrates a disposition of robot arms in the 3D emitting apparatus 10 according to an embodiment of the present invention.

[0049] Referring to FIG. 1, the 3D emitting apparatus 10 may include a table 100, a robot arm 200, and a controller (not shown).

[0050] An object may be disposed on the table 100.

[0051] When the 3D emitting apparatus 10 is used as a cyberknife, the object may be a cancer patient requiring radiation therapy or a tumor removing surgery. In this example, a target point T may be a treatment or surgery area, for example, a position of a tumor.

[0052] A position adjustment element 110 may be disposed at the table 100 to adjust a position of the table 100.

[0053] As shown in FIG. 1, when the position adjustment element 110 moves in a direction of an arrow, the table 100 may also move in the direction of the arrow.

[0054] The position of the table 100 or the object may be freely adjusted and thus, the target point T may be repositioned.

[0055] In detail, the table 100 may move in a direction vertical or horizontal to the ground.

[0056] Accordingly, the table 100 and the robot arm 200 may move relatively in the vertical or horizontal direction.

[0057] When the table 100 is fixed, the position of the object may be fixed. By moving the robot arm 200, an emitting position of an emitting member 300 or a position at which radiation is emitted from the emitting member 300 may be moved relatively with respect to the table 100.

[0058] The object may be repositioned to the target point T by relatively moving the table 100 with respect to the robot arm 200 through the position adjustment element 110, and the emitting member 300 may move to face the target point T.

[0059] Thus, the emitting member 300 provided at the robot arm 200 may be efficiently aimed at the target point T of the object disposed on the table 100.

[0060] The robot arm 200 may be disposed above or below the table 100.

[0061] The robot arm 200 may include an upper robot arm 210 and a lower robot arm 220. The emitting member 300 may be provided at an end portion of each of the upper robot arm 210 and the lower robot arm 220.

[0062] Thus, a number of robot arms 200 may be equal to a number of emitting members 300.

[0063] Referring to FIG. 2, the upper robot arm 210 and the lower robot arm 220 may be disposed within trajectories on spheres having an identical center, for example, the identical target point T.

[0064] The emitting member 300 of the upper robot arm 210 and the emitting member 300 of the lower robot arm 220 may move in response to rotation of the upper robot arm 210 and the lower robot arm 220. Thus, the emitting members 300 may move along spherical trajectories of the upper robot arm 210 and the lower robot arm 220. The emitting members 300 may be disposed to face the identical target point T.

[0065] Accordingly, radiation emitted from the emitting member 300 provided on the upper robot arm 210 and radiation emitted from the emitting member 300 provided on the lower robot arm 220 may be concentrated on a single singular point. The emitting members 300 may be easily aimed at the target point T.

[0066] The upper robot arm 210 and the lower robot arm 220 may be disposed to be spaced apart from each other based on the table 100.

[0067] Through such a disposition of the upper robot arm 210 and the lower robot arm 220, the upper robot arm 210 and the lower robot arm 220 may operate incoherently, and a mutual collision between the upper robot arm 210 and the lower robot arm 220 may be prevented.

[0068] The upper robot arm 210 and the lower robot arm 220 may respectively include a plurality of link members and a plurality of drive members.

[0069] For example, the upper robot arm 210 may include a first link member 211, a second link member 212, a third link member 215, and a fourth link member 216.

[0070] The first link member 211 may be connected to a first central member 202 to rotate on a longitudinal axis X_A of the first central member 202.

[0071] The first central member 202 may be disposed in a vertical direction on an inner side of a frame provided on an outer side of the 3D emitting apparatus 10, for example, a medical robot.

[0072] The first link member 211 may be disposed on a sphere having a center at the target point T, and provided in a form of an arc.

[0073] The first link member 211 may have a longer length than the second link member 212, the third link member 215, and the fourth link member 216, and be disposed farthest away from the target point T.

[0074] The second link member 212 may be connected to another end of the first link member 211.

[0075] The second link member 212 may rotate based on a first axis X_1.

[0076] The first axis X_1 may be angled with respect to the longitudinal axis X_A of the first central member 202.

[0077] The third link member 215 may be connected to a portion of the first central member 202, the portion differing from a portion to which the first link member 211 is connected.

[0078] The third link member 215 may rotate on the longitudinal axis X_A of the first central member 202.

[0079] For example, the first link member 211 may be connected to an upper portion of the first central member 202, and the third link member 215 may be connected to a lower portion of the first central member 202.

[0080] The fourth link member 216 may be connected to another end of the third link member 215.

[0081] The fourth link member 216 may rotate on a second axis X_2.

[0082] The second axis X_2 may be angled with respect to the longitudinal axis X_A of the first central member 202.

[0083] The upper robot arm 210 may further include a first drive member 213, a second drive member 214, a third drive member 217, and a fourth drive member 218.

[0084] The first drive member 213 may be included in the first central member 202. The first drive member 213 may transmit a torque to the first link member 211.

[0085] The second drive member 214 may transmit a torque to the second link member 212. The second drive member 214 may be disposed to face the target point T along the first axis X_1.

[0086] Similar to the first drive member 213, the third drive member 217 may be included in the first central member 202. The third drive member 217 may transmit a torque to the third link member 215.

[0087] The first drive member 213 and the third drive member 217 may be provided integrally or separately. For example, when the first drive member 213 and the third drive member 217 are provided separately, the first link member 211 and the third link member 215 may rotate in different directions or at different velocities.

[0088] The fourth drive member 218 may transmit a torque to the fourth link member 216. The fourth drive member 218 may be disposed to face the target point T along the second axis X_2.

[0089] In this example, extension lines of the longitudinal axis X_A of the first central member 202, the first axis X_1, and the second axis X_2 may be positioned at the target point T.

[0090] The emitting member 300 provided at the second link member 212 and the emitting member 300 provided at the fourth link member 216 may be provided in a vertical direction with respect to the second link member 212 and the fourth link member 216, and disposed to face the target point T.

[0091] In addition to the extension lines of the longitudinal axis X_A of the first central member 202, the first axis X_1, and the second axis X_2, the emitting members 300 and the drive members 213, 214, 217, and 218 may also be disposed to face the target point T. Thus, radiations may be emitted or irradiated from the emitting members 300 toward the target point T.

[0092] The lower robot arm 220 may include a fifth link member 221, a sixth link member 222, a seventh link member 225, and an eighth link member 226.

[0093] The fifth link member 221 may rotate on a longitudinal axis X_B of a second central member 204.

[0094] The second central member 204 may be disposed in a vertical direction on the inner side of the frame provided on the outer side of the 3D emitting apparatus 10, for example, the medical robot.

[0095] The first central member 202 and the second central member 204 may be provided on an identical axis. The second central member 204 may be spaced apart from the target point T by a distance corresponding to a distance between the first central member 202 and the target point T.

[0096] The fifth link member 221 may be disposed on a sphere having a center at the target point T, and provided in a form of an arc.

[0097] The sixth link member 222 may be connected to another end of the fifth link member 221.

[0098] The sixth link member 222 may rotate on a third axis X_3.

[0099] The third axis X_3 may be angled with respect to the longitudinal axis X_B of the second central member 204.

[0100] The seventh link member 225 may be connected to a portion of the second central member 204, the portion differing from a portion to which the fifth link member 221 is connected.

[0101] The seventh link member 225 may rotate on the longitudinal axis X_B of the second central member 204.

[0102] For example, the fifth link member 221 may be connected to a lower portion of the second central member 204, and the seventh link member 225 may be connected to an upper portion of the second central member 204.

[0103] The eighth link member 226 may be connected to another end of the seventh link member 225.

[0104] The eighth link member 226 may rotate on a fourth axis X_4.

[0105] The fourth axis X_4 may be angled with respect to the longitudinal axis X_B of the second central member 204.

[0106] The lower robot arm 220 may further include a fifth drive member 223, a sixth drive member 224, a seventh drive member 227, and an eighth drive member 228.

[0107] The fifth drive member 223 may be included in the second central member 204. The fifth drive member 223 may transmit a torque to the fifth link member 221.

[0108] The sixth drive member 224 may transmit a torque to the sixth link member 222. The sixth drive member 224 may be disposed to face the target point T along the third axis X_3.

[0109] Similar to the fifth drive member 223, the seventh drive member 227 may be included in the second central member 204. The seventh drive member 227 may transmit a torque to the seventh link member 225.

[0110] The fifth drive member 223 and the seventh drive member 227 may be provided integrally or separately. For example, when the fifth drive member 223 and the seventh drive member 227 are provided separately, the fifth link member 221 and the seventh link member 225 may rotate in different directions or at different velocities.

[0111] The eighth drive member 228 may transmit a torque to the eighth link member 226. The eighth drive member 228 may be disposed to face the target point T along the fourth axis X_4.

[0112] In this example, extension lines of the longitudinal axis X_B of the second central member 204, the third axis X_3, and the fourth axis X_4 may be positioned at the target point T.

[0113] The emitting member 300 provided at the sixth link member 222 and the emitting member 300 provided at the eighth link member 226 may be provided in a vertical direction with respect to the sixth link member 222 and the eighth link member 226, and disposed to face the target point T.

[0114] In addition to the extension lines of the longitudinal axis X_B of the second central member 204, the third axis X_3, and the fourth axis X_4, the emitting members 300 and the drive members 223, 224, 227, and 228 may also be disposed to face the target point T. Thus, radiations may be emitted or irradiated from the emitting members 300 toward the target point T.

[0115] In the drawings, the upper robot arm 210 and the lower robot arm 220 are provided in similar or identical forms. However, the forms of the upper robot arm 210 and the lower robot arm 220 are not limited thereto. The upper robot arm 210 and the lower robot arm 220 may be provided in any form in which the emitting member 300 provided at the upper robot arm 210 and the emitting member 300 provided at the lower robot arm 220 are disposed to face the identical target point T.

[0116] To prevent a mutual collision when the plurality of link members 211, 212, 215, 216, 221, 222, 225, and 226 of the upper robot arm 210 and the lower robot arm 220 rotates simultaneously, the plurality of link members 211, 212, 215, 216, 221, 222, 225, and 226 may be disposed as follows.

[0117] The first link member 211 and the second link member 212 may be disposed farther away from the target point T than the third link member 215 and the fourth link member 216, and the fifth link member 221 and the sixth link member 222 may be disposed farther away from the target point T than the seventh link member 225 and the eighth link member 226.

[0118] When the third link member 215 is disposed between the first link member 211 and the second link member 212, the length of the third link member 215 may be shorter than the length of the first link member 211, and the fourth link member 216 may be disposed closer to the target point T than the second link member 212.

[0119] When the seventh link member 225 is disposed between the fifth link member 221 and the sixth link member 222, the length of the seventh link member 225 may be shorter than the length of the fifth link member 221, and the eighth link member 226 may be disposed closer to the target point T than the sixth link member 222.

[0120] The 3D emitting apparatus 10 may further include the controller (not shown). Operations of the drive members 213, 214, 217, 218, 223, 224, 227, and 228 or the positions of the emitting members 300 may be easily controlled by the controller.

[0121] The controller may operate the drive members 213, 214, 217, 218, 223, 224, 227, and 228 selectively or simultaneously to dispose the emitting members 300 to face the target point T.

[0122] The controller may control the operations of the drive members 213, 214, 217, 218, 223, 224, 227, and 228 to adjust rotation velocities or rotation directions of the link members 211, 212, 215, 216, 221, 222, 225, and 226.

[0123] Further, the controller may control an operation of the position adjustment element 110 to relatively move the table 100 and the robot arm 200.

[0124] Although not shown in detail in the drawings, angle adjustment elements may be provided at the emitting members 300 or end portions of the second link member 212, the fourth link member 216, the sixth link member 222, and the eighth link member 226 to move the emitting members 300 at a relatively small angle.

[0125] The angle adjustment elements may be useful when a minute angle adjustment is required after the emitting members 300 are aimed at the target point T by means of the drive members 213, 214, 217, 218, 223, 224, 227, and 228.

[0126] All axes of the drive members 213, 214, 217, 218, 223, 224, 227, and 228 may face the target point T. Thus, the emitting members 300 may be continuously aimed at the target point T while the link members 211, 212, 215, 216, 221, 222, 225, and 226 are rotating. The foregoing may be achieved based on a structural disposition of the link members 211, 212, 215, 216, 221, 222, 225, and 226 and the drive members 213, 214, 217, 218, 223, 224, 227, and 228.

[0127] In particular, radiations may be emitted in a state in which the link members 211, 212, 215, 216, 221, 222, 225, and 226 of the robot arms 210 and 220 are stationary. Thus, radiations may not be emitted while the link members 211, 212, 215, 216, 221, 222, 225, and 226 of the robot arms 210 and 220 are moving to subsequent emission points.

[0128] However, when the robot arms 210 and 220 include the plurality of link members 211, 212, 215, 216, 221, 222, 225, and 226, radiations may be emitted in a state in which remaining link members are stationary while one of the link members 211, 212, 215, 216, 221, 222, 225, and 226 is moving. Thus, a treatment or surgery time may be reduced.

[0129] In addition, when the plurality of robot arms 210 and 220 is provided, the treatment or surgery time may be reduced more efficiently.

[0130] As described above, when the 3D emitting apparatus 10 is used as a cyberknife, a treatment or surgery time may be reduced, and a tumor at an inaccessible position may be removed efficiently through an excellent directivity. A robot arm may be added or detached, whereby a degree of freedom may increase or decrease and a flexible design may be achieved.

[0131] Hereinafter, the 3D emitting apparatus 10 used as a 3D scanner will be described.

[0132] FIG. 3 illustrates the 3D emitting apparatus 10 used as a 3D scanner according to an embodiment of the present invention.

[0133] Referring to FIG. 3, when the 3D emitting apparatus 10 is used as a 3D scanner, an object may be provided using an item to be scanned. The object may be disposed on the table 100, and light such as, for example, visible rays or lasers may be emitted from the emitting member 300.

[0134] Although not illustrated in detail, the 3D emitting apparatus may further include an image sensor to convert light reflected by the object into an electrical image signal, and a data processing apparatus to generate a 3D image by combining a plurality of images received from the image sensor.

[0135] The emitting member 300 of the 3D emitting apparatus 10 may be aimed at the object and emit light toward the object.

[0136] Although FIG. 3 illustrates the robot arm 200 disposed only above the object, it is obvious that the robot arm 200 may also be disposed below the object.

[0137] Light may be reflected by the object, and the reflected light may be converted into an electrical image signal. By combining electrical image signals, a 3D image of the object may be generated.

[0138] In this example, the 3D emitting apparatus 10 may be easily aimed at the object and reduce a time used to scan the object through its structure and operation. In addition, the 3D emitting apparatus 10 may be provided in a relatively simple structure and a small volume, the 3D scanner may be stored in a relatively small space.

[0139] In an example, the 3D emitting apparatus 10 may be used as a 3D printer.

[0140] When the 3D emitting apparatus 10 is used as a 3D printer, an object may be provided using a fluid material including an ink. The object may be disposed on the table 100, and ultraviolet rays may be emitted from the emitting member 300.

[0141] As shown in FIG. 3, the robot arm 200 of the 3D emitting apparatus 10 may be disposed above the object.

[0142] When ultraviolet rays are irradiated on the fluid material, a portion of the fluid material exposed to the ultraviolet rays may be hardened. By iteratively performing this process, the fluid material may be laminated on the table 100. By removing an unhardened portion from the laminated fluid material using chemical and physical methods, a desired hardened 3D shape may be left.

[0143] When ultraviolet rays are irradiated on the fluid material in a desired pattern using a projector, a portion of the fluid material exposed to the ultraviolet rays may be hardened. By iteratively performing this process, the fluid material may be laminated on the table 100.

[0144] When an ink is dropped on the table 100 using an inkjet head and ultraviolet rays are irradiated on the ink, a portion of the ink exposed to the ultraviolet rays may be hardened. By iteratively performing this process, the fluid material may be laminated on the table 100.

[0145] Accordingly, an object as shown in FIG. 3 may be printed by the 3D printer.

[0146] When the 3D emitting apparatus 10 as described above is used, more accurate emitting may be performed on the fluid material, whereby a more elaborate 3D shape may be obtained. In addition, a time used to aim at the fluid material may be reduced, whereby a time used for 3D printing may be reduced.

[0147] Hereinafter, a kinematical analysis on a structure of the 3D emitting apparatus 10 will be described in detail.

[0148] The following may be expressed based on forward kinematics.

[Equation 1]

$$x = f(\theta)$$

[0149] In the Equation 1, θ denotes a joint angle, and x denotes a location and direction of an end-effector.

[0150] Coordinates of an emitting member may be estimated based on an angle at which link members are connected to each other.

[0151] In addition, when a Denavit-Hartenberg (D-H) convention is used, the kinematics of the robot may include four parameters, for example, a link length a of a line member, a link offset d, a link distortion α, and a joint angle θ.

[0152] In this example, when a joint rotates around a z axis, transformation matrices may be expressed as follows.

[Transformation Matrix 1]

$$
{}^{0}_{1}T = \begin{bmatrix} c\theta 1 & -c\alpha 1\, s\theta 1 & s\alpha 1\, s\theta 1 & 0 \\ s\theta 1 & c\alpha 1\, c\theta 1 & -s\alpha 1\, c\theta 1 & 0 \\ 0 & s\alpha 1 & c\alpha 1 & R \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

[Transformation Matrix 2]

$$
{}^{1}_{2}T = \begin{bmatrix} c\theta 2 & -c\alpha 2\, s\theta 2 & s\alpha 2\, s\theta 2 & 0 \\ s\theta 2 & c\alpha 2\, c\theta 2 & -s\alpha 2\, c\theta 2 & 0 \\ 0 & s\alpha 2 & c\alpha 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

[0153] In Transformation Matrices 1 and 2, s denotes sine, and c denotes cosine.

[0154] Through the above transformation matrices, a transformation matrix may be derived as follows.

[Transformation Matrix 3]

$$
{}^{0}_{2}T = \begin{bmatrix} c\theta 1\, c\theta 2 - c\alpha 1\, s\theta 1\, s\theta 2 & s\alpha 1\, s\alpha 2\, s\theta 1 - c\alpha 2\,(c\alpha 1\, c\theta 2\, s\theta 1 + c\theta 1\, s\theta 2) & c\alpha 2\, s\alpha 1\, s\theta 1 + s\alpha 2\,(c\alpha 1\, c\theta 2\, s\theta 1 + c\theta 1\, s\theta 2) & 0 \\ c\theta 2\, s\theta 1 + c\alpha 1\, c\theta 1\, s\theta 2 & -c\theta 1\, s\alpha 1\, s\alpha 2 + c\alpha 2\,(c\alpha 1\, c\theta 1\, c\theta 2 - s\theta 1\, s\theta 2) & -c\theta 1\,(c\alpha 2\, s\alpha 1 + c\alpha 1\, c\theta 2\, s\alpha 2) + s\alpha 2\, s\theta 1\, s\theta 2 & 0 \\ s\alpha 1\, s\theta 2 & c\alpha 2\, c\theta 2\, s\alpha 1 + c\alpha 1\, s\alpha 2 & c\alpha 1\, c\alpha 2 - c\theta 2\, s\alpha 1\, s\alpha 2 & R \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

[0155] The above transformation matrix may represent a case in which two link members are provided. A point to which relocation is to be performed by a translation, an offset, a scale, or a rotation on a three-dimensional (3D) coordinate system may be estimated using the transformation matrix.

[0156] In addition, a location and direction of the emitting member or the end-effector may be expressed as follows.

[Transformation Matrix 4]

$$ {}^{0}_{2}T = \begin{bmatrix} {}^{0}x_2 & {}^{0}y_2 & {}^{0}z_2 & {}^{0}p_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

[Transformation Matrix 5]

$$ {}^{0}p_2 = \begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} $$

[0157] In this example, the location of the emitting member or the end-effector may be constantly uniform.

[0158] FIG. 4 illustrates a direction of the emitting member 300 in the 3D emitting apparatus 10.

[0159] Referring to FIG. 4, the emitting member 300 may face a z axis, and have a roll movement of rotating on the z axis, a yaw movement of oscillating up and down based on the z axis, and a pitch movement of rotating up and down based on the z axis.

[0160] In this example, a roll direction may be insignificant in the emitting member 300.

[0161] Only a z-vector may be considered for a direction of the emitting member 300.

[0162] Thus, Transformation Matrix 2 may be arranged as follows.

[Transformation Matrix 6]

$$ {}^{0}z_2 = \begin{bmatrix} z_1 \\ z_2 \\ z_3 \end{bmatrix} = \begin{bmatrix} c\alpha 2\ s\alpha 1\ s\theta 1 + s\alpha 2\ (c\alpha 1\ c\theta 2\ s\theta 1 + c\theta 1\ s\theta 2) \\ -\ c\theta 1\ (c\alpha 2\ s\alpha 1 + c\alpha 1\ c\theta 2\ s\alpha 2) + s\alpha 2\ s\theta 1\ s\theta 2 \\ c\alpha 1\ c\alpha 2\ -\ c\theta 2\ s\alpha 1\ s\alpha 2) \end{bmatrix} $$

[0163] A desired direction of the emitting member 300 may be designated as spherical coordinates α and β of FIG. 5. When the direction of the emitting member 300 is given as α and β of FIG. 5, rotation matrices corresponding to the direction may be expressed as follows.

[Rotation Matrix 1]

$$ R_{spherical} = R_{z,\alpha} R_{y,\beta} = \begin{bmatrix} c\alpha\ c\beta & -s\alpha & c\alpha\ s\beta \\ s\alpha\ c\beta & c\alpha & s\alpha\ s\beta \\ -s\beta & 0 & c\beta \end{bmatrix} $$

[Rotation Matrix 2]

$$ R_{spherical} = \begin{bmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{bmatrix} $$

[0164] Based on α and β from Rotation Matrices 1 and 2, ${}^{0}x_2=[x_1, x_2, x_3]^T$, ${}^{0}y_2= [y_1, y_2, y_3]^T$, and ${}^{0}z_2 = [z_1, z_2, z_3]^T$

may be determined, and θ_1 and θ_2 may also be determined.

[0165] Such a relationship may be expressed by inverse kinematics as follows.

[Equation 2]

$$\theta = f(x)^{-1}$$

[0166] In Equation 2, x denotes a vector ${}^0z_2 = [z_1, z_2, z_3]^T$ and, θ denotes a vector including θ_1 and θ_2. Equation 2 may be an inverse function of Equation 1.

[0167] The joints angles θ_1 and θ_2 may be calculated based on orthonormal vectors ${}^0x_2$, ${}^0y_2$, and ${}^0z_2$. An intuitive method of calculating such vectors may be performed using spherical coordinates. When a direction is given as α and β, a rotation matrix corresponding to the direction may be expressed as follows.

[Rotation Matrix 3]

$$R_{spherical} = R_{z,\alpha}R_{y,\beta} = \begin{bmatrix} c\alpha\, c\beta & -s\alpha & c\alpha\, s\beta \\ s\alpha\, c\beta & c\alpha & s\alpha\, s\beta \\ -s\beta & 0 & c\beta \end{bmatrix}$$

[0168] In this example, constituent elements of the vectors may correspond to ${}^0x_2= [x_1, x_2, x_3]^T$, ${}^0y_2= [y_1, y_2, y_3]^T$, and ${}^0z_2= [Z_1, Z_2, Z_3]^T$.

[0169] The following Equations may be extracted from Transformation Matrix 3.

[Equation 3]

$$x_3 = s\alpha_1 s\theta_2$$

$$z_3 = c\alpha_1 c\alpha_2 - c\theta_2 s\alpha_1 s\alpha_2$$

[0170] In Equation 3, θ_2 may be induced as follows.

[Equation 4]

$$s\theta_2 = x_3 - s\alpha_1$$

$$c\theta_2 = \frac{z_3 + c\alpha_1 c\alpha_2}{s\alpha_1 s\alpha_2}$$

$$\tan\theta_2 = \frac{s\alpha_1 s\alpha_2 (x_3 - s\alpha_1)}{z_3 + c\alpha_1 c\alpha_2}$$

$$\theta_2 = \arctan 2(x_3 - s\alpha_1, \frac{z_3 + c\alpha_1 c\alpha_2}{s\alpha_1 s\alpha_2})$$

[0171] A function arctan2, an arctangent function including two input variables, may be used due to a stability of being close to zero input values and a characteristic of a final angle returning to an appropriate quadrant.

[0172] θ_1 may be calculated as follows.

[0173] The following Equations 5 through 7 may be obtained from Transformation Matrix 4.

[Equation 5]

$$(x_2 = c\theta_2 s\theta_1 + c\alpha_1 c\theta_1 s\theta_2)c\alpha_1 s\theta_2$$
$$(x_1 = -s\theta_1 c\alpha_1 s\theta_2 + c\theta_1 c\theta_2)c\theta_2$$

[Equation 6]

$$c\alpha_1 s\theta_2 x_2 + c\theta_2 x_1 = c^2\alpha_1 s^2\theta_2 c\theta_1 + c^2\theta_2 c\theta_1$$
$$c\theta_1 = \frac{c\alpha_1 s\theta_2 x_2 + c\theta_2 x_1}{c_1^{\alpha} s^2\theta_2 + c^2\theta_2}$$

[Equation 7]

$$z_1 = (c\alpha_2 s\alpha_1 + s\alpha_2 c\alpha_1 c\theta_2)s\theta_1 + s\alpha_2 s\theta_2 c\theta_1$$
$$z_2 = -(c\alpha_2 s\alpha_1 + s\alpha_2 c\alpha_1 c\theta_2)c\theta_1 + s\alpha_2 s\theta_2 s\theta_1$$

[0174] In addition, the following may be assumed.

[Equation 8]

$$a = c\alpha_2 s\alpha_1 + s\alpha_2 c\alpha_1$$
$$b = s\alpha_2 s\theta_2$$

[0175] Through Equations 7 and 8, the following may be calculated.

[Equation 9]

$$a(z_1 = as\theta_1 + bc\theta_1)$$
$$b(z_2 = -ac\theta_1 + bs\theta_1)$$
$$az_1 = a^2 s\theta_1 + abc\theta_1$$
$$bz_2 = b^2 s\theta_1 - abc\theta_1$$
$$az_1 + bz_2 = (a^2 + b^2)s\theta_1$$
$$s\theta_1 = \frac{az_2 + bz_2}{a^2 + b^2}$$

[0176] Through Equations 6 and 9, θ_1 may be calculated as follows.

[Equation 10]

$$\theta_1 = \arctan 2\left(\frac{az_1 + bz_2}{a^2 + b^2}, \frac{c\alpha_1 s\theta_2 x_2 + c\theta_2 x_1}{c^2\alpha_1 s^2\theta_2 + c^2\theta_2}\right)$$

[0177] From Equations 4 and 10, the two joint angles θ_1 and θ_2 may be determined. A Jacobian matrix will be described hereinafter.

[0178] A linear mapping between a θ-space and an x-space may be as follows. Equation 1 may be differentiated as follows.

[Jacobian Matrix 1]

$$^0\dot{x} = {}^0J\,\dot{\theta}$$

$$^0J = \begin{bmatrix} ^0z_0 \times (^0p_n - {}^0p_0) & ^0z_1 \times (^0p_n - {}^0p_1) \\ ^0z_0 & ^0z_1 \end{bmatrix}$$

[0179] The Transformation Matrix 1 may be expressed as follows.

[Rotation Matrix 7]

$$ {}^{0}_{1}T = \begin{bmatrix} {}^{0}x_1 & {}^{0}y_1 & {}^{0}z_1 & {}^{0}p_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} = $$

cθ1	- cα1 sθ1	sα1 sθ1	0
sθ1	cα1 cθ1	- sα1 cθ1	0
0	sα1	cα1	R
0	0	0	1

[0180] Thus, the Jacobian matrix may be expressed as follows.

[Jacobian Matrix 2]

$$ {}^{0}J = \begin{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times \left(\begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \right) & \begin{bmatrix} s\alpha 1\ s\theta 1 \\ - s\alpha 1\ c\theta 1 \\ c\alpha 1 \end{bmatrix} \times \left(\begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} \right) \\ \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \begin{bmatrix} s\alpha 1\ s\theta 1 \\ - s\alpha 1\ c\theta 1 \\ c\alpha 1 \end{bmatrix} \end{bmatrix} $$

[Jacobian Matrix 3]

$$ {}^{0}J = \begin{bmatrix} {}^{0}z_0 \times ({}^{0}p_n - {}^{0}p_0) & {}^{0}z_1 \times ({}^{0}p_n - {}^{0}p_1) \\ {}^{0}z_0 & {}^{0}z_1 \end{bmatrix} $$

$$ = \begin{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times \left(\begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \right) & \begin{bmatrix} s\alpha 1\ s\theta 1 \\ - s\alpha 1\ c\theta 1 \\ c\alpha 1 \end{bmatrix} \times \left(\begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ R \end{bmatrix} \right) \\ \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \begin{bmatrix} s\alpha 1\ s\theta 1 \\ - s\alpha 1\ c\theta 1 \\ c\alpha 1 \end{bmatrix} \end{bmatrix} $$

$$ = \begin{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \\ \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \begin{bmatrix} s\alpha 1\ s\theta 1 \\ - s\alpha 1\ c\theta 1 \\ c\alpha 1 \end{bmatrix} \end{bmatrix} $$

[Jacobian Matrix 4]

$$J = \begin{bmatrix} 0 & s\alpha 1\, s\theta 1 \\ 0 & -s\alpha 1\, c\theta 1 \\ 1 & c\alpha 1 \end{bmatrix}$$

[0181] Through Jacobian Matrix 4, when only an angular velocity is considered and a translational velocity is not considered, a singularity may not be achieved except for a case in which $\alpha = n\pi$ and $n \in N$ are satisfied.

[0182] As described above, a relationship between a motion of a link member and a motion of an emitting member may be expressed through a Jacobian matrix.

[0183] In detail, a location of the emitting member may be estimated based on a current location of a link member. Conversely, to enable the emitting member to face a central point or a target, an operation of a link member may be controlled based on a current location of the emitting member.

[0184] Furthermore, when a plurality of robot arms is provided, the plurality of robot arms may be controlled to operate collaboratively through a Jacobian matrix.

[0185] Although a few exemplary embodiments of the present invention have been shown and described, the present invention is not limited to the described exemplary embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to these exemplary embodiments without departing from the scope of the appended claims.

Claims

1. A three-dimensional (3D) emitting apparatus (10) comprising:

a table (100) on which an object is to be disposed;
a robot arm (200) to perform a task on the object;
an emitting member (300) provided at an end portion of the robot arm (200); and
a controller to control an operation of the robot arm (200) or a position of the emitting member (300),
wherein the table (100) and the robot arm (200) move relatively in a vertical or horizontal direction, the emitting member (300) moves along a trajectory of rotation of the robot arm (200), and the trajectory of rotation is inscribed on a sphere having a center at which a target point is disposed, wherein the robot arm (200) comprises:

a first central member (202);
a first link member (211) to rotate around a longitudinal axis of the first central member;
a first drive member (213) disposed at one end of the first link member to transmit a torque to the first link member;
a second link member (212) connected to another end of the first link member to rotate on a first axis;
a second drive member (214) disposed between the first link member and the second link member to transmit a torque to the second link member;

characterized in that the robot arm further comprises:

a third link member (215) connected to a portion of the first central member, the portion differing from a portion to which the first link member is connected, to rotate around the longitudinal axis of the first central member;
a third drive member (217) disposed at one end of the third link member to transmit a torque to the third link member;
a fourth link member (216) connected to another end of the third link member to rotate on a second axis; and
a fourth drive member (218) disposed between the third link member and the fourth link member to transmit a torque to the fourth link member.

2. The 3D emitting apparatus (10) of claim 1, wherein a plurality of emitting members (300) is provided, and the plurality of emitting members (300) faces an identical target point (T).

3. The 3D emitting apparatus (10) of claim 1, wherein the first link member (211), the second link member (212), the third link member (215), and the fourth link member (216) are disposed on concentric spheres having an identical center, and extension lines of axes of the drive members intersect at the identical center.

4. The 3D emitting apparatus (10) of claim 1, wherein the robot arm (200) is disposed above or below the table (100), and the 3D emitting apparatus (10) is configured in a form of a cyberknife that emits radiation from the emitting member (300) toward the object.

5. The 3D emitting apparatus (10) of claim 1, further comprising:

an image sensor to convert light emitted from the emitting member and reflected by the object into an electrical image signal; and
a data processor to generate a 3D image by combining a plurality of images received from the image sensor, wherein the 3D emitting apparatus (10) is configured in a form of a 3D scanner that acquires a 3D shape of the object.

6. The 3D emitting apparatus (10) of claim 1, wherein the object is provided using a fluid material comprising an ink, an ultraviolet ray is emitted from the emitting member (300), and the 3D emitting apparatus (10) is configured in a form of a 3D printer that irradiates the ultraviolet ray toward the object to harden the object.

7. The 3D emitting apparatus (10) of claim 1, wherein another robot (220) arm comprises:

a second central member (204) disposed on an axis identical to the longitudinal axis of the first central member and spaced apart from the center by a distance corresponding to a distance between the first central member and the center;
a fifth link member (221) to rotate around a longitudinal axis of the second central member;
a fifth drive member (223) disposed at one end of the fifth link member to transmit a torque to the fifth link member;
a sixth link member (222) connected to another end of the fifth link member to rotate on a third axis; and
a sixth drive member (224) disposed between the fifth link member and the sixth link member to transmit a torque to the sixth link member.

8. The 3D emitting apparatus (10) of claim 7, wherein another robot arm (220) further comprises:

a seventh link member (225) connected to a portion of the second central member, the portion differing from a portion to which the fifth link member is connected, to rotate around the longitudinal axis of the second central member;
a seventh drive member (227) disposed at one end of the seventh link member to transmit a torque to the seventh link member;
an eighth link member (226) connected to another end of the seventh link member to rotate on a fourth axis; and
an eighth drive member (228) disposed between the seventh link member and the eighth link member to transmit a torque to the eighth link member.

9. The 3D emitting apparatus (10) of claim 8, wherein the longitudinal axis of the first central member (X_A), the longitudinal axis of the second central member (X_B), the first axis (x_1), the second axis (x_2), the third axis (x_3), and the fourth axis (x_4) intersect at the center of the sphere.

10. The 3D emitting apparatus (10) of claim 8, wherein the first axis (x_1), the second axis (x_2), the third axis (x_3), and the fourth axis (x_4) are formed to be perpendicular to tangential directions of end portions of the first link member (211), the second link member (212), the third link member (215), the fourth link member (216), the fifth link member (221), the sixth link member (222), the seventh link member (225), and the eighth link member (226).

11. The 3D emitting apparatus (10) of claim 8, wherein the first link member (211) and the second link member (212) are disposed farther away from the center than the third link member (215) and the fourth link member (216), and the fifth link member (221) and the sixth link member (222) are disposed farther away from the center than the seventh link member (225) and the eighth link member (226).

12. The 3D emitting apparatus (10) of claim 1, wherein, lengths of the third link member (215) and the fourth link member (216) are shorter than a length of the first link member (211).

13. The 3D emitting apparatus (10) of claim 12, wherein the third link member (215) and the fourth link member (216) are disposed closer to the center than the second link member (212), and the fourth link member (216) is disposed closer to the center than the third link member (215).

14. The 3D emitting apparatus (10) of claim 8, wherein, lengths of the seventh link member (225) and the eighth link member (228) are shorter than a length of the fifth link member (221).

15. The 3D emitting apparatus (10) of claim 14, wherein the seventh link member (225) and the eighth link member (226) are disposed closer to the center than the sixth link member (222), and the eighth link member (226) is disposed closer to the center than the seventh link member (225).

16. The 3D emitting apparatus (10) of claim 8, wherein the emitting member (300) is disposed to be perpendicular to tangential directions of end portions of the second link member (212), the fourth link member (216), the sixth link member (222), and the eighth link member (226).

17. The 3D emitting apparatus (10) of claim 1, further comprising:
a position adjustment element (110) to adjust a position of the table (100).

Patentansprüche

1. Dreidimensional (3D) emittierende Vorrichtung (10), umfassend:

einen Tisch (100), auf dem ein Objekt angeordnet werden soll;
einen Roboterarm (200) zum Ausführen einer Aufgabe an dem Objekt;
ein Emitterelement (300), das an einem Endabschnitt des Roboterarms (200) vorgesehen ist; und
eine Steuerung zum Steuern eines Betriebs des Roboterarms (200) oder einer Position des Emitterelements (300),
wobei sich der Tisch (100) und der Roboterarm (200) relativ in vertikaler oder horizontaler Richtung bewegen, sich das Emitterelement (300) entlang einer Rotationsbahn des Roboterarms (200) bewegt und die Rotationsbahn auf einer Kugel mit einem Zentrum, an dem ein Zielpunkt angeordnet ist,
einbeschrieben ist, wobei der Roboterarm (200) Folgendes umfasst:

ein erstes zentrales Element (202);
ein erstes Verbindungselement (211), um sich um eine Längsachse des ersten zentralen Elements zu drehen;
ein erstes Antriebselement (213), das an einem Ende des ersten Verbindungselements angeordnet ist, um ein Drehmoment auf das erste Verbindungselement zu übertragen;
ein zweites Verbindungselement (212), das mit einem anderen Ende des ersten Verbindungselements verbunden ist, um sich auf einer ersten Achse zu drehen; und
ein zweites Antriebselement (214), das zwischen dem ersten Verbindungselement und dem zweiten Verbindungselement angeordnet ist, um ein Drehmoment auf das zweite Verbindungselement zu übertragen;
dadurch gekennzeichnet, dass der Roboterarm ferner Folgendes umfasst:

ein drittes Verbindungselement (215), das mit einem Abschnitt des ersten zentralen Elements verbunden ist, wobei sich der Abschnitt von einem Abschnitt unterscheidet, mit dem das erste Verbindungselement verbunden ist, um sich um die Längsachse des ersten zentralen Elements zu drehen;
ein drittes Antriebselement (217), das an einem Ende des dritten Verbindungselements angeordnet ist, um ein Drehmoment auf das dritte Verbindungselement zu übertragen;
ein viertes Verbindungselement (216), das mit einem anderen Ende des dritten Verbindungselements verbunden ist, um sich auf einer zweiten Achse zu drehen; und
ein viertes Antriebselement (218), das zwischen dem dritten Verbindungselement und dem vierten Verbindungselement angeordnet ist, um ein Drehmoment auf das vierte Verbindungselement zu übertragen.

2. 3D-emittierende Vorrichtung (10) nach Anspruch 1, wobei mehrere Emitterelemente (300) vorgesehen sind und die mehreren Emitterelemente (300) einem identischen Zielpunkt (T) zugewandt sind.

3. 3D-emittierende Vorrichtung(10) nach Anspruch 1, wobei das erste Verbindungselement (211), das zweite Verbindungselement (212), das dritte Verbindungselement (215) und das vierte Verbindungselement (216) auf konzentrischen Kugeln angeordnet sind, die ein identisches Zentrum aufweisen, und sich Verlängerungslinien von Achsen der Antriebselemente in dem identischen Zentrum überschneiden.

4. 3D-emittierende Vorrichtung(10) nach Anspruch 1, wobei der Roboterarm (200) über oder unter dem Tisch (100) angeordnet ist und die 3D-emittierende Vorrichtung(10) in Form eines Cybermessers konfiguriert ist, das Strahlung vom Emitterelement (300) in Richtung des Objekts emittiert.

5. 3D-emittierende Vorrichtung(10) nach Anspruch 1, ferner umfassend:

einen Bildsensor, um vom Emitterelement emittiertes und vom Objekt reflektiertes Licht in ein elektrisches Bildsignal umzuwandeln; und
einen Datenprozessor, um ein 3D-Bild durch Kombinieren mehrerer vom Bildsensor empfangener Bilder zu erzeugen,
wobei die 3D-emittierende Vorrichtung(10) in Form eines 3D-Scanners konfiguriert ist, der eine 3D-Form des Objekts erfasst.

6. 3D-emittierende Vorrichtung(10) nach Anspruch 1, wobei das Objekt unter Verwendung eines Fluidmaterials bereitgestellt wird, das eine Tinte umfasst, wobei ein ultravioletter Strahl von dem Emitterelement (300) emittiert wird und die 3D-emittierende Vorrichtung(10) in einer Form eines 3D-Druckers konfiguriert ist, der die ultravioletten Strahlen auf das Objekt strahlt, um das Objekt zu härten.

7. 3D-emittierende Vorrichtung(10) nach Anspruch 1, wobei ein weiterer Roboterarm (220) Folgendes umfasst:

ein zweites zentrales Element (204), das auf einer Achse angeordnet ist, die mit der Längsachse des ersten zentralen Elements identisch ist und von dem Zentrum um einen Abstand beabstandet ist, der einem Abstand zwischen dem ersten zentralen Element und dem Zentrum entspricht;
ein fünftes Verbindungselement (221), um sich um eine Längsachse des zweiten zentralen Elements zu drehen;
ein fünftes Antriebselement (223), das an einem Ende des fünften Verbindungselements angeordnet ist, um ein Drehmoment auf das fünfte Verbindungselement zu übertragen;
ein sechstes Verbindungselement (222), das mit einem anderen Ende des fünften Verbindungselements verbunden ist, um sich um eine dritte Achse zu drehen; und
ein sechstes Antriebselement (224), das zwischen dem fünften Verbindungselement und dem sechsten Verbindungselement angeordnet ist, um ein Drehmoment auf das sechste Verbindungselement zu übertragen.

8. 3D-emittierende Vorrichtung(10) nach Anspruch 7, wobei ein weiterer Roboterarm (220) ferner Folgendes umfasst:

ein siebtes Verbindungselement (225), das mit einem Abschnitt des zweiten zentralen Elements verbunden ist, wobei sich der Abschnitt von einem Abschnitt unterscheidet, mit dem das fünfte Verbindungselement verbunden ist, um sich um die Längsachse des zweiten zentralen Elements zu drehen;
ein siebtes Antriebselement (227), das an einem Ende des siebten Verbindungselements angeordnet ist, um ein Drehmoment auf das siebte Verbindungselement zu übertragen;
ein achtes Verbindungselement (226), das mit einem anderen Ende des siebten Verbindungselements verbunden ist, um sich um eine vierte Achse zu drehen; und
ein achtes Antriebselement (228), das zwischen dem siebten Verbindungselement und dem achten Verbindungselement angeordnet ist, um ein Drehmoment auf das achte Verbindungselement zu übertragen.

9. 3D-emittierende Vorrichtung(10) nach Anspruch 8, wobei sich die Längsachse des ersten zentralen Elements (X_A), die Längsachse des zweiten zentralen Elements (X_B), die erste Achse (X_1), die zweite Achse (X_2), die dritte Achse (X_3) und die vierte Achse (X_4) in dem Zentrum der Kugel überschneiden.

10. 3D-emittierende Vorrichtung(10) nach Anspruch 8, wobei die erste Achse (X_1), die zweite Achse (X_2), die dritte Achse (X_3) und die vierte Achse (X_4) so ausgebildet sind, dass sie senkrecht zu den tangentialen Richtungen der Endabschnitte des ersten Elements (211), des zweiten Elements (212), des dritten Elements (215), des vierten

Elements (216) und des fünften Elements (221), des sechsten Verbindungselements (222), des siebten Verbindungselements (225) und des achten Verbindungselements (226) sind.

11. 3D-emittierende Vorrichtung(10) nach Anspruch 8, wobei das erste Verbindungselement (211) und das zweite Verbindungselement (212) weiter von dem Zentrum entfernt als das dritte Verbindungselement (215) und das vierte Verbindungselement (216) angeordnet sind, und das fünfte Verbindungselement (221) und das sechste Verbindungselement (222) weiter von dem Zentrum entfernt als das siebte Verbindungselement (225) und das achte Verbindungselement (226) angeordnet sind.

12. 3D-emittierende Vorrichtung(10) nach Anspruch 1, wobei die Längen des dritten Verbindungselements (215) und des vierten Verbindungselements (216) kürzer als eine Länge des ersten Verbindungselements (211) sind.

13. 3D-emittierende Vorrichtung(10) nach Anspruch 12, wobei das dritte Verbindungselement (215) und das vierte Verbindungselement (216) näher zu dem Zentrum als das zweite Verbindungselement (212) angeordnet sind, und das vierte Verbindungselement (216) näher zu dem Zentrum als das dritte Verbindungselement (215) angeordnet ist.

14. 3D-emittierende Vorrichtung(10) nach Anspruch 8, wobei die Längen des siebten Verbindungselements (225) und des achten Verbindungselements (228) kürzer sind als eine Länge des fünften Verbindungselements (221).

15. 3D-emittierende Vorrichtung(10) nach Anspruch 14, wobei das siebte Verbindungselement (225) und das achte Verbindungselement (226) näher zu dem Zentrum als das sechste Verbindungselement (222) angeordnet sind, und das achte Verbindungselement (226) näher zu dem Zentrum als das siebte Verbindungselement (225) angeordnet ist.

16. 3D-emittierende Vorrichtung(10) nach Anspruch 8, wobei das Emitterelement (300) so angeordnet ist, dass es senkrecht zu den tangentialen Richtungen der Endabschnitte des zweiten Verbindungselements (212), des vierten Verbindungselements (216) und des sechsten Verbindungselements (222) und des achten Verbindungselements (226) ist.

17. 3D-emittierende Vorrichtung(10) nach Anspruch 1, ferner umfassend:
ein Positionseinstellelement (110) zum Einstellen einer Position des Tisches (100).

Revendications

1. Appareil d'émission en trois dimensions (3D) (10) comprenant :

une table (100) sur laquelle un objet doit être disposé ;
un bras robotisé (200) pour effectuer une tâche sur l'objet ;
un élément d'émission (300) prévu au niveau d'une partie d'extrémité du bras robotisé (200) ; et
un dispositif de commande pour commander une opération du bras robotisé (200) ou une position de l'élément d'émission (300),
dans lequel la table (100) et le bras robotisé (200) se déplacent relativement dans une direction verticale ou horizontale, l'élément d'émission (300) se déplace le long d'une trajectoire de rotation du bras robotisé (200), et la trajectoire de rotation est inscrite sur une sphère ayant un centre au niveau duquel un point cible est disposé,
dans lequel le bras robotisé (200) comprend :

un premier élément central (202) ;
un premier élément de raccordement (211) pour tourner autour d'un axe longitudinal du premier élément central ;
un premier élément d'entraînement (213) disposé au niveau d'une extrémité du premier élément de raccordement pour transmettre un couple au premier élément de raccordement ;
un deuxième élément de raccordement (212) relié à une autre extrémité du premier élément de raccordement pour tourner sur un premier axe ;
un deuxième élément d'entraînement (214) disposé entre le premier élément de raccordement et le deuxième élément de raccordement pour transmettre un couple au deuxième élément de raccordement ;
caractérisé en ce que le bras robotisé comprend en outre :

un troisième élément de raccordement (215) relié à une partie du premier élément central, la partie différant d'une partie à laquelle le premier élément de raccordement est relié, pour tourner autour de l'axe longitudinal du premier élément central ;
un troisième élément d'entraînement (217) disposé au niveau d'une extrémité du troisième élément de raccordement pour transmettre un couple au troisième élément de raccordement ;
un quatrième élément de raccordement (216) relié à une autre extrémité du troisième élément de raccordement pour tourner sur un deuxième axe ; et
un quatrième élément d'entraînement (218) disposé entre le troisième élément de raccordement et le quatrième élément de raccordement pour transmettre un couple au quatrième élément de raccordement.

2. Appareil d'émission 3D (10) de la revendication 1, dans lequel une pluralité d'éléments d'émission (300) est prévue, et la pluralité d'éléments d'émission (300) fait face à un point cible identique (T) .

3. Appareil d'émission 3D (10) de la revendication 1, dans lequel le premier élément de raccordement (211), le deuxième élément de raccordement (212), le troisième élément de raccordement (215), et le quatrième élément de raccordement (216) sont disposés sur des sphères concentriques ayant un centre identique, et des lignes d'extension d'axes des éléments d'entraînement se croisent au niveau du centre identique.

4. Appareil d'émission 3D (10) de la revendication 1, dans lequel le bras robotisé (200) est disposé au-dessus de ou en dessous de la table (100), et
l'appareil d'émission 3D (10) est configuré sous une forme d'un cyberbistouri qui émet un rayonnement à partir de l'élément d'émission (300) vers l'objet.

5. Appareil d'émission 3D (10) de la revendication 1, comprenant en outre :

un capteur d'image pour convertir une lumière émise à partir de l'élément d'émission et réfléchie par l'objet en un signal d'image électrique ; et
un processeur de données pour générer une image 3D en combinant une pluralité d'images reçues à partir du capteur d'image,
dans lequel l'appareil d'émission 3D (10) est configuré sous une forme d'un scanner 3D qui acquiert une forme 3D de l'objet.

6. Appareil d'émission 3D (10) de la revendication 1, dans lequel l'objet est prévu à l'aide d'un matériau fluide comprenant une encre, un rayon ultraviolet est émis à partir de l'élément d'émission (300), et l'appareil d'émission 3D (10) est configuré sous une forme d'une imprimante 3D qui envoie le rayon ultraviolet vers l'objet pour faire durcir l'objet.

7. Appareil d'émission 3D (10) de la revendication 1, dans lequel un autre bras robotisé (220) comprend :

un second élément central (204) disposé sur un axe identique à l'axe longitudinal du premier élément central et espacé du centre d'une distance correspondant à une distance entre le premier élément central et le centre ;
un cinquième élément de raccordement (221) pour tourner autour d'un axe longitudinal du second élément central ;
un cinquième élément d'entraînement (223) disposé au niveau d'une extrémité du cinquième élément de raccordement pour transmettre un couple au cinquième élément de raccordement ;
un sixième élément de raccordement (222) relié à une autre extrémité du cinquième élément de raccordement pour tourner sur un troisième axe ; et
un sixième élément d'entraînement (224) disposé entre le cinquième élément de raccordement et le sixième élément de raccordement pour transmettre un couple au sixième élément de raccordement.

8. Appareil d'émission 3D (10) de la revendication 7, dans lequel un autre bras robotisé (220) comprend en outre :

un septième élément de raccordement (225) relié à une partie du second élément central, la partie différant d'une partie à laquelle le cinquième élément de raccordement est relié, pour tourner autour de l'axe longitudinal du second élément central ;
un septième élément d'entraînement (227) disposé au niveau d'une extrémité du septième élément de raccordement pour transmettre un couple au septième élément de raccordement ;

un huitième élément de raccordement (226) relié à une autre extrémité du septième élément de raccordement pour tourner sur un quatrième axe ; et
un huitième élément d'entraînement (228) disposé entre le septième élément de raccordement et le huitième élément de raccordement pour transmettre un couple au huitième élément de raccordement.

9. Appareil d'émission 3D (10) de la revendication 8, dans lequel l'axe longitudinal du premier élément central (X_A), l'axe longitudinal du second élément central (X_B), le premier axe (X_1), le deuxième axe (X_2), le troisième axe (X_3), et le quatrième axe (X_4) se croisent au niveau du centre de la sphère.

10. Appareil d'émission 3D (10) de la revendication 8, dans lequel le premier axe (X_1), le deuxième axe (X_2), le troisième axe (X_3), et le quatrième axe (X_4) sont formés pour être perpendiculaires à des directions tangentielles de parties d'extrémité du premier élément de raccordement (211), du deuxième élément de raccordement (212), du troisième élément de raccordement (215), du quatrième élément de raccordement (216), du cinquième élément de raccordement (221), du sixième élément de raccordement (222), du septième élément de raccordement (225), et du huitième élément de raccordement (226).

11. Appareil d'émission 3D (10) de la revendication 8, dans lequel le premier élément de raccordement (211) et le deuxième élément de raccordement (212) sont disposés plus loin à distance du centre que le troisième élément de raccordement (215) et le quatrième élément de raccordement (216), et le cinquième élément de raccordement (221) et le sixième élément de raccordement (222) sont disposés plus loin à distance du centre que le septième élément de raccordement (225) et le huitième élément de raccordement (226).

12. Appareil d'émission 3D (10) de la revendication 1, dans lequel, des longueurs du troisième élément de raccordement (215) et du quatrième élément de raccordement (216) sont plus courtes qu'une longueur du premier élément de raccordement (211).

13. Appareil d'émission 3D (10) de la revendication 12, dans lequel le troisième élément de raccordement (215) et le quatrième élément de raccordement (216) sont disposés plus près du centre que le deuxième élément de raccordement (212), et le quatrième élément de raccordement (216) est disposé plus près du centre que le troisième élément de raccordement (215).

14. Appareil d'émission 3D (10) de la revendication 8, dans lequel, des longueurs du septième élément de raccordement (225) et du huitième élément de raccordement (228) sont plus courtes qu'une longueur du cinquième élément de raccordement (221).

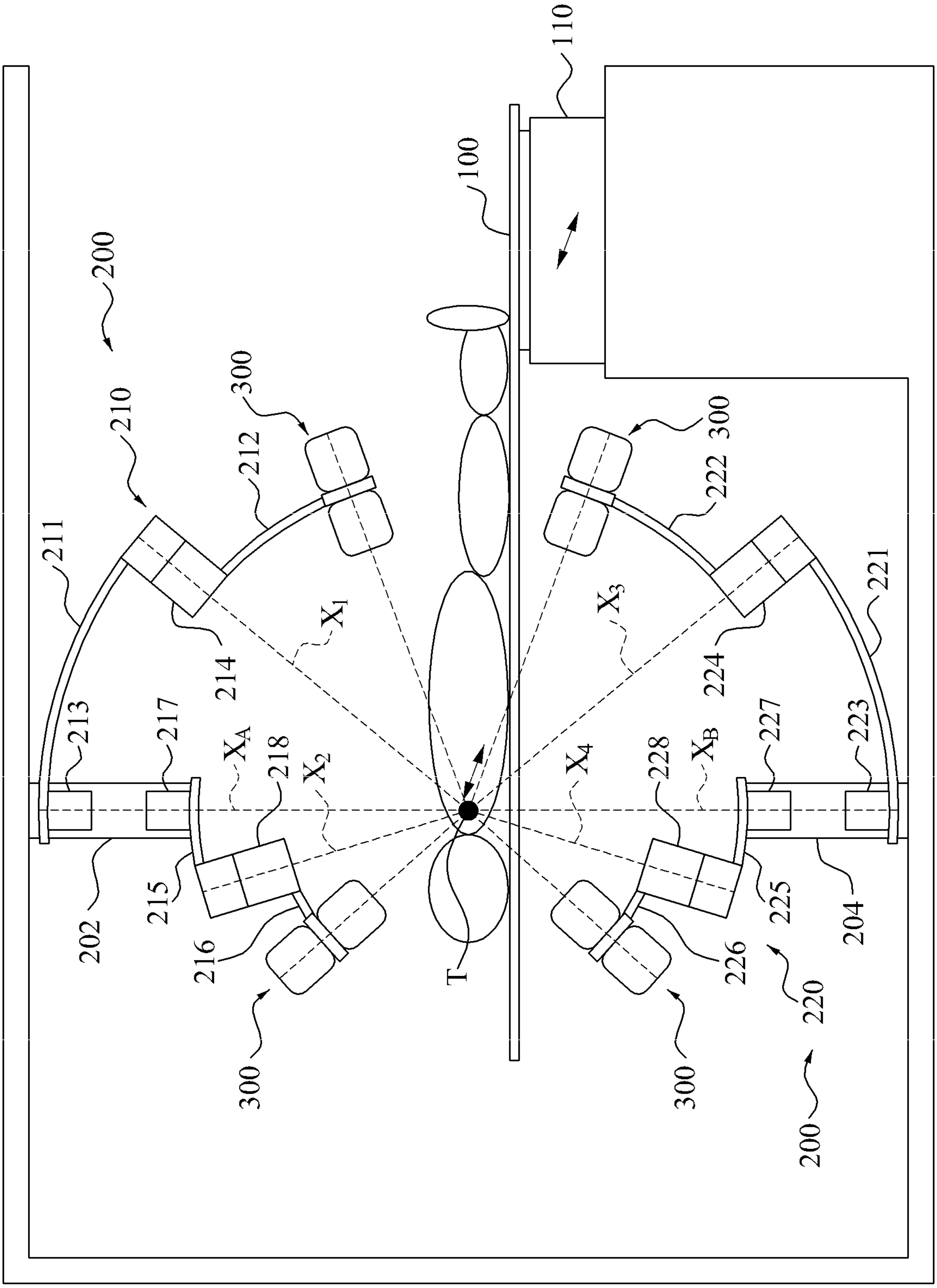
15. Appareil d'émission 3D (10) de la revendication 14, dans lequel le septième élément de raccordement (225) et le huitième élément de raccordement (226) sont disposés plus près du centre que le sixième élément de raccordement (222), et le huitième élément de raccordement (226) est disposé plus près du centre que le septième élément de raccordement (225) .

16. Appareil d'émission 3D (10) de la revendication 8, dans lequel l'élément d'émission (300) est disposé pour être perpendiculaire à des directions tangentielles de parties d'extrémité du deuxième élément de raccordement (212), du quatrième élément de raccordement (216), du sixième élément de raccordement (222), et du huitième élément de raccordement (226).

17. Appareil d'émission 3D (10) de la revendication 1, comprenant en outre :
un organe d'ajustement de position (110) pour ajuster une position de la table (100).

FIG. 1

10



100
110
200
210
211
212
213
214
215
216
217
218
202
300
X_1
X_2
X_A
X_3
X_4
X_B
T
220
221
222
223
224
225
226
227
228
204

FIG. 2

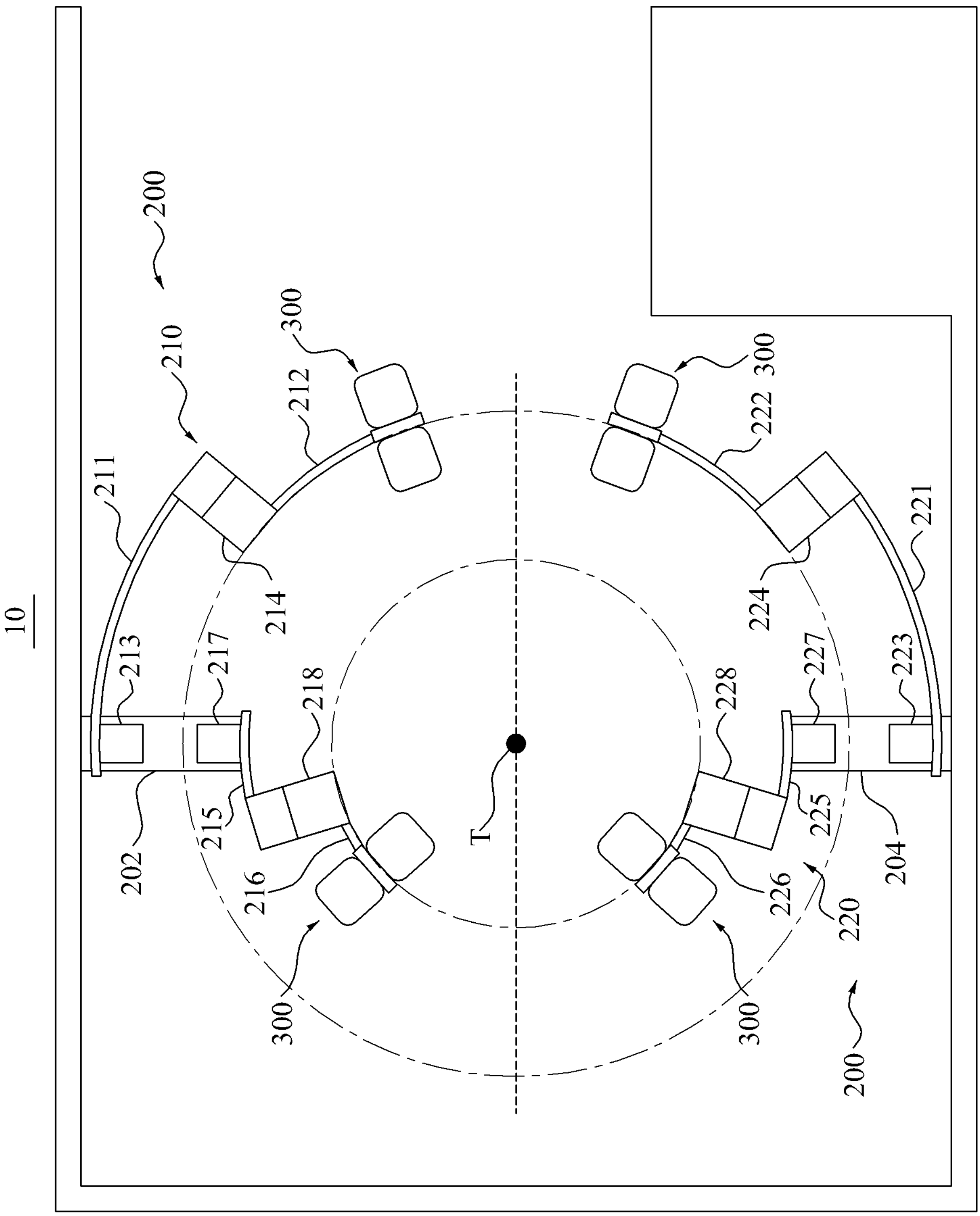

10
200
210
211
212
213
214
215
216
217
218
202
300
T
220
221
222
223
224
225
226
227
228
204

FIG. 3

10

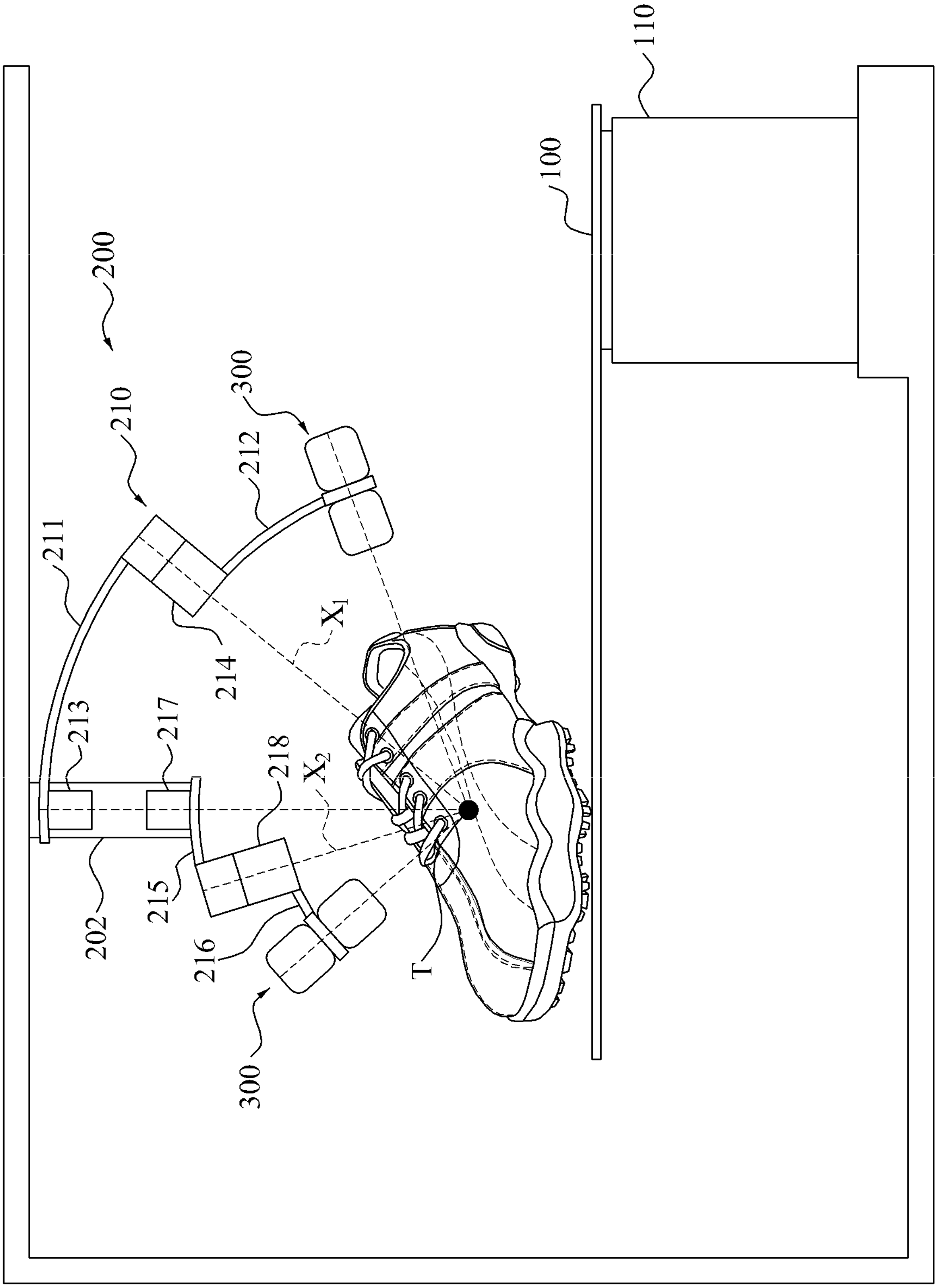

200
210
211
212
213
214
215
216
217
218
202
300
300
100
110
T
X_1
X_2

FIG. 4

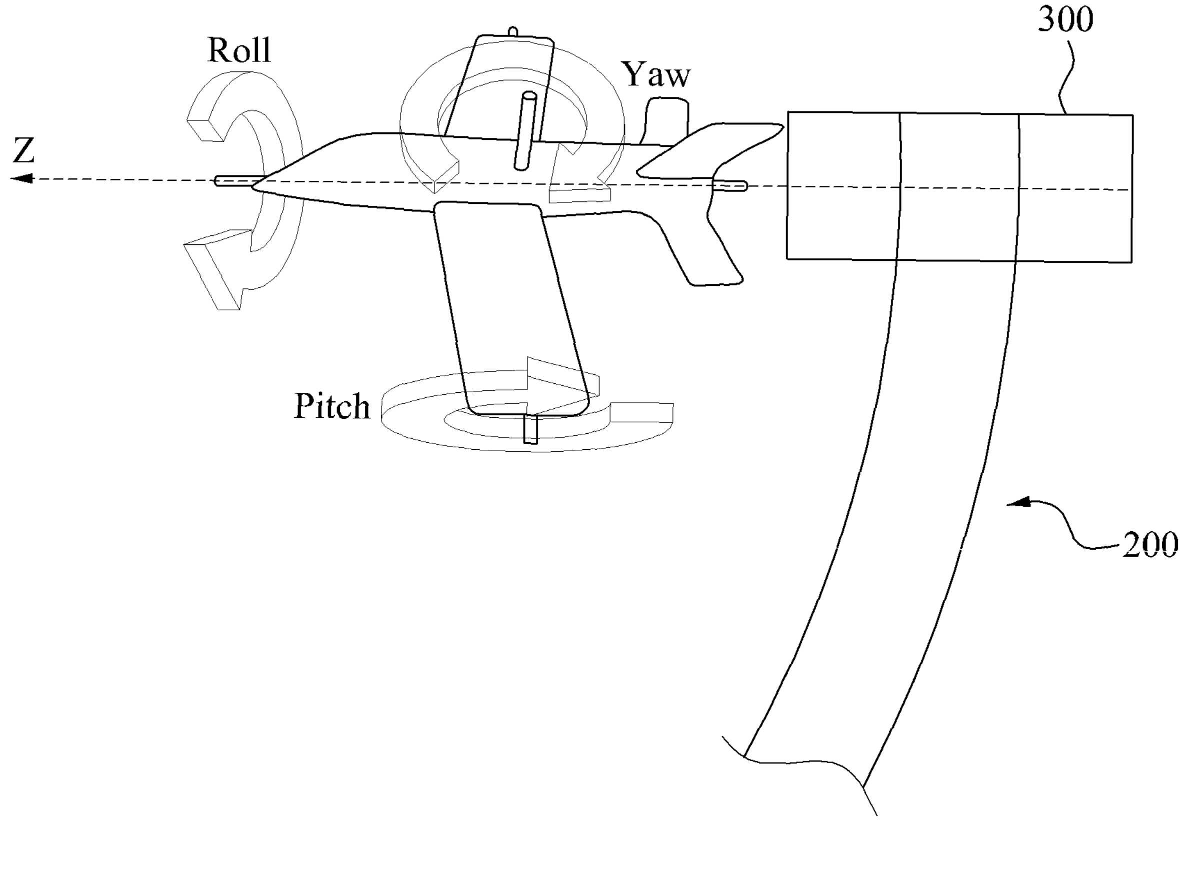
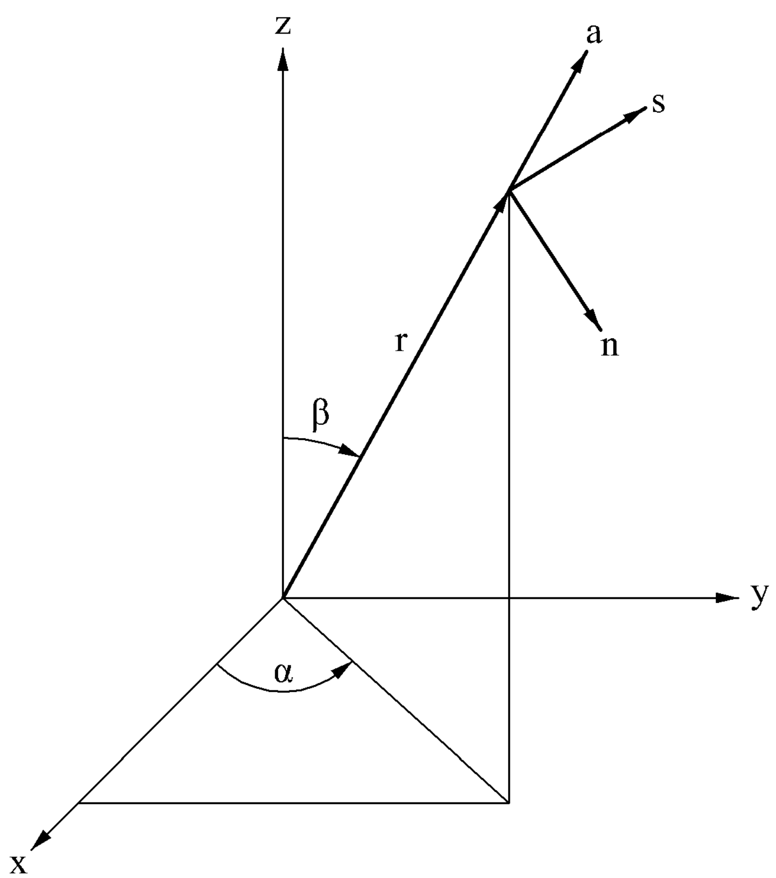


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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