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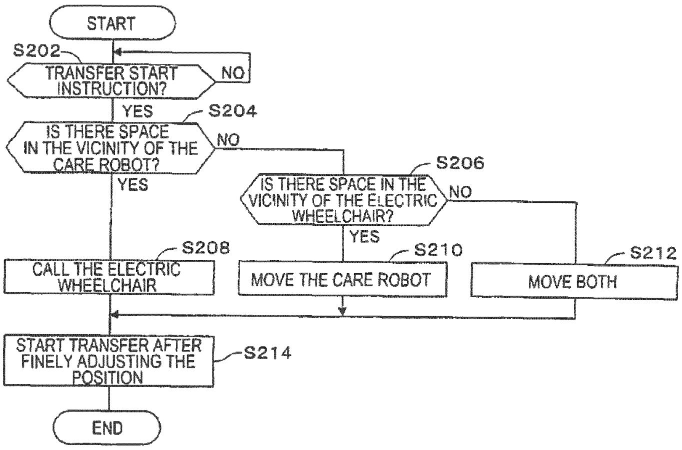
(54) ASSISTANCE ROBOT

(57) A care robot used to transfer a care receiver to/from a drive assistance apparatus such as an electric wheelchair which reduces the complexity of operation of the drive assistance apparatus and the care robot, and reduces the labor of a caregiver.

The care robot is provided with a holding section that assists a care receiver in standing up and sitting down by supporting a body part of the care receiver, and a control section that, when a care receiver transfers to/from a drive assistance apparatus that performs at least one of raising/lowering and traveling by using a drive source with the care receiver in at least a sitting state, at least receives (steps S204, 206) control information from the drive assistance apparatus, and performs control (steps S208, 212) to assist the transfer of the care receiver based on the control information.

[FIG. 22]



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Description

Technical Field

[0001] The present invention relates to a care robot.

Background Art

[0002] As a type of care robot, a care robot disclosed in patent literature 1 is known. As disclosed in fig. 1 of patent literature 1, the care robot is provided with a holding section (traveling + arm section) which assists the standing up and sitting down of a care receiver by supporting a body part. That is, the care robot assists a care receiver who is sitting, for example, on a bed to stand up by supporting a body part, and assists a care receiver who is standing up to sit down by supporting a body part.
[0003] Also, as a moving body such as an electric wheelchair, an item such as that disclosed in fig. 4 of patent literature 2 is known, the item being provided with a storage means (memory 45a) which stores map information including building interior plan information, and a driving control means (robot control section 45) which drives the moving body based on driving path set based on given circumstances while referring to the map information stored in the storage means.

Citation List

Patent Literature

[0004]

Patent Literature 1: JP-A-2011-019571

Patent Literature 2: JP-A-2008-129614

Summary of Invention

Technical Problem

[0005] With the care robot as disclosed in patent literature 1 above, when moving a care receiver who is on a bed to another location, there are cases in which a care receiver who is sitting on a bed is moved to a drive assistance apparatus such as an electric wheelchair by using the care robot. Here, a caregiver must operate both the care robot and the electric wheelchair, which is troublesome.
[0006] For this, since it is possible, for example, to move the above wheelchair (moving body) automatically, this could be thought to reduce the labor of the caregiver. However, if the care robot and the electric wheelchair are controlled independently from each other, there is a worry that their movements and driving will be unsynchronized, which itself is a troublesome problem to deal with.
[0007] In order to solve the above problem, an object of the present invention is to provide a care robot that, when the care robot is used to transfer a care receiver to/from a drive assistance apparatus such as an electric wheelchair, reduces the complexity of operation of the drive assistance apparatus and the care robot, and reduces the labor of a caregiver.

Solution to Problem

[0008] In order to solve the above problem, the present invention is a care robot provided with a holding section that assists a care receiver in standing up and sitting down by supporting a body part of the care receiver, the care robot comprising: a control section that, when a care receiver transfers to/from a drive assistance apparatus that performs at least one of raising/lowering and traveling by using a drive source with the care receiver in at least a sitting state, at least receives control information from the drive assistance apparatus, and performs control to assist the transfer of the care receiver based on the control information.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a schematic diagram illustrating a scheme of a care center in which care robots according to an embodiment of the present invention are arranged.

[Fig. 2] Fig. 2 is a right side view showing an embodiment of a care robot according to the present invention.

[Fig. 3] Fig. 3 is a plan view showing an embodiment of a care robot according to the present invention.

[Fig. 4a] Fig. 4a is a right side view illustrating a scheme of the internal structure of the care robot illustrated in fig. 2 which is in an extended state.

[Fig. 4b] Fig. 4b is a front view showing the vicinity including a first slide section shown in fig. 4a.

[Fig. 5a] Fig. 5a is a right side view illustrating a scheme of the internal structure of the care robot illustrated in fig. 2 which is in a contracted state.

[Fig. 5b] Fig. 5b is an end surface view taken along line 5b-5b shown in Fig. 5a.

[Fig. 5c] Fig. 5c is a front view showing the vicinity including a first slide section shown in fig. 5a.

[Fig. 6] Fig. 6 is a side view showing a state in which the care robot is supporting a sitting care receiver.

[Fig. 7] Fig. 7 is a side view showing a state in which the care robot is supporting a standing care receiver.

[Fig. 8] Fig. 8 shows a standing up motion on the left, and a sitting down motion on the right.

[Fig. 9] Fig. 9 is a diagram showing a standing up motion.

[Fig. 10] Fig. 10 is a diagram showing a sitting down motion.

[Fig. 11] Fig. 11 is a table showing the relationship between XY coordinates and robot coordinates.

[Fig. 12] Fig. 12 is a schematic side view showing lengths and angles of the robot arm section.

[Fig. 13] Fig. 13 is a map showing items such as the size and shape of a room (for example, a private room), the position of an entrance/exit (for example, an entrance/exit), and the position of an electric bed.

[Fig. 14] Fig. 14 is a diagram showing the travel space which is required for traveling of a care robot.

[Fig. 15] Fig. 15 is a diagram showing the transfer space (required transfer space) which is required for transferring between a care robot and an electric wheelchair.

[Fig. 16] Fig. 16 is a block diagram showing the care robot shown in fig. 2.

[Fig. 17] Fig. 17 is a plan view showing an electric wheelchair.

[Fig. 18] Fig. 18 is a block diagram showing the electric wheelchair shown in fig. 17.

[Fig. 19] Fig. 19 is a side view showing an electric bed.

[Fig. 20] Fig. 20 is a block diagram showing the electric bed shown in fig. 19.

[Fig. 21] Fig. 21 is a flowchart in a case in which the care robot according to the present invention stands up a care receiver from an electric bed.

[Fig. 22] Fig. 22 is a flowchart in a case in which the care robot according to the present invention sits down a care receiver who is standing up onto an electric wheelchair.

[Fig. 23] Fig. 23 is a flowchart in a case in which the care robot according to the present invention moves a care receiver who is sitting in an electric wheelchair while supporting the care receiver.

[Fig. 24] Fig. 24 is a side view showing an electric toilet seat raising/lowering device.

[Fig. 25] Fig. 25 is a block diagram showing the electric toilet seat raising/lowering device shown in fig. 24.

[Fig. 26] Fig. 26 is a flowchart in a case in which the care robot according to the present invention stands up (sits down) a care receiver from an electric toilet seat raising/lowering device.

Description of Embodiments

[0010] Hereinafter, an embodiment of a care robot according to the present invention will be described. Fig. 1 is a schematic view illustrating a scheme of a care center 10 where care robots 20 and electric wheelchairs 40 are arranged. Care center 10 has a station 11, a training room 12, and respective private rooms 13a to 13d. The care center 10 is a residential area where people live. The people in the care center 10 are care receivers M1 who require care and caregivers M2 who assist the care receivers M1.

[0011] As shown in fig. 1, station 11 is an office of the caregivers M2, and serves as a base where care robots 20 and electric wheelchairs 40 (described later) are on standby or charged. Care robot 20 is allowed to move in the residential area where the persons live, and is moved in the residential area by the movement of left and right drive wheel motors 21g and 21h that serve as drive sources. Training room 12 is a room where the care receivers M1 are in training or rehabilitation. The respective private rooms 13a to 13d are rooms where the care receivers M1 live. An electric bed 50 (described later) is provided in each of the private rooms 13a to 13d.

[0012] Station 11, training room 12, and respective private rooms 13a to 13d have respective entrances/exits 11a, 12a, and 13a1 to 13d1; the respective entrances/exits 11a, 12a, and 13a1 to 13d1 are connected to one another via corridor 14. In fig. 1, an arrow in the vicinity of a care robot 20 indicates the traveling direction of the care robot 20.

[0013] Also, guiding marks 14a are provided in corridor 14. Guiding marks 14a are provided at entrance/exit 11a of station 11, the corner of the respective entrance/exit 13a1 to 13d1 of respective private rooms 13a to 13d, and specified locations in corridor 14 (for example, corners of intersections, or the ceiling). Guiding marks 14a are marks which are able to be read by imaging device 28 of care robot 20. For example, guiding marks 14a may be two-dimensional barcodes. Information such as current position (for example, an intersection of corridor 14), and distance and direction from the current position to the target position (for example, in a case in which care robot 20 moves from station 11 to first private room 13a, when the care robot 20 approaches an intersection of corridor 14, the distance and direction [left turn] from the intersection to the first private room 13a) is stored in the two-dimensional barcode.

[0014] Care robot 20 is a care robot for assisting the standing up and sitting down of a care receiver M1 by supporting a body part (for example, the upper body, particularly, the chest) of care receiver M1. As shown in figs. 2 and 3, care robot 20 includes base 21, robot arm section 22, holding section 23, handle 24, operation device 25, storage device 26 (storage section), and control device 27 (control section).

[0015] Base 21 is provided with left/right base sections 21a and 21b, and left/right leg sections 21c and 21d. Left/right base sections 21a and 21b are provided spaced apart by a specified interval in the left/right direction, and as shown in fig. 3, left/right drive wheels 21e and 21f are respectively provided on left/right base sections 21a and 21b, and left/right drive wheel motors 21g and 21h that respectively drive left/right drive wheels 21e and 21f are internally incorporated in left/right base sections 21a and 21b. Care robot 20 travels using left/right drive wheels 21e and 21f which are respectively driven by left/right drive wheel motors 21g and 21h.

[0016] Traveling drive section AC is configured from left/right drive wheels 21e and 21f, and left/right drive wheel motors 21g and 21h.

[0017] Left/right leg sections 21c and 21d extend horizontally in a forward direction (left direction in figs. 2 and 3) from left/right base sections 21a and 21b. Left/right driven wheels 21i and 21j are respectively provided on an end section of left/right leg sections 21c and 21d. In addition, a pair of collision prevention sensors 21k and 21l are respectively provided on an end of the left/right leg sections 21c and 21d. Collision prevention sensors 21k and 21l are sensors for detecting an obstacle, and a detection signal thereof is transmitted to control device 27.

[0018] A base section of robot arm section 22 is attached to the base 21 and, as shown in figs. 4a and 5a, robot arm section 22 is provided with multiple arms 22a, 22b, and 22c which are relatively movable by using a drive section configured to mainly include first and second rotation motors 22a1c and 22b3 and a slide motor 22a2b. Robot arm section 22 may be configured from multiple axes. Axes in this case may include at least one of a rotation axis and a slide axis.

[0019] As shown in figs. 4a and 3b, and figs. 5a to 4c, a base section of first arm 22a is attached to base 21. First arm 22a is provided with slide base section 22a1, first slide section 22a2, and second slide section 22a3.

[0020] As shown in figs. 2 and 3, slide base section 22a1 is formed in a substantially rectangular cuboid shape. As shown in fig. 4a, the base end section of slide base section 22a1 is provided mainly with frame 22a1b which is attached to base 21 so as to be rotatable around first rotation axis 22a1a. Frame 22a1b is formed with a substantially U-shaped cross section, and as shown in fig. 5b, is configured mainly from left/right plate members 22a1b1 and 22a1b2 which are formed bent, and a rear plate member 22a1b3 whose left and right ends are connected to the upper rear ends of the left/right plate members 22a1b1 and 22a1b2.

[0021] As shown in fig. 4a, first rotation motor 22a1c is provided on base 21. First drive belt 22a1d is mounted around a pulley of first rotation motor 22a1c and a pulley of first rotation axis 22a1a. When first rotation motor 22a1c is driven, frame 22a1b, that is slide base section 22a1, is rotated around first rotation axis 22a1a in a forward direction or backward direction.

[0022] As shown in fig. 5b, a left/right guide groove 22a1e that slidably engages with the left/right end of rear plate member 22a2a2 of frame 22a2a of first slide section 22a2 which is described below is formed on the inside of frame 22a1b (on the inside of left/right plate member 22a1b1 and 22a1b2). Fixed section 22a1f that is attached to and fixes slide belt 22a2e which is described below is provided on an upper section of left plate member 22a1b1 of frame 22a1b (refer to figs. 4b and 5c).

[0023] Slide base section 22a1 is provided with knee sensor 22a1g. Knee sensor 22a1g is provided facing forwards from the front of slide base section 22a1 (the left direction is the front direction in figs. 2 and 3), and is provided at a position roughly equal to the knee height of care receiver M1 sitting on the seat. Knee sensor 22a1g is a distance detecting sensor that detects the distance to a knee of care receiver M1. A detection signal of knee sensor 22a1g is sent to control device 27. The knee of care receiver M1 sitting on the seat is the reference portion of care receiver M1, and knee sensor 22a1g is the first distance detecting sensor that detects the distance to the reference portion of care receiver M1.

[0024] As shown in figs. 2 and 3, first slide section 22a2 is formed in a substantially rectangular cuboid shape and is configured to be smaller than slide base section 22a1. First slide section 22a2 slides in a lengthwise direction (axis movement direction) with respect to slide base section 22a1, and is configured to be substantially housed inside slide base section 22a1 when contracted.

[0025] Specifically, first slide section 22a2 is provided with frame 22a2a (refer to fig. 4a). As shown in fig. 5b, frame 22a2a is formed in an H-shape in cross section and an H-shape in a side view, and is configured from front/rear plate members 22a2a1 and 22a2a2 and a connection plate member 22a2a3 whose front/rear ends are connected to a central portion in the vertical direction of front/rear plate members 22a2a1 and 22a2a2. Both the left and right ends of rear plate member 22a2a2 are slidably engaged with left/right guide groove 22a1e of frame 22a1b. As shown in fig. 4a, mainly slide motor 22a2b is provided on an upper section of rear plate member 22a2a2. Pulley 22a2c is rotatably provided on a lower section of rear plate member 22a2a2. Slide belt 22a2e is mounted around a pulley 22a2c and a pulley 22a2d of slide motor 22a2b.

[0026] As shown in fig. 5b, guide rail 22a2f is provided in both the left and right end sections of the front plate member 22a2a1 of frame 22a2a. Guide rail 22a2f slidably engages with left/right guide receiving section 22a3b on the inside of the left/right plate members of frame 22a3a of second slide section 22a3 which is described below.

[0027] As shown in figs. 2 and 3, second slide section 22a3 is formed in a substantially rectangular cuboid shape and is configured to be smaller than first slide section 22a2. Second slide section 22a3 slides in a lengthwise direction (axis movement direction) with respect to first slide section 22a2, and is configured to be substantially housed inside first slide section 22a2 when contracted.

[0028] Specifically, second slide section 22a3 is provided with frame 22a3a (refer to fig. 4a). As shown in fig. 5b, frame 22a3a is formed substantially in a U-shape in cross section, and is configured from left/right plate members 22a3a1 and 22a3a2 and a front/rear plate member 22a3a3 whose left/right ends are connected to the front section of left/right plate members 22a3a1 and 22a3a2. Left/right guide receiving section 22a3b that slidably engages with guide rail 22a2f of frame 22a2a is provided on the inside of frame 22a3a (the inner wall of left/right plate members 22a3a1 and 22a3a2). Fixed section 22a3c that is attached to and fixes slide belt 22a2e is provided on a lower section of right plate member 22a3a2 of frame 22a3a (refer to figs. 4b and 5c).

[0029] When slide motor 22a2b is driven, frame 22a2a of first slide section 22a2 extends in the axis movement direction with respect to frame 22a1b of slide base section 22a1 (the extended state shown in figs. 4a and 3b). At the same time, frame 22a3a of second slide section 22a3 extends with respect to frame 22a2a of first slide section 22a2 (the extended state shown in figs. 4a and 3b).

[0030] Conversely, if slide motor 22a2b is driven in the reverse direction, frame 22a2a of first slide section 22a2 contracts in the axis movement direction with respect to frame 22a1b of slide base section 22a1 (the contracted state shown in figs. 5a and 5c). At the same time, frame 22a3a of second slide section 22a3 contracts with respect to frame 22a2a of first slide section 22a2 (the contracted state shown in figs. 5a and 5c).

[0031] As shown in figs. 2 and 3, second arm 22b is formed in a substantially rectangular cuboid shape and is formed in an end section of second slide section 22a3 extending in a direction (forward direction) that is perpendicular to the lengthwise direction. Specifically, as shown in fig. 4a, second arm 22b is mainly provided with frame 22b1 configured from left/right plate members 22b1a and 22b1b. The rear end of left/right plate members 22b1a and 22b1b of frame 22b1 are respectively fixedly connected to an upper section of left/right plate members 22a3a1 and 22a3a2 of frame 22a3a.

[0032] Second rotation axis 22b2 is rotatably provided on an end section of left/right plate members 22b1a and 22b1b of frame 22b1. Second rotation motor 22b3 is provided on a center section of left/right plate members 22b1a and 22b1b. Second rotation drive belt 22b4 is mounted around a pulley of second rotation motor 22b3 and a pulley of second rotation axis 22b2.

[0033] Third arm 22c is formed in a substantially rectangular cuboid shape and the base section thereof is attached to an end section of second arm 22b so as to be rotatable around second rotation axis 22b2. Specifically, third arm 22c is provided with frame 22c2. The rear end section of frame 22c2 is fixed so as to be rotated as one with second rotation axis 22b2. The front end section of frame 22c2 is fixed to the rear end of holding section 23.

[0034] When second rotation motor 22b3 is driven, frame 22c2, that is, third arm 22c, rotates around second rotation axis 22b2 in an upward direction or a downward direction.

[0035] Holding section 23 is fixed to an end of third arm 22c. Holding section 23 assists the standing up and sitting down of care receiver M1 by supporting a body part (for example, the upper body, particularly, the chest) of care receiver M1. For example, holding section 23 is a member that supports both arms (both armpits) of care receiver M1 from below when working opposite care receiver M1 during standing up motion and sitting down motion, and is formed in a U-shape which is open in the forward direction in a plan view. Holding section 23 is formed, for example, from a relatively soft material on the assumption that holding section 23 contacts care receiver M1.

[0036] As shown in figs. 2 and 3, handle 24 is fixed to the upper surface of third arm 22c. Handle 24 is configured from a pair of left and right rod-shaped handgrips, and is provided such that the handgrips are to be gripped by the left and right hands of care receiver M1. Contact sensors 24a and 24b for detecting the gripping are provided in handle 24. Leftward turning switch 24c for turning the care robot 20 to the left and rightward turning switch 24d for turning the care robot 20 to the right are provided in handle 24. Furthermore, stop switch 24e for stopping the care robot 20 is provided in handle 24.

[0037] In addition, in a case where care receiver M1 walks in a state being supported by holding section 23, or in a case where care receiver M1 walks in a state gripping handle 24, load sensor 22c1 for detecting the force received from care receiver M1 is provided in third arm 22c. Load sensor 22c1 is a sensor for detecting as a voltage change the distortion amount of a distortion generating body which changes according to a load change, or a semiconductor-type pressure sensor in which gauge resistance is changed and converted into an electrical signal according to the distortion which arises when pressure is applied to a silicon chip.

[0038] Operation device 25 is provided with display unit 25a that displays images and operation section 25b that receives input operations from an operator (a caregiver or care receiver M1).

[0039] Display section 25a is configured from a liquid crystal display, and displays a selection screen for operation modes of care robot 20 and so on. A standing up motion assistance mode for assisting a standing up motion of care receiver M1, a sitting down motion assistance mode for assisting a sitting motion care receiver M1, and so on, are set as operation modes.

[0040] Operation section 25b is provided with a cursor key for moving a cursor up/down/left/right, a cancel key for canceling inputs, and a determination key for determining selected content; the configuration is such that operator instructions can be entered using the keys. Operation unit 25 may be configured from a touch panel that has the display function of display section 25a and the input function of operation section 25b such that the device is operated by pressing the display on the touch panel.

[0041] Storage device 26 (storage section) stores: standing up trajectory reference data that indicates a standing up trajectory along which a movement control position, for example shoulder position Ps, of care receiver M1 passes when a sitting care receiver M1 (refer to fig. 6) who is supported by holding section 23 stands up; and sitting down trajectory reference data that indicates a sitting down trajectory, which is different from the standing up trajectory, along which shoulder position Ps of care receiver M1 passes when a standing care receiver M1 (refer to fig. 7) who is supported by holding section 23 sits down.

[0042] As shown in fig. 8, standing up trajectory Tas1 is set such that center of gravity G of care receiver M1 is within range A of the soles of both feet of care receiver M1 between a point in time early after the start of standing up motion which is motion to stand up care receiver M1 and an end time point of the standing up motion of care receiver M1. Tg1 represents the trajectory of center of gravity G.

[0043] As shown in fig. 8, sitting trajectory Tbs1 is set such that center of gravity G of care receiver M1 is outside range A of the soles of both feet from a point in time early after the start of sitting down motion which is motion to sit down care receiver M1, and moves toward a planned sitting position of the care receiver M1. Sitting down trajectory Tbs1 is set such that sitting down trajectory Tbs1 is positioned above standing up trajectory Tas1. Tg2 represents the trajectory of the center of gravity G.

[0044] Standing up trajectory Tas1 and sitting down trajectory Tbs1 may be created by capturing images of actual standing up motion of a healthy person and creating the trajectories based on two-dimensional coordinates (for example, xy coordinates) of the shoulder position Ps. Fig. 9 shows a standing up trajectory (standing up motion). The standing up motion is shown sequentially from top left (sitting state) to bottom right (standing state). The second state (upper middle diagram) represents a point in time early after the start of standing up motion, which is a time point when the sitting care receiver M1 leans forward and lifts their posterior up. From the second state to the end point of the standing up motion (sixth state), the center of gravity G of care receiver M1 is in the range A of the soles of both feet of the care receiver M1.

[0045] Figure 10 shows a sitting down trajectory (sitting down motion). The sitting down motion is shown sequentially from top left (standing state) to bottom right (sitting state). The second state (upper middle diagram) represents a point in time early after the start of sitting down motion, which is a time point when the standing care receiver M1 lowers their posterior and when the center of gravity G of the care receiver leaves the range A of the soles of both feet of the care receiver M1. From the second state to the end point of the sitting down motion (fifth state), the center of gravity G of care receiver M1 leaves the range A of the soles of both feet of the care receiver M1 and moves toward a planned sitting position (the seat in the diagram [for example, a chair]) of the care receiver M1. Note that, the standing up trajectory and the sitting down trajectory may be created by simulation.

[0046] Each trajectory reference data is created as two-dimensional coordinates. Standing up trajectory reference data is expressed, for example, as xy coordinates (Xa1, Ya1), ... , (Xan, Yan), where n is the quantity of coordinates. Sitting down trajectory reference data is expressed, for example, as xy coordinates (Xb1, Yb1), ... , (Xbn, Ybn), where n is the quantity of coordinates. The origin point may be the reference point of care robot 20, the center of gravity of care robot 20, coordinates of first rotation axis 22a1a, coordinates of a foot (ankle) when sitting, or any point on the seat surface of care receiver M1.

[0047] Trajectory reference data is desirably configured to include an angle α of holding section 23 for each coordinate in addition to the xy coordinates. The angle α of holding section 23 for each coordinate represents an angle of holding section 23 at each point in the standing up trajectory Tas1 and the sitting down trajectory Tbs1 (refer to fig.12). The angle α is an angle which is formed by the upper body (inner wall surface of holding section 23 which contacts care receiver M1 so as to hold care receiver M1) of care receiver M1 and a horizontal plane. For example, as shown in fig. 12, when care receiver M1 is in a sitting position or in a standing position, the angle α is 90 degrees. The trajectory reference data is expressed, for example, as (Xa1, Ya1, α1),..., (Xan, Yan, αn).

[0048] Note that, the trajectory reference data may be represented by robot coordinates instead of two-dimensional coordinates. In this case, standing up trajectory reference data is configured to include, for example, as shown in fig. 11, first angle (θa) which is the rotation angle of first rotation motor 22a1c, the arm length (L: slide amount: rotation angle corresponding to the arm length) of slide motor 22a2b, and a second angle (θb) which is the rotation angle of second rotation motor 22b3. Coordinates which include angle α of the XY coordinates (Xa1, Ya1, α1) are expressed as robot coordinates (θa1, L1, θb1).

[0049] A method of calculating robot coordinates (θa1, L1, θb1) from coordinates which include angle α of the XY coordinates (Xa1, Ya1, α1) is briefly described. Fig. 12 is a schematic side view showing lengths and angles of robot arm section 22. As shown in fig. 12, La (variable value) represents the length of the first arm 22a, Lb (fixed value) represents the length of the second arm 22b, and Lc (fixed value) and Ld (fixed value) respectively represent lengths from second rotation axis 22b2 to shoulder position Ps along an extension direction of third arm 22c and along a direction perpendicular to the extension direction. Also, first angle θa is an angle formed by first arm 22a and a horizontal line, an angle formed by first arm 22a and second arm 22b is 90 degrees, and second angle θb is an angle formed by second arm 22b and third arm 22c.

[0050] The XY coordinates of point P1, at which first arm 22a intersects second arm 22b, are (La x (cos θa), La x (sin θa)). The XY coordinates of point P2 indicative of second rotation axis 22b2 is obtained by adding (Lb x (sin θa), Lb x (cos θa)) to the XY coordinates of point P1. The XY coordinates of point P3 at which a perpendicular line extending from the shoulder point Ps intersects third arm 22c, is obtained by adding (Lc x (cos (π/2-θa-θb), Lc x (sin (π/2-θa-θb)) to the XY coordinates of point P2. The XY coordinates of the shoulder position Ps, that is, point P4 are obtained by adding (Ld x (cos (θa+θb), Ld x (sin (θa+θb)) to the XY coordinates of point P3. Note that, the angle α of holding section 23 for each coordinate is expressed as π - (π/2 + (π/2-θa-θb), that is, α = θa + θb. According to the above, robot coordinates (θa1, L1, θb1) are calculated from coordinates (Xa1, Ya1, α1) obtained by adding the angle α to the XY coordinates.

[0051] Note that, as shown in fig. 11, robot coordinates may be configured to include: a first angular velocity (ωa) which is the angular velocity of the first angle (θa), that is, the rotation angle of first rotation motor 22a1c; a slide velocity (V: rotation angular velocity corresponding to the slide velocity) of the slide motor 22a2b; and a second angular velocity (ωb) which is the angular velocity of the second angle (θb), that is, the rotation angle of second rotation motor 22b3.

[0052] Further, storage device 26 stores the map (for example, two-dimensional coordinates) shown in fig. 13. This map shows items such as the size and shape of a room (for example, private room 13a), the position of an entrance/exit (for example, entrance/exit 13a1), and the position of electric bed 50. Also, as shown in fig. 14, storage device 26 stores the travel space which is required for traveling of care robot 20. Shown in fig.14 is the travel space when turning left 90 degrees with respect to the traveling direction. In fig. 14, the travel space range is shown by dashed lines, and the traveling direction is shown by an arrow. Further, as shown in fig. 15, storage device 26 stores transfer space (required transfer space) which is required for transferring between care robot 20 and electric wheelchair 40. For required transfer space, the length in the width direction (the maximum width out of care robot 20 and electric wheelchair 40) is X (mm), and the length in the traveling direction (the distance between an outer edge of care robot 20 and an outer edge of electric wheelchair 40) is Y (mm). The length of the traveling direction is set to be a distance sufficient for transfer between care robot 20 and wheelchair 40 as they are facing each other.

[0053] Further, storage device 26 stores a correction amount (first correction amount) according to the height of the seat such as a chair or a bed on which care receiver M1 sits. This first correction amount is a value for correcting each of the above data. Each of the above data is data when the height of the seat is a specified value (for example, 40 cm).

[0054] Also, storage device 26 stores a correction amount (second correction amount) according to the height of care receiver M1. The second correction amount is a value for correcting each of the above data. Each of the above data is data when the height of care receiver M1 is a specified value (for example, average height, specifically 170 cm).

[0055] The correction amounts above are stored as a map, but the correction amounts may be stored as calculation equations.

[0056] Control device 27 performs control related to traveling and posture changing of the care robot 20. As shown in fig. 16, the above collision prevention sensors 21k and 211, knee sensor 22a1g, load sensor 22c1, contact sensors 24a and 24b, leftward turning switch 24c, rightward turning switch 24d, stop switch 24e, left/right drive wheel motors 21g and 21h, first rotation motor 22a1c, slide motor 22a2b, second rotation motor 22b3, operation device 25, storage device 26, imaging device 28, guide device 29, and transceiver 30 are connected to control device 27. Also, control device 27 has a microcomputer (not shown); the microcomputer is provided with an input/output interface, CPU, RAM, and ROM (all not shown) that are connected to one another via a bus.

[0057] Imaging device 28 is provided respectively on the front surface of slide base section 22a1 and the rear surface of first slide section 22a2. Imaging device 28 provided on the front surface of slide base section 22a1 images a target in front of care robot 20. Imaging device 28 provided on the rear surface of first slide section 22a2 images a target behind or above care robot 20.

[0058] Guide device 29 provides guidance to people, including care receiver M1 and a caregiver, in the vicinity regarding the state of care robot 20 using sound or a display. Guide device 29 may be a speaker for outputting sound, or a display device such as an LCD or an LED for displaying characters or graphics and the like.

[0059] Transceiver 30 is capable of communication with transceiver 48 of electric wheelchair 40. Transceiver 30 receives transmission data from transceiver 48, and sends transmission data to transceiver 48.

[0060] Electric wheelchair 40 is a drive assistance apparatus that performs at least one of raising/lowering and traveling, with care receiver M1 in at least a sitting state, by using motors 44a1 and 441b (drive sources) for left and right drive wheels. Further, electric wheelchair 40 is a drive movement body that performs at least traveling with care receiver M1 in a sitting state, by using motors 44a1 and 441b (drive sources) for left and right drive wheels.

[0061] As shown in fig. 17, electric wheelchair 40 is provided with seat 41, backrest 42, armrest 43, left/right drive wheels 44a and 44b, left/right drive wheel motors 44a1 and 44b1, left/right steered wheels 44c and 44d, collision prevention sensor 45, operation device 46, storage memory 47, transceiver 48, and control device 49.

[0062] Seat 41 is for care receiver M1 to sit on. Backrest 42 is a section for care receiver M1 to rest their back against. Armrest 43 is a section for care receiver M1 to rest their arm on. Left/right drive wheels 44a and 44b are wheels for traveling (driving) electric wheelchair 40; each wheel 44a and 44b is driven independently by left/right drive wheel motors 44a1 and 44b1 respectively.

[0063] Left/right steered wheels 44c and 44d are wheels for steering electric wheelchair 40 and are steered by a steering motor (not shown). Collision prevention sensor 45 is a sensor which detects obstacles, and detection signals of prevention sensor 45 are sent to control device 49. Operation device 46 is an operation device (for example, a joystick) which receives operation inputs from an operator (care receiver M1), and sends operations signals of the operation inputs to control device 49.

[0064] Storage device 47 stores the map (for example, two dimensional coordinates) shown in fig. 13. This map shows items such as the size and shape of a room, the position of an entrance/exit, and the position of a bed. Further, storage device 47 stores the required travel space (which is travel space similar to that shown in fig. 14) for the traveling of electric wheelchair 40.

[0065] Transceiver 48 is capable of communication with transceiver 30 of care robot 20. Transceiver 48 receives transmission data from transceiver 30, and sends transmission data to transceiver 30.

[0066] Control device 49 performs control related to the traveling of electric wheelchair 40 and the raising/lowering of seat 41. As shown in fig. 18, control device 49 is connected to collision prevention sensors 45 and 45, left/right drive wheel motors 44a1 and 44b1, operation device 46, storage device 47, and transceiver 48. Also, control device 49 has a microcomputer (not shown); the microcomputer is provided with an input/output interface, CPU, RAM, and ROM (all not shown) that are connected to one another via a bus.

[0067] Electric bed 50 is a drive assistance apparatus that performs at least one of raising/lowering and traveling, with care receiver M1 in at least a sitting state, by using raising/lowering motor 54a (drive source). In other words, electric bed 50 is a bed section raising/lowering device that raises/lowers bed sections 53 on which care receiver M1 at least sits using raising/lowering motor 54a (drive source). As shown in fig. 19, electric bed 50 is provided with base 51, frame 52, bed sections 53, raising/lowering/corrugating mechanism 54, operation device 55, storage device 56, transceiver 57, and control device 58. Electric bed 50 is configured such that frame 52, on which bed sections 53 are corrugatably supported, can be raised/lowered with respect to base 51.

[0068] Wheels are provided on the lower surface of base 51 so that electric bed 50 can move. Frame 52 is provided on the upper portion of base 51 via raising/lowering/corrugating mechanism 54. Bed sections 53 are corrugatably supported with respect to frame 52. Bed sections 53 are divided into multiple floor sections, and in this example are configured from head-side back section 53a, leg-side lower back section 53b, and leg section 53c. For the configuration of the multiple floor sections, a known appropriate configuration may be used. Electric raising/lowering/corrugating mechanism 54 is shown conceptually by the 2-point dashed line in fig. 19, and raises/lowers bed sections 53 using in-built raising/lowering motor 54a, and corrugates bed sections 53 using in-built corrugating motor 54b.

[0069] Operation device 55 is an operation device which receives operation inputs from an operator (care receiver M1), and sends operations signals of the operation inputs to control device 58. Storage device 56 stores the height of bed sections 53. The height of bed sections 53 is detected by a height sensor which is not shown; the detected height may be stored in storage device 56, or a height set by operations of the operator may be stored in storage device 56. Transceiver 57 is capable of communication with transceiver 30 of care robot 20. Transceiver 57 receives transmission data from transceiver 30, and sends transmission data to transceiver 30.

[0070] Control device 58 performs control related to the raising/lowering/corrugating of bed sections 53 of electric bed 50. As shown in fig. 20, control device 58 is connected to raising/lowering motor 54a, corrugating motor 54b, operation device 55, storage device 56, and transceiver 57. Also, control device 58 has a microcomputer (not shown); the microcomputer is provided with an input/output interface, CPU, RAM, and ROM (all not shown) that are connected to one another via a bus.

[0071] Next, the basic operation of care robot 20 configured as given above will be described. First, movement of care robot 20 is described. A case is described in which care robot 20 moves independently from station 11 to the respective private rooms 13a to 13d (or from the respective private rooms 13a to 13d to station 11). When moving through corridor 14 from station 11 to the respective private rooms 13a to 13d, care robot 20 moves along a route stored in advance in storage device 26 which is a route from entrance/exit 11a of station 11 to the respective entrance/exit 13a1 to 13d1 of the respective private rooms 13a to 13d. At this time, care robot 20 reads guiding marks 14a provided in corridor 14 using imaging device 28, calculates the remaining traveling route from the information, and moves based on the calculation result.

[0072] Next, a case will be described in which care robot 20 comes close to a sitting care receiver M1. At this time, care robot 20 is, for example, approaching care receiver M1 who is sat on a bed. Care robot 20 advances with the front surface of care robot 20 facing in the traveling direction. Care robot 20 reads a guiding mark provided in the vicinity of care receiver M1 using imaging device 28 in the front surface of care robot 20, and approaches care receiver M1 based on the information.

[0073] Furthermore, a standing up motion and a sitting down motion of care robot 20 will be described with reference to figs. 8 to 10. Care robot 20 uses a detection result (distance between the care robot 20 and a knee of the care receiver M1) of knee sensor 22a1g, and moves to a predetermined position where the distance from a sitting care receiver M1 becomes a predetermined distance. The specified position is the optimum position for standing up care receiver M1 (standing up optimum position).

[0074] Then, care robot 20 gives the guidance "Grip the handle" to care receiver M1. If care receiver M1 grips both handles, the fact that handle 24 has been gripped is detected by contact sensors 24a and 24b, thus care robot 20 performs standing up motion for allowing the care receiver M1 to stand up.

[0075] If a standing up motion starts, care robot 20 holds the upper body of sitting care receiver M1 using holding section 23 (refer to fig. 6). Then, while holding the upper body of care receiver M1, care robot 20 stands the care receiver M1 up (refer to fig. 10). More specifically, as shown on the left in fig. 8, the standing up motion is performed along the reference standing up trajectory.

[0076] Care robot 20 assists care receiver M1 in a standing up state. Care receiver M1 moves by walking in a state supported by holding section 23 supporting the armpits of care receiver M1 from below. Also, care robot 20 moves with care receiver M1 in an upright riding state on the footrest sections (not shown) of care robot 20. Care robot 20 advances with the rear surface of care robot 20 facing in the traveling direction.

[0077] And, when a sitting down motion for sitting care receiver M1 down starts, care robot 20 brings care receiver M1 in a standing up state (refer to fig. 7) into a sitting down state while the upper body of care receiver M1 is held by holding section 23 (refer to fig. 6). More specifically, as shown on the right in fig. 8, the sitting down motion is performed along the sitting down trajectory.

[0078] Then, when the sitting down motion ends, care robot 20 gives the guidance "Let go of the handle" to care receiver M1. When care receiver M1 lets go of handle 24, contact sensors 24a and 24b detect the fact that the hands have let go of handle 24, thus, care robot 20 moves away from care receiver M1.

[0079] Furthermore, the operation when care receiver M1 transfers from electric bed 50 to electric wheelchair 40 will be described. Note that, as the operation when transferring from electric wheelchair 40 to electric bed 50 is the corresponding reverse operation of transferring from electric bed 50 to electric wheelchair 40, descriptions thereof are omitted.

[0080] First, description is given with regard to care receiver M1 standing up from electric bed 50 with reference to the flowchart of fig. 21. In step S102, control section 27 acquires an operation mode (any one of a standing up motion assistance mode, a sitting down motion assistance mode, and a motion series assistance mode) selected using operation device 25, and acquires reference data according to the acquired mode from storage device 26. Standing up trajectory reference data is acquired when in standing up motion assistance mode, sitting down trajectory reference data is acquired when in sitting down motion assistance mode, and standing up trajectory reference data and sitting down trajectory reference data are acquired when in motion series assistance mode.

[0081] In step S104, control device 27 acquires the height (height at transfer time) of bed sections 53 of electric bed 50 from transceiver 57 of electric bed 50 via transceiver 30. Control device 27 receives the height of bed sections 53 of electric bed 50 (in particular, the height of bed sections 53 when transferring set in advance), which is control information of electric bed 50. Also, in a case in which the condition of care receiver M1 (for example, paralysis on the left side of the body, or paralysis on the right side of the body) is stored in storage device 56 of electric bed 50, this condition may also be acquired as control information. In this case, care robot 20 automatically determines the boarding position (a right side position or a left side position of electric bed 50) of care robot 20 according to the paralysis of the body.

[0082] Note that, at this time, on the electric bed 50 side, control device 58 may receive travel position information of care robot 20, derive a remaining time to attainment, and raise/lower bed sections 53 to a specified height at the derived remaining time. Because bed sections 53 are usually in a low position when care receiver M1 is sleeping, bed sections 53 may be raised/lowered to a suitable height for transfer from the usual low position before care robot 20 arrives. In this way, for electric bed 50, the height of bed sections 30 can be adjusted in advance before care robot 20 arrives. Note that, for electric bed 50, the height of bed sections 53 may be adjusted after care robot 20 has arrived.

[0083] In step S106, control device 27 corrects the reference data acquired in step S102 according to the height of bed sections 53 acquired in step S104 (correction section). Specifically, control device 27 acquires a first correction amount according to the height of bed sections 53 from storage device 26. Then, control device 27 corrects the reference data according to the acquired correction amount.

[0084] In step S108, control device 27 drives the drive section configured to include first and second rotation motors 22a1c and 22b3, and slide motor 22a2b, so as to drive the standing up motion of robot arm section 22 based on the standing up trajectory reference data (drive control section). Also, control device 27 drives the drive section, so as to drive the sitting down motion of robot arm section 22 based on the sitting down trajectory reference data. Specifically, control device 27 drives the drive section to comply with the reference data that was corrected in step S106 (including reference data that is not corrected). In this way, control device 27 performs standing up motion and sitting down motion appropriately based on the height of bed sections 53, which is also control information of electric bed 50.

[0085] Next, description is given with regard to a standing care receiver M1 sitting down onto wheelchair 40 with reference to the flowchart of fig. 22. In step S202, control device 27 determines whether there is a transfer start instruction. When there is a transfer start instruction, control device 27 continues the program from step S204. When there is no transfer start instruction, control device 27 repeats the processing of step S202. For transfer start instructions, an instruction is issued when, for example, a transfer start button, which is not shown, is pushed.

[0086] When care robot 20 stands up care receiver M1 to transfer care receiver M1 to electric wheelchair 40 (drive movement body), in a case in which there is transfer space at the vicinity of the standing up position (care robot 20) at which care receiver M1 was stood up, control device 27 judges "YES" in step S4, proceeds to step S208 and performs control to make electric wheelchair 40 travel to the vicinity of the standing up position.

[0087] On the other hand, when care robot 20 stands up care receiver M1 to transfer care receiver M1 to electric wheelchair 40, in a case in which there is no transfer space at the vicinity of the standing up position, and there is transfer space at a vicinity of the standby position (electric wheelchair 40) of electric wheelchair 40, control device 27 judges "NO" at step S206, and "YES" at step 206, proceeds to step S210 and performs control to move care robot 20 to a vicinity of the standby position.

[0088] Further, when care robot 20 stands up care receiver M1 to transfer care receiver M1 to electric wheelchair 40, in a case in which there is no transfer space at the vicinity of either the standing up position or the standby position, control device 27 judges "NO" at step S204, and "NO" at step S206, proceeds to step S212 and performs control to move both electric wheelchair 40 and care robot 20 to a transfer position.

[0089] Then, in step S214, control device 27 finely adjusts the position of both electric wheelchair 40 and care robot 20, and starts transfer control (given above).

[0090] Note that, the transfer space is calculated from the map of the room, which is movement destination information (refer to fig. 13), travel space (refer to fig. 14), and required transfer space (refer to fig. 15). In steps S204 and S206, control device 27 acquires control information of electric wheelchair 40 which includes at least one of movement start information, movement speed information, movement destination information (including the map [refer to fig. 13] mentioned above), current position information, and movement finish information of electric wheelchair 40, from transceiver 48 of electric wheelchair 40 via transceiver 30. Control device 27 receives control information of electric wheelchair 40.

[0091] Further, description will be given with regard to moving care receiver M1 who is sitting in electric wheel 40 while being supported by care robot 20 with reference to the flowchart in fig. 23. Control device 27 executes the program shown in the flowchart of fig. 23 regularly at a specified short interval. In step S302, control device 27 acquires control information of electric wheelchair 40 which includes at least one of movement start information, movement speed information, movement destination information (map [refer to fig. 13] from above), current position information, and movement finish information of electric wheelchair 40, from transceiver 48 of electric wheelchair 40 via transceiver 30. Control device 27 receives control information of electric wheelchair 40.

[0092] Then, in step S304, control device 27 moves care robot 20 in cooperation with electric wheelchair 40 while maintaining the relative positions of care robot 20 and electric wheelchair 40 at a predetermined positional relationship, based on the control information acquired in step S302. At this time, control device 27 may measure the distance to electric wheelchair 40 using an image acquired from imaging device 28, or may measure the distance to the upper body of care receiver M1 who is sitting on electric wheelchair 40 which is moving. By this, it is possible to reliably support the upper body of care receiver M1 who is sitting on electric wheelchair 40 which is moving, and it is possible to support a care receiver M1 for whom the level of care required is large. That is, care receiver M1 with a wide range of care required levels can be supported with one type of care robot 20.

[0093] Also, care robot 20 may be provided with a connecting section which is mechanically detachably connectable with electric wheelchair 40. In this case, care robot 20 is automatically connected to electric wheelchair 40 via the connecting section. Here, control device 27, for the moving of electric wheelchair 40 on which care receiver M1 is sitting, performs control (connection control) for traveling in coordination with electric wheelchair 40 so as to maintain the relative positions of care robot 20 and electric wheelchair 40 at a predetermined positional relationship by the connection with the connecting section.

[0094] As given above, control device 27 is a control section that, when care receiver M1 transfers to/from a drive assistance apparatus (electric wheelchair 40 [drive movement body], electric bed 50 [bed section raising/lowering device]) that performs at least one of raising/lowering and traveling by using a drive source with care receiver M1 in at least a sitting state, at least receives control information from the drive assistance apparatus, and performs control to assist the transfer of care receiver M1 based on the control information. Further, control device 27 is a control section that, when assisting the transfer of care receiver M1, performs control in cooperation with the drive assistance apparatus based on the control information from the drive assistance apparatus.

[0095] Care robot 20 of the present embodiment is provided with holding section 23 that assists care receiver M1 in standing up and sitting down by supporting a body part of care receiver M1, and comprises: control device

27 that, when care receiver M1 transfers to/from a drive assistance apparatus (electric wheelchair 40, electric bed 50) that performs at least one of raising/lowering and traveling by using a drive source (left/right drive wheel motors 44a1 and 44b1, and raising/lowering motor 54a) with the care receiver in at least a sitting state, at least receives control information from the drive assistance apparatus (electric wheelchair 40, electric bed 50), and performs control to assist the transfer of care receiver M1 based on the control information.

[0096] According to this, care robot 20, when transferring care receiver M1 to/from a drive assistance apparatus such as electric wheelchair 40, can assist the transfer of care receiver M1 based on control information received from the drive assistance apparatus. That is, at least care robot 20 is operated to match the operation of the drive assistance apparatus, that is, in cooperation with the drive assistance apparatus. Thus, it is possible to provide a care robot 20 that, when the care robot 20 is used to transfer a care receiver M1 to/from a drive assistance apparatus such as an electric wheelchair, reduces the complexity of operation of the drive assistance apparatus and the care robot 20, and reduces the labor of a caregiver.

[0097] Also, with care robot 20 of the present embodiment, control device 27, when assisting the transfer of care receiver M1, performs control in cooperation with the drive assistance apparatus such as electric wheelchair 40 based on control information from the drive assistance apparatus.

[0098] According to this, care robot 20, when transferring care receiver M1 to/from a drive assistance apparatus, operates to match the operation of the drive assistance apparatus, that is, operates in reliable cooperation with the drive assistance apparatus. Thus, when care robot 20 is used to transfer care receiver M1 to/from a drive assistance apparatus, the complexity of operation of the drive assistance apparatus and the care robot 20, and the labor of a caregiver are reduced.

[0099] With care robot 20 of the present embodiment, the drive assistance apparatus is a drive movement body (electric wheelchair 40) that at least makes care receiver M1 who is in a sitting state travel using a drive source; the control information includes at least one of movement start information, movement speed information, movement destination information, current position information, movement finish information, travel space, and required transfer space of the drive movement body; and control section 27, when care robot 20 stands up care receiver M1 and transfers care receiver M1 to the drive movement body (electric wheelchair 40), performs control to call the drive movement body to a vicinity of a standing up position in a case in which there is transfer space at the vicinity of the standing up position at which care receiver M1 is to be stood up, performs control to make care robot 20 travel to a vicinity of a standby position of the drive movement body in a case in which there is no transfer space in the vicinity of the standing position and there is transfer space in the vicinity of the standby position of the drive movement body, and performs control to make both the drive movement body and care robot 20 travel to a transfer position in a case in which there is no transfer space in the vicinities of the drive movement body and care robot 20.

[0100] According to this, when care robot 20 is used to transfer care receiver M1 to/from a drive assistance apparatus such as wheelchair 40, care robot 20 (which is holding care receiver M1 in a state standing up) and the drive movement body are moved to an appropriate position based on the presence/absence of transfer space in the vicinity of the standing up position at which care receiver M1 is stood up by care robot 20, and in the vicinity of the standby position of the drive movement body (electric wheelchair 40), and care receiver M1 is reliably transferred to/from the drive movement body at the appropriate position.

[0101] Also, with care robot 20 of the present embodiment, control device 27, for the moving of the drive movement body (electric wheelchair 40) on which care receiver M1 is sitting, performs control (connection control) for traveling in coordination with the drive movement body so as to maintain the relative positions of care robot 20 and the drive movement body (electric wheelchair 40) at a predetermined positional relationship.

[0102] According to this, since holding section 23 of care robot 20 reliably supports a body part of care receiver M1 who is sitting on the moving drive movement body (electric wheelchair), it is possible to support a care receiver M1 for whom the level of care required is large.

[0103] Also, with care robot 20 of the present embodiment, the drive assistance apparatus is also a bed section raising/lowering device (electric bed 50) that raises/lowers a bed section on which care receiver M1 at least sits using a drive source, the control information includes at least a height of bed section 53, and control section 27 performs standing up motion and sitting down motion in accordance with the height of bed section 53.

[0104] According to this, when transferring care receiver M1 to/from a bed section raising/lowering device such as electric bed 50, since care robot 20 stands up and sits down care receiver M1 to match the height of bed section 53, care receiver M1 can sit down and stand up without any discomfort. Further, since care robot 20 only stands up and sits down care receiver M1 when bed section 53 is at an appropriate height for standing up/sitting down, care receiver can sit down and stand up without any discomfort even more reliably.

[0105] Also, care robot 20 of the present embodiment is a care robot provided with holding section 23 that assists care receiver M1 in standing up and sitting down by supporting a body part of care receiver M1; when care receiver M1 sitting on a seat stands up being supported by holding section 23, a standing up trajectory, through which a movement control portion (for example, shoulder position Ps) of care receiver M1, is set such that center of gravity G of care receiver M1 is within range A of the soles of both feet of care receiver M1 between a point in time early after the start of standing up motion which is motion to stand up care receiver M1 and an end time point of the standing up motion of care receiver M1; when standing care receiver M1 supported by holding section 23 sits down, a sitting down trajectory, which is different from the standing up trajectory and through which the movement control portion of care receiver M1 passes, is set such that center of gravity G of care receiver M1 is outside range A of the soles of both feet from a point in time early after the start of sitting down motion which is motion to sit down care receiver M1 and moves toward a planned sitting position of the care receiver M1.

[0106] According to this, when care receiver M1 is stood up such that the movement control portion (for example, shoulder position Ps) of care receiver M1 passes along the standing up trajectory, similar to when a healthy person stands up, the center of gravity G enters range A of the soles of both feet from a point in time early after the start of standing up, and remains in that range until the end time point of the standing up motion. Accordingly, care receiver M1 is assisted to stand up with the same feeling as when care receiver M1 stands up without assistance. Thus, care receiver M1 is stood up without discomfort.

[0107] On the other hand, when care receiver M1 is sat down such that the movement control portion (for example, shoulder position Ps) of care receiver M1 passes along the sitting down trajectory, similar to when a healthy person sits down, the center of gravity G is outside range A of the soles of both feet from a point in time early after the start of sitting down motion and moves toward a planned sitting position (for example, a seat) of the care receiver M1. Accordingly, care receiver M1 is assisted to sit down with the same feeling as when care receiver M1 sits down without assistance. Thus, care receiver M1 is sat down without discomfort.

[0108] Also, care robot 20 is a care robot provided with holding section 23 that assists care receiver M1 to stand up and sit down by supporting a part (the chest) of the body of care receiver M1, and is further provided with: base 21; robot arm section 22 that is provided on base 21 and includes multiple arms 22a, 22b, and 22c that are relatively movable to each other by using a drive section; holding section 23 that is provided on an end of robot arm section 22 and that supports care receiver M1; storage device 26 (storage section) that stores standing up trajectory reference data which indicates a standing up trajectory along which a movement control portion of care receiver M1 passes when care receiver M1 sitting on a seat stands up being supported by holding section 23, and sitting down trajectory reference data which indicates a sitting down trajectory, which is different from the standing up trajectory, along which the movement control position of care receiver M1 passes when standing care receiver M1 supported by holding section 23 sits down; and control device 27 that drives the drive section so as to drive robot arm section 22 based on the standing up trajectory reference data and the sitting down trajectory reference data.

[0109] According to this, because it is easy to set standing up trajectory reference data as data corresponding to the standing up trajectory of a healthy person, in a case in which care receiver M1 is stood up such that the movement control portion (for example, a shoulder position) of care receiver M1 passes along the standing up trajectory, robot arm section 22 can be driven based on standing up trajectory reference data corresponding to the standing up trajectory of a healthy person. Accordingly, care receiver M1 is assisted to stand up with the same feeling as when care receiver M1 stands up without assistance. Thus, care receiver M1 is stood up without discomfort.

[0110] In contrast, typically, a sitting down trajectory of a healthy person is different from a standing up trajectory of a healthy person; however, because it is easy to set sitting down trajectory reference data as data corresponding to the sitting down trajectory of a healthy person, in a case in which care receiver M1 is stood up such that a movement control portion of care receiver M1 passes along a sitting down trajectory, robot arm section 22 can be driven based on sitting down trajectory reference data corresponding to the sitting down trajectory of a healthy person. Accordingly, care receiver M1 is assisted to sit down with the same feeling as when care receiver M1 sits down without assistance. Thus, care receiver M1 is sat down without discomfort.

[0111] Note that, with the above embodiment, care receiver M1 may be transferred to/from an electric toilet seat raising/lowering device such as electric seat raising/lowering device 60. In this case, electric toilet seat raising/lowering device 60 is a drive assistance apparatus that performs at least one of raising/lowering and traveling, with care receiver M1 in at least a sitting state, by using raising/lowering motor 65a (drive source). In other words, electric toilet seat raising/lowering device 60 is an electric toilet seat raising/lowering device that raises/lowers a seat (that is, toilet seat 62) on which care receiver M1 sits using raising/lowering motor 65a (drive source).

[0112] As shown in fig. 24, electric toilet seat raising/lowering device 60 is provided with toilet bowl 61, toilet seat 62, fixing frame 63, raising/lowering frame 64, raising/lowering mechanism 65, operation device 66, transceiver 67, and control device 68. Fixing frame 63 is fixed to toilet bowl 61 or the floor. Toilet seat 62 is fixed to an upper portion of raising/lowering frame 64. Raising/lowering mechanism 65 is provided between fixing frame 63 and raising/lowering frame 64. Raising/lowering motor 65a is built into raising/lowering mechanism 65 and raising/lowering frame 64 is raised/lowered relative to fixing frame 63 by the operation of raising/lowering motor 65a.

[0113] Operation device 66 is an operation device which receives operation inputs from an operator (care receiver M1), and sends operations signals of the operation inputs to control device 68. Transceiver 67 is capable of communication with transceiver 30 of care robot 20. Transceiver 67 receives transmission data from transceiver 30, and sends transmission data to transceiver 30.

[0114] Control device 68 performs control related to the raising/lowering/pivoting of toilet seat 62 of electric toilet seat raising/lowering device 60. As shown in fig. 25, control device 68 is connected to raising/lowering motor 65a, operation device 66, and transceiver 67. Also, control device 68 has a microcomputer (not shown); the microcomputer is provided with an input/output interface, CPU, RAM, and ROM (all not shown) that are connected to one another via a bus.

[0115] Operation in this case, that is, when care receiver M1 sits down on toilet seat 62 of electric toilet seat raising/lowering device 60, is described with reference to the flowchart of fig. 26. Note that, as operation when standing up from toilet seat 62 is the corresponding reverse operation of sitting down, descriptions thereof are omitted.

[0116] In step S402, control section 27 acquires an operation mode (any one of a standing up motion assistance mode, a sitting down motion assistance mode, and a motion series assistance mode) selected using operation device 25, and acquires reference data according to the acquired mode from storage device 26. Standing up trajectory reference data is acquired when in standing up motion assistance mode, sitting down trajectory reference data is acquired when in sitting down motion assistance mode, and standing up trajectory reference data and sitting down trajectory reference data are acquired when in motion series assistance mode.

[0117] In step S404, control device 27 acquires the height of toilet seat 62 (the height at which the lowest portion of toilet seat 62 is positioned) of electric toilet seat raising/lowering device 60, raising/lowering start information (for example, raising/lowering start time), raising/lowering speed information (for example, raising/lowering speed), and raising/lowering completion information (for example, raising/lowering completion time) from transceiver 67 of electric toilet seat raising/lowering device 60 via transceiver 30. Control device 27 receives at least one of the height of toilet seat 62, raising/lowering start information, raising/lowering speed information, and raising/lowering completion information, which are control information of electric toilet seat raising/lowering device 60.

[0118] In step S406, control device 27 corrects the reference data acquired in step S402 according to the height of toilet seat 62 acquired in step S404 (correction section). Specifically, control device 27 acquires a first correction amount according to the height of toilet seat 62 from storage device 26. Then, control device 27 corrects the reference data according to the acquired correction amount.

[0119] In step S408, control device 27 drives the drive section configured to include first and second rotation motors 22a1c and 22b3, and slide motor 22a2b, so as to drive the standing up motion of robot arm section 22 based on the standing up trajectory reference data (drive control section). Also, control device 27 drives the drive section, so as to drive the sitting down motion of robot arm section 22 based on the sitting down trajectory reference data. Specifically, control device 27 drives the drive section to comply with the reference data that was corrected in step S406 (including reference data that is not corrected). Further, control device 27 performs standing up and sitting down motions to match the raising/lowering state (raising/lowering speed, raising/lowering start, raising/lowering completion) of toilet seat 62 based on the raising/lowering start information, raising/lowering speed information, and raising/lowering completion information of toilet seat 62 acquired in step S404. In this way, control device 27 performs standing up motion and sitting down motion appropriately based on the height of toilet seat 62, which is also control information of electric toilet seat raising/lowering device 60.

[0120] With care robot 20 of the present embodiment, the drive assistance apparatus is also a seat raising/lowering device (electric toilet seat raising/lowering device 60) that raises/lowers a seat (toilet seat 62) on which care receiver M1 sits using a drive source (raising/lowering motor 65a), the control information includes at least one of the raising/lowering start time, the raising/lowering speed, and the raising/lowering completion time of the seat raising/lowering device, and control device 27 performs standing up motion and sitting down motion of to match the raising/lowering state of the seat (toilet set 62).

[0121] According to this, when transferring care receiver M1 to/from a seat raising/lowering device such as electric toilet seat raising/lowering device 60, since care robot 20 stands up and sits down care receiver M1 to match the height of the seat (toilet seat 62), care receiver M1 can sit down and stand up without any discomfort.

[0122] Also, as seat raising/lowering devices, also applicable are devices in which the front passenger seat or rear passenger seat of a vehicle is lifted up.

[0123] Note that, in the above embodiments electric motors were used as the drive source; however, pneumatic drives sources may also be used.

Reference Signs List

[0124] 10: care center; 11: station; 12: training room; 13a to 13d: first to fourth private rooms; 14: corridor; 20: care robot; 21: base; 21g, 21h: left/right drive wheel motor (traveling drive section); 22: robot arm section; 22a: first arm; 22a1c: first rotation motor (drive section); 22a2b: slide motor (drive section); 22b: second arm; 22b3: second rotation motor (drive section); 22c: third arm; 23: holding section; 25: operation device; 26: control device (control section), 27: storage device (storage section); 28: imaging device; 29: guide device; 30: transceiver; 40: electric wheelchair (drive assistance apparatus, drive movement body); 50: electric bed (drive assistance apparatus, bed section raising/lowering device); 60: (drive assistance apparatus, seat raising/lowering device); M1: care receiver; M2: caregiver

Claims

1. A care robot provided with a holding section that assists a care receiver in standing up and sitting down by supporting a body part of the care receiver, the care robot comprising:

a control section that, when a care receiver transfers to/from a drive assistance apparatus that performs at least one of raising/lowering and traveling by using a drive source with the care receiver in at least a sitting state, at least receives control information from the drive assistance apparatus, and performs control to assist the transfer of the care receiver based on the control information.

2. The care robot according to claim 1,
wherein the control section, when assisting the transfer of the care receiver, performs control in cooperation with the drive assistance apparatus based on the control information from the drive assistance apparatus.

3. The care robot according to claim 1 or claim 2,
wherein the drive assistance apparatus is a drive movement body that at least makes the care receiver who is in a sitting state travel using a drive source,
wherein the control information includes at least one of movement start information, movement speed information, movement destination information, current position information, movement finish information, travel space, and required transfer space of the drive movement body,
and wherein the control section, when the care robot stands up the care receiver and transfers the care receiver to the drive movement body, performs control to call the drive movement body to a vicinity of a standing up position in a case in which there is transfer space at the vicinity of the standing up position at which the care receiver is to be stood up, performs control to make the care robot travel to a vicinity of a standby position of the drive movement body in a case in which there is no transfer space in the vicinity of the standing position and there is transfer space in the vicinity of the standby position of the drive movement body, and performs control to make both the drive movement body and the care robot travel to a transfer position in a case in which there is no transfer space in the vicinities of the drive movement body and the care robot.

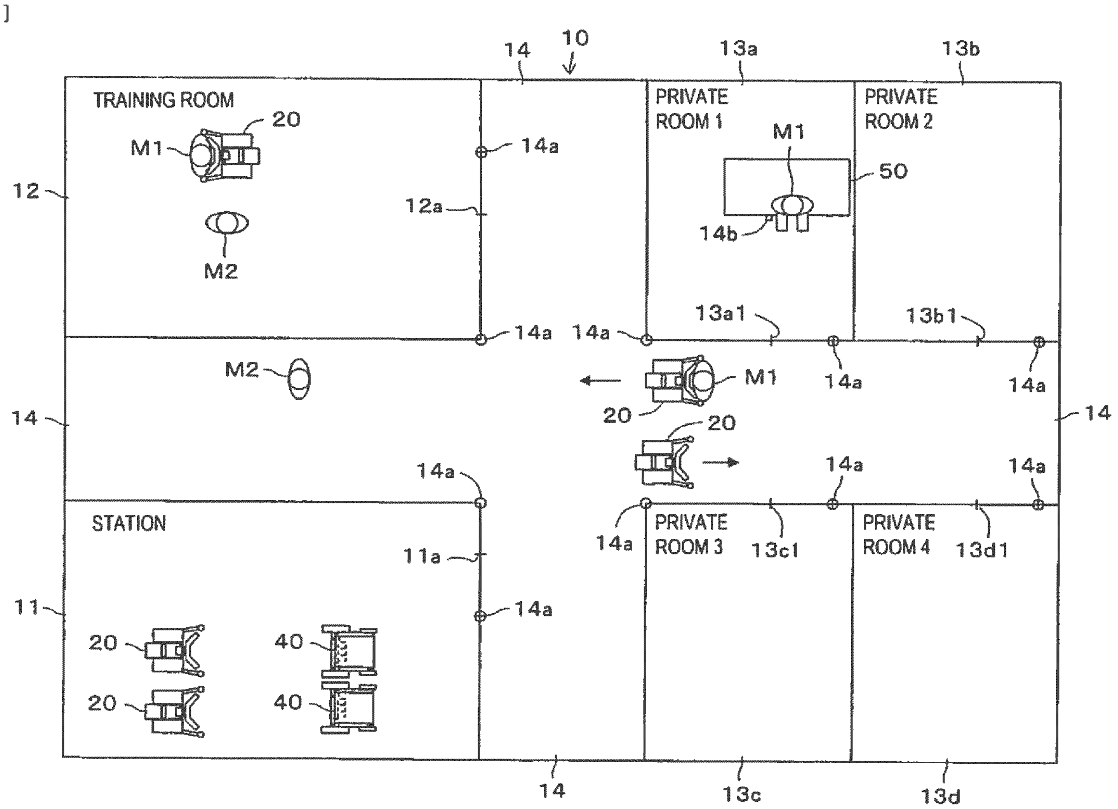
4. The care robot according to claim 3,
wherein the control section, during traveling of the drive movement section on which the care receiver is seated, performs control for traveling in coordination with the drive movement body so as to maintain the relative positions of the care robot and the drive movement body at a predetermined positional relationship.

5. The care robot according to any one of claims 1 to 3,
wherein the drive assistance apparatus is a seat raising/lowering device that raises/lowers a seat on which the care receiver sits using a drive source,
wherein the control information includes at least one of raising/lowering start information, raising/lowering speed information, and raising/lowering finish information of the seat raising/lowering device,
and wherein the control section performs standing up motion and sitting down motion to match the raising/lowering state of the seat.

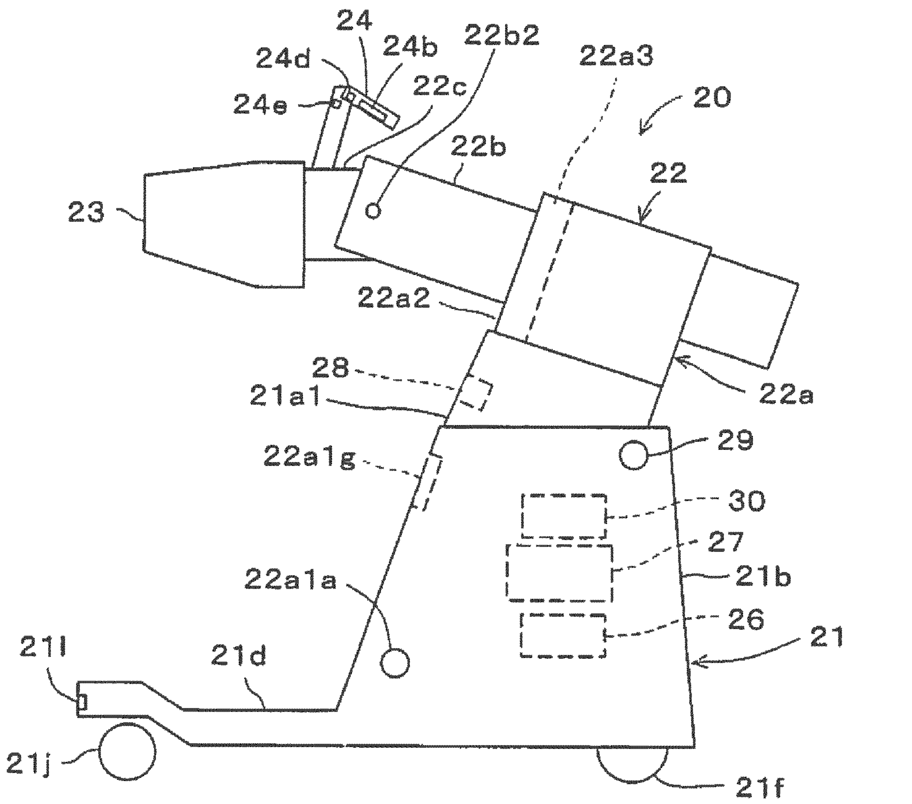
6. The care robot according to claim 1 or claim 2,
wherein the drive assistance apparatus is a bed section raising/lowering device that raises/lowers a bed section on which the care receiver at least sits using a drive source,
wherein the control information includes at least a height of the bed section,
and wherein the control section performs standing up motion and sitting down motion in accordance with the height of the bed section.

7. The care robot according to any one claims 1 to 6,
wherein, in a case in which the care receiver who is sitting down is stood up by a body part of the care receiver being supported by the holding section, a standing up trajectory through which a movement control portion of the care receiver passes is set such that, between a point in time early after the start of standing up motion which is motion to stand up the care receiver and an end time point of the standing up motion of care receiver, the center of gravity of the care receiver is positioned within the range of the soles of both feet of the care receiver,
and wherein, in a case in which the case receiver who is standing up is sat down by being supported by the holding section, a sitting down trajectory through which a movement control portion of the care receiver passes, which is a trajectory different to the standing up trajectory, is set such that, from a point in time early after the start of standing up motion which is motion to sit down the care receiver, the center of gravity of the care receiver is moved outside the range of the soles of both feet of the care receiver and moved to a planned sitting position of the care receiver.

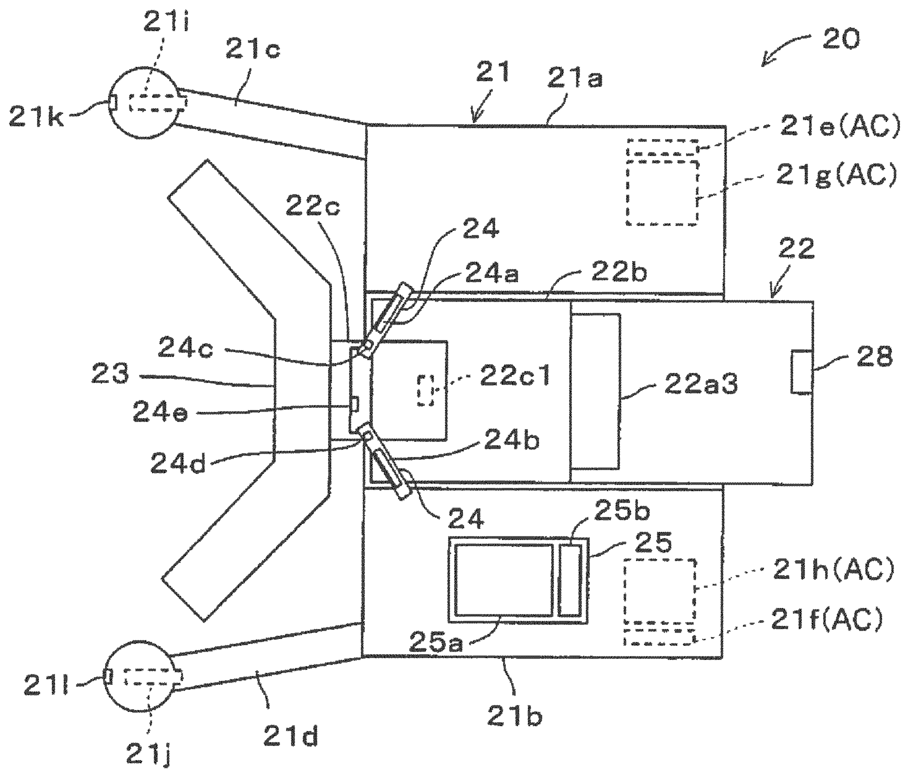
[FIG. 1]


14
10
13a
13b
TRAINING ROOM
20
M1
14a
PRIVATE ROOM 1
M1
PRIVATE ROOM 2
50
12
12a
14b
M2
13a1
13b1
14a
14a
M2
M1
14a
14a
14
20
20
14
14a
14a
14a
STATION
14a
PRIVATE ROOM 3
13c1
PRIVATE ROOM 4
13d1
11a
11
14a
20
40
20
40
14
13c
13d

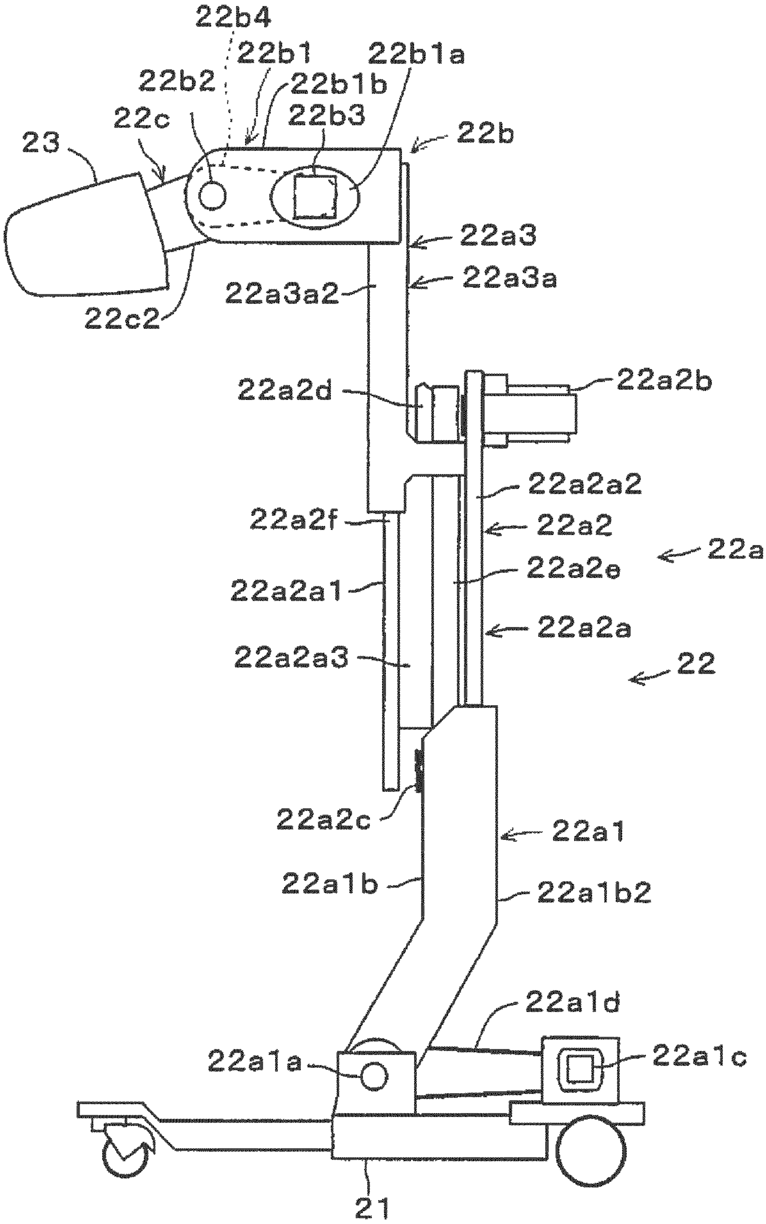
[FIG. 2]


24
24d
24b
22b2
22a3
24e
22c
20
22b
22
23
22a2
28
22a
21a1
29
22a1g
30
27
21b
22a1a
26
21
21l
21d
21j
21f

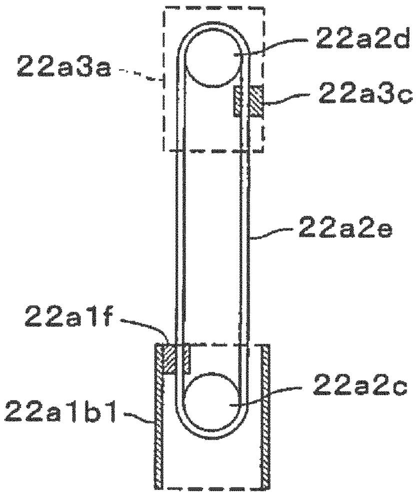
[FIG. 3]


21i
20
21c
21
21a
21k
21e(AC)
21g(AC)
22c
22
24
24a
22b
24c
28
23
22c1
22a3
24e
24b
24d
24
25b
25
21h(AC)
21f(AC)
25a
21l
21d
21b
21j

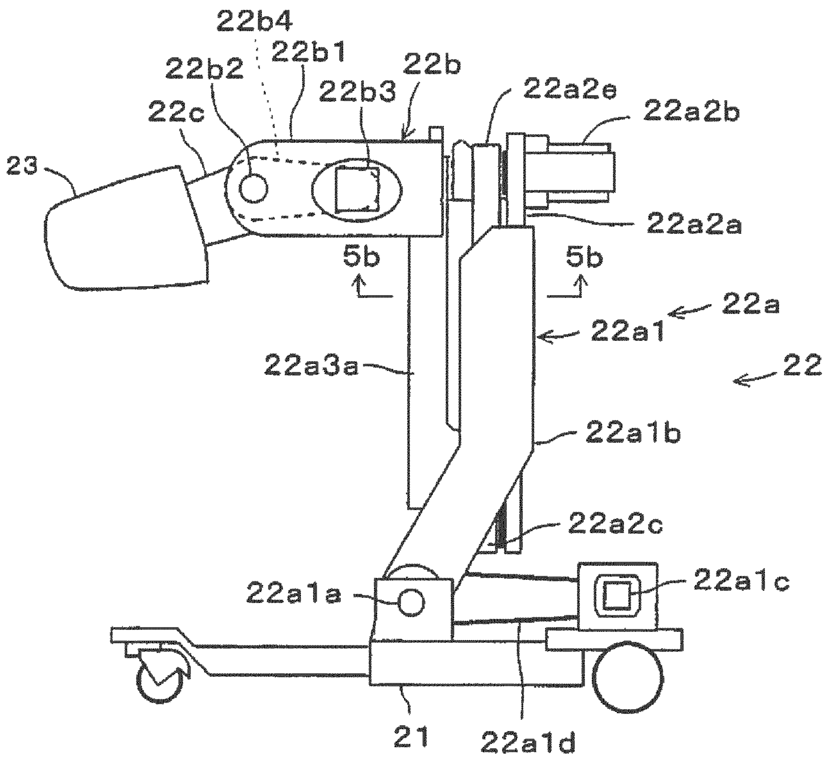
[FIG. 4a]


22b4
22b1
22b1a
22b2
22b1b
22b3
22c
22b
23
22a3
22a3a
22a3a2
22c2
22a2d
22a2b
22a2a2
22a2f
22a2
22a
22a2e
22a2a1
22a2a
22a2a3
22
22a2c
22a1
22a1b
22a1b2
22a1d
22a1a
22a1c
21

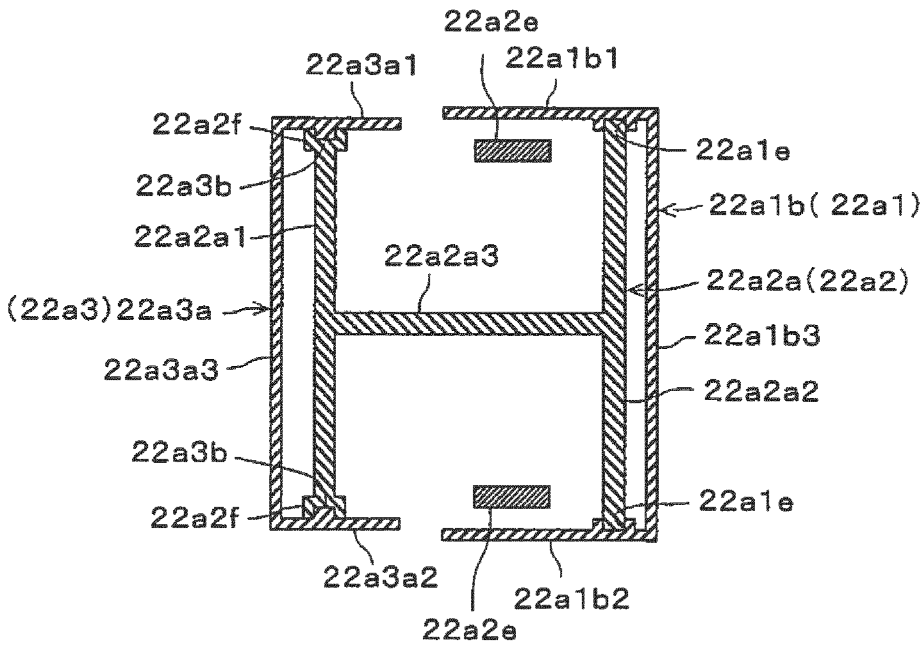
[FIG. 4b]


22a2d
22a3a
22a3c
22a2e
22a1f
22a2c
22a1b1

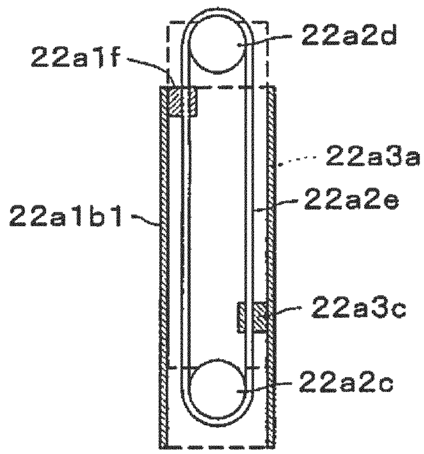
[FIG. 5a]


22b4
22b1
22b2
22b
22b3
22a2e
22a2b
22c
23
22a2a
5b
5b
22a
22a1
22a3a
22
22a1b
22a2c
22a1c
22a1a
21
22a1d

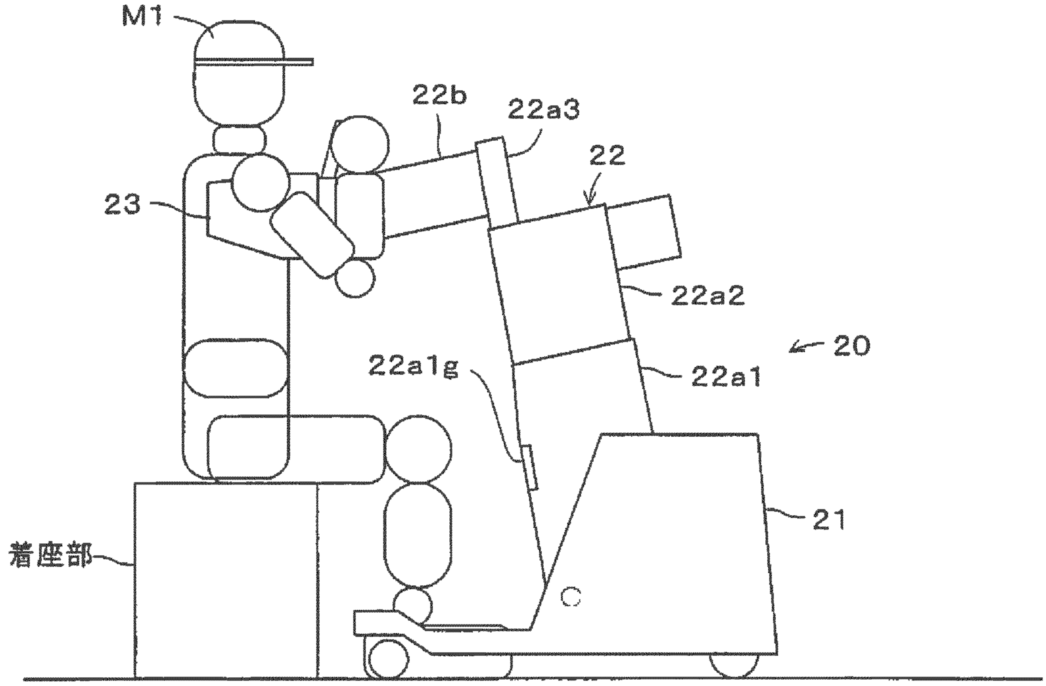
[FIG. 5b]


22a2e
22a1b1
22a3a1
22a2f
22a1e
22a3b
22a1b(22a1)
22a2a1
22a2a3
22a2a(22a2)
(22a3)22a3a
22a1b3
22a3a3
22a2a2
22a3b
22a1e
22a2f
22a3a2
22a1b2
22a2e

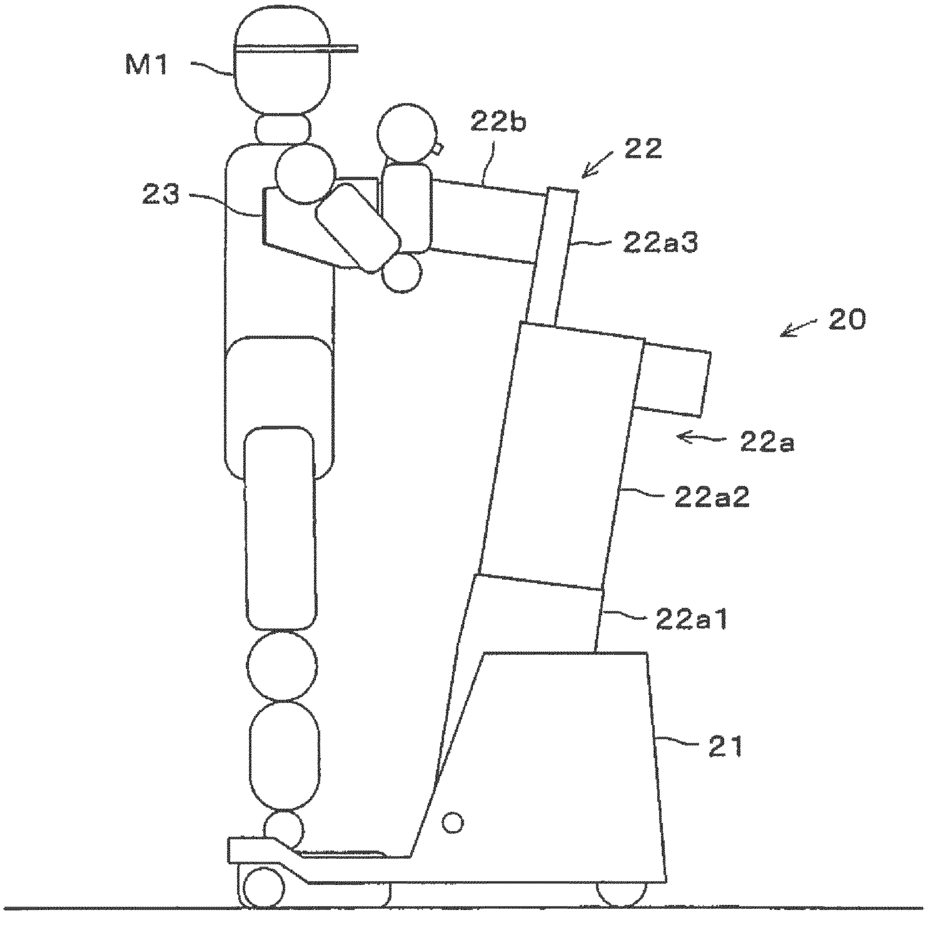
[FIG. 5c]


22a2d
22a1f
22a3a
22a2e
22a1b1
22a3c
22a2c

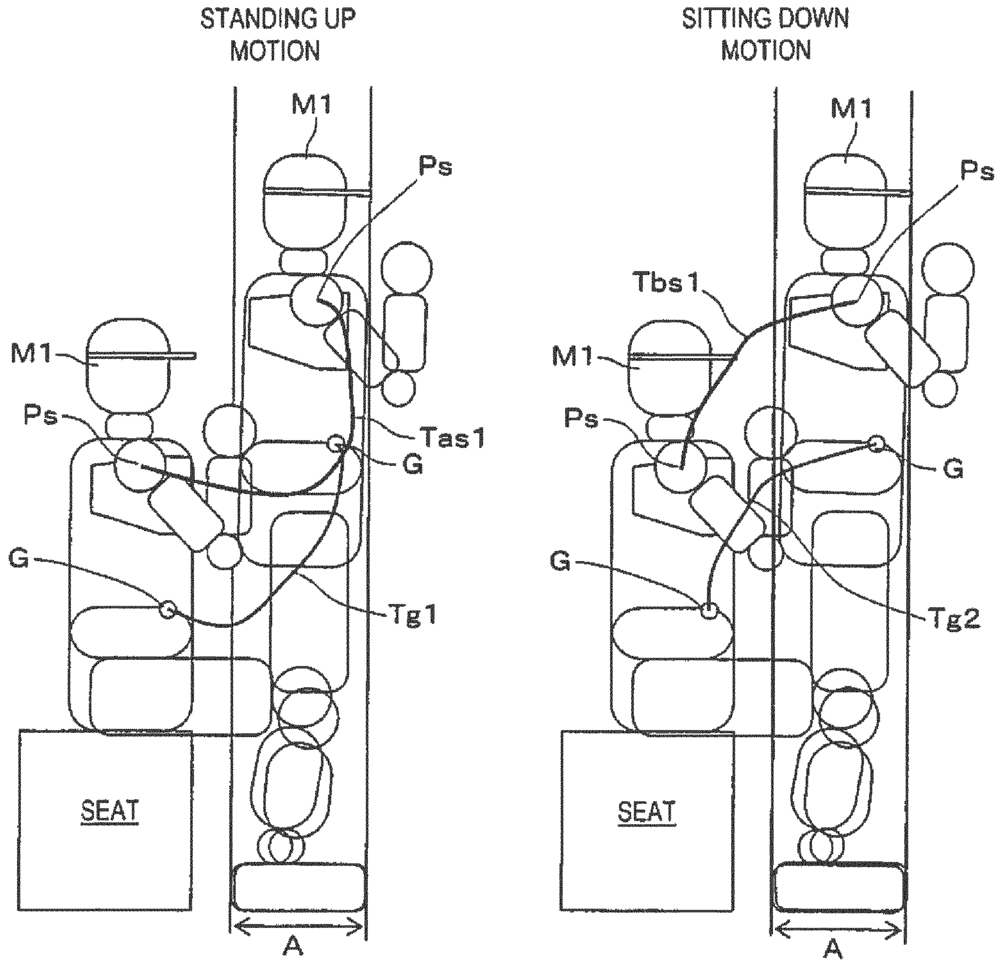
[FIG. 6]


M1
22b
22a3
22
23
22a2
20
22a1g
22a1
21
着座部

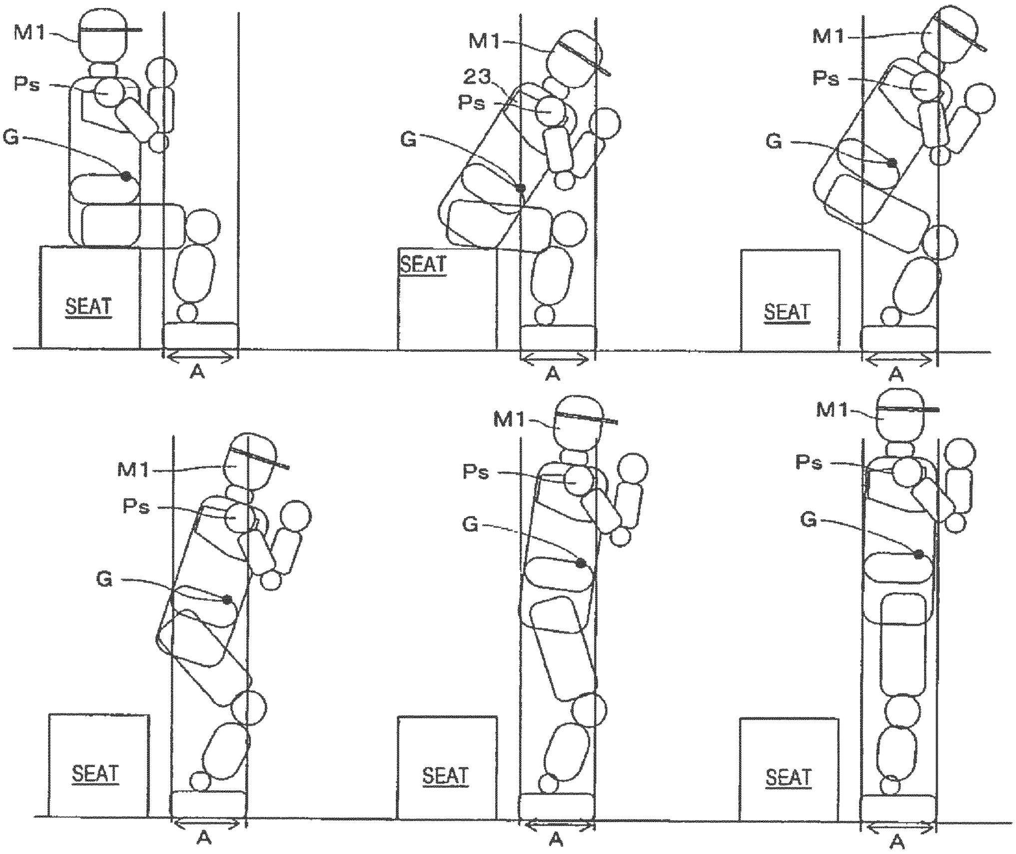
[FIG. 7]


M1
22b
22
23
22a3
20
22a
22a2
22a1
21

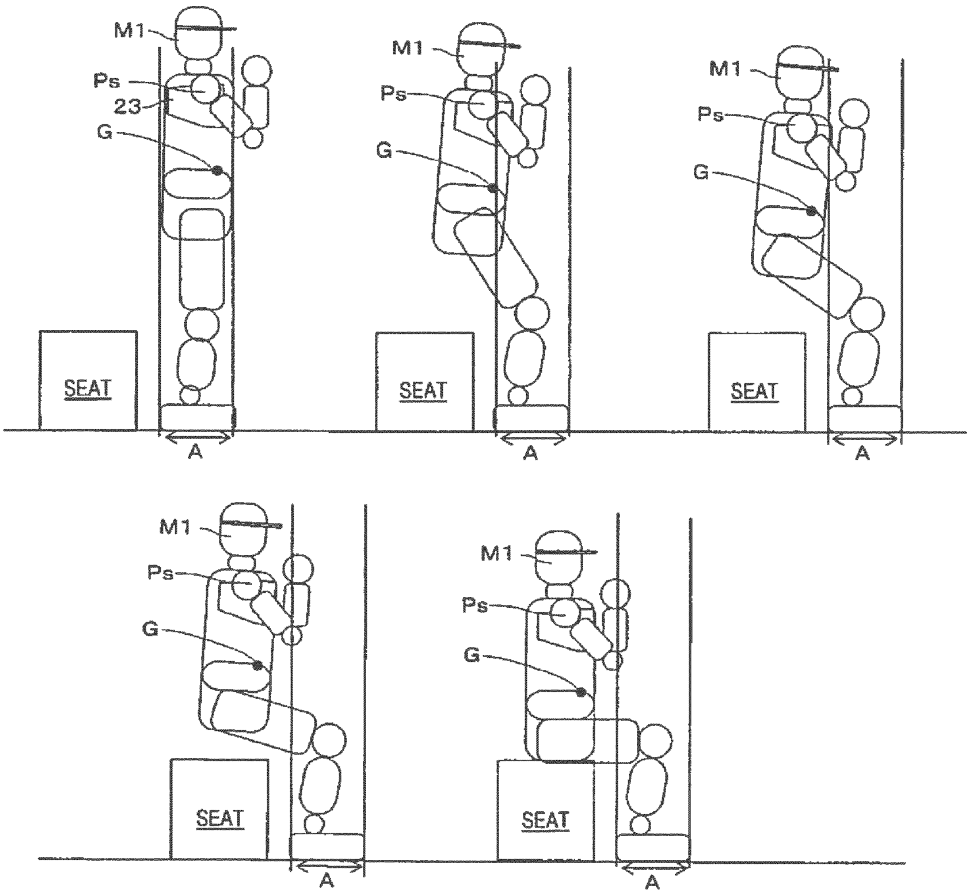
[FIG. 8]


STANDING UP
MOTION
SITTING DOWN
MOTION
M1
Ps
Tas1
G
Tg1
SEAT
A
M1
Ps
Tbs1
G
Tg2
SEAT
A

[FIG. 9]


M1
Ps
G
SEAT
A
M1
23
Ps
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A

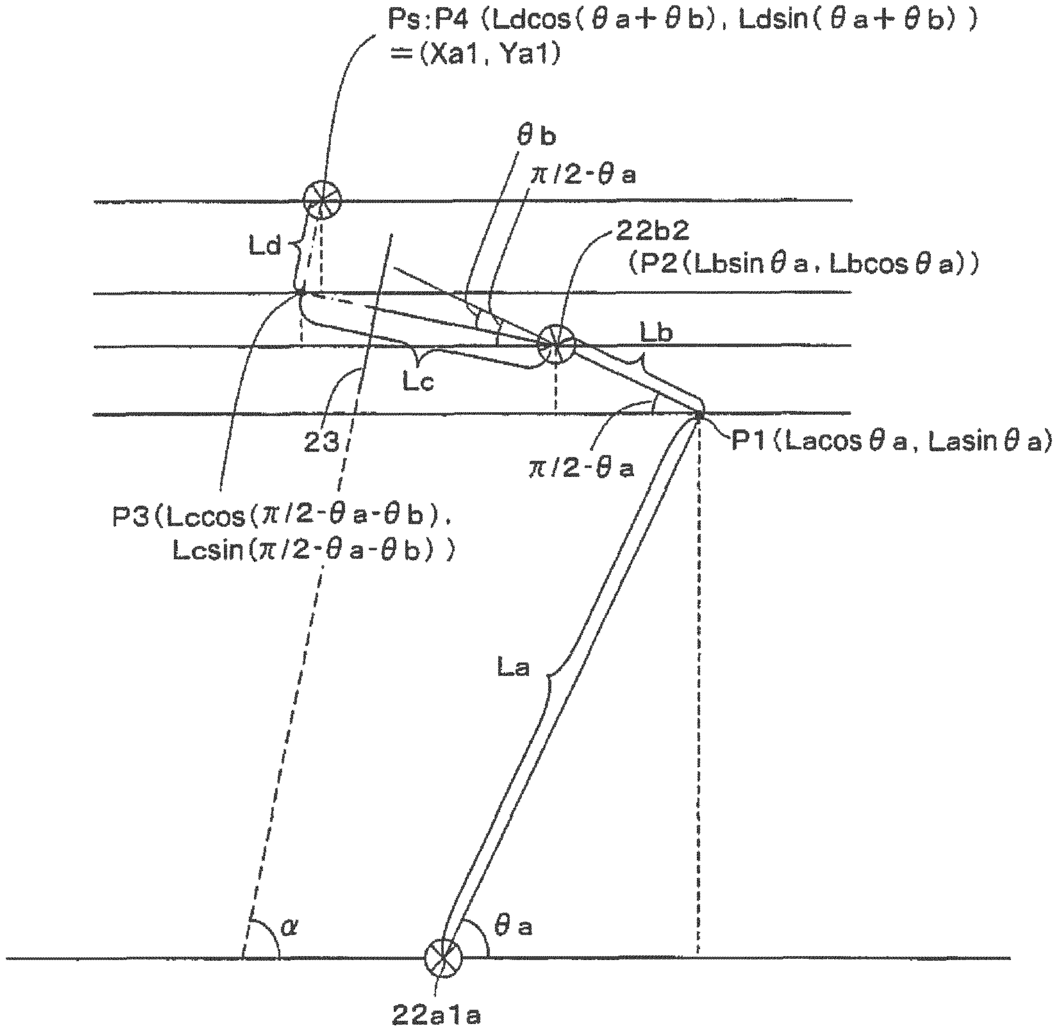
[FIG. 10]


M1
Ps
23
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A
M1
Ps
G
SEAT
A

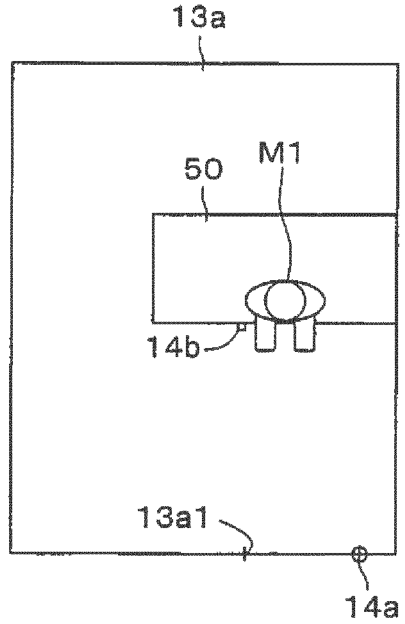
[FIG. 11]

XY COORDINATES			FIRST ANGLE (θa)	FIRST ANGULAR VELOCITY (ωa)	SLIDE AMOUNT (L)	SLIDE SPEED (V)	SECOND ANGLE (θb)	SECOND ANGULAR VELOCITY (ωb)
Xa1	Ya1	α1	θa1	ωa1	L1	V1	θb1	ωb1
Xa2	Ya2	α2	θa2	ωa2	L2	V2	θb2	ωb2
·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·
Xan	Yan	αn	θan	ωan	Ln	Vn	θbn	ωbn

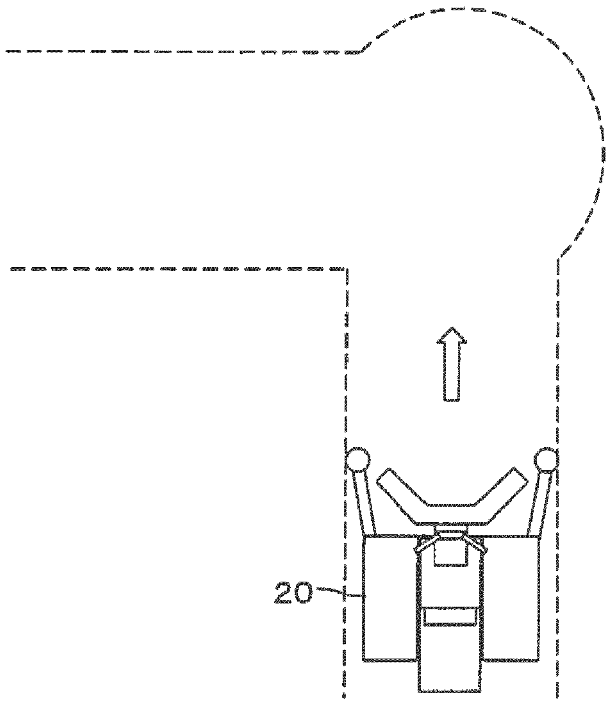
[FIG. 12]



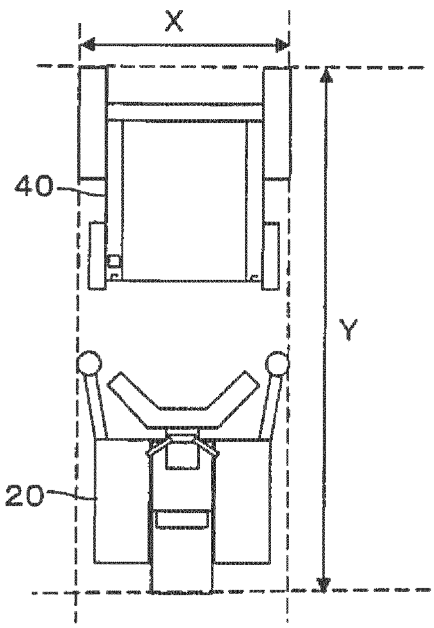
[FIG. 13]



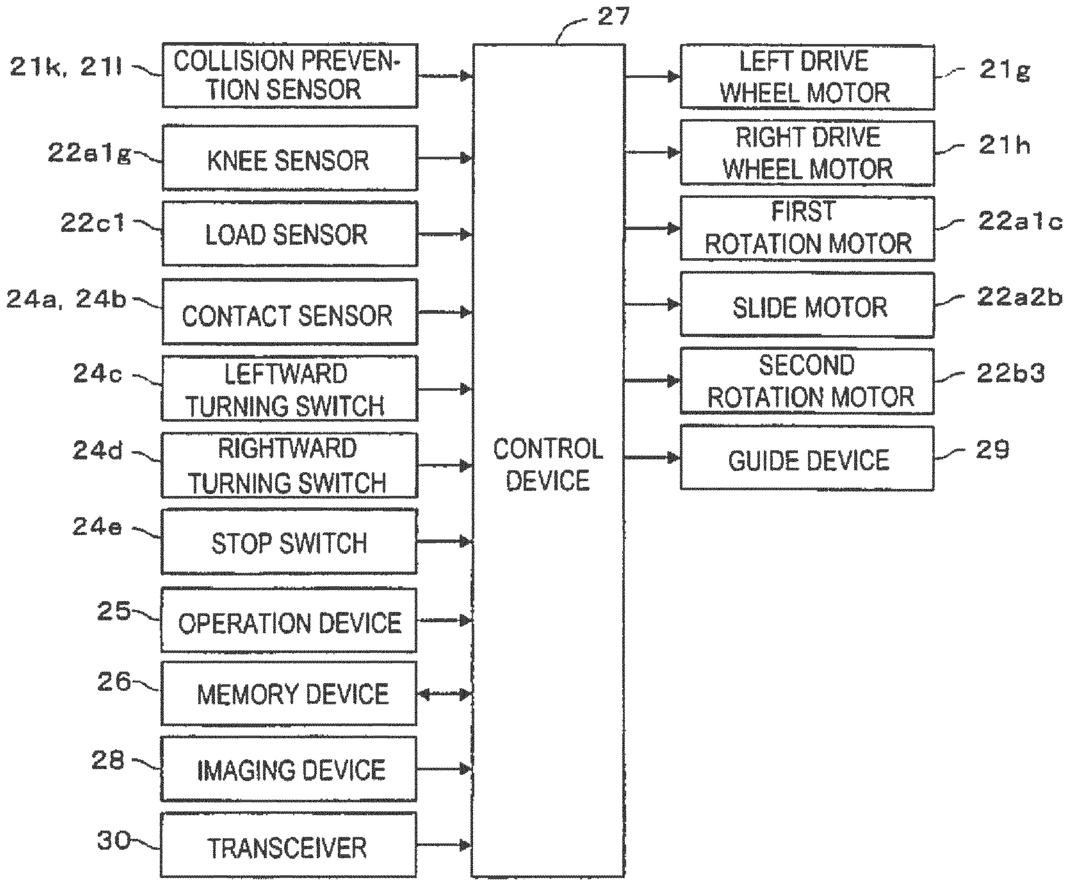
[FIG. 14]



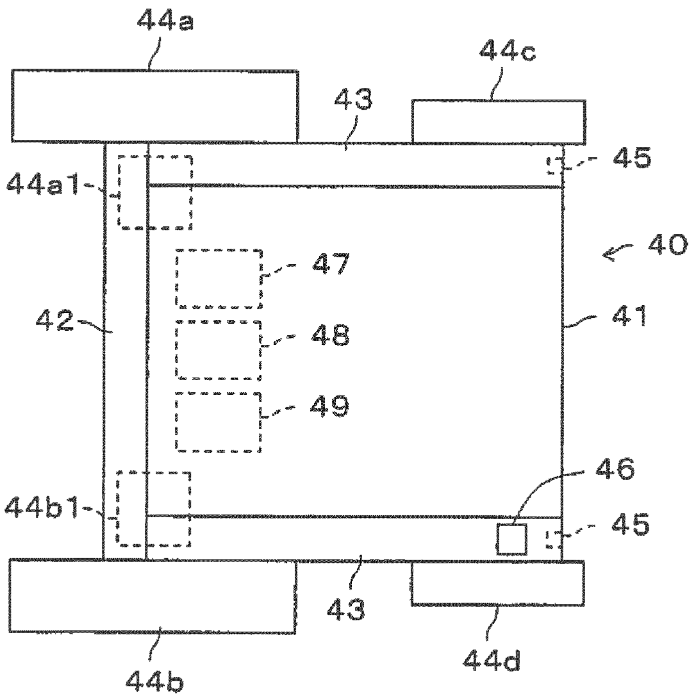
[FIG. 15]



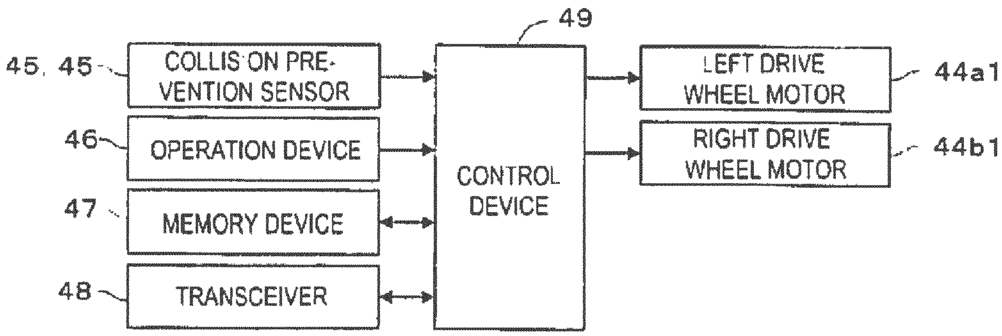
[FIG. 16]


27
21k, 21l
COLLISION PREVENTION SENSOR
22a1g
KNEE SENSOR
22c1
LOAD SENSOR
24a, 24b
CONTACT SENSOR
24c
LEFTWARD TURNING SWITCH
24d
RIGHTWARD TURNING SWITCH
24e
STOP SWITCH
25
OPERATION DEVICE
26
MEMORY DEVICE
28
IMAGING DEVICE
30
TRANSCEIVER
CONTROL DEVICE
LEFT DRIVE WHEEL MOTOR
21g
RIGHT DRIVE WHEEL MOTOR
21h
FIRST ROTATION MOTOR
22a1c
SLIDE MOTOR
22a2b
SECOND ROTATION MOTOR
22b3
GUIDE DEVICE
29

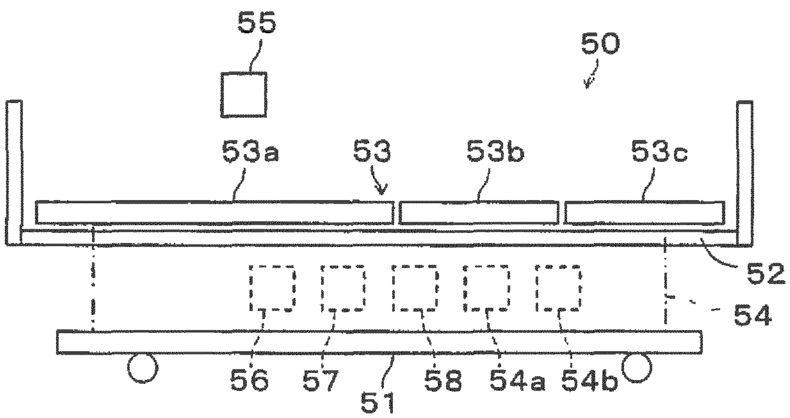
[FIG. 17]



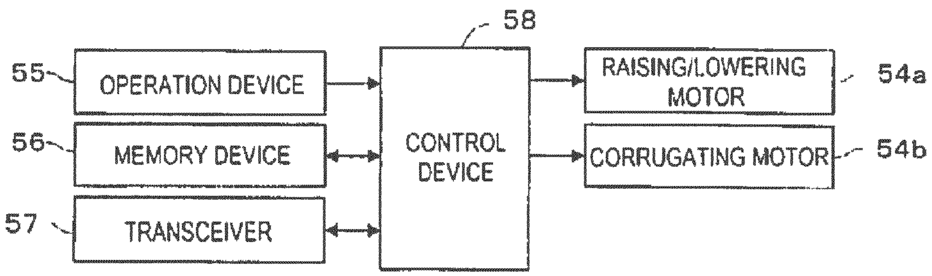
[FIG. 18]


49
45, 45
COLLISION PRE-VENTION SENSOR
46
OPERATION DEVICE
47
MEMORY DEVICE
48
TRANSCEIVER
CONTROL DEVICE
LEFT DRIVE WHEEL MOTOR
44a1
RIGHT DRIVE WHEEL MOTOR
44b1

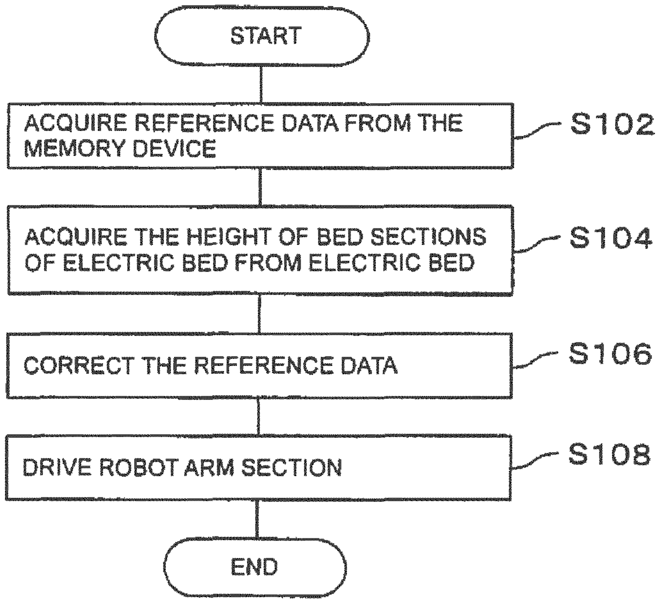
[FIG. 19]



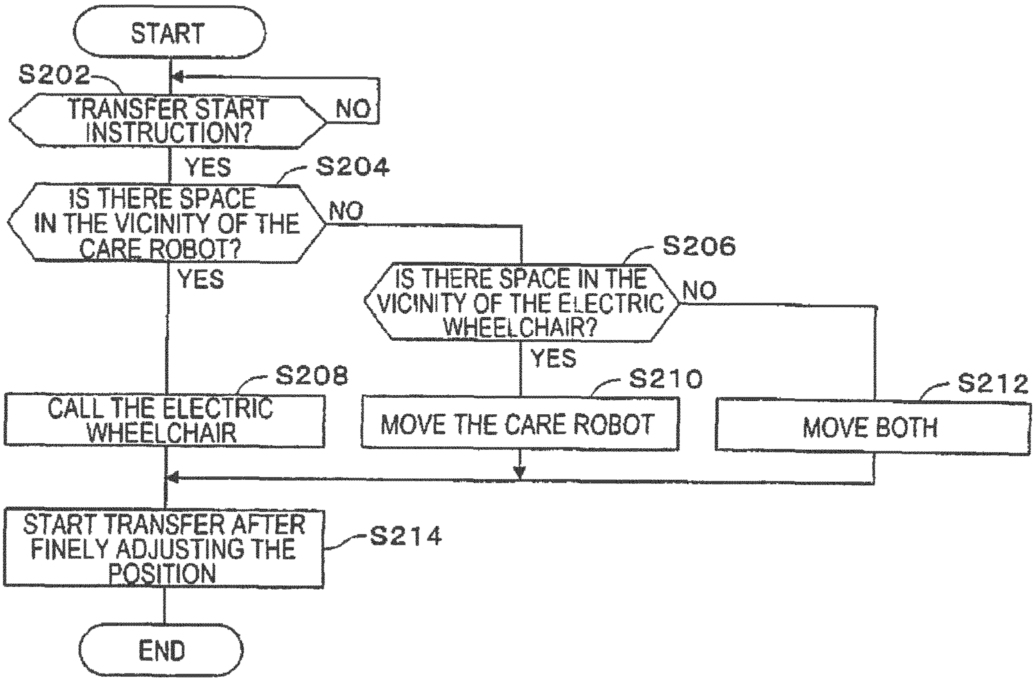
[FIG. 20]


58
55
OPERATION DEVICE
56
MEMORY DEVICE
57
TRANSCEIVER
CONTROL DEVICE
RAISING/LOWERING MOTOR
54a
CORRUGATING MOTOR
54b

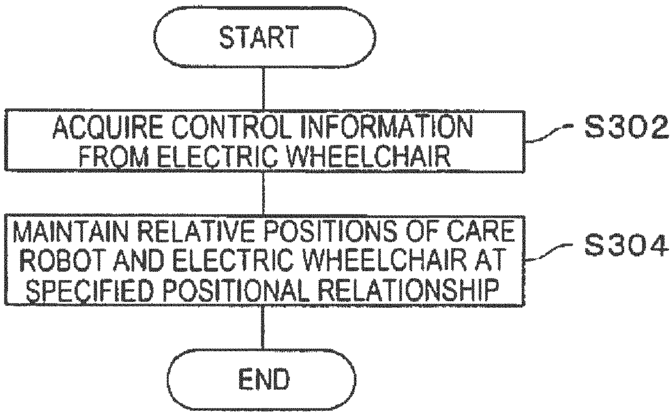
[FIG. 21]


START
ACQUIRE REFERENCE DATA FROM THE MEMORY DEVICE
S102
ACQUIRE THE HEIGHT OF BED SECTIONS OF ELECTRIC BED FROM ELECTRIC BED
S104
CORRECT THE REFERENCE DATA
S106
DRIVE ROBOT ARM SECTION
S108
END

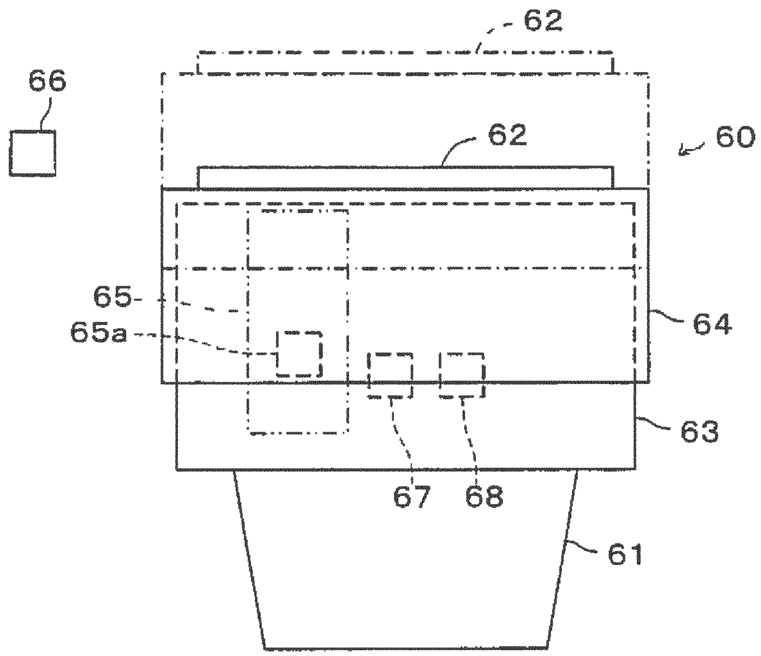
[FIG. 22]


START
S202
TRANSFER START INSTRUCTION?
NO
YES
S204
IS THERE SPACE IN THE VICINITY OF THE CARE ROBOT?
NO
YES
S206
IS THERE SPACE IN THE VICINITY OF THE ELECTRIC WHEELCHAIR?
NO
YES
S208
CALL THE ELECTRIC WHEELCHAIR
S210
MOVE THE CARE ROBOT
S212
MOVE BOTH
START TRANSFER AFTER FINELY ADJUSTING THE POSITION
S214
END

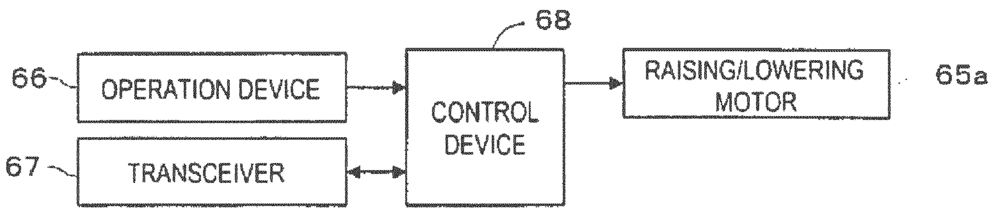
[FIG. 23]


START
ACQUIRE CONTROL INFORMATION FROM ELECTRIC WHEELCHAIR
S302
MAINTAIN RELATIVE POSITIONS OF CARE ROBOT AND ELECTRIC WHEELCHAIR AT SPECIFIED POSITIONAL RELATIONSHIP
S304
END

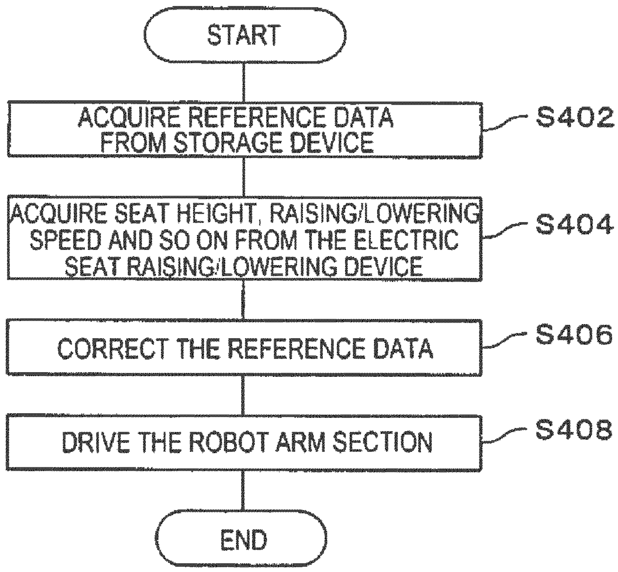
[FIG. 24]



[FIG. 25]


68
66
OPERATION DEVICE
CONTROL
DEVICE
RAISING/LOWERING
MOTOR
65a
67
TRANSCEIVER

[FIG. 26]


START
ACQUIRE REFERENCE DATA FROM STORAGE DEVICE
S402
ACQUIRE SEAT HEIGHT, RAISING/LOWERING SPEED AND SO ON FROM THE ELECTRIC SEAT RAISING/LOWERING DEVICE
S404
CORRECT THE REFERENCE DATA
S406
DRIVE THE ROBOT ARM SECTION
S408
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/075771

A. CLASSIFICATION OF SUBJECT MATTER
A61G7/10(2006.01)i, *A61G5/00*(2006.01)i, *G05D1/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61G7/10, A61G5/00, G05D1/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/042334 A1 (Panasonic Corp.), 28 March 2013 (28.03.2013), pages 1 to 44; fig. 1A to 20 (Family: none)	1-7
A	JP 2011-19571 A (Fuji Machine Mfg. Co., Ltd.), 03 February 2011 (03.02.2011), pages 2 to 13; fig. 1 to 13 (Family: none)	1-7
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Date of the actual completion of the international search	Date of mailing of the international search report
11 October, 2013 (11.10.13)	29 October, 2013 (29.10.13)

Name and mailing address of the ISA/	Authorized officer
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