

[0001] The present application relates to a therapy device for training fine motor skills. It also relates to methods of making, assembling, disassembling, installing, configuring, setting up and using the therapy device. The therapy device is alternatively known as hand motor therapy device, dexterity therapy device, robot or haptic device.

[0002] Stroke and cerebral palsy patients often suffer from dysfunction of manipulation, which greatly impair their daily lives. However, patients who undergo systematic therapy sessions can significantly improve or even regain some of their motor skills, especially when taking the therapy sessions immediately after the neurological injury (e.g. stroke incident). Effects of the therapy sessions may be further enhanced if the therapy sessions are carried out with sufficient intensity, duration, frequency and accuracy.

[0003] Currently, most health institutions are short on qualified occupational therapists and physiotherapists for meeting the needs of people with neurological dysfunctions of fine motor skills (patients). Therapy sessions of a repetitive and continuous nature have placed excessive financial and manpower burdens to these health institutions such that most patients are deprived from receiving a sufficient number of therapy sessions.

[0004] The present application provides a new, creative and useful therapy device for training patients' fine motor skills. Essential features of the application are provided by independent claims, whilst advantageous features are provided by dependent claims. In the application, the therapy device is also known as a dexterity therapy device, a haptic therapy device, a haptic knob, a therapy robot or a haptic robot. The present applications claims the priority date of earlier US provisional patent application US61/891,959, which was filed on 17 October 2013. All content or subject matter of the earlier application is hereby incorporated by reference.

[0005] Embodiments of the application provide a therapy device that guides fingers of a hand for closing or opening independently or in coordination. Instead of causing the

WO/2015/057162 or open along paths of a common rotary axis, PCT/SG2014/000475 vice enables two or more handles of the therapy device to move around different centres or rotary axes. Accordingly, a thumb and remaining fingers can follow movement paths that simulate natural actions of a healthy hand, promoting effective therapy.

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[0006] In fact, any of the two handles may include multiple holders with sensors attached. A patient can thus use the therapy device like a glove, whilst each of his fastened fingers may be individually exercised and monitored. The therapy device may be further connected to sensors for monitoring blood circulation, body
10 temperature and electric signals from hand, skin, other body parts or head of a patient such that the therapy program may be adjusted depending on the recovery status of the patient.

[0007] Moreover, since the embodiments facilitate finger and wrist movements, the
15 therapy device is more versatile for simulating different types of hand movements, such as forearm supination and pronation, palmar ulnar and radial deviation, wrist extension and flexion, finger hyper-extension, extension and flexion, as well as hand abduction and adduction. Since the present therapy device can be mounted onto a vertical rail for adjusting its height and affixed to a rail for shifting the entire therapy
20 device, finger, palm, hand, wrist and shoulder movements of a patient can be simultaneously exercised.

[0008] The embodiments provide simple, compact, intuitive, safe, and cost-effective therapy devices for assessment and training of upper-limb motor function to patients.
25 The patients include people suffering from stroke, spinal cord injury, cerebral palsy, multiple sclerosis and other sensorimotor dysfunctions. Although this device has been introduced for neuro-rehabilitation, it can also be used to provide haptic feedback, control in tele-operation and as an interface for robot surgery, as well as to study sensorimotor mechanisms of manipulation and learning of manipulation.

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[0009] The therapy device can be used as an individual device for hand opening/closing and forearm supination/pronation training. The device can also be integrated into other devices for training more motor functions. For example, the therapy device may be integrated with a sliding mechanism for hand opening/closing,

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for can supination/pronation and reaching movements of the arm. The therapy device can also be used for bimanual training. The therapy device may be made with lightweight materials (e.g. aluminium alloy or high density plastic materials) for providing a wearable device such that a patient can use the therapy device for providing both therapy and assistance to hand movement for daily living.

[0010] The therapy device may further comprise a third handle for attaching a finger of the hand, the third handle being connected to a third rotation centre. In other words, more fingers of a patient can be treated at the same time, depending patient's or therapist's requirements. Alternatively, the therapy device may further comprise a fourth handle for attaching a finger of the hand. The fourth handle is connected to a fourth rotation centre.

[0011] The therapy device can further comprise five handles for attaching to five fingers of the hand respectively. The five handles are connected to five rotation centres respectively. In the application any two or more of the handles or their rotation centres can be shared or combined such that the therapy device provides more flexibility in usage.

[0012] The one or more handles may be configured or designed to drive one or more fingers with forces up to about 150 Newton, which are measured at tips of the handles. Since a patient may have weak muscle or control over his/her fingers, the external driving force provides active movement to the fingers for speedy recovery. When required, the handles can be passively driven by the patient such that driving force from the patient's fingers can be monitored. When required, the handles may still exert slight resistance (e.g. about 32 Newton) either consistently, intermittently or progressively such that the more suitable therapy programmes may be designed to suit specific therapy needs of the patient.

[0013] The application further provides a therapy station for training fine motor skills. The therapy station comprises two or more such therapy devices so that two hands of a patient can be trained at the same time. Particularly, the two therapy devices can have different orientations to suit the patient's natural posture. In fact, orientation of the therapy device may be flexibly adjusted to provide comfort or convenience to

pat.WO.2015/057162, the therapy device may be floor mounted, side-wall mounted or table-mounted.

[0014] The accompanying figures (Figs. 1-8) illustrate the embodiment(s) and serve to explain the principles of operation. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining the limits of the relevant inventions.

[0015] Fig. 1 illustrates a perspective view of a therapy device for training fine motor skills;

Fig. 2 illustrates an actuation unit for hand closing and opening;

Fig. 3 illustrates a perspective view of a cam mechanism;

Fig. 4 illustrates a top view of a guide plate;

Fig. 5 illustrates an exposed handle of the therapy device;

Fig. 6 illustrates the handle installed with cushion and straps;

Fig. 7 illustrates a rotation unit for forearm turning; and

Fig. 8 illustrates an arm support unit of the therapy device.

[0016] Exemplary, non-limiting embodiment(s) of the present application will now be described with references to the above-mentioned figures. The embodiments may contain identical or similar parts with identical or similar functions. The similar parts may be labelled with identical or similar reference numbers or numerals. Description of the identical or similar parts is therefore incorporated by reference wherever relevant.

[0017] Figs. 1 to 8 relate to an embodiment. In particular, Fig. 1 illustrates a perspective view of a therapy device 20 for training fine motor skills. According to Fig. 1, the therapy device 20 comprises a supporting frame 22, an actuation unit 24, a rotation unit 26, two handles 28, 30 and an arm support unit 32. The actuation unit 24, the hand rotation unit 26, the two handles 28, 30 and the arm support unit 32 are mounted onto the supporting frame 22 for operation. The actuation unit 24 further comprises a cam mechanism 40 that is further illustrated by Figs. 2-4. The cam mechanism 40 is also known as cam follower mechanism 40.

[0018] WO 2015/057162 further shows parts of the supporting frame 22 of the therapy device 20. The supporting frame 22 comprises a first rail 42, a second rail 44, a first pillar 46 and a second pillar 48. The first rail 42 and the second rail 44 are parallel to each other in their longitudinal directions for providing a base 50, whilst the two pillars 46, 48 are also parallel to each other. The first pillar 46 and the first rail 42 are perpendicular and connected to each other at their ends. Similarly, the second rail 44 lies horizontally on a table top, while the second pillar 48 stands vertically at an end of the second rail 44, perpendicular to the table top. The two pillars 46, 48 have three separate cross bars 52, 54, 56 that link them 46, 48, and the two rails 42, 44 have tie bars 58, 60 interconnected to them too. The supporting frame 22 forms a rigid assembly for offering predetermined positions and orientations to various parts or components of the therapy device 20. The pronation/supination module can be used separately from the hand opening module. For instance, it may be fixed to an existing robot for arm rehabilitation, enabling rehabilitation of the arm and hand.

[0019] Fig. 2 illustrates the actuation unit 24 for hand closing and opening. The actuation unit 24 comprises an end plate 62, a chassis 64, a first step motor 66, a slider assembly 68, a cam mechanism 70 and an end bar 72. The actuation unit 24 further comprises a first load cell amplifier 73 and a second load cell amplifier 75, which are depicted in Fig. 1. The first load cell amplifier 73 is bolted to the first rail 42, whilst the second load cell amplifier is secured to the second rail 44 at their corresponding positions. Parts of the cam mechanism 70 are omitted from Fig. 2, but shown in Fig. 1 & 3.

[0020] The chassis 64 has two L-shaped narrow plates 74, 76, namely a first narrow plate 74 and a second narrow plate 76. Planar surfaces of the narrow plates 74, 76 face and parallel to each other. Moreover, the end plate 62 is clamped between the two narrow plates 74, 76 at their upper ends 78, 80, whilst the end bar 72 is fastened between two lower ends 82, 84 of the two narrow plates 74, 76. The two upper ends 78, 80 are located at opposite sides of the two lower ends 82, 84. One side the end plate 62 is fixed with a first pulley 86 via a first shaft 88. The first shaft 88 provides a rotation axis 88 in a longitudinal direction of the forearm 202 or two rails 42, 44. The chassis 64 further has a middle plate 90 connected between the two narrow plates 74,

WO.2015/057162 middle plate 90 provides a flat ground for motor 66. A driving shaft 92 protrudes at an opposite side of the middle plate 86 for connecting to a second pulley 94 (not shown).

5 [0021] The slider assembly 68 comprises the (fixed) end bar 72, a mobile end bar 96, a bearing frame 98, an adjustment screw 100 and several fastening screws 102. The bearing frame 98 further comprises a first strip 104 and a second trip 106 that are parallel to each other. The first trip 104 and the second strip 106 are movably attached to the first narrow plate 74 and the second narrow plate 76 respectively. In particular, the two strips 104, 106 are held onto the narrow plates 74, 76 by the fastening screws 102 such that the slide assembly 68 can move horizontally along the narrow plates 74, 76 within about 10 millimetre distance.

15 [0022] Fig. 3 illustrates the perspective view of the cam mechanism 70 of the actuation unit 24, although only some parts of the mechanism 70 are shown in Fig. 2. In detail, the cam mechanism 70 comprises an anchor bar 108, a first flap bar 110, a second flap bar 112 and a guide plate 114 (also known as cam) that are movably coupled together. The guide plate 114 also comprises a first arm 116 and a second arm 118 that are extending from its rotary centre (axis) 120 according to the predefined geometry of 114. Patterns of the two arms 116, 118 are better seen in Fig. 4, which illustrates a top view of the cam mechanism 70. The cam guiding curve 112 is uniquely defined for a set of constraints such as initial hand angle, hand range of motion, cam range of motion and force transmission between the cam and the follower 128.

25 [0023] Referring to both Figs. 3 and 4, the first arm 116 has a first cam slot 122 along its edge, whilst the second arm 118 includes a second cam slot 124 along its edge. The two cam slots 122, 124 have their radial axes (not shown) at opposite sides of the rotary centre 120. Each of the first cam slot 122 and the second radial slot 144 follows two-dimensional cam 114. These cam slots 122, 144 follow predetermined curvatures so that driving force from the motor can be transmitted to the hand or from the hand to the motor (known as "back-driveable" or not self-locking). The cam slots 122, 144 also provide accurate clearance between sides of the cam slots 122, 144 and edges of follower wheels respectively. Accordingly, the follower wheels slide

WO 2015/057162, the cam slots 122, 144. Lateral faces of the cam slots 122, 144 are vertical (i.e. perpendicular to the bottom face of the cam slots 122, 144 respectively), and parallel to the rotation axes of the follower wheels.) PCT/SG2014/000475

5 [0024] The first flap bar 110 has a first rotary pin 126 and a first guiding pin 128 at its opposite ends. The first rotary pin 126 is inserted into a first rotation centre/hole 127 on the anchor bar 108 such that the first flap bar 110 can revolve around the first rotary pin 126. In contrast, the first guiding pin 128 is inserted into both the end of the first flap bar 110 and the first cam slot 122. Accordingly, rotary movement of the guide
10 plate 114 at a constant speed can be converted to flapping or waving movement of the first flap bar 110 at uniform speed. The profile of the cam 114 can be obtained by defining the relation between the rotary movement of the guide plate 114 and the flapping or waving movement of the first flap bar 110. The attack angle of the guide plate 114 and the roller is defined by the tangent line to both (roller and the cam) with
15 origin at the contact point between both. The desired range of motion (ROM) of the CAM 114 is within 180° and the corresponding hand open/close ROM is 90°.

[0025] Similarly, the second flap bar 112 has a second rotary pin 130 and a second guiding pin 132 at its opposite ends. The second rotary pin 130 is inserted into a
20 second rotation centre/hole 131 on the same anchor bar 108 such that the second flap bar 112 can revolve around the second rotary pin 130. In contrast, the second guiding pin 132 is inserted into both the end of the second flap bar 112 and the second cam slot 124. Hence, rotary movement of the guide plate 114 can be converted to flapping or waving movement of the second flap bar 112, together with
25 the movement of the first flap bar 110.

[0026] An underside of the guide plate 114 is affixed with a cam shaft 134 (not shown), which is further attached to the rotary centre 120. The cam shaft 134 is inserted into a bearing (not shown) that is mounted onto the bearing frame 98. The cam shaft 134
30 passes through both the bearing and the bearing frame 98, and is further fixed to a third pulley 136. According to Figs. 1-3, the third pulley 136 is coupled to the second pulley 94 via a first belt 138.

[0025] Fig. 5 illustrates an exposed handle 30 of the therapy device. The therapy device has two such handles 28, 30 that are mounted to the two flap bars 110, 112 respectively. The exposed handle 28 is a second handle 28 that is attached to the second flap bar 112. The first handle 30 has similar components and structures as the second handle 30.

[0028] The exposed handle 30 has a standing frame 144 and a hand plate 146. The handle plate 146 is clasped by a few bars via screws such that the handle plate 146 can follow rotary movement of the second flap bar 112. The handle plate 146 has a generally rectangular shape such that a longitudinal edge at one side of the hand plate 146 is substantially aligned to a longitudinal axis of the second flap bar 112.

[0029] Fig. 6 illustrates the handle 30 installed with load cells 148-152. The load cells 148-152 include a first load cell 148, a second load cell 150 and a third load cell 152. A load cell is a transducer that is used to convert a force into an electrical signal, which is also known as force sensor or simply sensor. In detail, the standing frame 144 has a top strain bar 154 and a bottom strain bar 156 that are located at opposite sides of the handle plate 146. The first and second load cells 148, 150 are glued to the top strain bar 154, whilst the third load cell 152 is pasted to the bottom strain bar 156. Cables (not shown) connect the load cells 148-152, the load cell amplifiers 73, 75 and the step motors 66, 164 to an external data logger (not shown) and computer (not shown) for controlling or data logging.

[0030] The handle 30 further has a first strap 158, a second strap 160 and a cushion 162. The two straps 158, 160 are connected to opposite sides of the handle plate 146 and parallel to each other. The cushion 162 is bonded to a broad side of the handle plate 146.

[0031] Fig. 7 illustrates the rotation unit 26 for forearm turning in supination or pronation. The rotation unit 26 comprises a second step motor 164 and a second belt 166. The second belt 166 connects an output shaft (not shown) of the second step motor 164 to the first pulley 86 (only visible in Fig. 2).

[0032] illustrates the arm support unit 32 of the therapy PCT/SG2014/000475 arm support unit 32 comprises a cushioned armrest 168, a supporting base 170 and two arm straps 172, 174. The cushioned armrest 168 has a through-profiled plate 176 (not shown) that is wrapped around with foam 178. The supporting base 170 has a threaded bolt (not shown) for holding the cushioned armrest 168 at its bottom such that the cushioned armrest 168 can be adjusted in height (i.e. vertical distance from a base surface of the two rails 42, 44). The supporting base 170 further has a lever 180 for locking or releasing the supporting base 170 from the two rails 42, 44. The two rails 42, 44 and the two pillars 46, 48 are formed by aluminium struts. The two straps 172, 174 are made by Velcro® (hook-and-loop fastener) that includes a first strap 172 and a second strap 174 evenly distributed over a longitudinal direction of the cushioned armrest 168. Alternative fixation mechanisms are possible.

[0033] Functionally speaking, the cam mechanism converts rotary movements of the first step motor 66 to two linear movements of the two handles 28, 30 respectively. Specific curvatures of the slots 122, 124 on the guide plate 114 determine paths of the opening and closing. Since each of the slots determines the paths independently, the slots may follow different cams or radial curves, depending therapy requirements. The hand opening module, (including the CAM) module could be detached from our setup and used separately or as part of another therapy device.

[0034] The handles 28, 30 are provided for guiding movements of patient's fingers. The handles 28, 30 can drive, assist or resist movements of the patient's fingers/palm. For example, a coil spring can be installed between the two handles so that closure of the handles is met with resistance for training the patient's hand/fingers gripping strength.

[0035] The anchor bar 108 offers two more rotary centres for hand closing or opening. In other words, since the flap bar 110 is permitted to rotate around the first rotation centre 127, whilst the second flap bar 112 is allowed to rotate around the second rotation centre 131, a thumb fastened to the first handle 28 has a different centre of rotation as compared to the four remaining fingers fastened to the second handle 30. Accordingly, the two separate centres 127, 131 of rotation provide more ergonomic or natural movements of hand closing and opening.

[0036] The support frame 22 holds parts of the therapy device 20 with appropriate positions, distances and angles. The support frame 22 further provides a stable platform preventing movements of the therapy device when receiving a patient's arm.

5 In fact, the support frame 22 can be held on a vertical rail (not shown) such that the entire therapy device 20 may be raised or lowered to suit height requirements of various patients. In fact, the first and second rails 42, 44 can be further mounted onto for allowing linear movement in longitudinal direction of the two rails 42, 44 so that a patient's arm will also be permitted to move.

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[0037] Alternatively, in the embodiment, parts of the therapy device may be detached from one of the therapy device to another. Parts of the therapy device for providing pronation/supination (Fig. 2) can be independently operated without involving parts of for hand opening/closing. In other words, hand opening module (components of the

15 therapy device for hand opening or closing) and hand pronation/supination module (components of the therapy device for hand pronation/supination) may be independently activated or in coordination for providing more choices or flexibility to therapist or patients.

20 [0038] Furthermore, the cam mechanism 40 may be replaced by one of more other driving mechanisms. For example, any of the handles 28, 30 may be coupled to lever(s), gear(s) and gear trains, belt(s) and chain drive(s), cable transmission(s), cams and follower mechanisms, linkages, or friction devices (e.g. brakes and clutches) for moving the two handles 28, 30 independently or in cooperation. For example, the

25 guide plate 114 may contain two separate parts that have one guide slot each. The two parts may be driven separately for moving a thumb or four other fingers.

[0039] Any of the handles 28, 30 may be used with or replaced by a hand rehabilitation glove whose fingers are individually measured or driven. The hand

30 rehabilitation glove can further receive rotation movement of the wrist for simulating all types of hand movements.

[0040] The step motors 66, 164 provide driving force for moving the handles 28, 30. These two step motors 66, 164 provide both closing/opening motions, and wrist

WO/2015/057162 and PCT/SG2014/000475. The two types of motions can be independently achieved, simulating natural movements of a healthy hand. Thus, the two step motors may be replaced by a single motor, or multiple motors.

5 [0041] Methods of using the therapy device 20 have been illustrated below. Before operation, the cushioned armrest 168 is rotated around its supporting base 170 for adjusting its height. The supporting base 170 is further moved along the two rails 42, 44 for finding an optimum position to suit a patient forearm's length. The computer, the data logger, the actuation unit 24 and the rotation unit 26 are also turned on.

10 [0042] When in operation, a patient extends his right arm 202 into the therapy device 20 such that his forearm 202 rests upon the foam 178, and the fingers (not shown) are inserted into gaps between the two straps 158, 160 and the cushion 162. Moreover, an index finger, a middle finger, a ring finger and a little finger (not shown)
15 are slotted into the second handle 30 (see Figs. 1 and 3), whilst the thumb is put into the first handle 28. The left hand of the patient subsequently fastens the straps 158, 160, 172, 174 such that the right arm is 202 is secured onto the cushioned armrest 168.

20 [0043] According to a therapy programme, the first step motor 66 rotates at a predetermined speed of around 12 RPM (Round per Minute). The second pulley 94 spins as the driving shaft 92 of the first step motor 66 revolves. The first belt 138 pulls the second pulley 94 such that the third pulley 136 is also driven by the first step motor 66 via the first belt 138 and the second pulley 94. Since the guide plate 114 is
25 connected to the third pulley 136, the guide plate 114 revolves around its rotary centre 120 when the actuation unit 24 is energised. Rotary motion of the guide plate 114 is converted to linear motions of the two flap bars 110, 112 because the guiding pins 128, 130 move along and within the slots 122, 124 of the two arms 116, 118. Since the two handles 28, 30 are affixed to the flap bars 110, 112 at their bottom
30 sides, forward and rearward rotations of the first step motor 66 cause two handles 28, 30 to open and close. In the meantime, the second step motor 164 is also energised such that its driving shaft (not shown) rotates back and forth according to predetermined range at about 50 degree relative to its initial position. The second belt 166 transmits rotary motion of the second driving shaft to the chassis 64 via the first

WO 2015/057162 at the chassis 64 swings sidewise, which induce PCT/SG2014/000475 it of the right hand as therapy activity.

[0044] The therapy device 20 displays positions of the handles 28, 30 on a screen (not shown) of the computer, according to the therapy programme. Target positions, present positions and initial positions are represented by a graphical meter on the screen so that the patient receives visual feedback of his hand's exercise movements. Movement range, duration of the therapy, frequencies of the back and forth rotary motions, rotational speeds of the step motors 66, 164 are adjustable according to the therapy programme.

[0045] When assembling the therapy device 20, the two rails 42, 44 and the two pillars 46, 48 are provided by aluminium struts. Aluminium plates are further provided for the cross bars 52, 54, 56 and tie bars 58. The two pillars 46, 48 are attached together in parallel by the first cross bar 52 and the second cross bar at opposite sides. In contrast, the two rails 42, 44 are connected together in parallel by the first tie bar 58 and the second tie bar 60 at the same side (top side). Bottom ends of the two pillars 46, 48 are further connected to the two rails 42, 44 respectively, which are further strengthened by third cross bar 56 near the bottom ends.

[0046] The actuation unit 24 is attached to the first shaft 88 such that the first shaft 88 passes through both the first cross bar 52 and the second cross bar 54. The first pulley 86 is held between the two cross bars 52, 54. The load cells amplifiers 73, 75 are affixed onto the first rail 42 and the second rail 44 respectively. Conversely, the arm support unit 32 is mounted onto both rails 42, 44 via the support base 170 and the second tie bar 60.

[0047] Both degrees of freedom (1st degree for pronation/supination and 2nd degree for hand opening/closing) have a tension adjusting mechanism, which includes fasteners 100, 102 and other components 74, 76, 96, 98. The tension adjusting mechanism allows to fine tune the transmission belt tension in order to increase transmission smoothness and reduce backlash between the belt and the gear.

[0048] WO 2015/057162 application, unless specified otherwise, the PCT/SG2014/000475, "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

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[0049] As used herein, the term "about", in the context of concentrations of components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

[0050] Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0051] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims.

	20	therapy device
	22	supporting frame
5	24	actuation unit
	26	rotation unit
	28	first handle
	30	second handle
	32	arm support unit
10	40	cam mechanism
	42	first rail
	44	second rail
	46	first pillar
	48	second pillar
15	50	base
	52	first cross bar
	54	second cross bar
	56	third cross bar
	58	first tie bar
20	60	second tie bar
	62	end plate
	64	chassis
	66	first step motor
	68	slider assembly
25	72	end bar
	73	first load cell amplifier
	74	first narrow plate
	75	second load cell amplifier
	76	second narrow plate
30	78	first upper end
	80	second upper end
	82	first lower end
	84	second lower end
	86	first pulley
35	88	first shaft

- 92 driving shaft
- 94 second pulley
- 96 mobile end bar
- 5 98 bearing frame
- 100 adjustment screw
- 102 fastening screw
- 104 first strip
- 106 second strip
- 10 108 anchor bar
- 110 first flap bar
- 112 second flap bar
- 114 guide plate
- 116 first arm
- 15 118 second arm
- 120 rotary centre
- 122 first cam slot
- 124 second cam slot
- 126 first rotary pin
- 20 127 first rotation centre
- 128 first guiding pin
- 130 second rotary pin
- 131 second rotation centre
- 132 second guiding pin
- 25 134 cam shaft
- 136 third pulley
- 138 first belt
- 144 standing frame
- 146 hand plate
- 30 148 first load cell
- 150 second load cell
- 152 third load cell
- 154 top strain bar
- 156 bottom strain bar

- 160 second strap
- 162 cushion
- 164 second step motor
- 5 166 second belt
- 168 cushioned armrest
- 170 supporting base
- 172 first arm strap
- 174 second arm strap
- 10 176 trough-profiled plate
- 178 foam
- 180 lever
- 202 right arm

Claims

1. Therapy device for training fine motor skills, the therapy device comprising:
 - a first handle for attaching a thumb of a hand, the first handle being connected to a first rotation centre, and
 - a second handle for attaching at least one of the remaining fingers of the hand, the second handle being connected to a second rotation centre, wherein the first handle, the second handle or both are connected to an actuation unit for causing rotations of the two handles around the two rotation centres respectively; and the actuation unit further comprises a cam mechanism having an arm, the arm including a slot for guiding movement of the first handle or the second handle.
2. Therapy device of Claim 1, wherein driving force is operable to be transferred from a motor of the actuation unit to the handles or vice versa for driving or resisting movements of a patient's fingers or palm.
3. Therapy device of Claim 1 or 2 further comprising a rotation unit connected to at least one of the handles, the rotation unit being configured to cause at least one of the handles to rotate around a longitudinal direction of a patient's forearm.
4. Therapy device of Claim 1, wherein at least one of the first handle and the second handle comprises at least one load cell for monitoring force, acceleration, distance, temperature, or position.
5. Therapy device of any of the preceding Claims further comprising at least one electrical probe for discharging or measuring electric current at a patient using the therapy device.

6. Therapy device of any of the preceding Claims further comprising a third handle for attaching a finger of the hand, the third handle being connected to a third rotation centre.
- 5 7. Therapy device of any of the preceding Claims further comprising five handles for attaching to five fingers of the hand respectively, the five handles being connected to five rotation centres respectively.
- 10 8. Therapy device of any of the preceding Claims, wherein at least one of the first handle and the second handle is configured to drive or resist at least one finger by a motor with force up to substantially 150 Newton, which are measured at tips of the first handle, the second handle or both the first and second handles.
- 15 9. Therapy device of claim 8, wherein the at least one of the first handle and the second handle is configured to drive or resist the at least one finger by the motor with force from substantially 50 Newton to substantially 150 Newton.
- 20 10. Therapy device of any of the preceding Claims further comprising a computer having a screen for providing visual feedback to the patient's hand exercise movements.
- 25 11. Therapy device of Claim 10, wherein the computer has a therapy programme that is configured to represent a graphic meter on the screen for showing target positions, present positions or initial positions of the patient's hand exercise movements.
- 30 12. Therapy station for training fine motor skills, the therapy station comprising at least two of the therapy device according to any of the preceding claims.
13. Therapy station of Claim 12, wherein the at least two of the therapy device have different orientations.

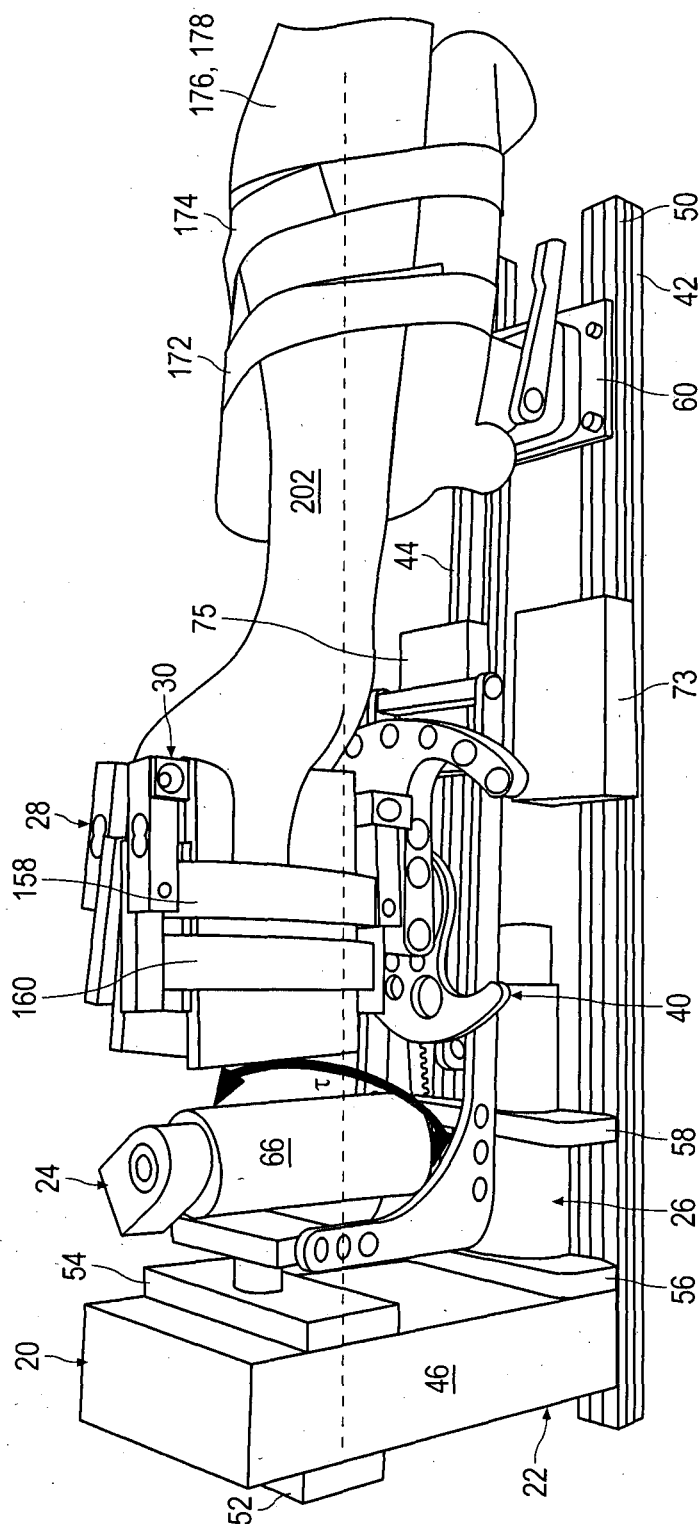


FIG. 1

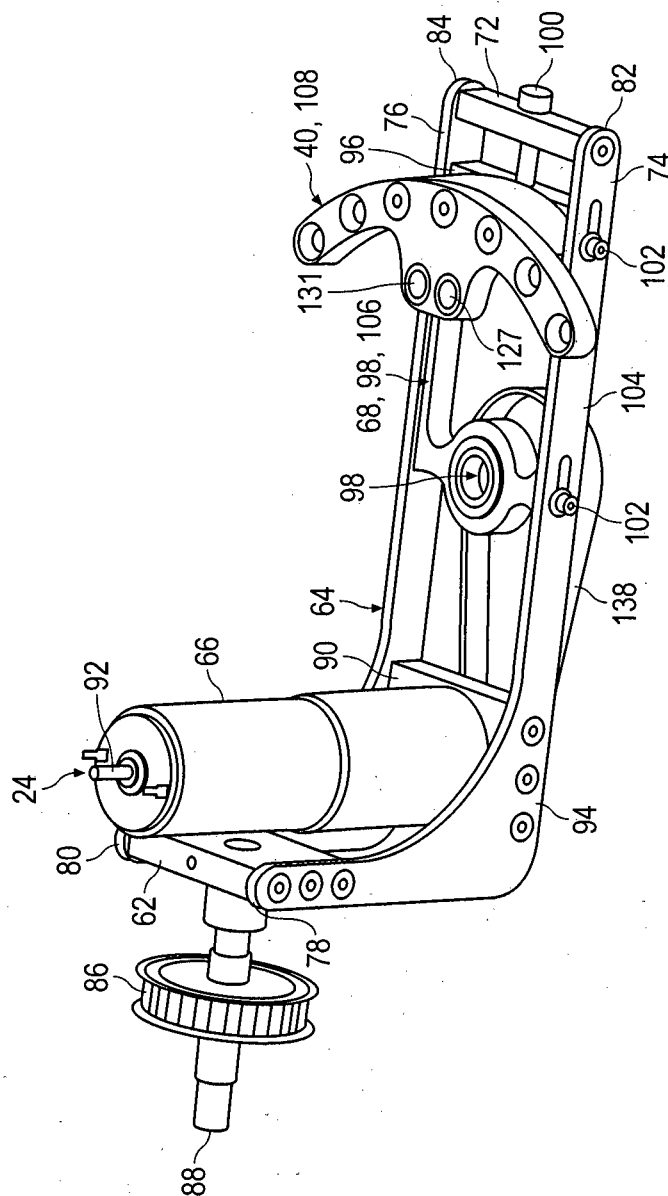


FIG. 2

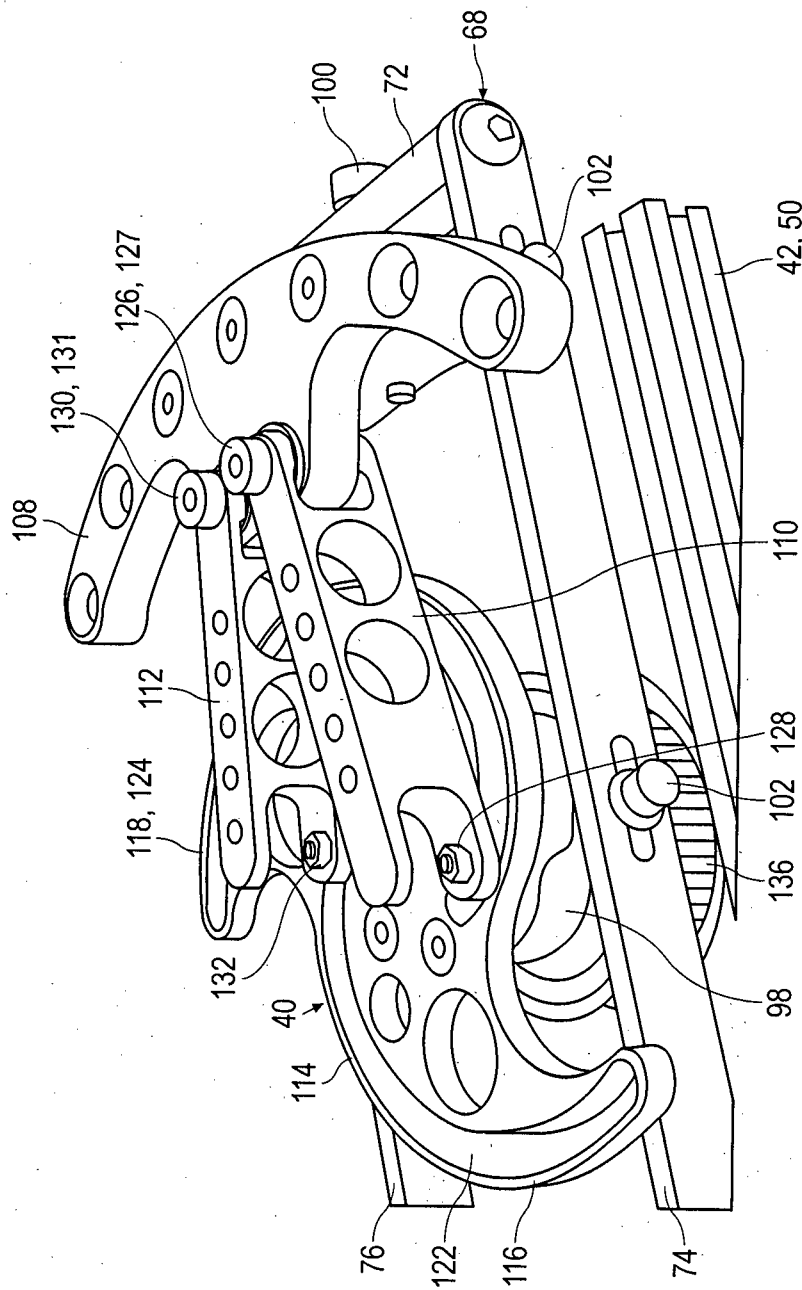


FIG. 3

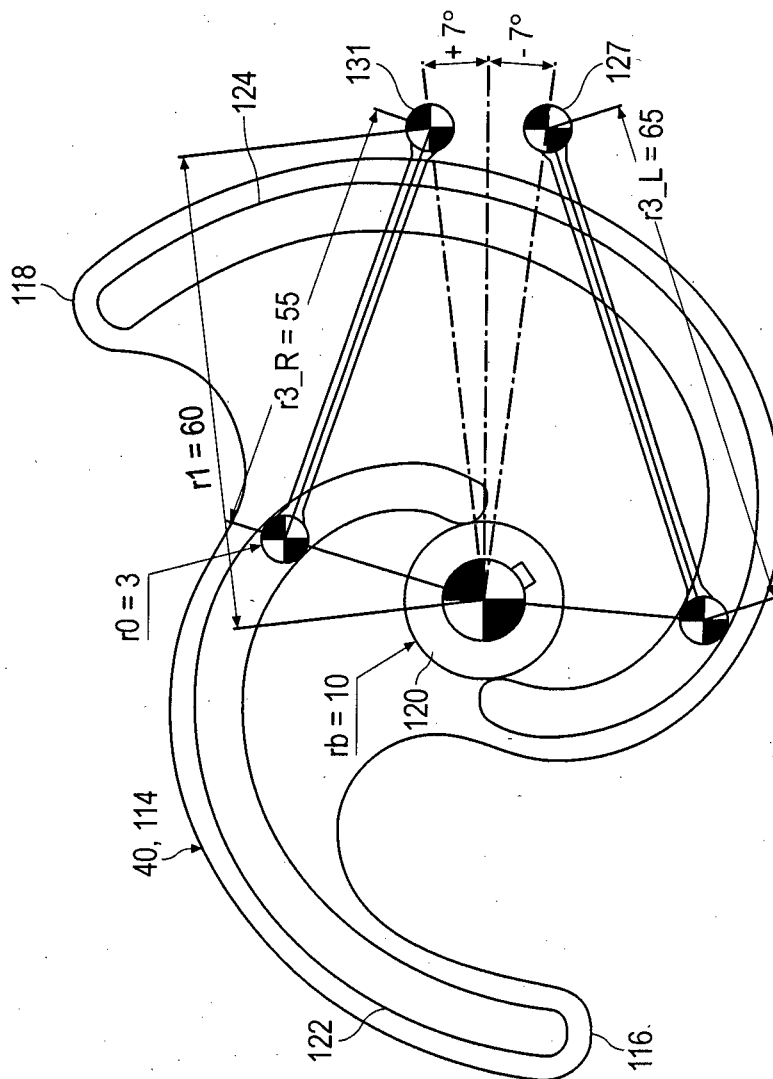


FIG. 4

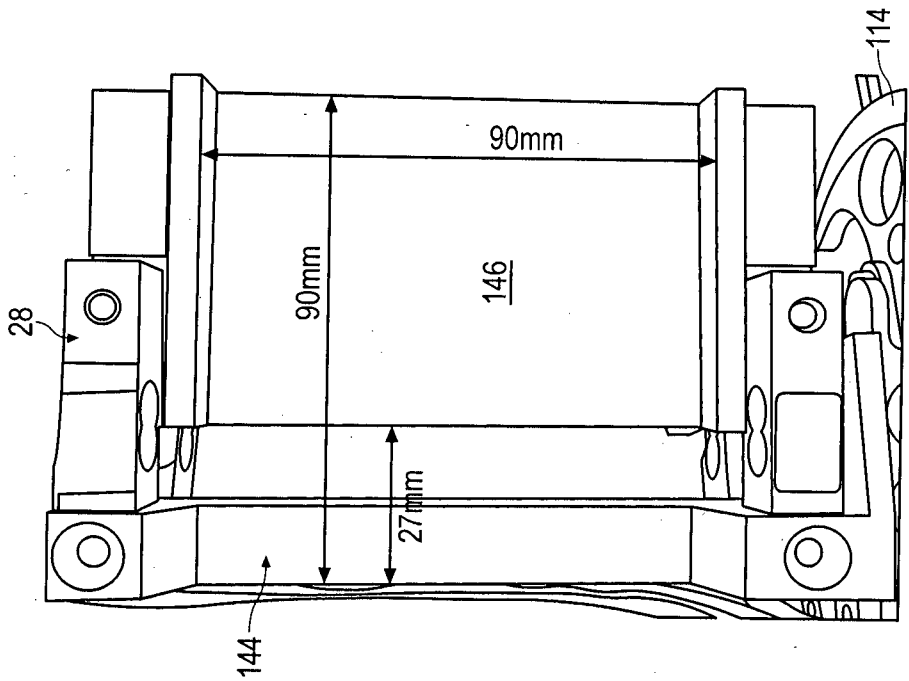


FIG. 5

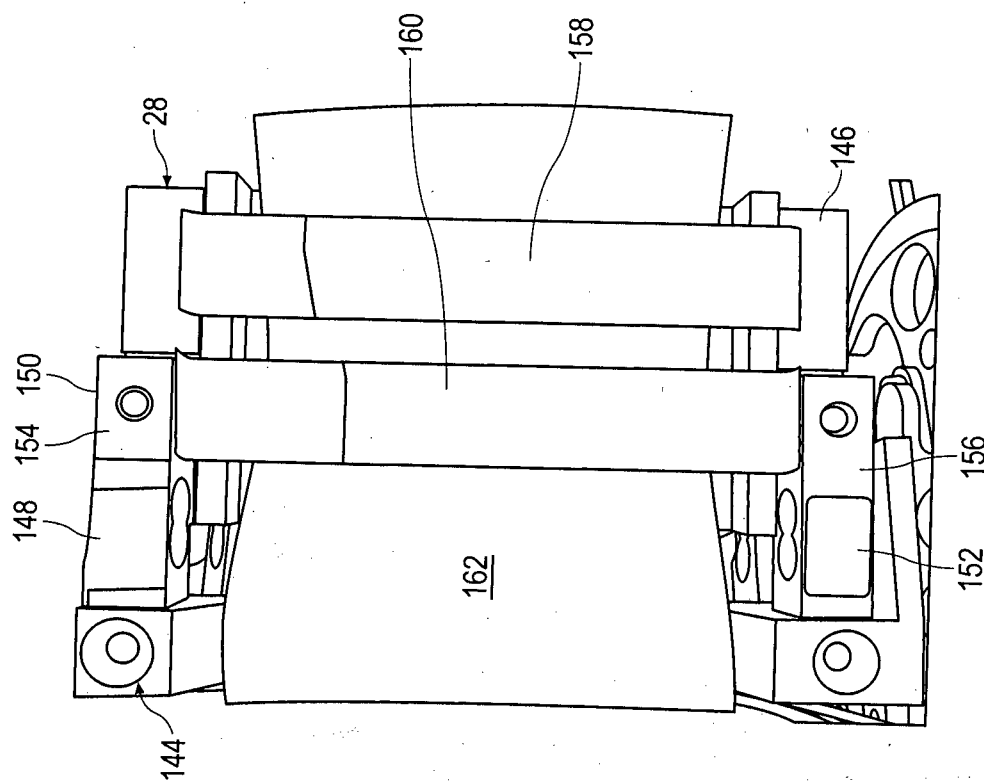


FIG. 6

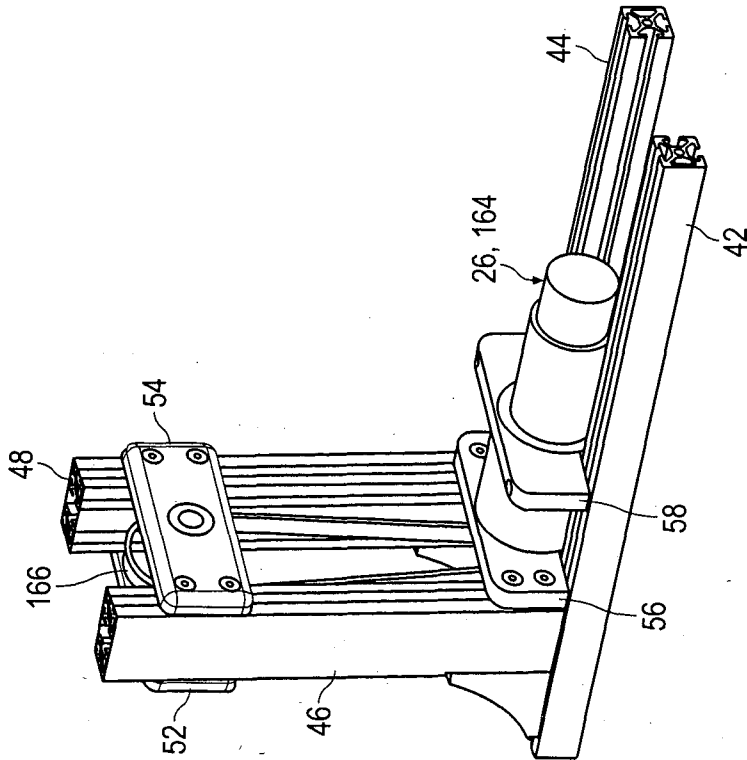


FIG. 7

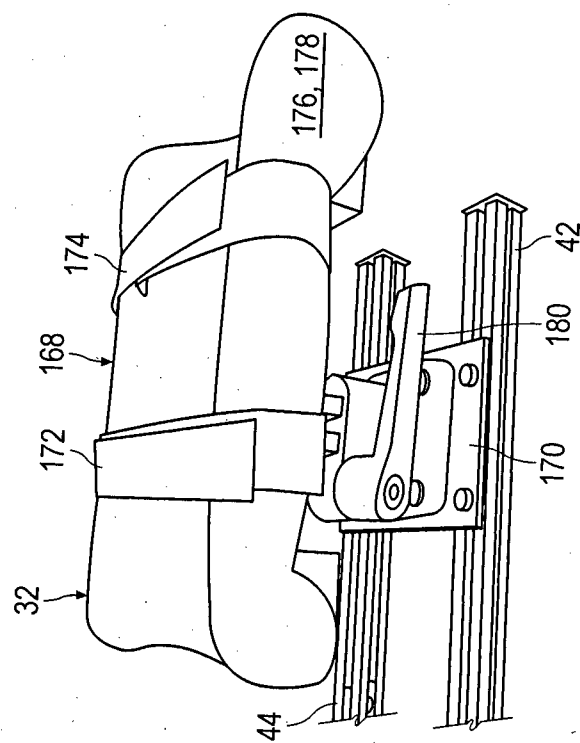


FIG. 8