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(54) Title: MOVABLE CHASSIS

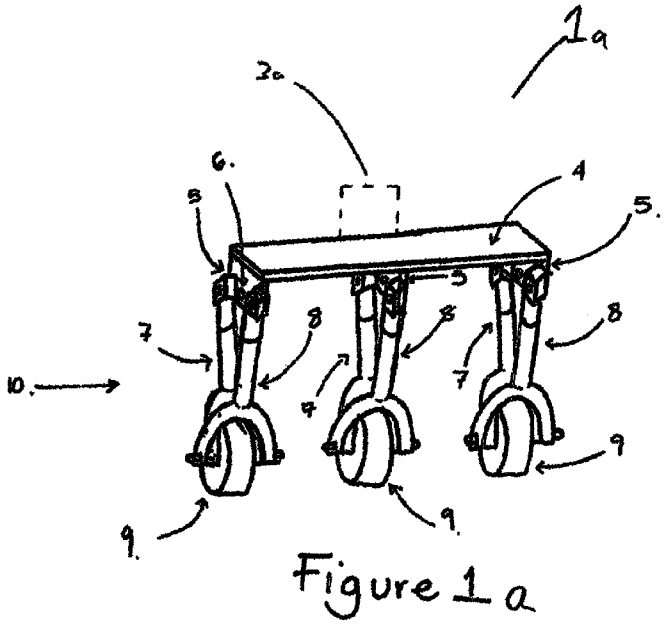

Figure 1a

(57) Abstract: According to the invention, there is provided a movable chassis (la), comprising: means for supporting a load (3a), a transverse actuator beam (4) connected to the means for supporting a load, at least 6 linear actuators (7, 8) connected in pairs to the actuator beam at their top end, and at the bottom ends pivotally connected to a respective one of, and at least 3 direct drive wheels (9), wherein the position of each wheel can be individually adjusted with respect to another wheel by its actuators. The movable chassis can also include a processor, Wifi capabilities, voice recognition services and emergency communication to a third party. The movable chassis can be adapted for multiple purposes including, but not limited to, a walking aid. Figure la

[Continued on next page]

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MOVABLE CHASSIS

The present invention relates to a movable chassis particularly, but not exclusively intended for use in robotics.

Presently, there are a multitude of known arrangements to allow a robot to move. Robots often have wheels, although other options exist. Bomb disposal robots, for example, often have tracks, whilst bio-mimicry has resulted in bipedal, quadrupedal, and hexapedal robots.

One application envisaged for the improved movable chassis is as an electromechanical walking aid. Walking aids with motorised elements are well known in the art. People currently use "Rollators" to walk assisted. "Rollators" are supportive walkers with wheels to help movement on a flat surface. These devices tend to be quite large in comparison to a traditional walking stick and can therefore cause problems when trying to move around indoors.

"Couch Canes" are also a popular aid for the elderly in helping people to get on and off the toilet or a chair. These devices tend not to have wheels or rollers to improve the stability of the device when force is applied to it by the user. "Couch Canes" are therefore difficult for the user to take everywhere with them. They can be a fixed height or can have an adjustable element to change the height depending on the user's requirements.

There are walking aids which enable someone to get upstairs, however in practice it is unlikely that an elderly person would use a hand held device to walk up a flight of stairs when there many known stair lifts available. It would however be helpful if one or a few steps could be navigated such as a step up to a door, a pavement edge or even the threshold of a doorway.

There are walking aids in the prior art which teach a variable wheel base with the adjustment of a third central wheel, for example US 2013/0306120 A1. This, like others, has a single wheel axis for the two outer wheels which can cause stability

issues when walking along a slope. For example most pavements in the UK experience a gentle incline towards the road for ease of drainage.

The object of the present invention is to provide an improved movable chassis, particularly, but not limited for use in robotics.

According to the invention there is provided a movable chassis, comprising:

- means for supporting a load,
- a transverse actuator beam connected to the means for supporting a load,
- at least 6 linear actuators connected in pairs to the actuator beam at their top end, and at the bottom ends pivotally connected to a respective one of,
- at least 3 direct drive wheels,

wherein the position of each wheel can be individually adjusted with respect to another wheel by its actuators.

It is envisaged that the load to be supported could be a handle with a shaft, such that the movable chassis can be used as an electromechanical walking aid. Alternatives include the load to be supported as a robotic arm, camera, cargo hold etc. The movable chassis may form the basis of any robot, and should not be limited to the load/equipment to be carried. The invention is not intended to be limited by the load to be supported.

Preferably the actuator beam has at least 3 integral brackets with a plurality of apertures. It is intended that each actuator pair has an integral bracket. The apertures provide a location for each linear actuator to be pivotally connected and the plurality allows for adjustment of the device. An alternative is that the brackets are separate components to the actuator beam, they may also contain only two apertures.

Normally, the brackets are located equally spaced along the actuator beam, however it can be envisaged that they are spaced unequally. Preferably, the brackets

are also orientated along the same centreline, alternatively they can be spaced with the middle bracket off centre.

The movable chassis can comprise one or more sensors to detect, particularly although not exclusively, changes in the external forces applied to the movable chassis, position of the device including pitch, roll, tilt and acceleration, extension of the linear actuators, and of particular interest for the walking aid embodiment, the force applied by the user.

It is envisaged that the movable chassis comprises a processor to receive communication from each sensor and to instigate adjustment of the device in the event of unexpected, and/or destabilising movements, or based on measurements form one or more of the sensors.

It is envisaged that the movable chassis could have more than 3 wheels, however preferably there are 3.

It is envisaged that the movable chassis may comprise a Wifi connection, enabling the processor to access cloud services, for example. The cloud services could include speech recognition services, access to audio files and emergency numbers as well as other health related services.

The movable chassis may also consist of further sensors and transmitters so that distant operators/third parties are able to check whether the status of the movable chassis is abnormal or any other parameter of interest. This may include falling over. For the walking aid embodiment, the interested parties may be a relative. Measurements of interest may be, whether they have been for a walk that day, and if so how far. There may also be the capability of a relative being alerted if something changes for the user that could cause concern. Such features or capabilities may also be desirable for other applications of the movable chassis, albeit for different reasons.

It is envisaged that the movable chassis can be adapted to alert a third party whether there is: unexpected movement of the chassis, expected movement that has not occurred, or if the chassis has fallen over, for example. In truth, any measurement

from a sensor not in the realm of normal operation could be transmitted, automatically or otherwise.

The movable chassis may not be in use at all times and could be located some distance from the user. It is envisaged that the movable chassis can have speech recognition and voice direction finding capabilities. The processor can digitise local binary audio and instigate an adjustment to the device or cause the device to move towards a user.

It is envisaged that the movable chassis may comprise GPS or other location tracking and/or detecting means. This may be coupled with the processor so that the current location fo the chassis can be known, and/or the past routes taken by the chassis, depending upon application.

The movable chassis may alert a third party in certain circumstances such as, but not limited to the following: unexpected movement of the movable chassis, whether expected movement has occurred, or other parameters measured by one or more of the sensors

Whilst it can be envisaged that the walking aid could have 3 linear actuators paired with a fixed leg which is pivotally connected to the direct drive wheel it is preferable that it has 6 linear actuators arranged in pairs and connected to the direct drive wheel. Normally, the pairs will be triangular pairs.

For larger loads, it is envisaged that a plurality of chassis in accordance with the present invention may be connected to form a larger, more robust platform to accommodate a larger load to be supported. Further processors may be employed to ensure communication between all of the actuators and wheels to ensure a stable journey.

To help with the understanding of the invention, a specific embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 a is an isometric view of a movable chassis in accordance with the present invention,

Figure 1b is an isometric view of a walking aid, a variant of the movable chassis in accordance with the present invention

Figure 2 is a side view of the walking aid navigating a step,

Figure 3 is a side view of the walking aid helping a user to stand,

Figure 4 is a front view of the walking aid helping a user to walk on a slope,

Figure 5 is a plan view of cut through X-X on Figure 4,

Figure 6 is a flow chart representing the control of the present invention.

In Figure 1a, a movable chassis in accordance with the present invention is shown. The remaining figures are based upon an embodiment of the invention being used as a walking aid. The movable chassis 1a comprises means for carrying a load 3a atop an actuator beam 4. The movable chassis is then represented in the remaining figures in its embodiment as a walking aid.

Referring to the remaining Figures, there is a walking aid which can be used by an elderly person. The walking aid 1 consists of a handle 2, a shaft 3 and an actuator beam 4. The actuator beam has three integral brackets 5 with a plurality of apertures 6. The apertures are for pivotally connecting six linear actuators arranged in pairs consisting of a rear actuator 7 and a front actuator 8. Each pair of actuators is pivotally connected to a direct drive wheel 9 arranged in a triangular arrangement where the actuator beam provides one side of the triangle. Each pair of linear actuators and a direct drive wheel can be collectively referred to as a leg 10.

The front and rear actuators are arranged in the same plane as seen in Figure 5. One actuator corresponds to a single assembly including an armature 11 and an axle 12 on which the other actuator is connected. This assembly fixes one actuator with respect to the axle where the other actuator is allowed to rotate relative to the first actuator. This also prevents the motor from rotating. In the centre of the wheel 9 is a series of coils 13 which when energised attract permanent magnets 14, housed in a cylinder 15. This cylinder revolves around the armature on ball bearings 16 when the coils are activated. The cylinder is then surrounded by rubber completing the tyre 17.

The walking aid is driven by three brushless direct drive DC motors 18 which drive the wheels 9. The linear actuators are based on stepper motors 19 for leg rotation and elongation. Each of the three legs includes rotation and extension sensors 20. They are all driven by the main electronics and computation module 21 which receives sense data from the users hand and fingers and motion and orientation sensors. Low level stability control is performed within the local processor 22.

Each actuator is individually lengthened or shortened to suit the user's environment, to either rotate the legs forward or backwards, reduce or increase the wheel base or reduce or increase the overall height of the legs. The way in which the walking aid can achieve this is described by the following examples.

One function of the walking aid is to help a user to sit on a toilet or sofa for example, or to stand from a seated position. To sit, a user would bring the walking aid to near where they wanted to sit, the walking aid would then increase its wheelbase to enable a more stable foundation for the user to lean against while sitting. In increasing the wheel base you are also reducing the overall height of the walking aid to follow the user into a sitting position. An example of this is shown in Figure 3.

Once a user is stood up, the walking aid requires a smaller wheelbase to be able to navigate indoors, which also avoids the requirement for specially adapted housing.

When the user is walking, either indoors or outside, the walking aid senses the pressure of a user's hand on the handle, the walking aid then moves in the desired direction at the speed required for the hand to always be fully supported. The walking aid can reduce its wheelbase to the minimum and act like a Segway (RTM), a self-supported inverse pendulum.

The walking aid can navigate steps, for example the threshold of a doorway or a pavement edge. For support on a step as shown in Figure 2, the walking aid can shorten and extend forward its middle wheel, while lengthening and stabilising the outer two legs to ensure a stable tripod wheelbase to support the user. Once the user has taken the step, the back legs shorten and move forward to be in the desired

position for walking again. The user does not have to lift the walking aid, or walk unsupported at any time.

The walking aid is also beneficial when walking on a slope. For example pavements in the UK are sloped to help drainage into the gutters of the road. The fact that each leg of the walking aid is individually adjustable allows the road to be sloped but the actuator beam to remain horizontal to best support the user as shown in Figure 4.

An advantage to the preferred embodiment is that the walking aid can assist the user in walking, moving around indoors, helping to stand or sit, navigate a step and remain stable while walking along a slope among others features all in one ergonomic device.

The invention is not intended to be restricted to the details of the above described embodiment. For instance, the load to be carried is not restricted to a walking aid handle. The movable chassis may be adapted to carry a robotic arm, cargo, camera or any other thing which may be desirable on a robot.

Additionally, the processor could also digitise local binary audio for use in speech recognition and voice direction finding.

The movable chassis can also replay audio received as MP3 files. This is done by any suitable means for accessing audio files.

The movable chassis can be Wifi enabled which allows the processor to access cloud services where amongst other health related services, speech recognition services and access to entertaining audio files is performed.

The movable chassis can have an adjustable handle or shaft to suit the height of any user without amending the wheelbase to compensate.

The movable chassis can have 3 linear actuators paired with 3 fixed legs which are pivotally connected to the direct drive wheel, however it is preferable that it has 6 linear actuators arranged in pairs as described hereinbefore.

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CLAIMS:

1. A movable chassis, comprising:
   - means for supporting a load,
   - a transverse actuator beam connected to the load supporting means ,
   - at least 6 linear actuators connected in pairs to the actuator beam at their top end, and at the bottom end each pivotally connected to a respective one of,
   - at least 3 direct drive wheels,

wherein the position of each wheel can be individually adjusted with respect to another wheel by its actuators.

2. A movable chassis as claimed in claim 1, wherein the load to be supported is handle with a shaft, a robotic arm, a camera, cargo hold, or combination thereof

3. A movable chassis as claimed in claim 1, wherein the movable chassis has 6 linear actuators connected as triangular pairs to the actuator beam at their top end, and at the bottom end connected to the at least 3 direct drive wheels.

4. A movable chassis as claimed in claim 1 or claim 2 or claim 3, wherein the actuator beam has integral brackets for each linear actuator to be connected to.

5. A movable chassis as claimed in claim 1 or claim 2 or claim 3, wherein the actuator beam has separate brackets for each linear actuator, or pair of linear actuators to be connected to.

6. A movable chassis as claimed in claim 4 or claim 5, wherein the brackets have at least two apertures adapted to adjust the movable chassis to suit a purpose.

7. A movable chassis as claimed in any preceding claim, wherein the movable chassis can further comprise sensors to detect at least one of:
   - changes in the external forces applied to the movable chassis, and/or
   - the position of the device including pitch, roll, tilt and acceleration, and/or
   - the extension of the linear actuators.

8. A movable chassis as claimed in claim 7, wherein the movable chassis comprises a processor to receive communication from each sensor and to instigate adjustment of the movable chassis.

9. A movable chassis as claimed in claim 8, wherein the movable chassis comprises a Wifi connection adapted to enable the processor to access cloud services.

10. A movable chassis as claimed in any preceding claim, wherein the movable chassis is adapted to comprise GPS or an alternative location or tracking system.

11. A movable chassis as claimed in any preceding claim, wherein the movable chassis is adapted to comprise at least one of:

- speech recognition services, and/or
- means to access audio files, and/or
- means to access emergency phone numbers, and/or
- means to access other health related services.

12. A movable chassis as claimed in any preceding claim, wherein the movable chassis is adapted to communicate to a third party whether:

- there is unexpected movement of the movable chassis,
- there is movement of the chassis, as expected and
- the sensors detect something not in the realm of normal operation, such as the movable chassis falling over

13. A movable chassis as claimed in any preceding claim, wherein the movable chassis is adapted to alert a third party automatically if something changes for the movable chassis that could cause concern.

14. A movable chassis as claimed in any preceding claim, wherein the movable chassis further comprises:

- voice direction finding capabilities, and
- a processor, adapted to digitise local binary audio and instigate:
  - an adjustment to the device; and/or
  - the device to move towards the user.

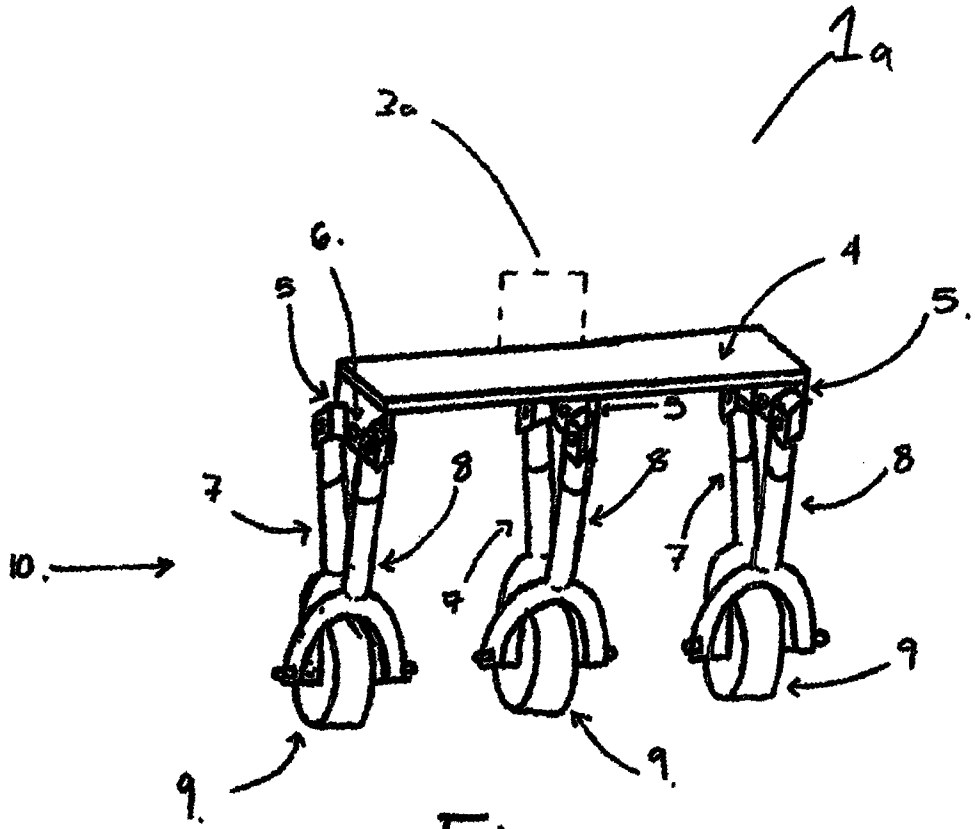

Figure 1a

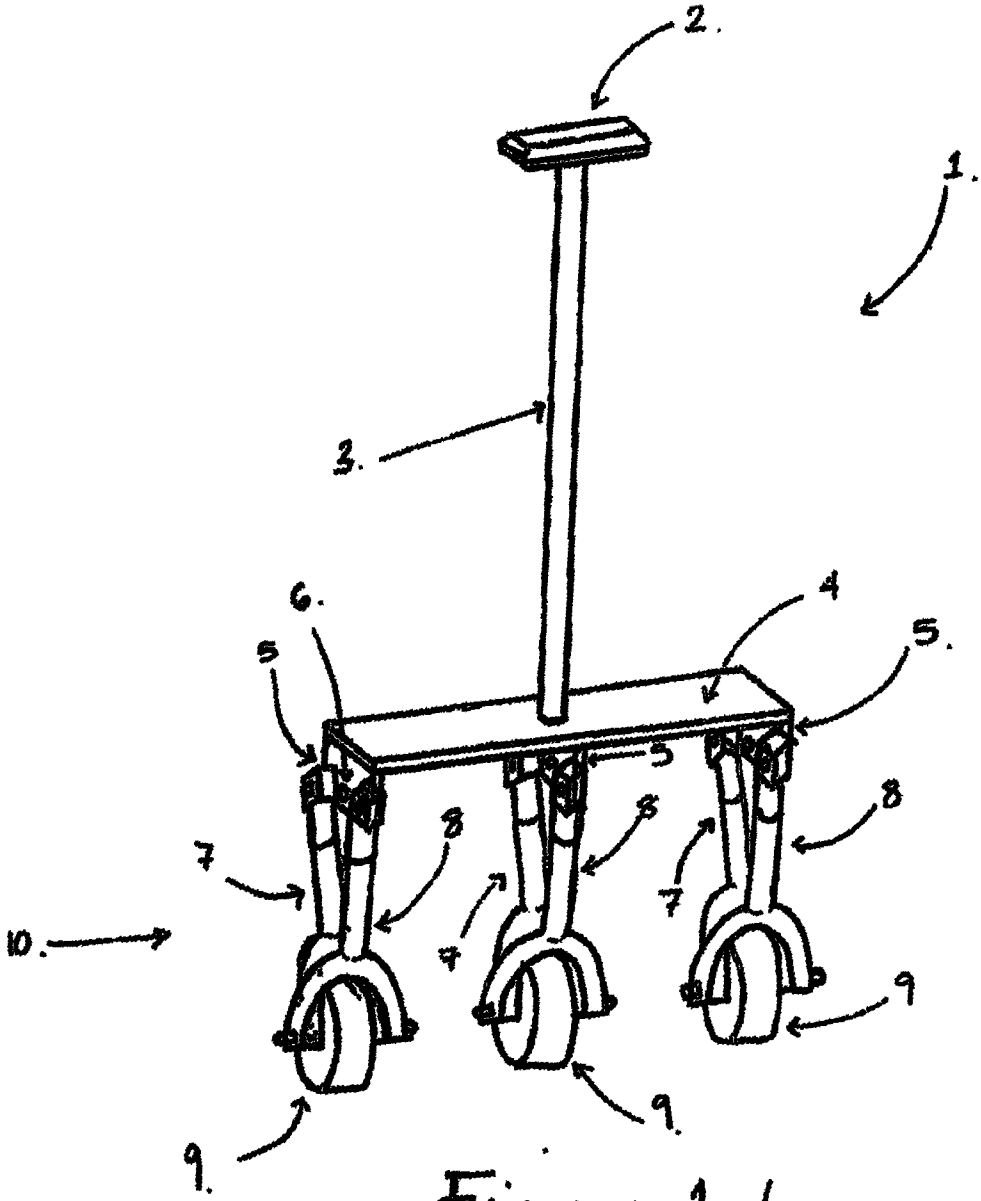

Figure 1 b

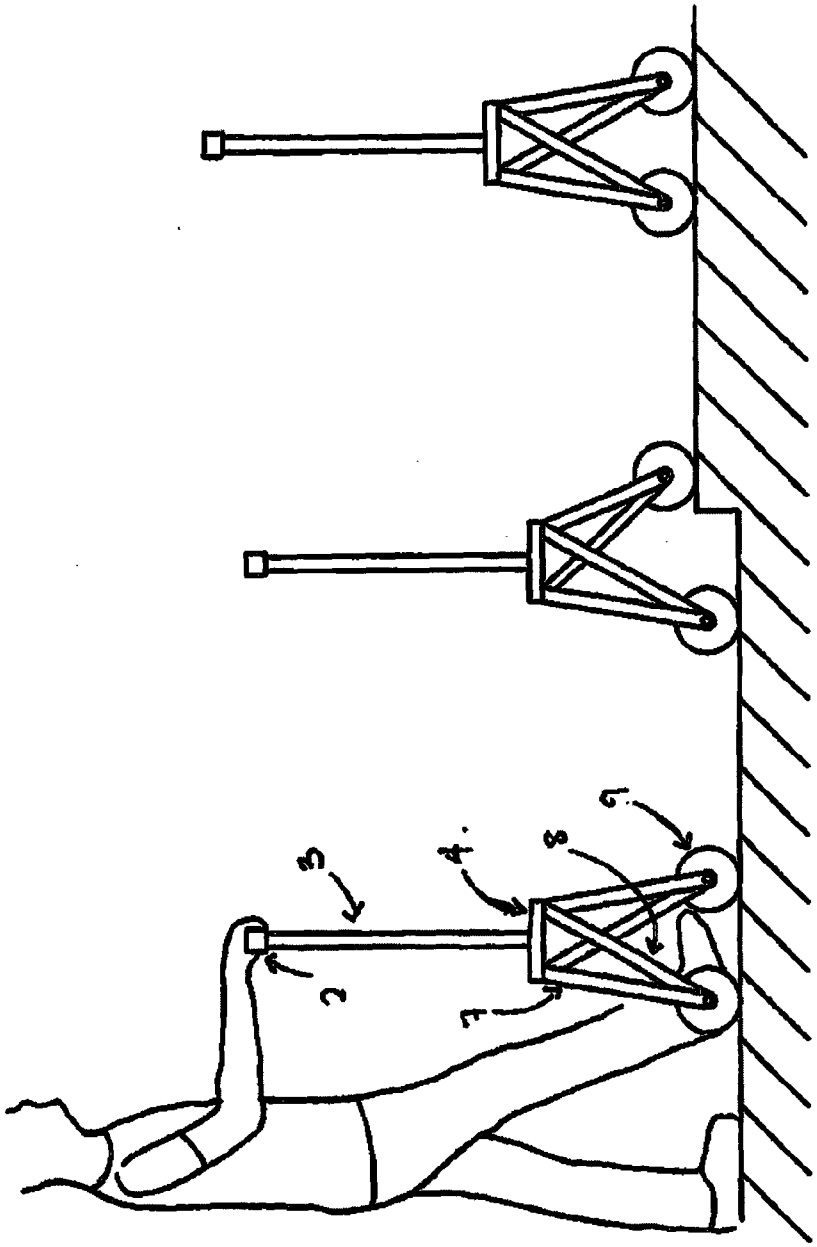

Figure 2

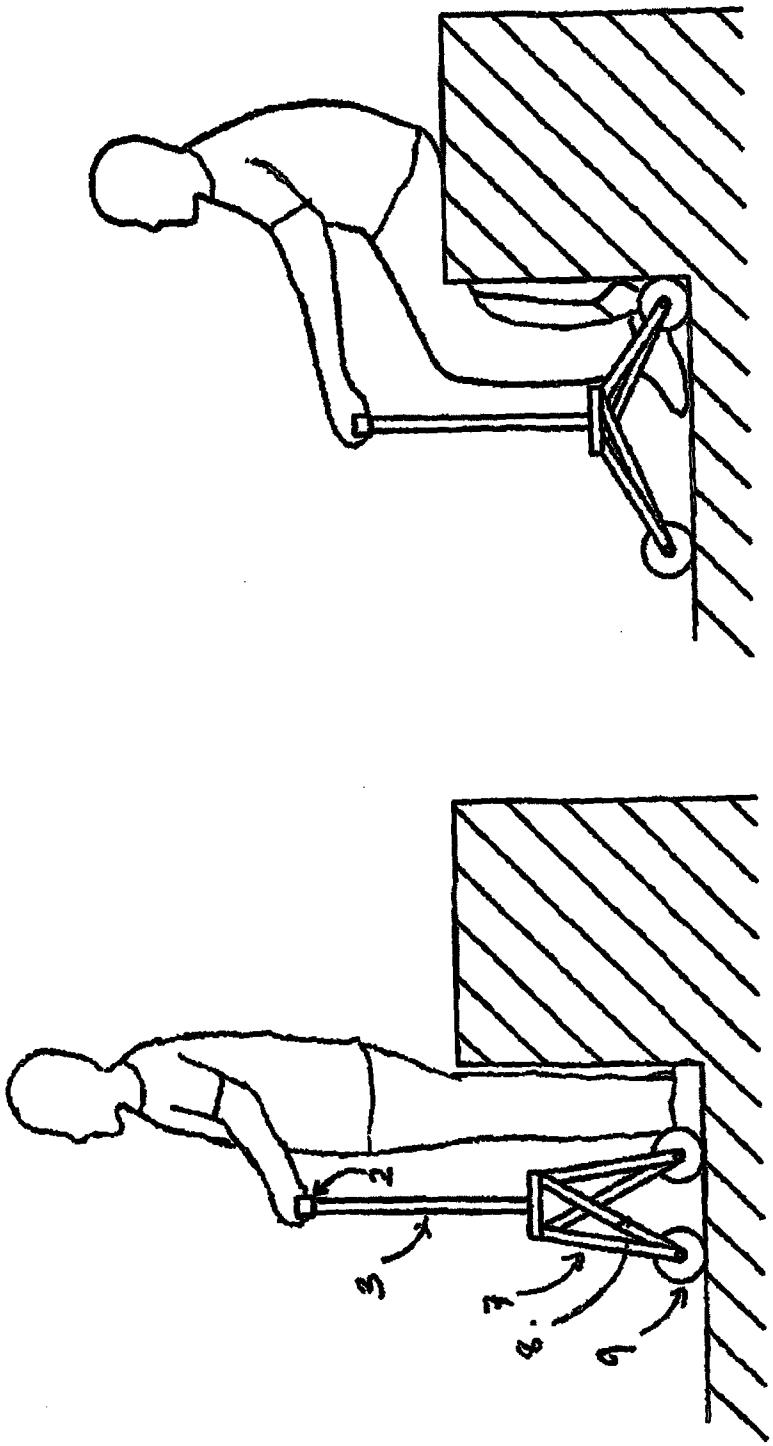

Figure 3

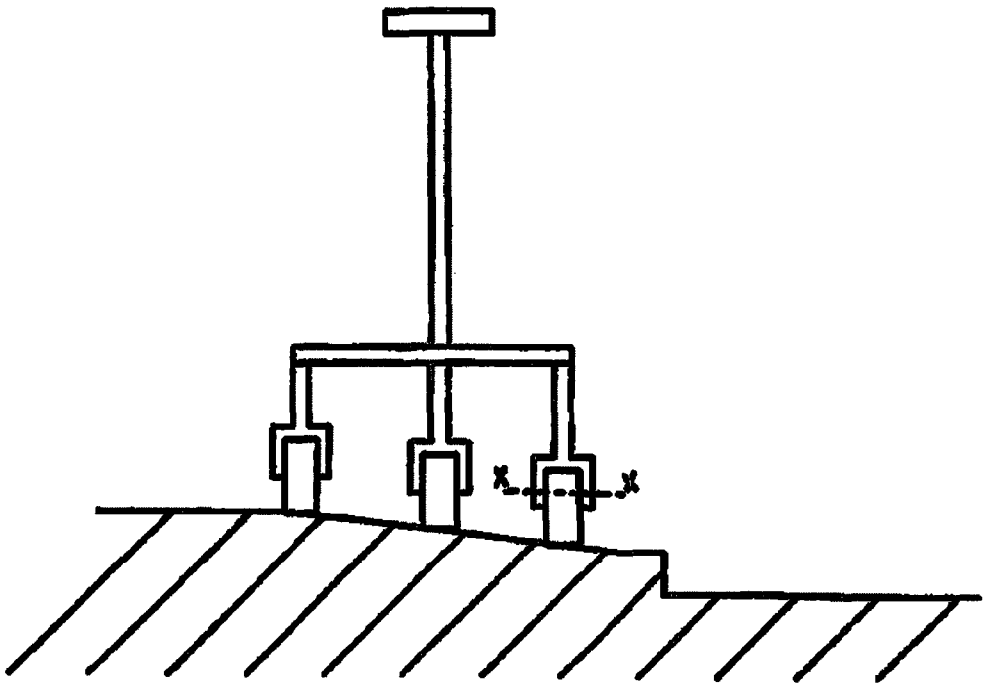

Figure 4

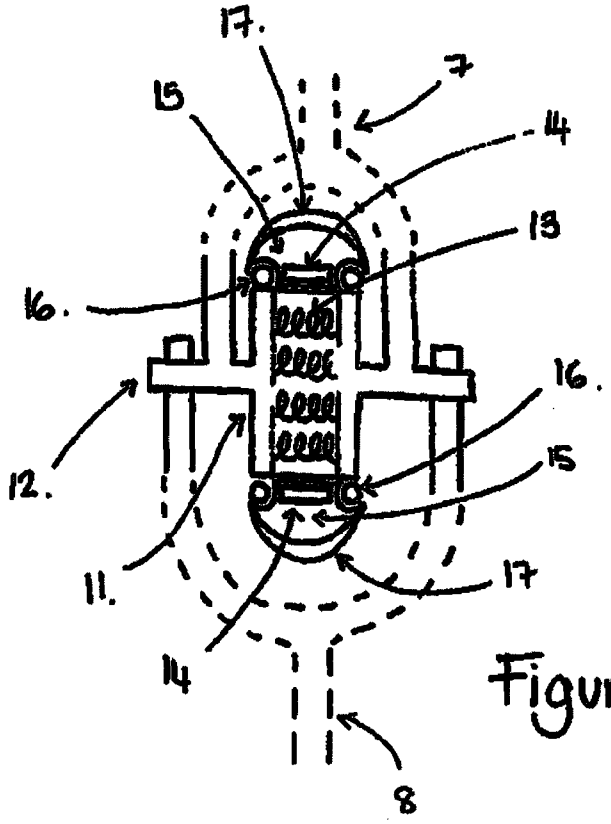

Figure 5.

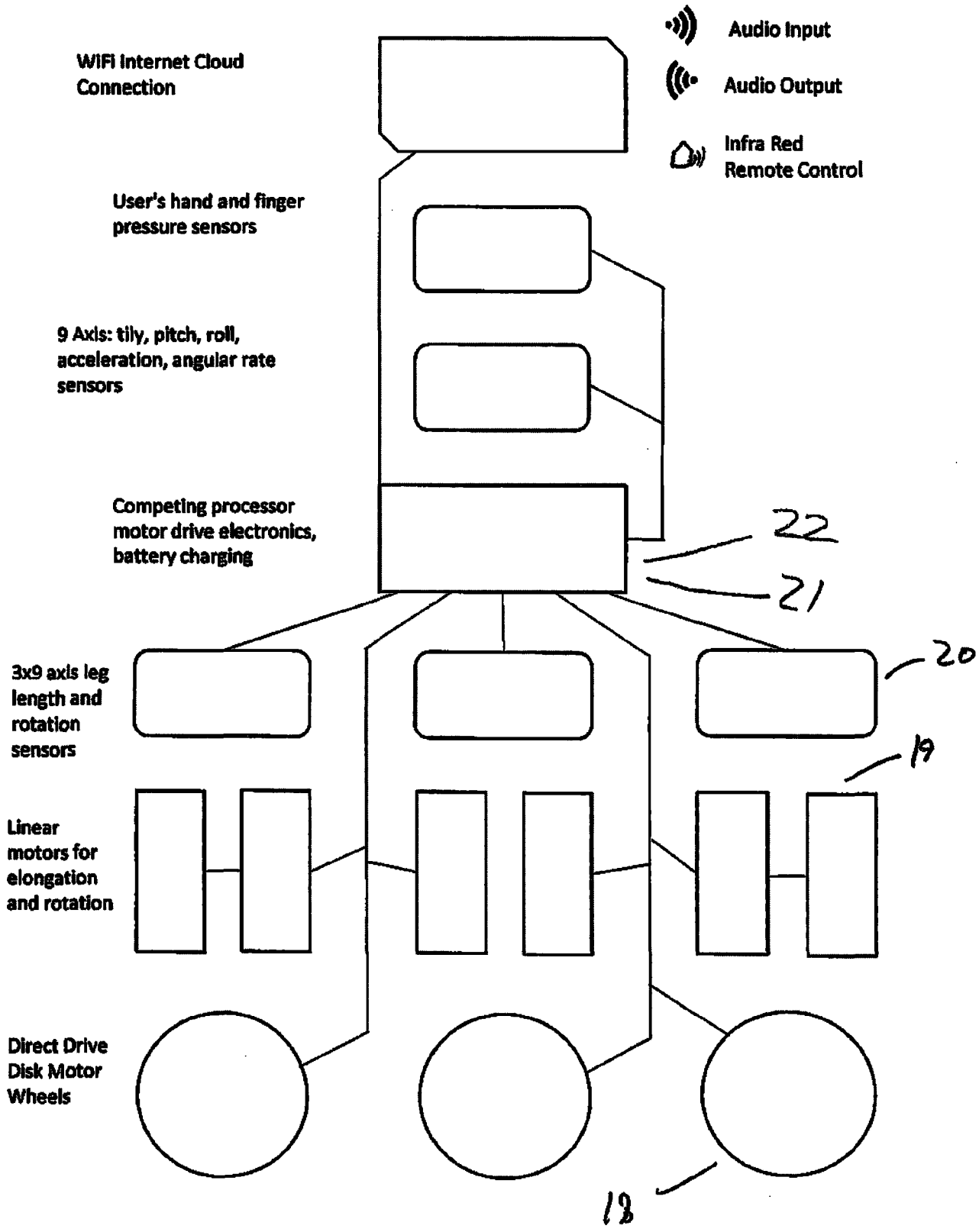
Audio Input
Audio Output
Infra Red Remote Control
WIFI Internet Cloud Connection
User's hand and finger pressure sensors
9 Axis: tily, pitch, roll, acceleration, angular rate sensors
Competing processor motor drive electronics, battery charging
22
21
3x9 axis leg length and rotation sensors
20
19
Linear motors for elongation and rotation
Direct Drive Disk Motor Wheels
18

Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/050904

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61H3/04 A61G5/14
ADD. A61H3/00

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)
A61H A61G

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X Y A	US 2005/023052 A1 (BECK MICHAEL S [US] ET AL) 3 February 2005 (2005-02-03) pages 3-9; claims; figures -----	1,2,4-8 9-14 3
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Y	US 2016/074262 A1 (MOSES SOPHIA VASILIKI [US] ET AL) 17 March 2016 (2016-03-17) figures ----- -/--	7-14

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 December 2018	20/12/2018

Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/050904

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

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