

BIO-FEEDBACK GAIT TRAINER

Field of the Invention

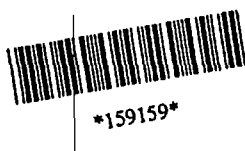
[001] The present invention relates to an apparatus and method for a bio-feedback gait trainer. In particular, the invention relates to an apparatus and method for providing instant visual feedback of a patient's gait for gait rehabilitation.

Background of the Invention

[002] Gait trainers are widely used by therapists and medical workers in the rehabilitation profession to help patients (for example stroke and accident) with walking problems.

[003] There are several and a variety of Gait rehabilitation methods and these are well documented in professional journals and articles. To assist in gait rehabilitation, therapists often use the aid of a variety of training aids and devices.

[004] Of the many training aids and devices, one of the most important is the Gait Trainer. Most Gait Trainers allow a patient to physically perform walking exercises while being supported by supporting means such as hand rails and body harnesses. A conventional Gait Trainer would be a platform having raised hand rails on either side, where a patient can support himself using both handrails while walking on the platform. The therapist would likely be assisting the patient at the same time monitoring the progress of the patient as he walks on the platform. In addition, predetermined targets can be placed on the platform requiring the patient to coordinate his walking and footsteps to fall on the targets. The therapists can use these targets for progress monitoring and for increasing level of difficulty in rehabilitant the patient by placing these targets further apart.



[005] To assist therapists in monitoring the patient's gait and progress, video cameras are often used so that therapists can concentrate on assisting a patient during gait training and then review the video tape at a later time to monitor the progress of the patient. The limitations and disadvantages of such a system is obvious. Time is disadvantageously wasted and the therapists are unable to monitor and correct or advise the patients during the gait training.

[006] Recent developments in technology have resulted in improved Biofeedback Gait Trainers. These Gait Trainers allow the gait training process of a patient to be recorded via sensors on the Gait Trainer and further allow data to be recorded for future reference.

[007] In US Patent Application No. 5,476,103 a Gait Trainer apparatus is disclosed for assessing and biofeedback training. The apparatus disclosed utilizes several force plates mounted on a platform allowing sensing of a patients gait as he walks on the platform. Each force plate is large enough to accommodate a patient's foot and computes the center of force on each force plate for displaying the patient's progress.

[008] In European Patent Application Publication No. EP 1 145 682, a gait rehabilitation apparatus is disclosed comprising a treadmill whose speed matches a patient's own step cycle which can be evaluated by the apparatus and also provides biofeedback displaying the patient's own foot falls on the treadmill.

[009] However, present Gait Trainers still do not provide direct biofeedback to a patient allowing the patient to directly interact with the biofeedback to further improve his own gait training and further assisting therapists in fulfilling their functions.

Summary of the Invention

[0010] The present invention seeks to provide a method and apparatus for providing instant visual feedback of a patient's gait for gait rehabilitation.

[0011] Accordingly, in one aspect, the present invention provides, an apparatus for gait training comprising: a platform having a high resolution sensing means for detecting pressure applied on the high resolution sensing means; a plurality of targets arranged in a predetermined manner on the platform; a displaying means for displaying images; and a processor for processing data from the high resolution sensing means and for sending images to the displaying means for display; wherein the data comprises a plurality of electrical contacts from the high resolution sensing means; and further wherein the images displayed on the displaying means correlate to the data from the high resolution sensing means.

[0012] In another aspect, the present invention provides, a method for enhancing gait rehabilitation of a patient comprising the steps: providing a platform gait trainer having a high resolution sensing means for detecting pressure from footfalls, a plurality of targets on the high resolution sensing means, a processor for processing data from the high resolution sensing means, a displaying means for displaying images of the pressure from footfalls on the platform gait trainer; placing the plurality of targets in a predetermined arrangement on the platform; applying pressure on the plurality of targets; generating a plurality of target footfall images corresponding to the plurality of targets and displaying the plurality of target footfall images on the displaying means; guiding a patient to step on the plurality of targets; and generating a plurality of patient footfall images corresponding to the plurality of targets and displaying the plurality of patient footfall images on the displaying means.

Brief Description of the Drawings

[0013] A preferred embodiment of the present invention will now be more fully described, with reference to the drawings of which:

[0014] FIG.1 illustrates an apparatus in accordance with the present invention;

[0015] FIG.2 illustrates the high resolution sensing means of FIG.1;

[0016] FIG.3 illustrates a cross sectional view of FIG.2;

[0017] FIG.4 illustrates a cross sectional view of FIG.2 when pressure is applied;

[0018] FIG.5 illustrates the visual feedback on the displaying means.

[0019] FIG.6 illustrates a flowchart of a method for enhancing gait rehabilitation.

[0020] FIG.7 illustrates a flowchart of the method for the generating of footfall images from FIG.6.

Detailed description of the Drawings

[0021] In this description, an apparatus and method for providing instant visual feedback of a patient's gait for gait rehabilitation is disclosed. In the following description, details are provided to describe the preferred embodiment. It shall be apparent to one skilled in the art, however that the invention may be practiced without such details. Some of the details may not be described at length so as not to obscure the invention.

[0022] Referring to FIG.1, an apparatus 10 for gait training having instant visual feedback of a patients' gait is illustrated. The apparatus 10 generally comprises a platform 20 having a high resolution sensing means 30, a covering means such as a rubber mat 22, a processor 34, and a displaying means 40.

[0023] The high resolution sensing means 30 is covered and protected by the rubber mat 22, but may be made a covering means made of any of a variety of materials possessing the property of electrical insulation. The platform 20 and the high resolution sensing means 30 are coupled to the processor 34 which processes data from the high resolution sensing means 30 and displays the data from the high resolution sensing means 30 on the displaying means 40. Examples of the displaying means 40 could be computer monitors or Liquid Crystal Display monitors.

[0024] The apparatus 10 further comprises at least one set of handrail 12 for a patient to support himself while walking or performing gait training exercises on the apparatus 10. Several targets 24 each in the shape of a footprint may be placed on the rubber mat 22. The targets 24 may be placed in a predetermined manner on the rubber mat and in accordance to the gait training or rehabilitation program of a specific patient. These targets do not comprise part of the high resolution sensing means 30 and can be made of any material. Further, standard templates of the targets 24 printed onto the rubber mat 22 or additional rubber mats 22. Changing a particular gait training program may simply be a matter of changing the rubber mats 22 or simply placing one on top of another.

[0025] Referring to FIG.2 and FIG.3, the high resolution sensing means 30 comprises at least two portions, a left portion and a right portion. Each portion comprising of a first plurality of longitudinal conductive elements and a second plurality of longitudinal conductive elements. The first plurality of longitudinal conductive elements are in the present embodiment a plurality of metal rods 50 mounted substantially parallel to each

other and substantially perpendicular to the intended direction of a patient walking on the platform 20.

[0026] The second plurality of longitudinal conductive elements 52 are in the present embodiment a plurality of tensioned metal wires 52 mounted substantially parallel to each other and substantially perpendicular to and slightly above the metal rods 50. It is important that the tensioned metal wires 52 are mounted above and not in electrical contact with the metal rods 50. Each portion of the high resolution sensing means 30 in the present embodiment is then made up of a plurality of metal rods 50 and a plurality of tensioned metal wires 52 mounted above, not in electrical contact with and perpendicular to the plurality of metal rods 50.

[0027] Referring to FIG.2, the resulting arrangement of the metal rods 50 and the tensioned metal wires 52 of the high resolution sensing means is a grid or a matrix comprising of several rows and columns having a resolution determined by distances between the metal rods 50 to each other and the tensioned metal wires 52 from each other.

[0028] Referring to Fig. 3, the plurality of metal rods 50 are further provided with a first plurality of spacers arranged in between each longitudinal conductive element from each other. A second plurality of spacers are also arranged in between the metal rods 50 from each other. The first and second plurality of spacers are alternately arranged between each of the metal rods 50. The first plurality of spacers are electrically non-conductive and are elastically deformable and in the present embodiment are a plurality of foam spacers 54. The second plurality of spacers are electrically non-conductive and non-elastic and in the present embodiment are a plurality of wood spacers 56.

[0029] Referring to FIG.3, an example of an arrangement of the metal rods 50 and the foam 54 and wood 56 spacers would then comprise: a metal rod 50, followed by a foam spacer 54, followed by another metal rod 50, followed by a wood spacer 56, followed by another

metal rod 50 and followed by another foam spacer 54. This arrangement is merely an example and illustrates the alternating arrangement of the foam 54 and wood 56 spacers arranged alternatingly between each of the metal rods 50.

[0030] Referring to FIG.4, when pressure 60 is applied on a particular region on the high resolution sensing means 30, the tensioned metal wires 52 in that particular region experience elastic deformation and results in the establishing of electrical contact between the metal rods 50 and the tensioned metal wires 52 in that particular region.

[0031] When the pressure 60 applied is that of a patient stepping onto the high resolution sensing means 30, the shape of the particular region experiencing pressure 60 is likely in the shape of a foot or a shoe. The tensioned metal wires 52 in that particular region resembling a foot or a shoe would experience elastic deformation and come into electrical contact with the metal rods 52 also in the same region resembling a foot or a shoe. The resulting shape of the foot or shoe exerting pressure 60 on the high resolution sensing means 30 comprises a plurality of electrical contacts between the metal rods 50 and the tensioned metal wires 52. Referring to FIG.4 and FIG.5, data which comprises these plurality of electrical contacts are sent to the processor 34 for processing to determine the location of these electrical contacts which are then used to generate an image of the shape of the foot or shoe for displaying on the displaying means 40.

[0032] Referring to FIG.5 and FIG.6, a method 600 for enhancing gait rehabilitation of a patient using the apparatus 10 for gait training having instant visual feedback of a patients' gait is illustrated. The method 600 starts with placing 610 the plurality of targets 24 on the rubber mat 22 of the platform of the apparatus 10 in a predetermined arrangement and in accordance to the gait training and rehabilitation program of a specific patient.

[0033] Next, pressure is applied on all of the plurality of targets 24 on the rubber mat 22. The pressure may be applied on the plurality of targets 24 by a therapist or someone

actually stepping onto the targets to simulate the actual gait desired. A plurality of target footfall images 60a,b,c are then generated 620 by the processor in accordance to the pressure applied on the plurality of targets 24 and displayed on the displaying means 40. The target footfall images 60a,b,c are presented in a first predetermined color. Alternatively, the target footfall images 60a,b,c may also be presented in a first predetermined pattern.

[0034] The patient is then brought onto the platform 20 of the apparatus 10 and guided 620 to walk on or step on the plurality of targets 24 on the rubber mat 22. The patient's footsteps on the rubber mat also applies pressure on the rubber mat 24 and consequently on the high resolution sensing means 30. A plurality of patient footfall images 62a,b,c are then generated 630 by the processor in accordance to the pressure applied on the plurality of targets 24 and displayed on the displaying means 40. The patient footfall images 62a,b,c are presented in a second predetermined color. Alternatively, the patient footfall images 62a,b,c may also be presented in a second predetermined pattern.

[0035] As the patient is walking on the platform 20 attempting to place his own feet onto the targets 24, he can also look up and observe the displaying means 40 to monitor his own progress. Referring to FIG.5, the target footfall images 60a,b,c serves as a visual representation of the corresponding targets 24 on the rubber mat 22. As the patient walks or attempts to place his feet onto the targets 24, the patient footfall images 62a,b,c are generated.

[0036] When a generated patient footfall image 62a,b,c overlaps or partially covers a target footfall images 60a,b,c, an overlapping image 64a,b,c is generated 635 to illustrate this overlapping portion between the patient footfall image 62a,b,c and the target footfall image 60a,b,c. The overlapping image 64a,b,c is presented in a third predetermined color or a third predetermined pattern. By observing the positions of the patient footfall images 62a,b,c with respect to the target footfall images 60a,b,c, the patient can correlate his

actions or his intended actions with the corresponding results and make adjustments to improve his gait accordingly.

[0037] The overlapping images 64a,b,c displayed on the displaying means allow the patient to determine whether his intended actions have achieved an intended result. The larger the overlapping image 64a,b,c, the closer the patient was to placing his feet properly onto the target 24. Referring to FIG.5, the first patient footfall image 62a and the second patient footfall image 62b did not result in overlapping images 64a,b greater than 40% of the target footfall image 60a,b. However, the third patient footfall image 62c shows the overlapping image 64c amounting to almost 80% of the target footfall image 60c. Presenting to the patient this overlapping images 64a,b,c helps motivates and allows the patient to visualize his gait training and to take a more pro-active approach when performing gait training and rehabilitation. This also allows the therapist to more easily monitor and track the progress of the patient's gait training and rehabilitation program.

[0038] Referring to FIG.7, the process 700 for generating 615, 630 the target footfall images 60a,b,c and the patient footfall images 62a,b,c are similar. The process 700 starts with the causing of elastic deformation or elastically deforming the tensioned metal wires 52 when pressure is applied on the high resolution sensing means 30. Next, the metal rods 50 and the tensioned metal wires 52 come into physical contact thereby establishing 720 electrical contact between the metal rods 50 and the tensioned metal wires 52.

[0039] Data which comprises the electrical contacts between the metal rods 50 and tensioned metal wires 52 are sent 725 to the processor 34 and the locations of the electrical contacts are determined 730 by the processor 34 and an image of the electrical contacts is generated 735 by the processor and displayed on the displaying means 40. This image of the electrical contacts essentially form the image of the target footfall images 60a,b,c, the patient footfall images 62a,b,c and the overlapping images 64a,b,c.

[0040] In a single gait training session, a particular patient would have walked the entire length or a predetermined length of the platform 20 of the apparatus 10 and attempted to step onto a plurality of targets 24 pre-arranged on the rubber mat 24 of the platform 20. The target footfall images 60a,b,c, the patient footfall images 62a,b,c and the overlapping images 64a,b,c can all be recorded on a recording means such as the hard drive of a computer that may be coupled to the processor 34 or a floppy disk. Other data including the session date, time and the patient's and therapists name can also be recorded. By recalling such recorded data, the therapist can easily monitor and track the progress of a patient easily.

[0041] It will be appreciated that various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention.

Claims

1. An apparatus for gait training comprising:
 - a platform having a high resolution sensing means for detecting pressure applied on said high resolution sensing means;
 - a plurality of targets arranged in a predetermined manner on said platform;
 - a displaying means for displaying images; and
 - a processor for processing data from said high resolution sensing means and for sending images to said displaying means for display;wherein said data comprises a plurality of electrical contacts from said high resolution sensing means; and
further wherein said images displayed on said displaying means correlate to said data from said high resolution sensing means.
2. The apparatus in accordance with claim 1, wherein said high resolution sensing means comprises:
 - a first plurality of longitudinal conductive elements; and
 - a second plurality of longitudinal conductive elements;said second plurality of longitudinal conductive elements disposed above said first plurality of longitudinal conductive elements;
whereupon pressure being applied on a region of said platform results in elastic deformation of said second plurality of longitudinal conductive elements in said region further resulting in establishing said plurality of electrical contact between said first and said second plurality of longitudinal conductive elements in said region.
3. The apparatus in accordance with claim 2, wherein said plurality of electrical contacts are sent to said processor for processing.
4. The apparatus in accordance with claim 2, wherein said first plurality of

longitudinal conductive elements are arranged substantially parallel to each other in a first direction, said second plurality of longitudinal elements further arranged substantially parallel to each other in a second direction; and said first and second direction being substantially perpendicular to each other.

5. The apparatus in accordance with claim 2 wherein a first spacer and a second spacer are alternately arranged between each of said first plurality of longitudinal conductive elements.

6. The apparatus in accordance with claim 4, wherein said first spacer is made of at least one material of high elasticity .

7. The apparatus in accordance with claim 4, wherein said second spacer is made of at least one material of low elasticity..

8. The apparatus in accordance with claim 1 wherein said images comprises a plurality of target footfall images, a plurality of patient footfall images and a plurality of overlapping images.

9. The apparatus in accordance with claim 8 wherein said overlapping images comprises overlapping portions of said plurality of target footfall images with respect to said plurality of patient footfall images.

10. The apparatus in accordance with claim 9 wherein said target footfall image, said patient footfall image and said overlapping image are each of a different predetermined color or comprises a different predetermined pattern.

11. A method for enhancing gait rehabilitation of a patient comprising the steps:

- a. providing a platform gait trainer having a high resolution sensing means for detecting pressure from footfalls, a plurality of targets on said high resolution sensing means, a processor for processing data from said high resolution sensing means, a displaying means for displaying images of said pressure from footfalls on said platform gait trainer;
- b. placing said plurality of targets in a predetermined arrangement on said platform;
- c. applying pressure on said plurality of targets;
- d. generating a plurality of target footfall images corresponding to said plurality of targets and displaying said plurality of target footfall images on said displaying means;
- e. guiding a patient to step on said plurality of targets; and
- f. generating a plurality of patient footfall images corresponding to said plurality of targets and displaying said plurality of patient footfall images on said displaying means.

12. The method in accordance with claim 11 further comprising:

g. generating a plurality of overlapping images to illustrate overlapping portions of said plurality of target footfall images and said plurality of patient footfall images.

13. The method in accordance with claim 11 wherein said plurality of target footfall images is presented in a first predetermined colour or a first predetermined pattern.

14. The method in accordance with claim 11 wherein said plurality of patient footfall images is presented in a second predetermined colour or a second predetermined pattern.

15. The method in accordance with claim 12 wherein said plurality of target footfall images is presented in a third predetermined colour or a third predetermined pattern.

16. The method in accordance with claim 8, wherein said high resolution sensing means comprises:

- a first plurality of longitudinal conductive elements; and
- a second plurality of longitudinal conductive elements;
- said second plurality of longitudinal conductive elements disposed above said first plurality of longitudinal conductive elements;

whereupon pressure being applied on a region of said high resolution sensing means results in elastic deformation of said second plurality of longitudinal conductive elements in said region further resulting in establishing electrical contact between said first and said second plurality of longitudinal conductive elements in said region.

17. The method in accordance with claim 9, wherein step d. further comprises:

- i) causing elastic deformation of said second plurality of longitudinal conductive elements;
- ii) establishing a plurality of electrical contacts between said first and said second plurality of longitudinal conductive elements;
- iii) sending data comprising said plurality of electrical contacts to said processor;
- iv) determining plurality of locations of said plurality of electrical contacts;
- v) generating a target footfall image on said displaying means to illustrate locations of said plurality of locations of said plurality of electrical contacts.