

AN APPARATUS AND METHOD FOR ASSESSING BALANCE

Technical Field

The present invention relates to apparatus and methods for assessing balance.

- 5 Embodiments of the invention find particular application in assessing the balance of people, but could also be used to assess the balance of animals.

Background to the Invention

- 10 Balance refers to an individual's ability to maintain a particular stance. To remain standing requires ongoing and continuous postural adjustments. Tools to characterise the balance of an individual are used in a range of health and sports organisations for such purposes as falls risk assessment, concussion evaluation, neurological disease assessment and capabilities in sports requiring good balance.

- 15 Tools currently used include questionnaires; equipment with software to calculate movement of the subject's Centre of Pressure, including force plates and balance boards including the Nintendo Wii and devices based on the design of the Wii, and straps attached to the subject's torso with a pen which draw the sway patterns; and apps using accelerators in mobile phones.

- 20 The tools available to date either suffer from the problems of being expensive to produce, require specialised training in order to implement, or yield inconsistent results. There remains a need to provide improved apparatus and methods for assessing balance of a subject.

Summary of the Invention

- 25 In a first aspect the present invention provides an apparatus for assessing balance including: a light source; a light guide; and a light detector; the light source is arranged to introduce light into the light guide; the light guide is arranged to be stood upon by a subject; the light detector is arranged to detect light emanating from the light guide to thereby facilitate an assessment of the balance of a subject standing upon the
30 light guide.

The light source may be a light emitting diode.

The light guide may be an optical fibre which is convoluted in a substantially planar arrangement.

The optical fibre may be convoluted in a grid pattern.

The grid pattern may be a substantially orthogonal grid pattern.

The optical fibre may be embedded in a mat.

5 The light detector may be arranged to measure the intensity of light emanating from the light guide.

The assessment of balance may be based on variances in the output of the light detector over time

10 In a second aspect the present invention provides a method of assessing the balance of a subject including the steps of: providing an apparatus according to the first aspect of the invention; directing the subject to stand on the light guide; and analysing the output of the light detector to thereby make an assessment of the balance of the subject.

Brief Description of the Drawings

15 An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of an apparatus for assessing the balance of a person;

20 Figure 2 shows a mat partially constructed to depict the pattern of the convolution of the optical fibre; and

Figure 3 shows examples of test results obtained by use of the apparatus of figure 1.

Detailed Description of the Preferred Embodiment

25 Referring to figure 1, an apparatus 10 is shown for assessing the balance of a subject (being a person) including a light source in the form of a light emitting diode (LED) 22, a light guide in the form of a convoluted optical fibre 24 and a light detector in the form of a phototransistor 26. The optical fibre is convoluted and embedded in a mat 20.

30 The optical fibre used is a plastic optical fibre such as a polyethylene jacketed optical fibre cord. The optical fibre is convoluted and embedded in a mat type arrangement. The optical fibre is sandwiched in a mesh between two pieces of adhesive PE foam inside a mat which is laid on the ground for use.

Referring to figure 2, a mat is shown part-way through construction to illustrate the convolution pattern of the optical fibre. The fibre is convoluted in a grid pattern woven in such a way that the bends are not too tight. A back and forth pattern is laid down first one way (East-West) followed by a subsequent layer of grid pattern oriented the other way (North -South). The fibres in the two layers are oriented substantially orthogonally to one another. The free ends of the fibre 28 are subsequently terminated by optical connectors in a known fashion.

Referring again to figure 1, the terminated ends of the optical fibre 24 connect to a small-sized electronic module which is housed at an edge portion of the finished mat. The module includes an analog stage and a digital stage. The analog stage drives the LED and receives an analog output voltage from the phototransistor. The module further includes a digital stage which controls the LED and processes the signal received from the phototransistor. The digital stage interfaces with a computing device, such as a laptop computer (not shown), by way of an RS485 interface and cable.

In order to assess the balance of a person the mat which contains the convoluted optical fibre is laid on the ground. The person is then directed to stand upright on the mat for a period of time (for example, one minute). The person is asked to try to maintain a static upright position and to move as little as possible during the test.

During the test the computing device receives and processes the conditioned output from the phototransistor. Over the period of one minute the output of the phototransistor is sampled 1200 times (20 times per second). Any large or small movements made by the person standing on the mat give rise to bending movements of the optical fibre which result in changes in the intensity of the light detected by the phototransistor and hence influence the output of the phototransistor. The variance of the output of the phototransistor over time is used as the basis for assessing the person's balance.

The laptop computer displays a graphical user interface which presents the variance in the output of the phototransistor over time as a number on a scale of 1 to 100 as a general indicator of a person's balance ability. The interface also allows the raw data (1200 data points) to be downloaded and analysed to allow for subsequent additional analysis of the test results if required.

Referring to figure 3, several examples of the output displayed by the user

interface at the conclusion of a test are shown. The vertical axis depicts variance and the horizontal axis depicts time:

A - The first graph shows an example typical of the results for an individual with good balance with a typical variance score of 1.1.

5 B - The graph with a score of 100 shows a pattern indicated by a person with serious difficulty maintaining their balance. The person who produced this result was visibly struggling to maintain their balance.

C, D, E & F - These four graphs showing variance scores in the 40's are typical of people who make frequent small postural adjustments to maintain their balance.

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By way of calculating a variance score, the system can consistently distinguish quickly and easily between people with good balance (variance scores of less than 1 are common) and people with poor balance. Having identified people with a 'balance problem' then the raw data can be analysed over multiple tests to gain further insight
15 into the extent of the balance problem with a view to diagnosing the cause of the problem.

Although in the embodiment described above the electronic module in the mat was attached to a computing device by a cable, in other embodiments the mat may
20 communicate wirelessly.

In the embodiment described above a light detector in the form of a phototransistor was utilised. In other embodiments other types of components may be used such as a light dependent resistor.

The apparatus and method can be used in many different areas such as in aged
25 care for Falls Risk Assessment; concussion testing in sport; a mat with a single footstep for use in Yoga classes; and use in rehabilitation to monitor the progress of patients undergoing therapy.

Although the embodiment described above was described in use to assess the balance of people, other types of subjects may be assessed such as animals.

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It can be seen that embodiments of the invention have at least one of the following advantages:

- A typical subject may have a balance disorder or a potential balance problem. The arrangement of the optical fibre convoluted in a mat has a very low profile and is easy for test subjects to step onto and off, facilitating ease of use by subjects who can feel secure whilst undergoing testing.
- 5 • The apparatus is light weight and easily portable and can be used on any flat surface.
- The apparatus is of simple and durable construction and provides consistent test results from one test to another.
- No specialised training is required in order to use the apparatus or method.
- 10 • The testing methodology used requires very little cooperation or effort on the part of the test subject and can be conducted quickly and easily in any location.

Any reference to prior art contained herein is not to be taken as an admission that the information is common general knowledge, unless otherwise indicated.

- 15 Finally, it is to be appreciated that various alterations or additions may be made to the parts previously described without departing from the spirit or ambit of the present invention.

CLAIMS:

1. An apparatus for assessing balance including:
a light source;
a light guide; and
a light detector;
the light source is arranged to introduce light into the light guide;
the light guide is arranged to be stood upon by a subject;
the light detector is arranged to detect light emanating from the light guide to
thereby facilitate an assessment of the balance of a subject standing upon the
light guide.
2. An apparatus according to claim 1 wherein the light source is a light emitting
diode.
3. An apparatus according to either of claims 1 or 2 wherein the light guide is an
optical fibre which is convoluted in a substantially planar arrangement.
4. An apparatus according to claim 3 wherein the optical fibre is convoluted in a
grid pattern.
5. An apparatus according to claim 4 wherein the grid pattern is a substantially
orthogonal grid pattern.
6. An apparatus according to any one of claims 3 to 5 wherein the optic fibre is
embedded in a mat.
7. An apparatus according to any preceding claim wherein the light detector is
arranged to measure the intensity of light emanating from the light guide.
8. An apparatus according to any preceding claim wherein the assessment of
balance is based on variances in the output of the light detector over time.
9. A method of assessing the balance of a subject including the steps of:
providing an apparatus according to claim 1;
directing the subject to stand on the light guide; and
analysing the output of the light detector to thereby make an assessment of the
balance of the subject.