A GARMENT FOR TREATING SENSORY DISORDER

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Field

The present invention relates to a garment for treating sensory disorder such as anxiety attacks for people with sensory disorder, such as people with autism spectrum disorder or attentional difficulties.

Background

It is known to provide a deep pressure touch simulation garment, such as that disclosed in European Patent publication number 2355767. This includes an internal harness that supports a number of controllable air bladders. An external garment attaches over the harness. However it is not possible to independently control the bladders. Other prior art examples are given in US20040054306, WO20080314, US5437610, WO2011084709, US20120284898, WO2009114822, KR20120102434, KR20120078760, US2002089304, US2006242746, KR20120034095, US6086551, US2003074711, US2010199405, US2003230474 and CN201541756.

Summary

In general terms the present invention proposes a garment with a plurality of integrated air bladders which can be independently pressure controlled. This may have the advantage of maximising therapeutic efficacy of a pressure garment for people with autism spectrum disorder or attentional difficulties, such as autistic children, during an anxiety attack, when they are hyperactive, experiencing attentional difficulties, or when they are hypoactive. The variable pressure on different body portions may be prescribed after diagnosis by a clinician or healthcare professional, the symptoms remotely monitored and/or the prescribed treatment revised in view of monitoring.

In a first particular expression of the invention there is provided a garment as claimed in claim 1.

Brief Description of Drawings

One or more example embodiments of the invention will now be described, with reference to the following figures, in which:

Figure 1 is a block diagram showing a system according to an example embodiment;

Figure 2a is a flow diagram showing the interaction between the User, App, Cloud and Jacket;

Figure 2b is a flow diagram showing the interaction between the Cloud and the Therapist (Caregiver);

Figure 3 is Circuit Diagram of the Hardware Master;

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Figure 4 is a circuit Diagram of the Hardware Slave;
Figure 5 is a Flowchart of the Master Unit Firmware;
Figure 6 is a Flowchart of the Air Bladder Update Routine;
Figure 7 is a Case Diagram of the Software Use;
Figure 8 is a photo of the bladders providing Upper body inwards pressure;
Figure 9 is a photo of the bladders providing inwards pressure and constrictive effects (Upper and lower body);
Figure 10 is a photo of the Adjustment strap;
Figure 11 is a photo of the bladders avoiding pressure on diaphragm area;
Figure 12 is a schematic diagram of the Anti vibration measures;
Figure 13 is a photo of the Removable belt design for easy washing;
Figure 14 is a schematic diagram of the Power button holder;
Figure 15 is a schematic diagram of the Power button pocket;
Figure 16 is a photo of the Configurations and Positions of electronic components (3 units); and
Figure 17 is a photo of the Smaller airbag channels under main controller unit.

Detailed Description

A system 100 according to an example embodiment will now be described with reference to Figure 1. The system 100 includes a garment 200, a user control app (loaded on a mobile phone 300), a remote cloud 400, and a remote app 500 used by the therapist. The user can control the garment 200 using the app 300. The user's settings and the user's physiological parameters are monitored via the user phone 300 and stored in the cloud 400. In turn the therapist 500 can monitor the physiological parameters. The therapist can monitor physiological parameters or change settings.

The garment 200 may be a jacket, which incorporates multiple air bladders 202, batteries 214, a controller 208 including sensors 210 and valves 206, a pump 204 energised by the batteries 214 according to the controller 208. One sensor may be provided for each air bladder to detect the pressure in each air bladder. A communications module 212 connects the controller 208 to the phone 300. As mentioned above each bladder may be independently pressure controlled.

The phone 300 includes app 302 which may downloadable from an app store and installable into a mobile phone operating system such as Andriod, iOS, WindowPhone BlackBerry etc. The app 302 includes a user interface and protocols to communicate via the phone 300 native communications processors 304, eg: Bluetooth. The phone 300 includes a screen that receives input from the user and displays a status of the garment 200. The screen may be a touch screen.

The app 302 stores data from the garment 200 and the app 302 periodically transfers this data to the cloud 400. The cloud 400 includes a webserver 404 which communicates with each app 302 via a secure https channel. A database 402 stores the data from all of the users, and includes security protocols to ensure data privacy.

The remote user 500 may include a therapist, medical professional, parents or governmental concerns. A remote user app 502 includes the functionality to monitor user in real-time or review historical trends in the check on the physiological parameters. The therapist can select from a range of pre-set therapies, or may customise a specific therapy for each user. For example the app 302 may be programed to automatically respond to a particular physiological parameter breaching a threshold by providing different pressures to specific bladders. Later after reviewing the user's response to the therapy, the therapist may revise the settings.

Figure 2a shows the interaction between the user app 300 and the cloud 400.

1. A user can use the app to start a therapy session. The Jacket can be manually controlled via app to give the right pressure profile to the body. User's control pattern on the app and motion feedback from the Jacket will be logged on the Cloud for analytics. The data will be further compute into an Activity Index that may be related to user's stress or arousal level.
2. The user can also choose to view the Activity Index computed in graphical format.
3. With the feedback that reflect effectiveness of the therapy profile applied, the user can create and share the profile to other users through saving and uploading it to the social networking platform integrated to the Cloud. All users that the profile is shared to can make comments with regard to the profile.
4. The app will periodically update the Cloud with the connected Jacket status so that remote user will be able to know whether the Jacket is ready to be controlled remotely.

Figure 2b shows the interaction between the therapist 500 and the cloud 400:

5. Therapist or parents can remote control a Jacket anywhere they want by using the app.

a. They can view the real time Activity Index of the Jacket wearer via the app.

b. They can make changes to the therapy profile that will be applied to the wearer based on the feedback they have get.

c. After making profile changes, they can view the response again and further adjust the profile until satisfactory result is observed.

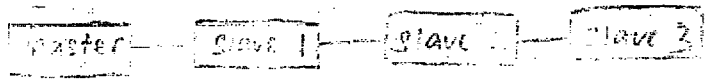
The controller 208 may be implemented as shown in Figures 3 and 4. The master unit contains the main controller that controls the pressure to be applied to the Jacket wearer. It receives

commands from the Jacket app via Bluetooth and instructs the slave circuit to inflate/deflate the air bladders to the right pressure level. It senses user's motion through the inertial measurement unit. A battery and battery management circuit are integrated into the system to

- Battery Management – Usage while charging is allowed. Low heat generation to ambient environment.
- Power Connector – May utilise USB connector for charging purposes for size optimization and ease of use.
- Battery – Flat rechargeable Lithium Battery is used to optimize power over weight ratio of the system.
- Bluetooth – Can be upgraded to Bluetooth Low Energy to allow low wireless communication power consumption.
- Inertial Measurement Unit – Consists of accelerometer and/or gyroscope and/or magnetometer
- Master unit may combine with slave units to form a more integrated system. Integration can be done via eliminating processing unit at slave units and its processing control will be taken over by microcontroller at master unit.
- Slave Connection – Inter circuit connection to the slave unit is pure digital to reduce signal deterioration due to noise.detect
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As shown in Figure 4 each slave unit consists of one actuator (pump), one sensor (pressure sensor) and control to form a closed loop control system.

- General - Plurality of slave modules allowed in the following daisy-chain connection



- Modularize system allows weight distributed more evenly on wearer body.
- Slave/Master Connection – Inter circuit connection to the other unit is pure digital to reduce signal deterioration due to noise.
- Voltage Converter – Dedicated voltage converter for each slave unit allows multi-slave expansions without having the need to change the design of the master unit.
- Normally Closed Valve – The valve is chosen to be normally closed to reduce power consumption while holding the pressure in the air bladder. We expect the air pressure of the air bladder will remain constant most of time during the therapy session. Exhausting pump may be required if the deflation duration is too long.
- Air pump – Air flow silencer will be required to reduce operational noise.
- Air pump – Rolling pump with three diaphragm chamber is chosen to optimize the size, noise and vibration of the system.

- Pressure sensor – Pressure sensor is chosen to have sensing range between 0 kPa and 40 kPa to maximize sensing precision.
- Processing Unit – Processing unit may just consist of analogue to digital converter and logic input of output to simplify production process.

The controller 208 has main operating algorithm according to the firmware shown in Figure 5.

As shown in Figure 6 the firmware includes an operation algorithm which manages the pressure of each bladder using the pressure sensors according to the set point for each bladder:

a. Air Bladder Update
b. Air Bladder Check
c. IMU Read
d. UART Communication

Each of the tasks may have a different period to ensure even controller load distribution and task can be performed in a timely manner.

Figure 7 illustrates how users can interact with the system. Users can (from top to bottom):

1) Login to system (access to Cloud)
2) Register new user
3) Establish Bluetooth connection between Mobile phone and Jacket
4) Start therapy session (control pressure level & location)
5) View activity level (through motion sensor data from the Jacket). Auto therapy will trigger the appropriate pressure therapy based on activity level detected. The system may also be configured to be in manual therapy mode where an alert notification will be sent to the therapist to give them the option to provide pressure therapy
6) Enter comments
7) View comments
8) Upload data on the phone to the cloud server to be stored online

There are services designed on the cloud server to communicate with the mobile phone app and the database.

1) User Login Service: interface between user login data and server authentication
2) User Register Service: interface between new user registration and server database
3) Therapy Record Data Service: enables system to save user feedback at the end of the therapy session through a structured form.

4) Comments Data Service, Activity Data Service, Gyro Data Service, Pressure Level Data Service, Multimedia Upload Service: enables user to save comments, activity, gyro, pressure level, and multimedia (pictures, videos) on the database.

The bladders 202 include a number of separately controlled bladders. Each bladder is made by having two layers of thermoplastic polyurethane (TPU) like material placed together and heat sealing them with a metal mold placed over the TPU layers. The mold is shaped accordingly to the form of the air channels. In this way, two air channels are fabricated, one for the upper body and one of the lower body of the user. In use, the air channel for the upper body is for the abdomen area of the user and the air channels for the lower body is for the lower back area of the user. The air channels are sewn onto an inner fabric lining of the jacket.

Figure 8 shows the bladders demonstrating an inwards pulling effect (in the direction perpendicular to the long strip seals). The bladders have significant inner seals, so that the shoulder area can be constricted inwards, giving pressure around and on the shoulders. A downwards pressure on the shoulders is further enhanced due to the sufficient anchorage provided by traction from the inflated bladder under the arm pit. This constriction inwards also reduces the uplifting of the airbags on shoulder region, and more inward pressure can be applied on the upper chest and upper back areas.

Figure 9 shows a mixture of small and large channels within for an all round tightening pressure and inwards pushing effects at pressure sensitive areas. This results in greater all round pressure and inwards pressure at pressure sensitive areas.

Figure 10 shows the use of a double D ring size adjustment strap to better fit the jacket to the user. This adjustment straps are located on the side in contact with the body and not within the jacket layers, allowing easy pulling of the straps to adjust the jacket to fit user. By pulling the straps, the inner lining of the jacket will be pulled in to fit the user. This helps to ensure that the user can feel the pressure from the airbags more effectively. This adjustment is easy to make and automatically locks compared to a velcro adjustment.

Figure 11 shows the bladders are designed to avoid the diaphragm area and yet applying sufficient pressure on upper chest and abdomen area. This improves safety, and reduces pressure on the chest and abdomen area.

As a safety mechanism, when the upper body pressure is activated, the lower body pressure will deflate and vice versa. This will ensure the respiratory motion is not fully restricted. This

means that even though breathing is somewhat restricted during an anxiety attack, there is still a safety margin for adequate breathing.

Figure 12 shows by careful positioning the pump, when the airbags surrounding it are inflated, the vibration can be insulated from the user. This may improve the user experience and may reduce noise level.

The master unit which comprises the controller is separated from the slave unit which comprises the air pump to minimise air chambers that will contribute to propagating the noise when there is a vibrational source. The slave unit is separated from he user by the bladders. Thus the air pump is as small and as isolated as possible to minimise the amount of noise produced.

Figure 13 shows a "belt" that contains all the electronics. It is designed to be easily removed from the jacket. This "belt" will be attached to the jacket by fasteners. The electronics are easily removed for washing and maintenance.

Figure 14 shows an overhanging shaped casing feature that holds the power button and the casing close to the fabric. The button protrudes out of the fabric for easy locating and pressing.

Figure 15 shows the LED lights indicators concealed within a small pocket. The LED lighting is less obvious to people other than the jacket user or someone who is in close proximity.

Figure 16 shows the electronic components split into 3 locations: the main controller unit is placed near the main zip and each pump unit is placed near the waist of the user on opposite sides. This distribution minimises discomfort to the user while they are doing their daily activities. It reduces bulges on the soft outer fabric by placing them in non-obvious positions. It better distributes the weight of the system around the user's body to improve usability.

Figure 17 shows the airbag channels under the main controller unit are smaller so as to reduce the bulging effect caused by both the airbag inflation and the thickness of the main controller unit. This reduces bulging and makes the jacket more aesthetically pleasing.

All edges of the casings holding the electronics are designed to be more rounded so that there are no sharp edges which might make the users more uncomfortable especially when they are wearing them. A more rounded design also reduces the bulging look when the casings are lying against a soft fabric material.

Stimming situations at home or in the outdoors

When at home or outdoors, the child can get hyperactive or start stimming. When this happens, the parent can use the remote app to apply deep pressure therapy from the jacket to calm down the child (which the child has already being wearing as the jacket is designed to be an everyday wear or would be instructed to wear the jacket by the parent). However, there will be stimming situations whereby the child is not wearing the jacket or the child would not want to put on the jacket.

Pre empting stimming situations

- *Habitual*

Some stimming situations may be pre-empted by enticing the child to put on the jacket habitually as an everyday wear and using the pressure therapy regularly as part of their routine.

- *Self recognition*

The child also can be trained to recognise that when they are getting anxious, they will ask for or put on the jacket.

- *Self regulation*

For higher functioning children, if they recognise that they are getting anxious or they just like the pressure therapy, they might control the app themselves and activate the pressure.

Detection of hyperactivity or stress level

Assuming that they are already wearing the jacket, when sensors on the jacket detect hyperactivity or high stress level of the child, a notification will be sent to the parent or therapist. They will then have the option to start the pressure therapy or use other methods to calm down the child. An automatic triggering of the pressure therapy can also be activated when the hyperactivity or high stress level of the child is detected. This detection of hyperactivity or stress level offers convenience to the parents as they might not be always aware that their children are getting hyperactive or anxious. Early detection also allows the caregivers to intervene before a full attack occurs.

Logging and sharing of pressure profiles used

The pressure profile used for the child is logged and can be anonymously shared with other users so that other parents and therapists will know what kind of pressure profile might be effective for a child with a particular profile.

Logging and sharing of care givers comments

The comments entered by caregivers before, during and after the pressure therapy sessions can be logged and be anonymously shared with other users so that other parents and therapists will understand better the effects of a certain pressure therapy on a child with a particular profile.

Therapist / teacher controlled

When the therapist or teacher is controlling the jacket, a parent will still be able to remotely supervise the pressure therapy sessions.

Teacher / therapist - multiple kids

As teachers and therapists sometimes conduct one teacher or therapist to many children (3 to 5 children) classes or therapy sessions, there are situations whereby multiple children can get hyperactive or start stimming at the same time. When this happens, the teacher or therapist can use their app to remotely apply deep pressure therapy to these children all at once to calm them down simultaneously.

Whilst exemplary embodiments of the invention have been described in detail, many variations are possible within the scope of the invention as will be clear to a skilled reader.

STATEMENTS OF INVENTION

1. A garment comprising:
at least two compartments,
at least two independently controlled air bladders within the compartments,
a sensor to detect the pressure in the air bladders, and
a controller to control the pressure in the air bladders according to predetermined criteria.

2. The garment in claim 1 wherein the controller comprises at least a master processor and a pump for a first of the air bladders, and a slave processor and a pump for a subsequent air bladder.

3. The garment in any preceding claim wherein the air bladders are configured to minimise the garment lifting up when inflated.

4. The garment in any preceding claim wherein the air bladders are configured to avoid pressure on diaphragm and provide a constriction effect of the sides of the body.

5. The garment in any preceding claim further comprising an outer soft shell with a self locking adjustment strap.

6. The garment in any preceding claim wherein the controller alternates the pressure in the air bladders.

7. The garment in claim 2 wherein the processors are physically isolated from the pumps, and the pumps are isolated from the user by the bladders.

8. The garment in any preceding claim wherein the controller is attached to a removable belt, the controller is distributed in separate units around the user waist and/or the bladders are minimised adjacent to the controller.

9. The garment in any preceding claim further comprising a power button configured to be easily located and pressed and with light indicators that are obscured to third parties, other than the user.

10. The garment in any preceding claim wherein the controller includes a rounded casing.

11. The garment in any preceding claim wherein the predetermined criteria comprise whether a physiological parameter is above a threshold.

12. The garment in claim 11 wherein the predetermined criteria further comprise the user manually selecting a pressure profile.

13. The garment in claim 11 or 12 wherein the predetermined criteria may be set remotely by a parent, clinician or healthcare professional.

14. The garment in any preceding claim configured to store data in a remote database, including the physiological parameters and usage of the garment.

15. The garment in any preceding claim further comprising an actuator for producing an air pressure in the air bladders.

16. A user app for controlling a garment according to any of claims 1 to 15.

17. A cloud server or remote database for storing data from a garment according to any of claims 1 to 15.

18. A remote app for controlling a garment, or for analysing data from a garment, according to any of claims 1 to 15.