US 20130204146A1

(19) **United States**

(12) **Patent Application Publication**

CHO

(10) **Pub. No.: US 2013/0204146 A1**

(43) **Pub. Date: Aug. 8, 2013**

(54) **RESPIRATION INDUCING APPARATUS AND CONTROL METHOD THEREOF**

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(21) Appl. No.: **13/759,635**

(22) Filed: **Feb. 5, 2013**

(30) **Foreign Application Priority Data**

Feb. 8, 2012 (KR) 10-2012-0012722

Publication Classification

(51) **Int. Cl.**

A61B 5/00	(2006.01)
A61B 5/0205	(2006.01)
A61B 5/113	(2006.01)

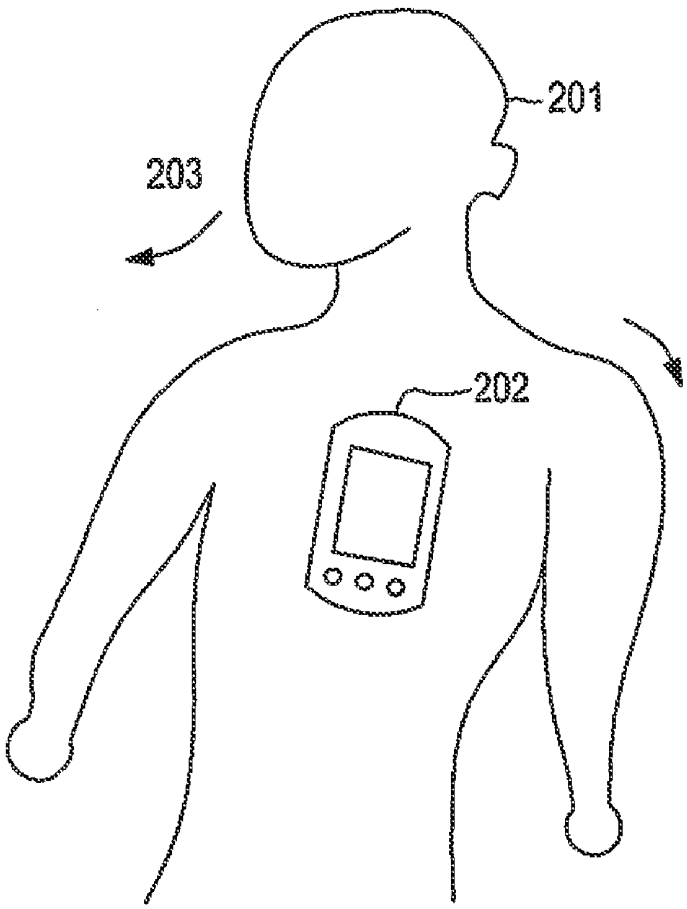
(52) **U.S. Cl.**

CPC ***A61B 5/7246*** (2013.01); ***A61B 5/742*** (2013.01); ***A61B 5/7475*** (2013.01); ***A61B 5/6823*** (2013.01); ***A61B 5/113*** (2013.01); ***A61B 5/0205*** (2013.01); ***A61B 5/7278*** (2013.01)

USPC **600/484**; 600/529; 600/534

(57) **ABSTRACT**

A respiration inducing apparatus is provided, and includes a respiration waveform data collection unit for collecting respiration waveform data from a user; a storage unit for storing a respiration waveform template; a controller for comparing the respiration waveform data and the respiration waveform template and determining a respiration fidelity based on a similarity of a comparison result; and a user interface unit for displaying at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity.



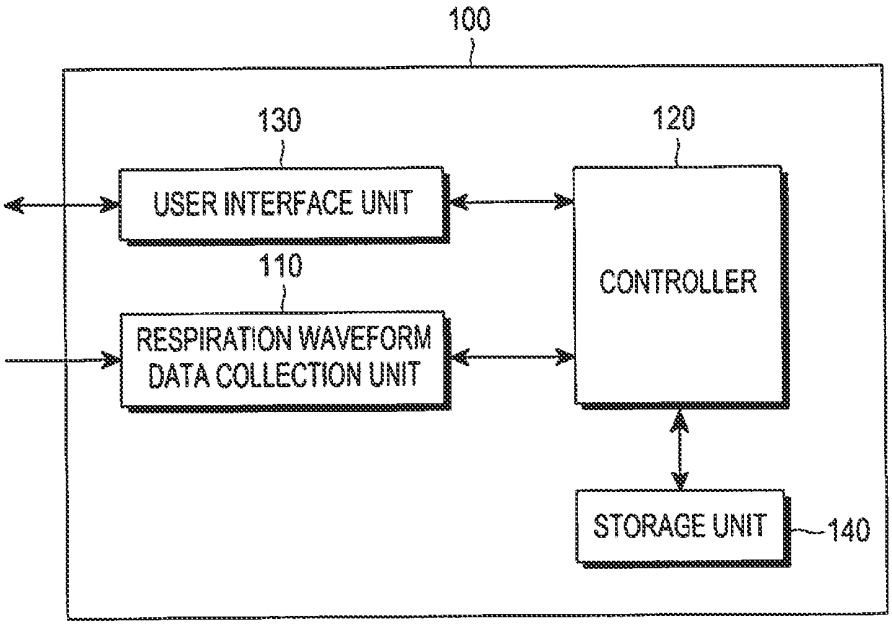

100
130
120
USER INTERFACE UNIT
110
CONTROLLER
RESPIRATION WAVEFORM DATA COLLECTION UNIT
STORAGE UNIT
140

FIG.1

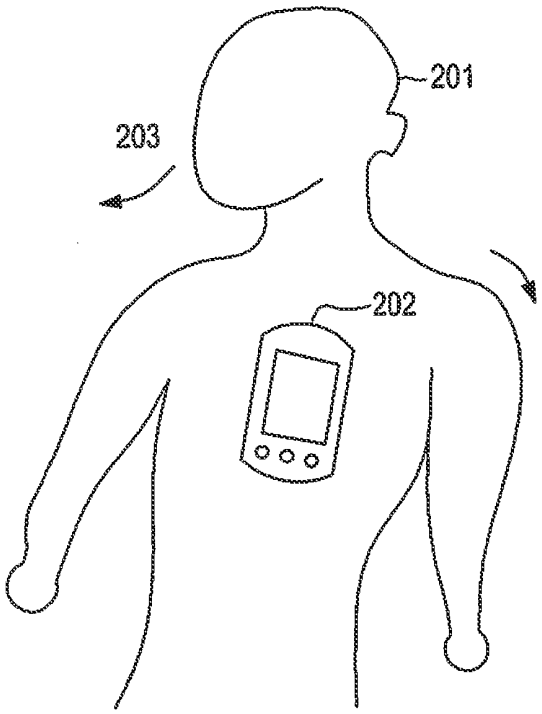


FIG.2A

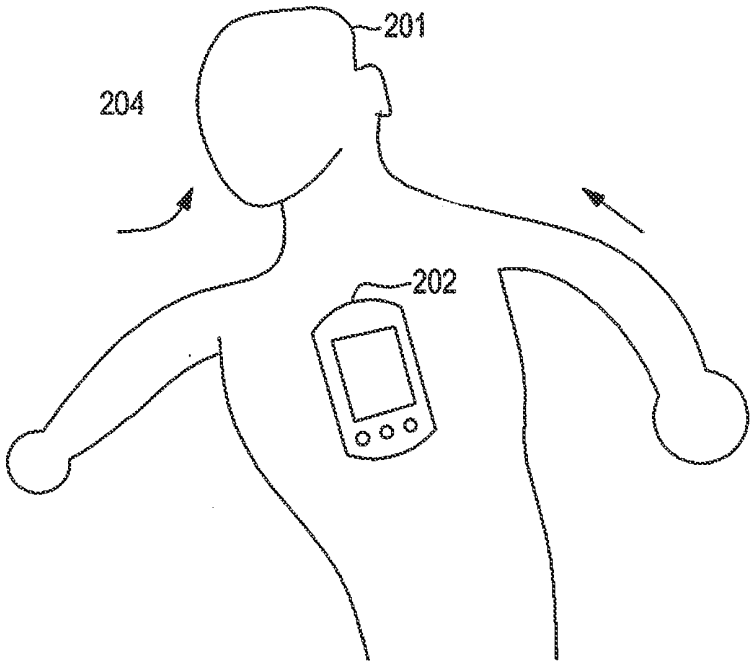


FIG.2B

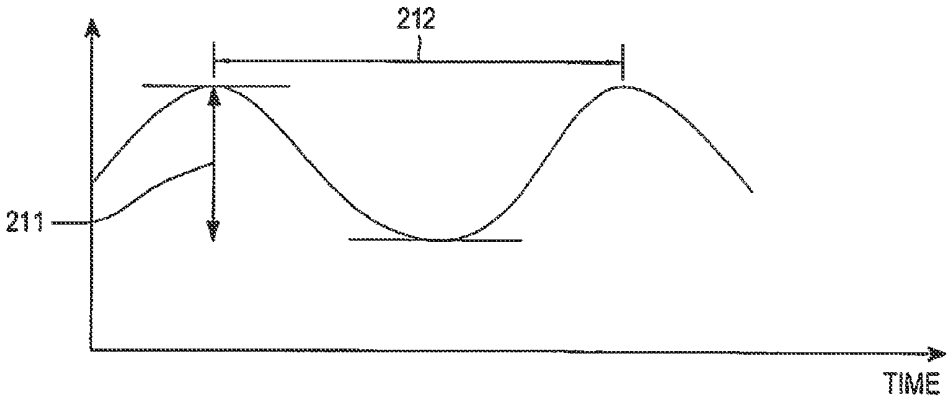


FIG.2C

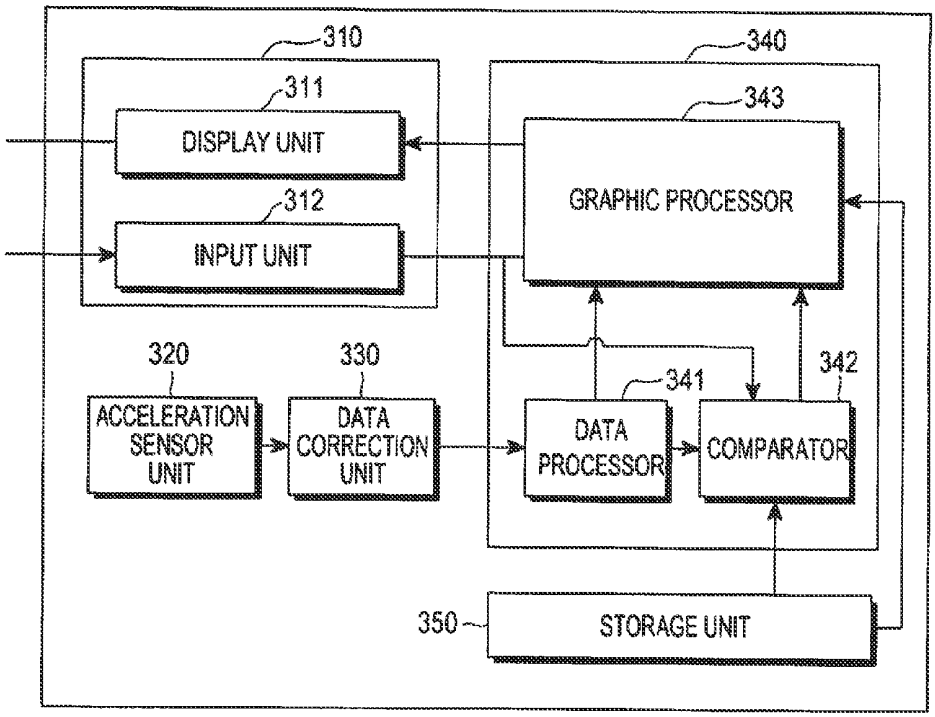

310
311
DISPLAY UNIT
312
INPUT UNIT
340
343
GRAPHIC PROCESSOR
320
ACCELERATION SENSOR UNIT
330
DATA CORRECTION UNIT
341
DATA PROCESSOR
342
COMPARATOR
350
STORAGE UNIT

FIG.3

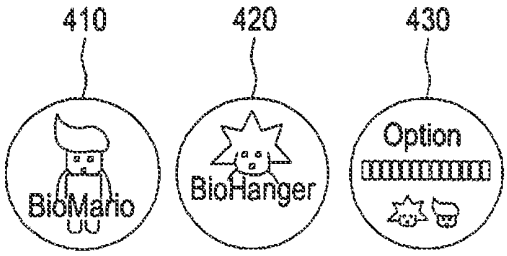

410
420
430
BioMario
BioHanger
Option

FIG.4A

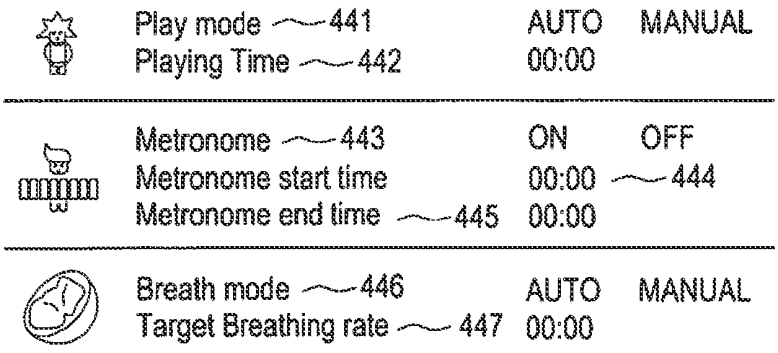

Play mode 441
AUTO
MANUAL
Playing Time 442
00:00
Metronome 443
ON
OFF
Metronome start time
00:00 444
Metronome end time 445
00:00
Breath mode 446
AUTO
MANUAL
Target Breathing rate 447
00:00

FIG.4B

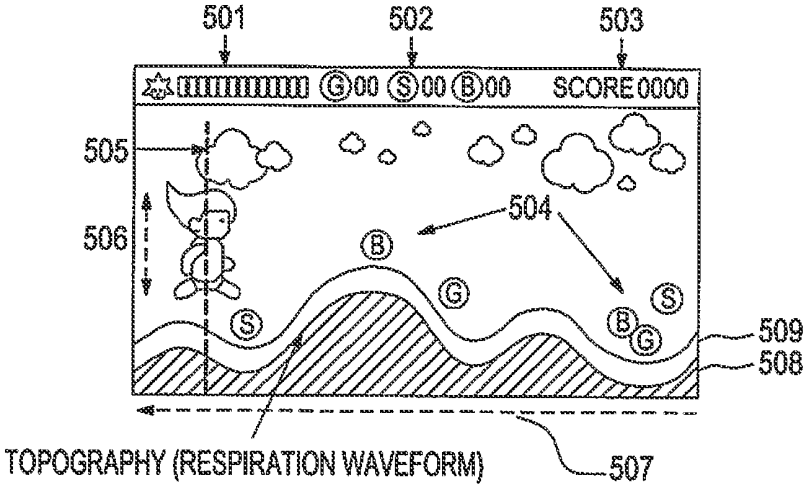

501
502
503
Ⓖ00 Ⓢ00 Ⓑ00 SCORE 0000
505
506
504
Ⓑ
Ⓖ
Ⓢ
Ⓢ
Ⓑ
Ⓖ
509
508
TOPOGRAPHY (RESPIRATION WAVEFORM)
507

FIG.5

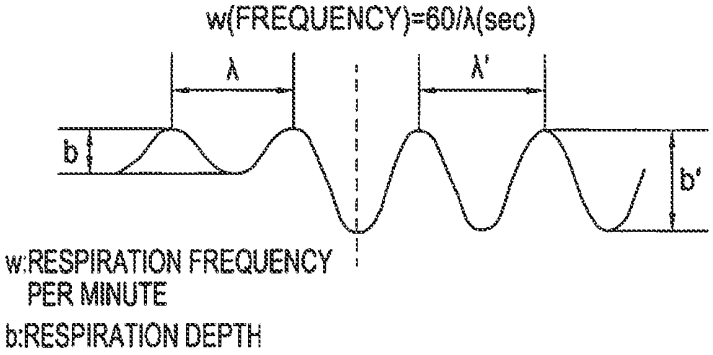

w(FREQUENCY)=60/λ(sec)
λ
λ'
b
b'
w:RESPIRATION FREQUENCY PER MINUTE
b:RESPIRATION DEPTH

FIG.6A

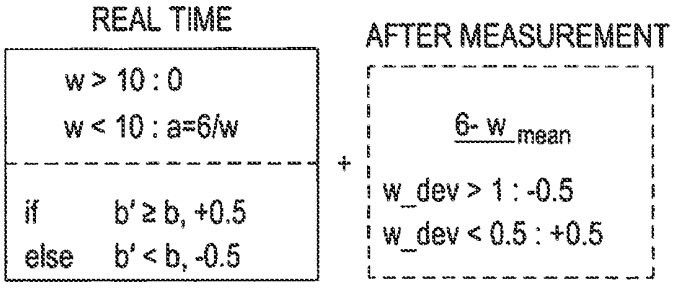

REAL TIME
AFTER MEASUREMENT
w > 10 : 0
w < 10 : a=6/w
if b' ≥ b, +0.5
else b' < b, -0.5
+
6- w mean
w_dev > 1 : -0.5
w_dev < 0.5 : +0.5

FIG.6B

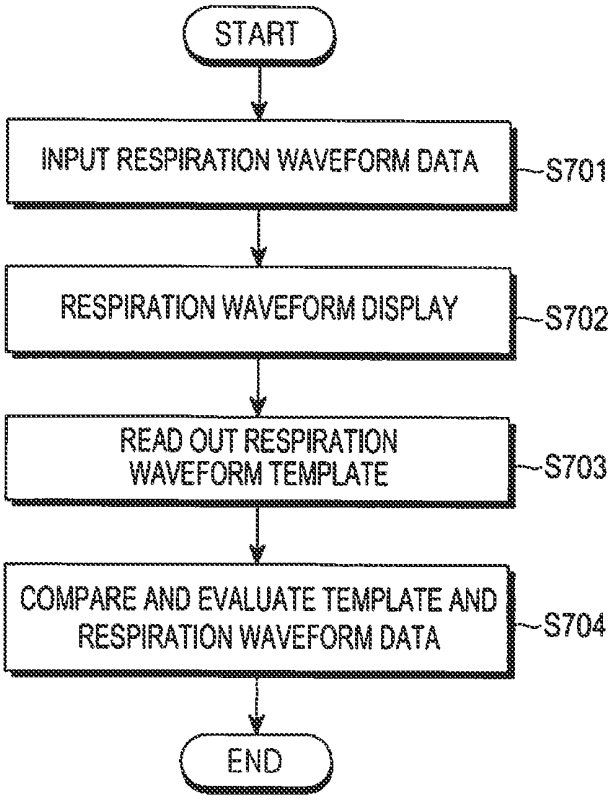

START
INPUT RESPIRATION WAVEFORM DATA
S701
RESPIRATION WAVEFORM DISPLAY
S702
READ OUT RESPIRATION WAVEFORM TEMPLATE
S703
COMPARE AND EVALUATE TEMPLATE AND RESPIRATION WAVEFORM DATA
S704
END

FIG.7

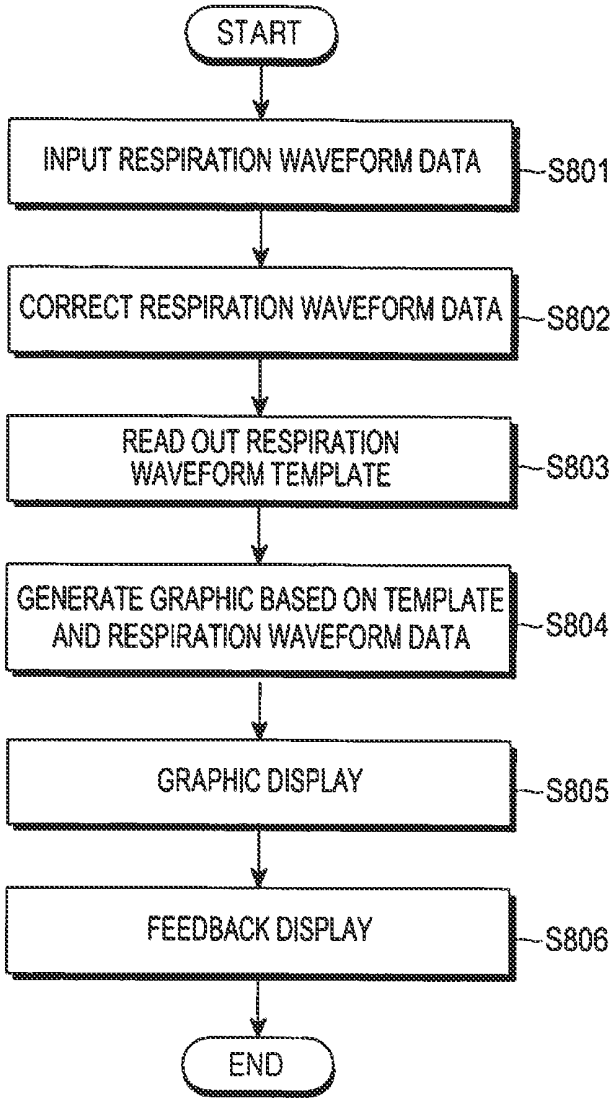

START
INPUT RESPIRATION WAVEFORM DATA
S801
CORRECT RESPIRATION WAVEFORM DATA
S802
READ OUT RESPIRATION WAVEFORM TEMPLATE
S803
GENERATE GRAPHIC BASED ON TEMPLATE AND RESPIRATION WAVEFORM DATA
S804
GRAPHIC DISPLAY
S805
FEEDBACK DISPLAY
S806
END

FIG.8

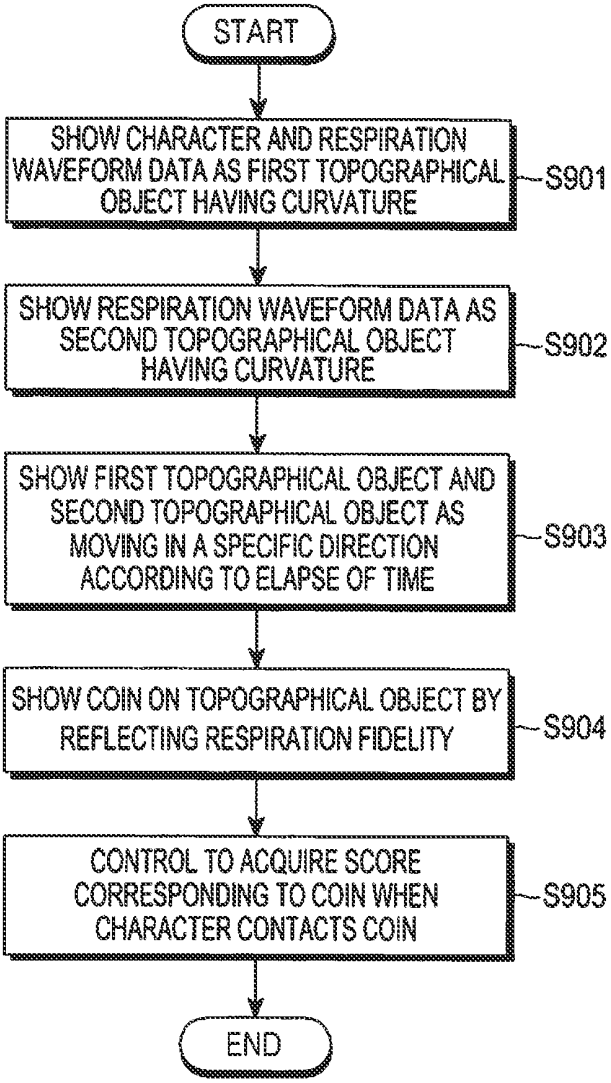

START
SHOW CHARACTER AND RESPIRATION WAVEFORM DATA AS FIRST TOPOGRAPHICAL OBJECT HAVING CURVATURE
S901
SHOW RESPIRATION WAVEFORM DATA AS SECOND TOPOGRAPHICAL OBJECT HAVING CURVATURE
S902
SHOW FIRST TOPOGRAPHICAL OBJECT AND SECOND TOPOGRAPHICAL OBJECT AS MOVING IN A SPECIFIC DIRECTION ACCORDING TO ELAPSE OF TIME
S903
SHOW COIN ON TOPOGRAPHICAL OBJECT BY REFLECTING RESPIRATION FIDELITY
S904
CONTROL TO ACQUIRE SCORE CORRESPONDING TO COIN WHEN CHARACTER CONTACTS COIN
S905
END

FIG.9

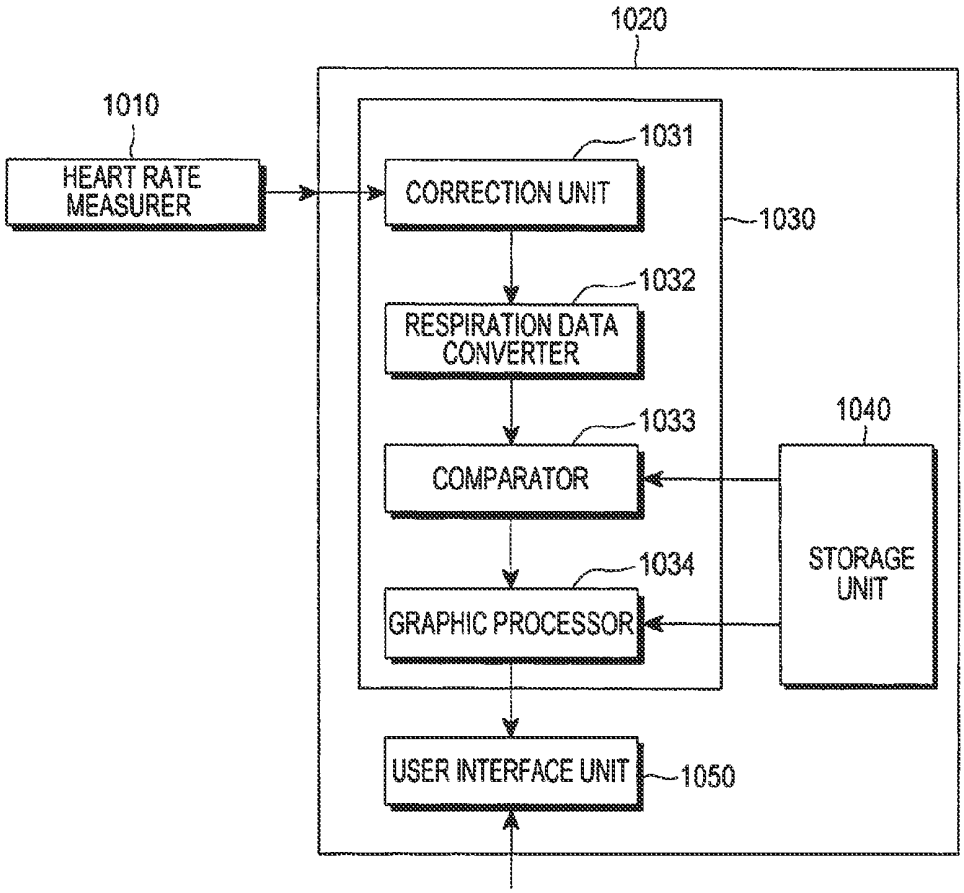

1020
1010
HEART RATE MEASURER
1031
CORRECTION UNIT
1030
1032
RESPIRATION DATA CONVERTER
1040
1033
COMPARATOR
STORAGE UNIT
1034
GRAPHIC PROCESSOR
USER INTERFACE UNIT
1050

FIG.10

RESPIRATION INDUCING APPARATUS AND CONTROL METHOD THEREOF

PRIORITY

[0001] This application claims priority under 35 U.S.C. §119(a) to Korean Application Serial No. 10-2012-0012722, which was filed in the Korean Intellectual Property Office on Feb. 8, 2012, the entire content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to a respiration inducing apparatus and a control method using respiration waveform data, and more particularly, to a respiration inducing apparatus and a control method capable of inducing respiration having a specific period and depth.

[0004] 2. Description of the Related Art

[0005] It is widely known and proven that stress is a major cause of developing various diseases. Accordingly, various methods of reducing stress are being researched. Particularly, in psycho-analytical and related medical fields, respiration during a specific period is identified as a method of reducing stress.

[0006] Statistical results of stress reduction experiments in the medical field shows continuing respiration in a specific period, e.g., six times in one minute, has a stress reduction effect. The aforementioned continuous respiration in a specific period has an effect not only for stress reduction but also for a good sleep, and thus, continuous respiration in the specific period needs to be promoted.

[0007] On the other hand, there is no specific disclosure of a technique for promoting continuous respiration in a specific period. Accordingly, a method of promoting the continuous respiration in the specific period is needed. However, since a user may easily become tired of performing continuous respiration in the specific period, there is a need for an apparatus for stably promoting respiration in the specific period and a control method thereof which triggers a user's interest.

SUMMARY OF THE INVENTION

[0008] Accordingly, an aspect of the present invention is to solve at least the above-described problems occurring in the prior art, and to provide at least the advantages described below.

[0009] Another aspect of the present invention is to provide a respiration inducing apparatus and a control method thereof capable of inducing respiration in a specific period.

[0010] In accordance with an aspect of the present invention, a respiration inducing apparatus is provided. The respiration inducing apparatus includes a respiration waveform data collection unit for collecting respiration waveform data from a user; a storage unit for storing a respiration waveform template; a controller for comparing the respiration waveform data and the respiration waveform template and determining a respiration fidelity based on a similarity of a comparison result; and a user interface unit for displaying at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity.

[0011] In accordance with another aspect of the present invention, a method of controlling a respiration inducing apparatus is provided. The method includes collecting respiration waveform data from a user; reading out a pre-stored respiration waveform template; comparing the respiration waveform data and the respiration waveform template and determining a respiration fidelity based on a similarity of a comparison result; and displaying at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The above and other aspects, features, and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0013] FIG. **1** illustrates a block diagram of a respiration inducing apparatus according to an embodiment of the present invention;

[0014] FIGS. **2**A and **2**B illustrate conceptual views in which a user wears a respiration inducing apparatus including a respiration waveform data collection unit;

[0015] FIG. **2**C illustrates respiration waveform data in analog form according to an embodiment of the present invention;

[0016] FIG. **3** illustrates a block diagram of a respiration inducing apparatus according to an embodiment of the present invention;

[0017] FIGS. **4**A and **4**B illustrate examples of game screens according to an embodiment of the present invention;

[0018] FIG. **5** illustrates a conceptual view of a game play screen according to an embodiment of the present invention;

[0019] FIGS. **6**A and **6**B illustrate conceptual views explaining a respiration fidelity and a score thereof;

[0020] FIG. **7** illustrates a flow chart of a control method of a respiration inducing apparatus according to an embodiment of the present invention;

[0021] FIG. **8** illustrates a flow chart of a control method of a respiration inducing apparatus according to another embodiment of the present invention;

[0022] FIG. **9** illustrates a flow chart of a game screen display method according to another embodiment of the present invention; and

[0023] FIG. **10** illustrates a block diagram of a respiration inducing apparatus according to another embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

[0024] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the following description, the same elements will be designated by the same reference numerals wherever possible. Further, in the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention unclear.

[0025] FIG. **1** illustrates a block diagram of a respiration inducing apparatus according to an embodiment of the present invention;

[0026] As shown in FIG. **1**, a respiration inducing apparatus **100** includes a respiration waveform data collection unit **110**, a controller **120**, a user interface unit **130**, and a storage unit **140**. Here, the respiration inducing apparatus **100** is not limited in structure as long as the respiration inducing apparatus **100** has a structure of including the respiration waveform data collection unit **110**, the controller **120**, the user interface unit

130, and the storage unit **140**; however, in an embodiment of the present invention, the respiration inducing apparatus **100** may be implemented in a smart phone or a tablet personal computer (PC). The smart phone or the tablet PC may include a touch screen corresponding to the user interface unit **130**, a central processor corresponding to the controller **130**, and a storage means corresponding to the storage unit **140**.

[0027] The respiration waveform data collection unit **110** collects respiration waveform data of a user who wears, directly or indirectly, the respiration inducing apparatus **100**. Here, the respiration waveform data is time series data and, for example, has a higher value with respect to inhalation and a lower value with respect to exhalation. A form of the respiration waveform data will be described later in more detail with reference to FIG. **2**C.

[0028] The respiration waveform data collection unit **110** collects respiration waveform data in analog form to be output to the controller **120**. Alternatively, the respiration waveform data collection unit **110** may perform preset pre-treatment on the respiration waveform data in analog form to be converted into a digital form and output.

[0029] The respiration waveform data collection unit **110**, for example, is implemented in a three axis acceleration sensor. Here, the three axis acceleration sensor means a sensing means capable of measuring an acceleration respectively corresponding to three dimensions of a space. The respiration waveform data collection unit **110** may be directly mounted to the user.

[0030] When the user performs respiration, the user's diaphragm moves downward when the user inhales and the diaphragm moves upward when the user exhales. The respiration waveform data collection unit **110** is preferably mounted around the level of the a user's diaphragm.

[0031] FIG. **2**A illustrates a conceptual view in which the user wears the respiration inducing apparatus **100** including the respiration waveform data collection unit **110**. As shown in FIG. **2**A, a user **201** mounts the respiration inducing apparatus **202** near the diaphragm. As described above, when the user exhales at **203**, the diaphragm moves upward.

[0032] The respiration waveform data collection unit **110** senses an acceleration of the ascending diaphragm. For example, the respiration waveform data collection unit **110** senses an increasing acceleration in an opposite direction of gravity due to the ascending of the diaphragm. Alternatively, the respiration waveform data collection unit **110** senses an increasing acceleration in a direction toward the chest because the chest ascends due to the ascending diaphragm.

[0033] FIG. **2**B illustrates a conceptual view for explaining a process in which the user inhales. Similar to the embodiment of FIG. **2**A, the user **201** mounts a respiration inducing apparatus **202** near the diaphragm. When the user **201** inhales at **204**, the diaphragm of the user **201** moves downward.

[0034] The respiration waveform data collection unit **110** senses an acceleration of the descending diaphragm. For example, the respiration waveform data collection unit **110** senses an increasing acceleration in a direction of gravity due to the descending of the diaphragm. Alternatively, the respiration waveform data collection unit **110** senses an increasing acceleration in an opposite direction of the chest because the chest descends due to the descending diaphragm.

[0035] The respiration waveform data collection unit **110** outputs collected acceleration increase/decrease information to the controller **120** as raw data in analog form. Alternatively, as described above, the respiration waveform data collection unit **110** outputs respiration waveform data, which is converted into the digital form through predetermined pre-treatment, to the controller **120**.

[0036] FIG. **2**C shows respiration waveform data in analog form according to an embodiment of the present invention. As shown in FIG. **2**C, the respiration waveform data may be time series data. The respiration waveform data has a certain depth **211** and a certain period **212**. As a user's respiration becomes faster, the period **212** may be shortened, and as a user's respiration volume is increased, the depth **211** may be increased.

[0037] On the other hand, the respiration waveform data collection unit **110** may collect the respiration waveform data in various methods other than a method of measuring an acceleration of the user's diaphragm or chest, and this will be described in further detail later.

[0038] The controller **120** receives the respiration waveform data to be compared with a respiration waveform template read out from the storage unit **140**. The respiration waveform template is respiration waveform related data including information about a period and a depth which are proven to have a stress reduction effect. For example, the respiration waveform template may be sinusoidal data having a frequency of 360 Hz.

[0039] The controller **120** compares the respiration waveform data and the respiration waveform template and outputs a comparison result to the user interface unit **130**. The controller **120** determines a similarity between the respiration waveform data and the respiration waveform template and determines a user's current respiration fidelity based on the determined similarity.

[0040] For example, the controller **120** determines a correlation between the respiration waveform data and the respiration waveform template and determines a correlation value as the similarity.

[0041] Here, time series data of the respiration waveform is designated as [x**1**, x**2**, . . . , xn] and time series data of the respiration waveform template is designated as [y**1**, y**2**, . . . , yn]. In this case, a correlation r_{xy} between the respiration waveform data and the respiration waveform template may be determined by Equation (1).

$$r_{xy} = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}} \quad \text{Equation (1)}$$

[0042] In Equation 1, is an average of the respiration waveform data and $\bar{y}$ is an average of the respiration waveform template. As the correlation value according to Equation (1) is higher, a waveform similarity between the respiration waveform data and the respiration waveform template is higher and, as the correlation value according to Equation (1) is lower, the waveform similarity between the respiration waveform data and the respiration waveform template is lower.

[0043] The controller **120** determines the above described correlation to determine the user's respiration fidelity. For example, the controller **120** determines that a current respiration fidelity is higher when the correlation is higher and determines that the current respiration fidelity is lower when the correlation is lower.

[0044] The controller **120** may render a graphic of the above described respiration fidelity in a manner which more conforms to a user's intuition. For example, the controller **120** may score the respiration fidelity to render a user-friendly graphic including the scored respiration fidelity. The controller **120** may control the user interface unit **130** to display the rendered graphic.

[0045] The controller **120** may control the user interface unit **130** to display, in addition to the respiration fidelity, a respiration induction indicator for a higher respiration fidelity, a respiration waveform data currently input, and a respiration waveform template.

[0046] The controller **120** controls an overall operation of the respiration inducing apparatus **100**. The controller **120** may reads out, from the storage unit **140**, and performs a program, and an application, an algorithm about the overall operation of the respiration inducing apparatus **100**. The controller **120** may be implemented in a form of a central processor, a microprocessor, an integrated circuit (IC) chip, or a mini computer, and it is apparent to those skilled in the art that the controller **120** is not limited in kind. The controller **120** may further include at least one of a ROM and a RAM which are additional storage means, and in this case, the central processor, the ROM, and the RAM may be interconnected through an internal bus.

[0047] The user interface unit **130** receives an input signal from the user. The user interface unit **130** may also display the rendered graphic. The user interface unit **130** may include, for example, a key input means and a display means. On the other hand, the user interface unit **130** may be implemented in a form of a touch screen. When the user interface unit **130** is implemented in the form of the touch screen, the user interface unit **130** includes a touch screen module and a touch screen driving module at the same time.

[0048] The user interface unit **130** displays rendered graphic data input from the controller **120**. The user interface unit **130** receives a user input from the user. Here, the user input may be an input which causes the overall operation of the respiration inducing apparatus **100**. Particularly, the user input may be a manipulation in a form of a game, which will be described later in further detail.

[0049] As described above, the user identifies a current respiration status and an ideal respiration status of the user at the same time and receives a similarity between the current respiration status and the ideal respiration status. Accordingly, the user may change a user's respiration status into the ideal respiration status, and the ideal respiration status may be maintained.

[0050] FIG. **3** illustrates a block diagram of a respiration inducing apparatus according to an embodiment of the present invention.

[0051] As shown in FIG. **3**, a respiration inducing apparatus **300** includes an interface unit **310**, an acceleration sensor unit **320**, a data correction unit **330**, a controller **340**, and a storage unit **350**. The user interface unit **310** includes a display unit **311** and an input unit **312**. Also, the controller **340** includes a data processor **341**, a comparator **342**, and a graphic processor **343**.

[0052] The user interface unit **310** displays the graphic rendered by the controller **340**, as described above in connection with FIG. **1**. Also, the user interface unit **310** receives a user input. Specifically, the display unit **311** displays the respiration waveform data and the respiration waveform template. Further, the display unit **311** displays the current respiration fidelity based on the similarity between the respiration waveform data and the respiration waveform template. Also, the display unit **311** displays a respiration induction indicator which can increase the respiration fidelity. The display unit **311** may be implemented in an LCD module and may be implemented as the touch screen together with the input unit **312**. The input unit **312** receives a user input.

[0053] The acceleration sensor unit **320** may be, for example, a three axis acceleration sensor. The acceleration sensor unit **320** senses an acceleration which is applied to the respiration inducing apparatus **300**. As described in connection with FIGS. **2**A and **2**B, acceleration information sensed by the acceleration sensor unit **320** corresponds to the respiration waveform data. The acceleration sensor unit **320** outputs sensed raw data in analog form to the data correction unit **330**.

[0054] The data correction unit **330** amplifies input respiration waveform data with a preset gain. Also, the data correction unit **330** may filter the amplified respiration waveform data. Here, the data correction unit **330** includes an amplification means for amplifying with the preset gain and a filtering means for filtering. For example, the amplification means may be implemented as an OP-AMP and the filtering means may be implemented as a low pass filter, a high pass filter, or a band pass filter, or a combination thereof.

[0055] The respiration waveform data corrected by the data correction unit **330** is input to the data processor **341**.

[0056] The data processor **341** performs an analog to digital conversion (ADC) on the input respiration waveform data in analog form and outputs the respiration waveform data in the digital form. Specifically, the data processor **341** samples the input respiration waveform data in analog form in a preset period. The data processor **341** performs quantification on the sampled respiration waveform data and generate the respiration waveform data in digital form based on a quantification result. The data processor **341** outputs the generated respiration waveform data in digital form to the comparator **342** and the graphic processor **343**.

[0057] The comparator **342** reads out the respiration waveform template from the storage unit **350** and compares the read out respiration waveform template with the respiration waveform data. The comparator **342**, for example, determines the correlation between the respiration waveform data and the respiration waveform template based on Equation (1). A comparison result of the comparator **342** corresponds to a similarity between the respiration waveform data and the respiration waveform template. Further, the similarity may be based on the current respiration fidelity.

[0058] On the other hand, the comparator **342** may compare the respiration waveform data and the respiration waveform template in various methods other than using the correlation and it should be understood by those skilled in the art that the present invention is not limited in this regard.

[0059] The graphic processor **343** renders at least one of the respiration waveform data input from the data processor **341**, the respiration waveform template read out from the storage unit **350**, and the current respiration fidelity input from the comparator **342** to generate graphic data. The graphic processor **343** generates rendered graphic data based on a graphic generation algorithm read out from the storage unit **350**. The graphic processor **343** may be implemented in a central processor and render a graphic with respect to each pixel of the display unit **311** in a serial manner. Also, the graphic proces-

sor **343** may be implemented in a graphic processor (GPU) to render the graphic with respect to each pixel of the display unit **311** in a parallel manner.

[0060] The graphic processor **343**, for example, may render a graphic of a game screen which may trigger a user's interest.

[0061] FIGS. **4**A and **4**B illustrate example game screens according to an embodiment of the present invention.

[0062] FIG. **4**A shows a game screen related to a character which is a subject that plays a game and an option in a game according to an embodiment of the present invention. The user selects one of characters **410**, **420** through manipulation of the input unit **312**. Also, the user may select an option menu **430** through manipulation of the input unit **312**.

[0063] FIG. **4**B is a screen in which the option menu **430** in FIG. **4**A is selected. The user determines whether a play mode **441** is automatic or manual through the manipulation of the input unit **312**. Also, the user may adjust a play time **442** through manipulation of the input unit **312**.

[0064] The user determines whether to use a metronome **443** through the manipulation of the input unit **312**. Here, the metronome is an example of the respiration inducing indicator and is a means for indicating a predetermined time period based on a period of the respiration waveform template. This will be described below in further detail.

[0065] The user may adjust a start time **444** and an end time **445** of the metronome through the manipulation of the input unit **312**.

[0066] The user determines a respiration mode **446** through the manipulation of the input unit **312**. The respiration mode **446** may be about whether to use a pre-stored respiration waveform template or whether to use a respiration waveform template adjusted by the user.

[0067] The user may adjust a period **447** of the respiration waveform template through the manipulation of the input unit **312**. The graphic processor **343** adjusts and renders the period of the respiration waveform template when a user manipulation is involved.

[0068] FIG. **5** illustrates a conceptual view of a game play screen according to an embodiment of the present invention.

[0069] The metronome **501** is an example of the respiration inducing indicator. The metronome **501** expresses the period of the respiration waveform template. For example, when the period of the respiration waveform template is 10 seconds, a number of an activation bar of the metronome may be increased over 5 seconds and a number of the activation bar may be decreased over 5 seconds.

[0070] On the other hand, the controller **330** may gradually change a period of the metronome **501**. For example, it is assumed that the period of the respiration waveform data is 5 seconds and the period of the respiration waveform template is 10 seconds. In other words, the ideal respiration status is relatively slow whereas the current respiration status of the user, to the contrary, is fast. Accordingly, the controller **330** may not fix the period of the metronome **501** to be 10 seconds in an early stage but may gradually change the period of the metronome **501** from 5 seconds, which is the period of the respiration waveform data, to 10 seconds. Therefore, an effect such that the user naturally reaches the ideal respiration status may be created.

[0071] An acquired coin number **502** represents the respiration fidelity based on the similarity between the respiration waveform data and the respiration waveform template in the form of a user-friendly score. A total acquired score **503** represents a final result according to counting the acquired coin number **502**. The acquired coin number and the score will be described below in more detail with reference to FIGS. **6**A and **6**B.

[0072] A fixed location **505** is a location at which the character exists. In a game according to an embodiment of the present invention, the character is located at the fixed location **505** and moves in an upward and downward direction **506** without movement in a left and right direction. The character moves in the upward and downward direction **506** according to a rise and fall of a topographical object **508**. For example, a character may be displayed as if disposed on the topographical object **508**.

[0073] On the other hand, the topographical object **508** may correspond to the respiration waveform data and a topographical object **509** may correspond to the respiration waveform template. Also, the topographical objects **508** and **509** may move in a preset direction **507**. Namely, the topographical objects **508** and **509** move in a specific direction as time elapses, but the character does not move in the left and right direction, only up and down, thereby creating an effect as if the character moves on the topographical object **508**.

[0074] A plurality of coins **504** may be disposed on the topographical object **509** corresponding to the respiration waveform template. In other words, when the user outputs the respiration waveform data similar to the respiration waveform template, the character obtains a coin.

[0075] FIGS. **6**A and **6**B illustrates conceptual views for explaining the respiration fidelity and a score thereof. As shown in FIG. **6**A, the respiration waveform data includes a period λ and a depth b in an early stage, and includes a period λ' and a depth b' in a later stage. On the other hand, it is assumed that the period λ corresponds to a frequency of w and the period λ' corresponds to a frequency of w'.

[0076] FIG. **6**B illustrates an evaluation criteria for a user's respiration. A part shown in real time is a score counted during game play, and a part shown after measurement means a score counted after the game play. In a case where the frequency w of the current respiration waveform data exceeds 10, a score is not assigned. On the other hand, in a case where the frequency w is below 10, a result of dividing 6 by the frequency w is assigned as a score (a).

[0077] Also, if a subsequent depth b' is deeper than a previous depth b, a score of 0.5 is assigned, and if the previous depth b is deeper than the subsequent depth b', a score of −0.5 is assigned.

[0078] On the other hand, after the game play is finished, when a value w_dev obtained by subtracting an average frequency w_{mean} from 6 is greater than 1, the score of −0.5 is assigned, and when the value w_dev obtained by subtracting the average frequency w_{mean} from 6 is less than 0.5, the score of 0.5 is assigned.

[0079] Further, in real time, a graphic may be rendered such that a gold coin (representing 5 won in Korean currency or 5 dollars in US currency) is obtained in a case of a score greater than 3 points, a silver coin (representing 2 won in Korean currency or 2 dollars in US currency) is obtained in a case of a score between 2 points and the 3 points, and a copper coin (representing 1 won in Korean currency or 1 dollar in US currency) is obtained in a case of a score between a 1 point and the 2 points.

[0080] According to the game play described above, the user may adjust, with interest, the respiration such that the user's respiration waveform data approximates the respiration waveform template.

[0081] FIG. **7** illustrates a flow chart of a control method of a respiration inducing apparatus according to another embodiment of the present invention.

[0082] The respiration inducing apparatus receives the respiration waveform data at step S**701**. Here, the respiration inducing apparatus is a means for receiving the respiration waveform data and includes a three axis acceleration sensor. The respiration inducing apparatus may receive the respiration waveform data based on various methods other than sensing the acceleration, which will be described below in further detail.

[0083] The respiration inducing apparatus displays the respiration waveform data at step S**702**. The user identifies the user's respiration status by monitoring the respiration waveform data in real time. Further, the respiration inducing apparatus reads out the respiration waveform template in step S**703**.

[0084] The respiration inducing apparatus estimates the respiration fidelity about the current respiration status by comparing the input respiration waveform data with the read out respiration waveform template at step S**704**. The respiration inducing apparatus may, for example, determine the similarity between the respiration waveform data and the respiration waveform template based on the correlation which is related to Equation (1). The respiration inducing apparatus may display the determined similarity, i.e., respiration fidelity. As a result, the respiration inducing apparatus displays at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity, thereby creating an effect of naturally inducing the ideal respiration status from the user.

[0085] FIG. **8** illustrates a flow chart of a control method of a respiration inducing apparatus according to another embodiment of the present invention.

[0086] The respiration inducing apparatus receives the respiration waveform data at step S**801**. The respiration inducing apparatus performs correction on input respiration waveform data at step S**802**. The respiration inducing apparatus may, for example, amplify the input respiration waveform data with the preset gain and may apply at least one filtering process among a low pass filtering, a high pass filtering, and a band pass filtering to the amplified respiration waveform data.

[0087] The respiration inducing apparatus reads out the respiration waveform template at step S**803**. Also, the respiration inducing apparatus renders a graphic based on the respiration waveform data and the respiration waveform template at step S**804**. Here, the graphic may be one screen of a game screen which may trigger the user's interest. The respiration inducing apparatus displays the rendered graphic at step S**805** and the user may, for example, perform game play corresponding thereto.

[0088] The respiration inducing apparatus also receives feedback respiration waveform data at step S**806**, which is changed respiration waveform data output by the user when the user recognizes the graphic and renders and displays the feedback respiration waveform data. Accordingly, an effect of allowing the user to identify a changed circumstance of the respiration status of the user may be created.

[0089] FIG. **9** illustrates a flow chart of a game screen display method according to another embodiment of the present invention.

[0090] The respiration inducing apparatus shows the character and also shows the input respiration waveform data as a first topographical object having a curvature at step S**901**.

[0091] Also, the respiration inducing apparatus shows the respiration waveform template as a second topographical object having a curvature at step S**902**. The respiration inducing apparatus shows the first topographical object and the second topographical object moving in a specific direction as time elapses at step S**903**. In this case, the character may be controlled not to move in the left and right direction but only move in the upward and downward direction, thereby creating an effect that the character is shown as moving on the first and the second topographical objects.

[0092] The respiration inducing apparatus shows a coin reflecting the respiration fidelity on the second topographical object at step S**904**. Here, the type of the coin and the score corresponding thereto have already been described in detail, and thus, a further description thereof will be omitted.

[0093] When the character contacts the coin, the respiration inducing apparatus controls to acquire a score or a number corresponding to the coin at step S**905**. According to the above described process, the user may adjust the respiration status such that the respiration waveform data approximates the respiration waveform template in order for the character to acquire more coins or a higher score.

[0094] FIG. **10** illustrates a block diagram of a respiration inducing apparatus according to another embodiment of the present invention.

[0095] As shown in FIG. **10**, a respiration inducing apparatus **1020** is connected to a heart rate measurer **1010**. The respiration inducing apparatus **1020** includes a controller **1030**, a storage unit **1040**, and a user interface unit **1050**. The controller **1030** includes a correction unit **1031**, a respiration data converter **1032**, a comparator **1033**, and a graphic processor **1034**.

[0096] The respiration inducing apparatus **1020** according to the embodiment of FIG. **10** induces the respiration waveform data based on an input heart rate rather than directly collecting the respiration waveform data.

[0097] The heart rate measurer **1010** measures a heart rate of the user during a preset period. The heart rate measurer **1020** includes, for example, an electrode or a light sensor. The heart rate measurer **1020** may be mounted to a chest, an arm, or a leg of the user when the heart rate measurer **1020** is implemented as an electrode and may be mounted near an arterial blood vessel or a venous blood vessel when the heart rate measurer **1020** is implemented as an light sensor.

[0098] The heart rate measurer **1010** outputs the heart rate of the user to the correction unit **1031**. The correction unit **1031** performs at least one of amplifying or filtering of input heart rate data.

[0099] The respiration data converter **1032** converts the input heart rate data into the respiration waveform data. The respiration data converter **1032** converts heart rate data into the respiration waveform data based on a relationship between the heart rate and the respiration waveform. For example, it is assumed that the heart rate and the respiration waveform have a relationship such that the period of the respiration waveform data is decreased when the heart rate is increased and the period of the respiration waveform data is increased when the heart rate is decreased. In this case, the respiration data converter **1032** generates the respiration waveform data by considering a change of the heart rate data.

[0100] A step of the comparator **1033** comparing the converted respiration waveform data and the respiration waveform template read out from the storage unit **1040**, a step of the graphic processor **1034** rendering a graphic, and a step of

the user interface unit **1050** displaying the rendered graphic or receiving the user input have already described, and thus, a detailed description thereof will be omitted.

[0101] In the embodiment of FIG. **10**, it is shown that the heart rate measurer **1010** is connected to the respiration inducing apparatus **1020**; however, those skilled in the art would understand that the present invention is not limited to this as long as an apparatus may measure data which can be converted into the respiration waveform data. For example, those skilled in the art may easily devise embodiments in which a brainwave sensor, a skin resistance sensor, a skin temperature sensor, or a muscle signal sensor is connected to the respiration inducing apparatus **1020** in replacement of the heart rate measurer.

[0102] Accordingly, a structure in which various biometric signals are measured and converted into the respiration waveform data to induce respiration is possible, and a user may use a biometric signal from a desired part, thereby maximizing user convenience.

[0103] While the present invention has been shown and described with reference to certain embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A respiration inducing apparatus, comprising:

a respiration waveform data collection unit for collecting respiration waveform data from a user;

a storage unit for storing a respiration waveform template;

a controller for comparing the respiration waveform data and the respiration waveform template and determining a respiration fidelity based on a similarity of a comparison result; and

a user interface unit for displaying at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity.

2. The respiration inducing apparatus of claim **1**, wherein the respiration waveform data collection unit comprises an acceleration sensor for sensing an acceleration applied to the respiration inducing apparatus.

3. The respiration inducing apparatus of claim **2**, wherein the controller interprets the respiration waveform data based on acceleration information from the respiration waveform data collection unit.

4. The respiration inducing apparatus of claim **1**, wherein the controller determines the respiration fidelity based on a correlation between the respiration waveform data and the respiration waveform template.

5. The respiration inducing apparatus of claim **4**, wherein the respiration waveform data is an n number of time series data, the respiration waveform template is an n number of time series data, and the correlation is determined by the following:

$$r_{xy} = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}}$$

, wherein $\bar{x}$ is an average of the respiration waveform data $\bar{y}$ and is an average of the respiration waveform template.

6. The respiration inducing apparatus of claim **1**, wherein the respiration fidelity is represented as a score through playing of a preset game, and the controller renders the preset game and controls the user interface unit to display a rendered game screen.

7. The respiration inducing apparatus of claim **6**, wherein, when a depth of the respiration waveform data is increased time serially, the controller treats a result of adding an additional score to the score as a score.

8. The respiration inducing apparatus of claim **6**, wherein the controller compares an average of a frequency of the respiration waveform data and a frequency of the respiration waveform template to calculate the score.

9. The respiration inducing apparatus of claim **1**, wherein the respiration waveform data collection unit comprises:

a correction unit for receiving and correcting a biometric signal; and

a respiration data converter for converting the biometric signal into the respiration waveform data.

10. The respiration inducing apparatus of claim **9**, wherein the biometric signal is heart rate data.

11. A method of controlling a respiration inducing apparatus, comprising:

collecting respiration waveform data from a user;

reading out a pre-stored respiration waveform template;

comparing the respiration waveform data and the respiration waveform template and determining a respiration fidelity based on a similarity of a comparison result; and

displaying at least one of the respiration waveform data, the respiration waveform template, and the respiration fidelity.

12. The method of claim **11**, wherein collecting the respiration waveform data comprises:

sensing an acceleration applied to the respiration inducing apparatus.

13. The method of claim **12**, further comprising:

interpreting the respiration waveform data based on acceleration information.

14. The method of claim **11**, wherein determining the respiration fidelity comprises:

determining the respiration fidelity based on a correlation between the respiration waveform data and the respiration waveform template.

15. The method of claim **14**, wherein the respiration waveform data is an n number of time series data, the respiration waveform template is an n number of time series data, and the correlation is determined by the following:

$$r_{xy} = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}}$$

, wherein $\bar{x}$ is an average of the respiration waveform data and $\bar{y}$ is an average of the respiration waveform template.

16. The method of claim **11**, wherein the respiration fidelity is represented as a score through playing of a preset game, and the method further comprises:

rendering the preset game; and

controlling a user interface unit to display a rendered game screen.

17. The method of claim **16**, wherein, when a depth of the respiration waveform data is increased time serially, the controller treats a result of adding an additional score to the score as a score.

18. The method of claim **16**, wherein the controller compares an average of a frequency of the respiration waveform data and a frequency of the respiration waveform template to calculate the score.

19. The method of claim **11**, wherein collecting the respiration waveform data comprises:

receiving and correcting a biometric signal; and

converting the biometric signal into the respiration waveform data.

20. The method of claim **19**, wherein the biometric signal is heart rate data.

* * * * *

专利名称(译)	呼吸诱导装置及其控制方法		
公开(公告)号	US20130204146A1	公开(公告)日	2013-08-08
申请号	US13/759635	申请日	2013-02-05
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO.，LTD.，		
当前申请(专利权)人(译)	SAMSUNG ELECTRONICS CO.，LTD.		
[标]发明人	CHO CHUL HO		
发明人	CHO, CHUL-HO		
IPC分类号	A61B5/00 A61B5/0205 A61B5/113		
CPC分类号	A61B5/7246 G09B23/288 A61B5/7475 A61B5/6823 A61B5/113 A61B5/0205 A61B5/7278 A61B5/6898 A61B5/743 A61B5/744 A61B5/02438 A61B5/0816 A61B5/486 A61B2562/0219 A61B5/742		
优先权	1020120012722 2012-02-08 KR		
外部链接	Espacenet USPTO		

摘要(译)

提供一种呼吸诱导装置，包括呼吸波形数据收集单元，用于收集来自用户的呼吸波形数据;存储单元，用于存储呼吸波形模板;控制器，用于比较呼吸波形数据和呼吸波形模板，并基于比较结果的相似性确定呼吸保真度;用户界面单元，用于显示呼吸波形数据，呼吸波形模板和呼吸保真度中的至少一个。