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(71) Applicant: **CREATIVE TECHNOLOGY LTD** [SG/SG];
31 International Business Park, #03-01, Creative Resource,
Singapore 609921 (SG).

(72) Inventors: **CHEAH, Chee Sin**; 27 West Coast Crescent,
#15-23, Singapore 128048 (SG). **DONG, Cunsheng Vin-**
cent; 30 Bukit Batok Street 21, #09-04, THE DEW, Singa-
pore 659636 (SG). **ZHANG, Yuming**; Blk 286B, Toh
Guan Road, #11-36, Singapore 602286 (SG). **TAN, Tock**
Kuan; Blk 7A, #16-658, Commonwealth Ave, Singapore
141007 (SG).

(74) Agent: **AMICA LAW LLC**; 30 Raffles Place, #14-01
Chevron House, Singapore 048622 (SG).

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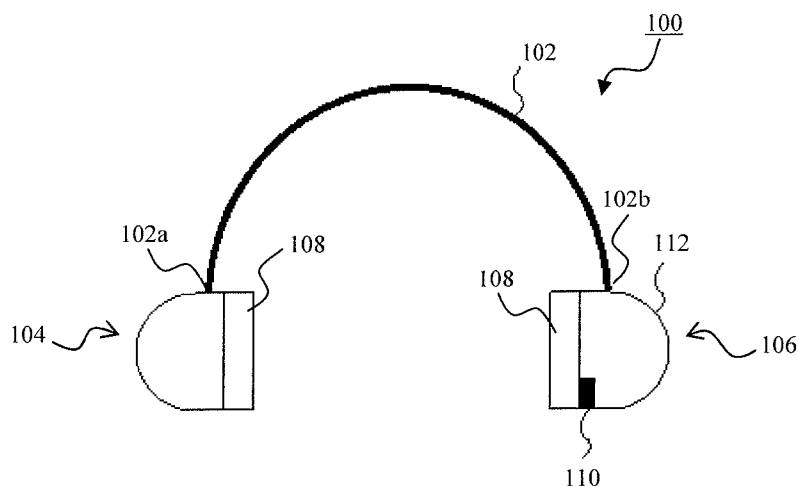


Fig. 1a

(57) Abstract: There is provided a method for optimizing user workout based on audio feedback provided to a user. The method can include providing an input module for the user to input reference data, collecting biometric data associated with the user, comparing the collected biometric data and the reference data, and varying one of beat rate and rhythm of the audio feedback based on the comparison between the collected biometric data and the reference data. User workout can be optimized by manner of user controlling workout pace in accordance with variance in either beat rate or rhythm of the audio feedback provided to the user.

WORKOUT MONITORING DEVICE WITH FEEDBACK CONTROL SYSTEM

Field Of Invention

The present disclosure generally relates a workout monitoring device which is capable of sensing user characteristic and biometric data to produce sensor data, and which is further capable of providing feedback to the user based on the sensor data so that workout activity can be optimized.

Background

It is fairly common these days for people who workout to want to monitor workout progress etc. In view of this, gadgets have been developed to meet such a demand. Such gadgets may be useful workout companions for people who wish to adopt a more efficient/effective workout regime in that numbers in relation to, for example, calories burnt, exercise duration, heart rate during workout can be provided.

Based on such numbers provided, exercise regimes can be tweaked/optimized to achieve certain desired outcomes (e.g., in terms of cardiovascular fitness).

However, such gadgets do not allow exercise regimes to be optimized in an intuitive manner

It is therefore desirable to provide a solution to address the foregoing problem.

Summary of the Invention

In accordance with an aspect of the disclosure, there is provided a method for optimizing user workout based on audio feedback provided to a user. The method can include:

- 1) providing an input module for the user to input reference data,
- 2) collecting biometric data associated with the user,
- 3) comparing the collected biometric data and the reference data, and
- 4) varying one of beat rate and rhythm of the audio feedback based on the comparison between the collected biometric data and the reference data.

User workout can be optimized by manner of user controlling workout pace in accordance with variance in either beat rate or rhythm of the audio feedback provided to the user.

In accordance with another aspect of the disclosure, there is provided an apparatus capable of being worn by a user during a workout. The apparatus can be further capable of generating audio signals audibly perceived by the user. The audio signals can be associated with either beat rate or rhythm. The apparatus can include a workout monitoring device.

The workout monitoring device can include an input module, a sensor module, a processor module and an output module.

The input module can be operated by the user to input reference data (e.g., target heart rate). The sensor module can be configured to collect biometric data (e.g., heart rate) from the user. The processor module can be configured to compare the reference data and the collected biometric data so as to generate control signals. The output module can be configured to generate audio feedback based on the control signals.

The audio feedback can correspond to variance in either beat rate or rhythm associable with the audio signals so as to be indicative of workout pace required during user workout.

Brief Description of the Drawings

Embodiments of the disclosure are described hereinafter with reference to the following drawings, in which:

Fig. 1a shows a headphone which can carry a workout monitoring device, according to an embodiment of the disclosure;

Fig. 1b shows an earphone which can carry a workout monitoring device, according to an embodiment of the disclosure;

Fig. 1c shows an earpiece which can carry a workout monitoring device, according to an embodiment of the disclosure;

Fig. 2a and Fig. 2b show the workout monitoring device of Fig. 1 in further detail, according to an embodiment of the disclosure;

Fig. 3 shows an exemplary scenario concerning the use of the workout monitoring device of Fig. 2, according to an embodiment of the disclosure;

Fig. 4 shows an exemplary waveform having a music waveform and a beat tone, according to an embodiment of the disclosure; and

Fig. 5 shows a method of optimizing workout activity based on the workout monitoring device of Fig. 2, according to an embodiment of the disclosure.

Detailed Description

Representative embodiments of the disclosure, for addressing the foregoing problem(s), are described hereinafter with reference to Fig. 1 to Fig. 5.

Specifically, the present disclosure contemplates a workout monitoring device which is capable of sensing user data such as biometric data to produce sensor data. The workout monitoring device can be further capable of providing feedback to the user based on the sensor data so that workout activity can be optimized. Preferably, the feedback provided to the user is audio based. Specifically, the workout monitoring device can be further capable of providing audio feedback to the user based on the sensor data so that workout activity can be optimized.

Preferably, the workout monitoring device can be carried by an apparatus/a portable device which can be worn by the user. Examples of the apparatus/the portable device are a headphone and an in-ear type earphone and an earbud as will be discussed with reference to Fig. 1. The workout monitoring device will be discussed in further detail with reference to Fig. 2. An exemplary scenario concerning the workout monitoring device will be discussed with reference to Fig. 3. Further clarification is provided by manner of discussion, with reference to Fig. 4, based on an exemplary waveform having a music waveform and a beat tone. Additionally, a method of optimizing workout activity based on the workout monitoring device will be discussed with reference to Fig. 5.

Referring to Fig. 1a, a headphone 100 is shown in accordance with an embodiment of the disclosure.

The headphone 100 can include a headband 102, a first audio reproduction module 104 and a second audio reproduction module 106. Each of the first and second audio reproduction modules 104/106 can be shaped and dimensioned to carry an audio transducer 108. Moreover, one or both of the first and second audio reproduction modules 104/106 can be shaped and dimensioned to carry a workout monitoring device 110 which can be coupled to the audio transducer 108. Specifically, each of the first and second audio reproduction modules 104/106 can include a housing 112, and the audio transducer 108 and the workout monitoring device 110 can preferably be carried within the housing 112.

As shown, the first audio reproduction module 104 can carry an audio transducer 108. The second audio reproduction module 106 can carry an audio transducer 108 and a workout monitoring device 110. Preferably, the first audio reproduction module 104 can carry, within its housing 112, an audio transducer 108 (i.e., the audio transducer 108 is hidden from view). The second audio reproduction module 106 can carry, within its housing 112, an audio transducer 108 and a workout monitoring device 110 (i.e., both the audio transducer 108 and the workout monitoring device 110 are hidden from view). The workout monitoring device 110 can be coupled to one or both of the audio transducer 108 carried by the first audio reproduction module 104 and the audio transducer 108 carried by the second audio reproduction module 106. Coupling between the workout monitoring device 110 and the audio transducer(s) 108 can be based on one or both of wired coupling and wireless coupling.

Moreover, as shown, the headband 102 can include a first end 102a and a second end 102b. The first audio reproduction module 104 can be coupled to the headband 102 at the first end 102a. The second audio reproduction module can be coupled to the headband 102 at the second end 102b.

Referring to Fig. 1b, an in-ear type earphone 150 is shown in accordance with an embodiment of the disclosure.

As with the headphone 100, the in-ear type earphone 150 can include a housing 112 which can be shaped and dimensioned to carry an audio transducer 108 and a workout monitoring device 110. The workout monitoring device 110 can be coupled to the audio transducer 108 based on one or both of wired coupling and wireless coupling.

As shown, the audio transducer 108 can be carried outside of the housing 112 (i.e., the audio transducer 108 is exposed to view) while the workout monitoring device 110 can be carried within the housing 112 (i.e., the workout monitoring device 110 is hidden from view).

Referring to Fig. 1c, an earbud 160 is shown in accordance with an embodiment of the disclosure.

As with both the earlier discussed headphone 100 and the in-ear type earphone 150, the earbud 160 can include a housing 112 which can be shaped and dimensioned to carry an audio transducer 108 and a workout monitoring device 110. The workout monitoring device 110 can be coupled to the audio transducer 108 based on one or both of wired coupling and wireless coupling.

The workout monitoring device 110 will be discussed in further detail with reference to Fig. 2 hereinafter.

Fig. 2a shows a block diagram representation of the workout monitoring device 110 circuitry, in accordance with an embodiment of the disclosure. Fig. 2b shows a model representing the general operation of the workout monitoring device 110, in accordance with an embodiment of the disclosure.

Referring to Fig. 2a, the workout monitoring device 110 can include an input module 202, a processor module 204, a sensor module 206 and an output module 208. The workout monitoring device 110 can, optionally, further include a communication module 210, a memory module 212 and/or a measurement module 214.

The input module 202 can be coupled to the processor module 204. The sensor module 206 can be coupled to the processor module 204. Additionally, the processor module 204 can be coupled to the output module 208. The output module 208 can be coupled to the audio transducer(s) 108. Moreover, each of the communication module 210, the memory module 212 and the measurement module 214 can be coupled to the processor module 204. Furthermore, the communication module 210 can be further coupled to the output module 208.

Operationally, the input module 202 can be configured to generate and communicate input signals to the processor module 204. The sensor module 206 can be configured to generate and communicate sensor signals to the processor module 204. The processor module 204 can be

configured to receive and process the input signals and the sensor signals to produce control signals. In this regard, control signals can be produced by the processor module 204 based on the input signals and the sensor signals. The control signals can be communicated from the processor module 204 to the output module 208. The output module 208 can be configured to receive and process the control signals to produce output signals. In this regard, the output module 208 can be configured to produce the output signals based on the control signals. The output signals can be further communicated from the output module 208 to the audio transducer 108 for processing so as to produce audio signals which can be audibly perceived by a user. Specifically, the output signals can be communicated from the output module 208 to drive the audio transducer 108 so that audio signals, which can be audibly perceived by a user, can be produced and output by the audio transducer 108.

As an option, the control signals can be further communicated to the communication module 210 for further communication to another device (not shown) by manner of, for example, wireless streaming (i.e., wireless communication). For example, the communication module 210 can be configured to communicate the control signals to an audio gateway, such as a smart phone or a media player by manner of wireless communication. Additionally, with reference to the headphone 100 as discussed with reference to Fig. 1a, where the output signals are communicated from the output module 208 to the audio transducer 108 carried by the second audio reproduction module 106, it is appreciable that, in one embodiment, the control signals can be communicated to the first audio reproduction module 104 from the communication module 210 so that output signals can similarly be generated based on the control signals (in which case the first audio reproduction module 104 can further include an output module which is analogous to the output module 208 and which is coupled to the audio transducer 108 carried by the first audio reproduction module 104).

As another option, the output signals can be further communicated to the communication module 210 for further communication to another device (not shown) by manner of, for example, wireless streaming (i.e., wireless communication). For example, the communication module 210 can be configured to communicate the output signals to an audio gateway, such as a smart phone or a media player by manner of wireless communication. Additionally, with reference to the headphone 100 as discussed with reference to Fig. 1a, where the output signals are communicated from the output module 208 to the audio transducer 108 carried by the second audio reproduction module 106, it is appreciable that, in one embodiment, the output signals can also be communicated from

the communication module 210 to the audio transducer 108 carried by the first audio reproduction module 104.

As yet another option, the sensor signals can be further communicated to the memory module 212 for storage so that the sensor signals can be retrieved for subsequent use and/or processing as desired by the user. Additionally, if desired, the sensor signals can yet be further communicated to another device (not shown) by manner of, for example, wireless streaming (i.e., wireless communication). In this regard, the communication module 210 can, for example, be further configured to communicate the sensor signals to an audio gateway, such as a smart phone or a media player by manner of wireless communication.

As yet a further option, the measurement module 214 can be configured to detect user movement during workout. Based on detected user movement, the measurement module 214 can be configured to generate and communicate measurement signals to the processor module 204. The processor module 204 can be configured to process the input signals and the sensor signals in combination with the measurement signals to produce control signals. The measurement signals can improve accuracy of sensed data associated with the sensor signals as will be discussed later in further detail.

The input module 202 can, in one example, correspond to a hardware module having a user interface and/or buttons for a user to make a selection and/or to key in data so as to generate the input signals. The input module 202 can, in another example, correspond to a module capable of being interfaced (via one or both of wireless based coupling and wired based coupling) with a computer/another device which can be configured to display a user interface for use by a user to make a selection and/or key in data so as to generate the input signals. In a more specific example, when the input module 202 is interfaced with another device such as a Smartphone or tablet, a user interface can be displayed by the Smartphone/tablet for use by a user to make a selection and/or key in data so as to generate the input signals.

The input module 202 will be discussed later in further detail with reference to Fig. 3 in relation to an exemplary scenario.

The processor module 204 can, for example, correspond to a microprocessor capable of receiving and processing the input signals, sensor signals and/or the measurement signals to produce the control signals. This will be discussed later in further detail with reference to Fig. 2b.

The sensor module 206 can, for example, correspond to a biometric based sensor which can be configured to detect/measure the biometric characteristics/data of the user. In this regard, the sensor module 206 can be considered to be collecting biometric data from the user. Moreover, the sensor module 206 can be configured to detect/measure the biometric characteristics/data of the user based on one or both of contact based sensing and contactless based sensing. An example of contact based sensing can be sensing by manner of electrode(s) being attached to the user's body. An example of contactless based sensing can be sensing by manner of photometric sensing. Examples of biometric characteristic/data include body temperature, heart rate and blood oxygen saturation level. The sensor module 206 can, for example, be configured to detect/measure user heart rate as will be discussed later in further detail with reference to Fig. 3 in the context of an exemplary scenario.

The output module 208 can, for example, correspond to an audio device capable of communicating audio data to the audio transducer(s) 108. In this regard, the output signals can correspond to audio data. Audio data can, for example, be associated with beat tones. The audio data can also be associated with music which can be associated with a beat/rhythm. The audio data can also be associated with a combination of music which can be associated with a beat/rhythm and beat tone. Therefore, the audio signals which are output from the audio transducer(s) 108 can correspond to music and/or beat tones. Specifically, the audio data can be communicated from the output module 208 and processed by the audio transducer(s) 108 to produce and output audio signals which can be audibly perceived. More specifically, the audio data can be communicated from the output module 208 for driving by the audio transducer(s) 108 so as to produce audio signals which can be audibly perceived.

In one embodiment, the output module 208 can correspond to an audio device having stored therein a plurality of audio files. Each of the audio files can correspond to a beat tone and/or music associated with a beat/rhythm. Thus it is appreciable that one audio file can, in one example, correspond to a beat tone which has a higher beat compared to another beat tone corresponding to another audio file. In another example, one audio file can correspond to music having a slower rhythm compared to the rhythm of music corresponding to another audio file.

In another embodiment, the output module 208 can correspond to an audio device which is capable of generating beat tones. Specifically, the output module 208 can be configured to generate beat tones with varying beat rates. For example, the output module 208 can be configured to generate a first beat tone associated with a beat rate of 60 beats per minute followed by a second beat tone associated with a beat rate which is higher compared to the beat rate associated with the first beat tone (i.e., faster than 60 beats per minute) or a second beat tone associated with a beat rate which is lower compared to the beat rate associated with the first beat tone (i.e., slower than 60 beats per minute). Therefore, it is appreciable that the output module 208 can effectively be configured to vary beat rate associated with the generated beat tones.

In yet another embodiment, the output module 208 can correspond to an audio device which is capable of varying beat/rhythm of music corresponding to the audio data. For example, music corresponding to the audio data can be associated with an original rhythm/beat and the output module 208 can be configured to vary rhythm/beat of music so that the music can be audibly perceived to be slower/faster than the original rhythm/beat.

In yet a further embodiment, the output module 208 can correspond to an audio device which is capable of varying beat rate of a beat tone and combining the varied beat tone with an audio file (i.e., corresponding to music). In this regard, the audio data can correspond to music combined with beat tone which beat rate is varied. This will be discussed later in further detail with reference to Fig. 4.

Therefore, audio data communicated from the output module 208 can, in general, be associated with a beat rate/rhythm. Additionally, the output module 208 can be configured to vary beat rate/rhythm associated with the audio data being output/communicated (i.e., from the output module 208) based on the control signals communicated from the processor module 204.

The communication module 210 can, for example, correspond to a transceiver capable of wireless communication. Wireless communication can, for example, be Bluetooth based communication or Bluetooth Low Energy based communication.

The memory module 212 can, for example, correspond to a memory card capable of data storage.

The measurement module 214 can, for example, correspond to an instrument capable of detecting user motion and/or measuring acceleration of a moving/vibrating body. Specifically the measurement module 214 can, for example, correspond to an accelerometer. More specifically, the measurement module 214 can, for example, correspond to a 3-axes accelerometer. Earlier mentioned, the measurement signals can improve accuracy of sensed data associated with the sensor signals. Specifically, when a user is in motion, the present disclosure contemplates that accuracy in terms of biometric data collected/sensed by the sensor module 206 may be affected. By taking into account user movement/motion (i.e., based on measurement signals communicated from the measurement module 214 to the processor module 204), the processor module 204, when producing control signals, can factor in user movement/motion when processing the input signals and the sensor signals so as to mitigate any effect owing to any inaccurate biometric data collected/sensed by the sensor module 206 when the user is in motion. In this regard, as mentioned earlier, the processor module 204 can, in one embodiment, be configured to produce the control signals based on the input signals, the sensor signals and the measurement signals.

As mentioned earlier, Fig. 2b shows a model 215 representing the general operation of the workout monitoring device 110, in accordance with an embodiment of the disclosure. The model 215, taking into account user interaction with the workout monitoring device 110, can be based on a closed loop feedback control model as will be discussed hereinafter.

Referring to Fig. 2b, the model 215 can include an input portion 216, a processing portion 218, an output portion 220 and a feedback portion 222. The input portion 216 can be coupled to the processing portion 218. The processing portion 218 can be coupled to the output portion 220. The feedback portion 222 can be coupled to the processing portion 218 and the output portion 220.

The input portion 216 can be representative of the input module 202. The processing portion 218 can be representative of the processor module 204. The feedback portion 222 can be representative of the sensor module 206. The output portion 220 can be representative of the output module 208, the audio transducer(s) 108 and a user 224 who interacts with the workout monitoring device 110. Interaction between the user 224 and the workout monitoring device 110 can be based, at least, on audible perception of audio signals from the audio transducer(s) 108 and biometric data of the user 224 as obtained (e.g., by manner of measurement) by the sensor module 206.

As shown, the processor module 204 can include a comparison part 226 and a computing part 228. The comparison part 226 can be coupled to the computing part 228. The comparison part 226 can be coupled to the input module 202 and the sensor module 206. The computing part 228 can be coupled to the output module 208 which, as mentioned earlier, can be coupled to the audio transducer(s) 108. Audio signals from the audio transducer(s) 108 can be audibly perceived by the user 224 as represented by dotted line 230. Biometric data associated with the user 224 can be obtained by the sensor module 206 by manner of measurement as represented by dotted line 232.

Input signals and sensor signals can be communicated, respectively, from the input module 202 and the sensor module 206 to the comparison part 226. The comparison part 226 can be configured to receive and process the input signals and the sensor signals to produce comparison signals. In this regard, the comparison signals can be generated by the comparison part 226 based on the input signals and the sensor signals. Specifically, the comparison part 226 can, for example, correspond to an adder-subtractor circuit capable of performing the operation of subtracting the input signals from the sensor signals and vice versa (i.e., sensor signals – input signals or input signals – sensor signals) to produce error/difference signals. In this regard, the comparison signals can, for example, correspond to the error signals/difference signals.

The comparison signals can be communicated from the comparison part 226 to the computing part 228. The computing part 228 can be configured to receive and process the comparison signals to produce the control signals.

The control signals can be communicated to the output module 208 which can be configured to produce audio data based on the control signals. Specifically, the output module 208 can be configured to communicate audio data in accordance with the control signals received. More specifically, control signals can be communicated to the output module 208 to determine beat rate/rhythm associated with audio data communicated from the output module 208. In this regard, control signals communicated from the processor module 204 to the output module 208 can effectively be considered to be the basis for varying beat rate/rhythm associated with the audio data. Therefore variance to beat rate/rhythm associated with audio data can be based on control signals communicated from the processor module 204.

Earlier mentioned, the output module 208 can be configured to vary beat rate/rhythm associated with the audio data being output/communicated (i.e., from the output module 208) based on the

control signals communicated from the processor module 204. Additionally, audio signals which are output from the audio transducer(s) 108 can correspond to music and/or beat tones can be audibly perceived from the audio transducer(s) 108.

Hence audibly perceivable audio signals being output can be based on the audio data driving the audio transducer(s) 108. Therefore, it is appreciable that variance in beat rate/rhythm associated with the audio data can correspondingly be audibly perceived by the user 224 as the user 224 audibly perceives the audio signals from the audio transducer(s) 108.

During a workout, a user 224 can be working out (e.g., exercising) at an initial workout pace (i.e., current workout pace). Based on the audibly perceived audio signals, the user 224 can control workout pace by manner of either increasing workout pace or decreasing workout pace as desired with reference to the current workout pace. Workout pace can also be controlled by manner of maintaining current pace if there is no need to either increase workout pace or decrease workout pace with reference to the current workout pace. Appreciably, by controlling workout pace, biometric data collected from the user 224 can also be varied accordingly.

The feedback portion 222 can be configured to receive (i.e., collect) and process the received biometric data to produce the sensor signals. In this regard, variance in biometric data collected from the user 224 can, corresponding, vary sensor signals produced by and communicated from the feedback portion 222.

It is appreciable that any variance in sensor signals communicated to the comparison part 226 causes corresponding variance in comparison signals produced. Further appreciably, any variance in comparison signals communicated to the computing part 228 causes corresponding variance in the control signals produced.

Therefore, by virtue of the feedback portion 222 providing some form of feedback (e.g., variance in sensor signals) in accordance with biometric data collected from the user 224 and the feedback being used as a basis (e.g., variance in comparison signals) for control in regard the control signals being produced by the computing part 228, the model 215 can be considered to be based on a closed loop feedback control model. Additionally, by virtue of workout pace being controlled in accordance with feedback from the feedback portion 222, the closed loop feedback control model

can be considered to be a closed-loop feedback control system which can be maintained in steady-state condition.

To put the forgoing in context, Fig. 2 will be further discussed based on an exemplary scenario with reference to Fig. 3 hereinafter.

Referring to Fig. 3, an exemplary scenario 300 concerning the use of the workout monitoring device is illustrated in accordance with an embodiment of the disclosure. The exemplary scenario 300 can be based on a user using an exercise machine (e.g., user running on a treadmill) and wearing the headphone 100. Specifically, the user can be running while listening to music (i.e., from the headphone 100). The biometric characteristic/data collected can be in relation to the heart rate of the user. Moreover, as shown, in the exemplary scenario 300, a user interface 310 can be presented to the user.

The user interface 310 can include a plurality of selection portions 320. As shown, the plurality of selection portions 320 can include a first selection portion 320a ("Level 1" per Fig. 3), a second selection portion 320b ("Level 2" per Fig. 3), a third selection portion 320c ("Level 3" per Fig. 3), a fourth selection portion 320d ("Level 4" per Fig. 3) and a fifth selection portion 320e ("Level 5" per Fig. 3).

Each of "Level 1" to "Level 5" can correspond to a preset heart rate as shown in Fig. 3.

Specifically, "Level 1" (i.e., the first selection portion 320a) can correspond to a heart rate of 100, "Level 2" (i.e., the second selection portion 320b) can correspond to a heart rate of 120, "Level 3" (i.e., the third selection portion 320c) can correspond to a heart rate of 140, "Level 4" (i.e., the fourth selection portion 320d) can correspond to a heart rate of 160 and "Level 5" (i.e., the fifth selection portion 320e) can correspond to a heart rate of 180.

Earlier mentioned, the input module 202 can, in one example, correspond to a hardware module having a user interface and/or buttons for a user to make a selection and/or to key in data so as to generate the input signals. The input module 202 can, in another example, correspond to a module capable of being interfaced (via one or both of wireless based coupling and wired based coupling) with a computer/another device (e.g., Smartphone/tablet) which can be configured to display a user

interface for use by a user to make a selection and/or key in data so as to generate the input signals. The user interface 310 shown in Fig. 3 is one such example as will be discussed hereinafter.

In one embodiment, the input module 202 can be configured to display the user interface 310. Moreover, the input module 202 can include a touch sensitive screen which allows a user to make a selection (i.e., any of level 1 to level 5) by making contact with an appropriate selection portion (i.e., any of the first selection portion 320a to the fifth selection portion 320e) from the plurality of selection portions 320.

In another embodiment, the input module 202 can be coupled to the exercise machine (e.g., tread mill) which can be configured to display the user interface 310. The user interface 310 can be operable by the user from the exercise machine.

In yet another embodiment, the input module 202 can be coupled to the exercise machine (e.g., tread mill) having a display unit and the input module 202 can be configured to generate and send display signals to the exercise machine. Based on the display signals communicated from the input module 202, the user interface 310 can be displayed on the display unit of the exercise machine and be operated by a user by making a selection (i.e., any of the first selection portion 320a to the fifth selection portion 320e) per earlier discussion.

In the exemplary scenario 300, while using the tread mill, a user can select "Level 2" by making contact with the second selection portion 320b. An input signal indicative of the desired heart rate to be achieved during workout being "120" (i.e., heart rate of 120 beats per minute) can be communicated from the input module 202. While the user is running, the sensor module 206 collects biometric data in relation to the real-time heart rate of the user and communicates the collected biometric data in the form of sensor signals.

As mentioned earlier, both the Input signals and sensor signals can be communicated to the comparison part 226 which can be configured to receive and process them (i.e., the input signals and the sensor signals) to produce comparison signals.

In one instance where, for example, the user is just beginning to run and is listening to music (i.e., the earlier mentioned audio signals) associated with an initial beat rate/rhythm, the heart rate of the user (as measured by the sensor module 206) can be relatively lower compared to the

target/desired heart rate to be achieved (i.e., as indicated by the input signals). Specifically, in the beginning phase of the user's run, the measured heart rate of the user can, for example, be "95". In this regard, an error signal/difference signal indicative of "+25" (i.e., input signals – sensor signals = $120 - 95 = +25$) can be generated. Hence, the comparison part 226 can generate and communicate comparison signals corresponding to a difference of "+25" to the computing part 228. The computing part 228 can then generate control signals to the output module 208 so that audio data associated with higher beat rate/rhythm (i.e., relative to the initial beat rate/rhythm) can be communicated from the output module 208. Specifically, beat rate/rhythm associated with audio data can effectively be increased relative to the initial beat rate/rhythm if the measured user heart rate is lower than the target heart rate to be achieved (i.e., as indicated by the input signals). In this regard, the user can audibly perceive, for example, beat rate of the music to increase when real-time user heart rate measured (e.g., 95) while the user is running is below the target heart rate (e.g., "Level 2" = 120).

Conversely, in another instance where, the user has been running for sometime and may have been running to the point of exhaustion/over-exertion, the heart rate of the user (as measured by the sensor module 206) can be relatively higher compared to the target/desired heart rate to be achieved (i.e., as indicated by the input signals). Appreciably, at the point of exhaustion/over-exertion during the run, the user can be listening to music associated with a current beat rate/rhythm. The measured heart rate of the user can, for example, be "130". In this regard, an error signal/difference signal indicative of "-10" (i.e., input signals – sensor signals = $120 - 130 = -10$) can be generated. Hence, the comparison part 226 can generate and communicate comparison signals corresponding to a difference of "-10" to the computing part 228. The computing part 228 can then generate control signals to the output module 208 so that audio data associated with a lower beat rate/rhythm (i.e., relative to the current beat rate/rhythm) can be communicated from the output module 208. Specifically, beat rate/rhythm associated with audio data can effectively be decreased relative to the current beat rate/rhythm if the measured user heart rate is higher than the target heart rate to be achieved (i.e., as indicated by the input signals). In this regard, the user can audibly perceive, for example, beat rate of the music to decrease when real-time user heart rate measured (e.g., 130) while the user is running is above the target heart rate (e.g., "Level 2" = 120).

In regard to variance of beat rate/rhythm with reference to either the initial beat rate/rhythm or the current beat rate/rhythm, it is appreciable that the initial beat rate/rhythm or the current beat rate/rhythm can be treated as a reference point from which beat rate/rhythm can effectively be

varied. Therefore, the initial beat rate/rhythm and the current beat rate/rhythm can be generally referred to as "reference beat rate/rhythm".

In general, it is appreciable that beat rate/rhythm associated with audio signals can be audibly perceived by a user to be varied in accordance with measured biometric data/user characteristic (e.g., heart rate) of the user. Specifically, the processor module 204 can be configured to compare the biometric data (e.g., user heart rate) collected (i.e., by the sensor module 206) and reference data (i.e., input signals) input by a user via the input module 202. More specifically, the input signals can be considered to be reference data, and the biometric data (e.g., user heart rate) collected (i.e., by the sensor module 206) and reference data (i.e., input signals) can be compared to analyze whether the biometric data/user characteristic is leading or lagging with reference to the reference data. In one earlier example where the error signal/difference signal indicative of "+25" is produced, "+25" can be indicative that the biometric data/characteristic is "lagging" the reference data and there is a need to increase beat rate of the music. In another earlier example, where the error signal/difference signal indicative of "-10" is produced, "-10" can be indicative that the biometric data/characteristic is "leading" the reference data and there is a need to reduce beat rate of the music. Additionally, the processor module 204 can be further configured to process the difference of the reference data and the biometric data and output an audible feedback signal to the user. The audible feedback signal can correspond to the aforementioned variance in beat rate/rhythm associated with the audio signals. Specifically, the audible feedback signal can be in the form of audibly perceivable variance in beat rate/rhythm associated with the audio signals. Based on the audible feedback signal, the user can be able to optimize workout in a manner so as to minimize, as much as possible, difference between the reference data and collected biometric data.

In one example, if beat rate of the music can be audibly perceived by the user 224 to have decreased, the user 224 can take the decreased beat rate as an indication that the user 224 is running too vigorously as the measured real-time user heart rate is above the target heart rate. In which case, the user 224 can reduce running speed/pace so as to lower real-time heart rate.

In another example, , if beat rate of the music can be audibly perceived by the user 224 to have increased, the user 224 can take the increased beat rate as an indication that the user 224 needs to quicken running speed/pace as the measured real-time user heart rate is below the target heart rate. In which case, the user 224 can increase running speed/pace so as to increase real-time heart rate.

In the above manner, a user can be provided with an avenue for optimizing workout activity in an intuitive manner.

Moreover, based on the exemplary scenario 300, it can be noted that the heart rate of the user can be pre-classified into five levels (i.e., "Level 1" to "Level 5"). The five levels can correspond to differing levels (e.g., "Level 1" which can correspond to a normal level to "Level 5" which can correspond to a vigorous level) in terms of workout activity.

In one embodiment, a user can be provided with a way of editing the heart rate of each level according to preference (e.g., based on self health assessment) as opposed to having a preset heart rate for each level as discussed earlier. For example, based on the user interface 310 presented to the user, the user can edit the heart rate corresponding to "Level 4" by contacting the fourth selection portion 320d. Specifically, the user can edit the preset value (e.g., "160") of the heart rate corresponding to a level (e.g., "Level 4") so that the preset value can be changed (i.e., by the user) to a value (e.g., "163") in accordance with user preference. Therefore, after editing by the user, the heart rate corresponding to, for example, "Level 4" can, for example, correspond to a value of "163" instead of the preset value of "160" as shown in Fig. 3.

Earlier mentioned, the audio data can correspond to music combined with beat tone which beat rate is varied, in accordance with an embodiment of the disclosure. This will be discussed with reference to Fig. 4 hereinafter.

Fig. 4 shows an exemplary waveform 400 having a music waveform 410 and a beat tone 420, in accordance with an embodiment of the disclosure. As shown, the beat tone 420 can be superimposed onto the music waveform 410. Both the music waveform 410 and the beat tone 420 can be audibly perceived by a user. The beat tone 420 can be in the form of a bass tone (i.e., low frequency signal) so that it can be easily audibly distinguished from the music waveform 410. The beat tone 420 can include a first portion 420a which is associated with a first beat rate and a second portion 420b which is associated with a second beat rate.

As shown, beat rate of the beat tone 420 can be varied in accordance with biometric data/user characteristic. That is, frequency (i.e., beat rate) associated with the beat tone 420 can be varied in accordance with biometric data/user characteristic. Specifically, the first portion 420a and the second portion 420b signify that the first beat rate is faster as compared to the second beat rate.

The first portion 420a can, for example, correspond to a situation where there is a need to increase workout speed/pace and the second portion 420b can, for example, correspond to a situation where there is a need to reduce workout speed/pace. For clarity, this will be discussed with reference to the earlier discussed exemplary scenario 300 hereinafter.

With reference to the earlier discussed exemplary scenario 300, the first portion 420a illustrates that a user can audibly perceive beat rate of the beat tone 420 (it is to be noted that there should be no audibly perceived change to the music waveform 410 itself) to increase because real-time user heart rate measured (e.g., 95) while the user is running is below the target heart rate (e.g., "Level 2" = 120). This signifies, to the user, that there is a need to increase workout speed/pace.

Further with reference to the earlier discussed exemplary scenario 300, the second portion 420b illustrates that a user can audibly perceive beat rate of the beat tone 420 (it is to be noted that there should be no audibly perceived change to the music waveform 410 itself) to decrease because real-time user heart rate measured (e.g., 130) while the user is running is above the target heart rate (e.g., "Level 2" = 120). This signifies, to the user, that there is a need to reduce workout speed/pace.

Appreciably, the beat tone 420 can serve to pace a user while the user is working out. For example, if the measured real-time heart rate is faster than the target heart rate, frequency of the beat tones 420 can automatically be reduced so as to prompt the user to slow down (i.e., reduce workout speed/pace) during workout. Conversely, if the measured real-time heart rate is slower than the target heart rate, frequency of the beat tones 420 can automatically be increased so as to prompt the user to increase workout speed/pace during workout. Hence variance in beat rate or rhythm associable with the audio signals can be indicative of workout pace required during user workout. Therefore, as mentioned earlier, a user can be provided with an avenue for optimizing workout activity in an intuitive manner.

Fig. 5 shows a method 500 of optimizing workout activity based on the workout monitoring device 110, according to an embodiment of the disclosure.

Specifically, Fig. 5 shows a flow diagram for a method 500 for optimizing user workout based on audio feedback provided to a user. The method 500 can include providing an input module for the user to input reference data 510, collecting biometric data associated with the user 520, comparing the collected biometric data and the reference data 530 and varying one of beat rate and rhythm of

the audio feedback based on the comparison between the collected biometric data and the reference data 540.

In regard to providing an input module for the user to input reference data 510, reference data can, as discussed earlier, correspond to input signal(s) input by a user via the input module 202. Moreover, reference data can, for example, relate to target heart rate.

In regard to collecting biometric data associated with the user 520, biometric data can, as discussed earlier, be collected by the sensor module 206. Moreover, biometric data collected can, for example, relate to measured real-time heart rate of the user.

In regard to comparing the collected biometric data and the reference data 530, comparison can be performed by the processor module 204 as discussed earlier.

In regard to varying one of beat rate and rhythm of the audio feedback based on the comparison between the collected biometric data and the reference data 540, control signals can, as discussed earlier, be communicated from the processor module 204 to the output module 208 to effectively control or vary beat rate/rhythm associated with audio data communicated from the output module 208. Specifically, the output module 208 can be configured to communicate audio data in accordance with the control signals received. More specifically, control signals can be communicated to the output module 208 to determine beat rate/rhythm associated with audio data communicated from the output module 208. In this regard, control signals communicated from the processor module 204 to the output module 208 can effectively be considered to be the basis for varying beat rate/rhythm associated with the audio data. Therefore variance to beat rate/rhythm associated with audio data can be based on control signals communicated from the processor module 204. Additionally, as mentioned earlier, it is appreciable that variance in beat rate/rhythm associated with the audio data can correspondingly be audibly perceived by a user as the user audibly perceives the audio signals from the audio transducer(s) 108.

In the above manner, user workout can be optimized by manner of user controlling workout pace in accordance with an audible feedback signal (i.e., variance in one of beat rate and rhythm of the audio signals) provided to the user. The audible feedback signal can also be referred to as “audio feedback”. In one earlier example, if beat rate of the music can be audibly perceived by the user to have decreased, the user can take the audibly perceived decreased beat rate as an indication that

the user is running too vigorously as the measured real-time user heart rate is above the target heart rate. In which case, the user can reduce running speed/pace so as to lower real-time heart rate. In another earlier example, if beat rate of the music can be audibly perceived by the user to have increased, the user can take the audibly perceived increased beat rate as an indication that the user needs to quicken running speed/pace as the measured real-time user heart rate is below the target heart rate. In which case, the user can increase running speed/pace so as to increase real-time heart rate.

In the foregoing manner, various embodiments of the disclosure are described for addressing at least one of the foregoing disadvantages. Such embodiments are intended to be encompassed by the following claims, and are not to be limited to specific forms or arrangements of parts so described and it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made, which are also intended to be encompassed by the following claims.

Claims

1. A method for optimizing user workout based on audio feedback provided to a user, the method comprising:
 - providing an input module for the user to input reference data;
 - collecting biometric data associated with the user;
 - comparing the collected biometric data and the reference data;
 - varying one of beat rate and rhythm of the audio feedback based on the comparison between the collected biometric data and the reference data,
 - wherein user workout is optimized by manner of user controlling workout pace in accordance with variance in one of beat rate and rhythm of the audio feedback provided to the user.
2. An apparatus capable of being worn by a user during a workout and capable of generating audio signals audibly perceived by the user, the apparatus comprising:
 - a workout monitoring device comprising:
 - an input module operable by the user to input reference data;
 - a sensor module configurable to collect biometric data from the user;
 - a processor portion configurable to compare the reference data and the collected biometric data so as to generate control signals; and
 - an output module configurable to generate audio feedback based on the control signals, the audio feedback being variance in one of beat rate and rhythm associable with the audio signals so as to be indicative of workout pace required during user workout.

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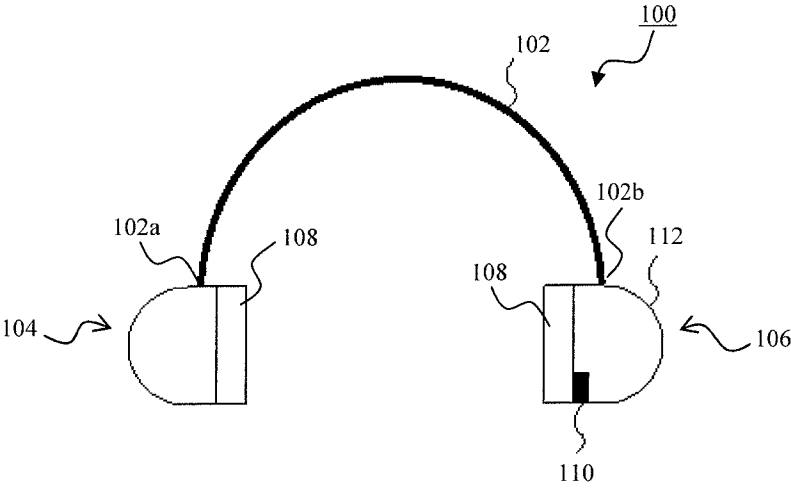


Fig.1a

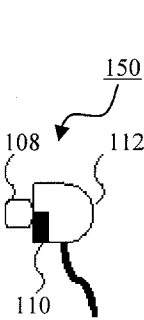


Fig.1b

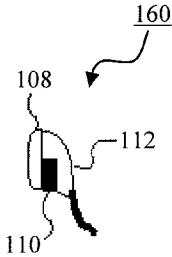


Fig.1c

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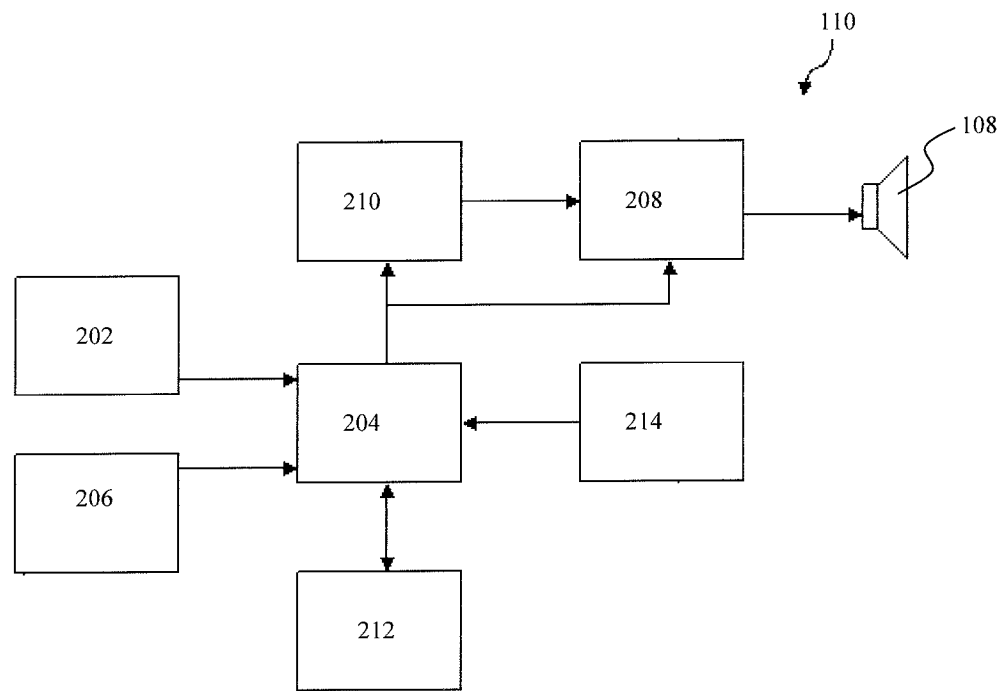


Fig.2a

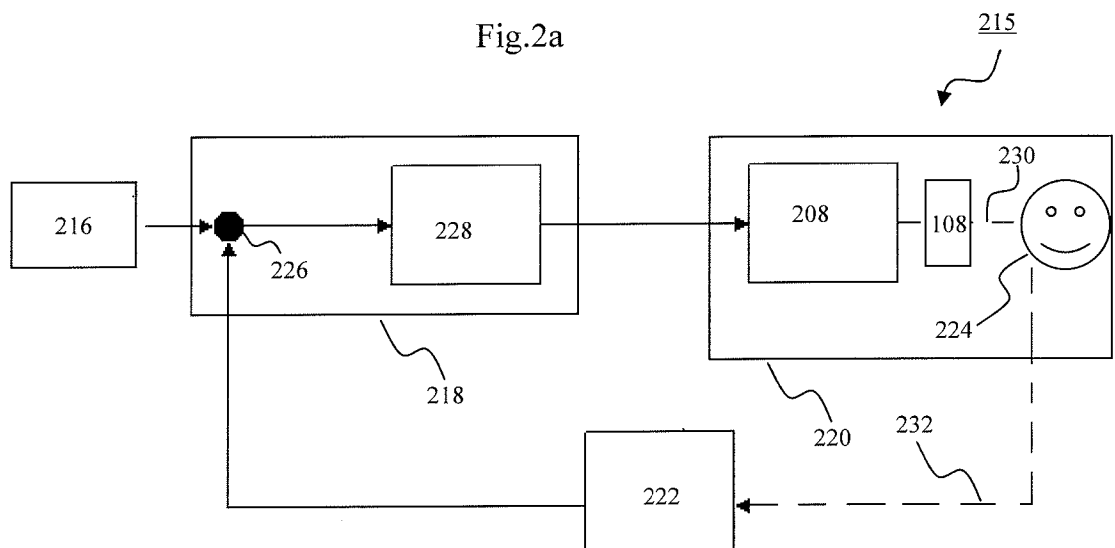


Fig.2b

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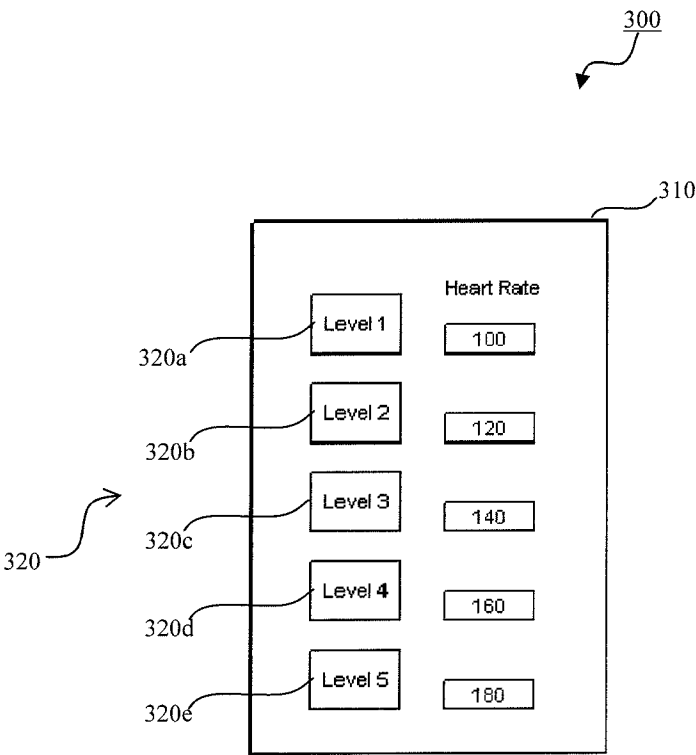


Fig.3

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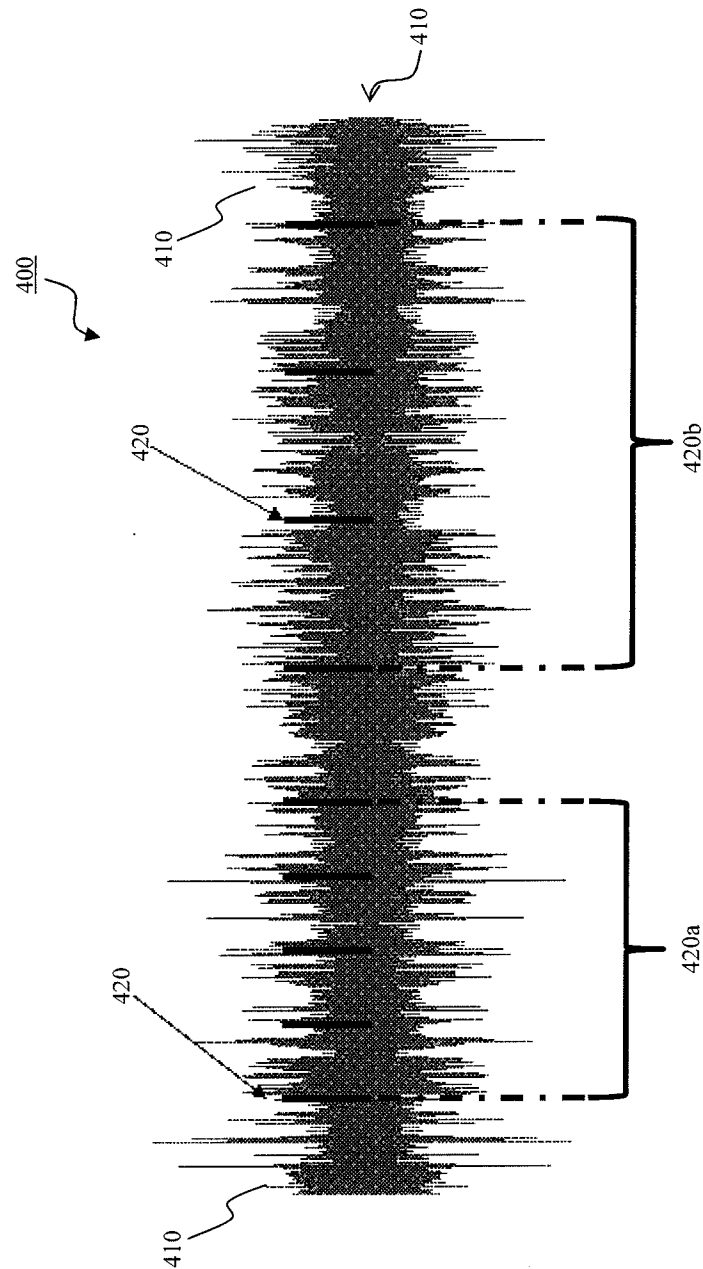


Fig.4

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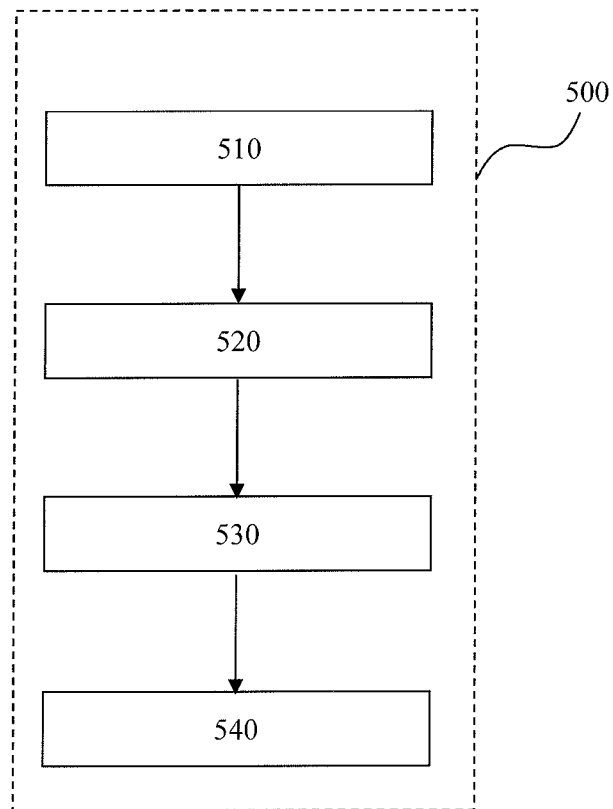


Fig.5

INTERNATIONAL SEARCH REPORT

International application No
PCT/SG2015/050216

A. CLASSIFICATION OF SUBJECT MATTER
INV. A63B24/00 A63B71/06 A61B5/024
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A63B A61B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Shmonin, Vladimir

INTERNATIONAL SEARCH REPORT

International application No
PCT/SG2015/050216

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