US 20150018112A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2015/0018112 A1

(43) Pub. Date: Jan. 15, 2015

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(54) **SYSTEM AND METHOD FOR GOLF SWING TRAINING**

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(21) Appl. No.: **14/328,288**

(22) Filed: **Jul. 10, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/844,793, filed on Jul. 10, 2013.

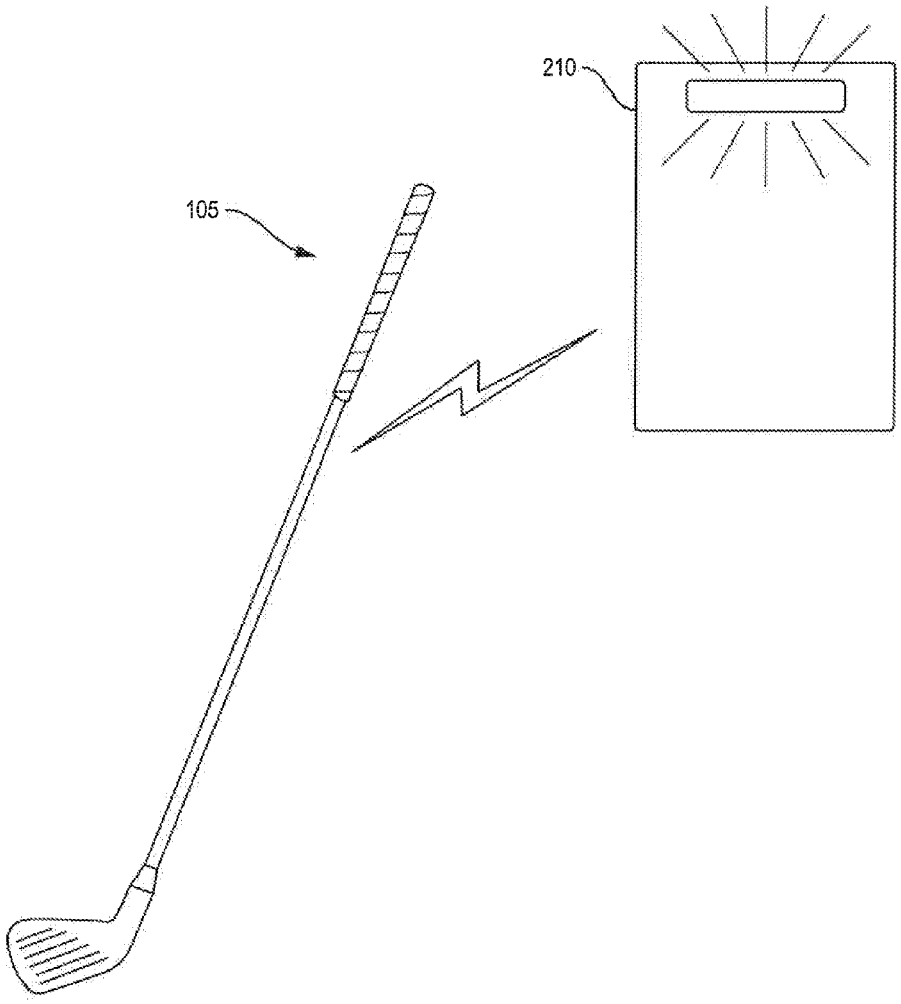
Publication Classification

(51) **Int. Cl.**
A63B 69/36 (2006.01)

(52) **U.S. Cl.**
CPC ***A63B 69/3635*** (2013.01); ***A63B 69/3623*** (2013.01); *A63B 2069/3602* (2013.01); *A63B 2220/833* (2013.01)
USPC **473/224**

(57) **ABSTRACT**

A method and system for training the movement of a golf club that includes a mobile device that receives positional data based on movement of a golf club and stores summation parameters of golf club movements in a trainee database. In addition, the mobile device builds a training envelope that determines the parameters for training and detraining movements. The mobile device then selects a best movement from a plurality of training iterations and outputs an instantaneous feedback based on the positional data during the training iterations. The best movement is the positional and rotational data generated by a best swing. A new best movement is determined from a training iteration that produces a better result than the previous movement.



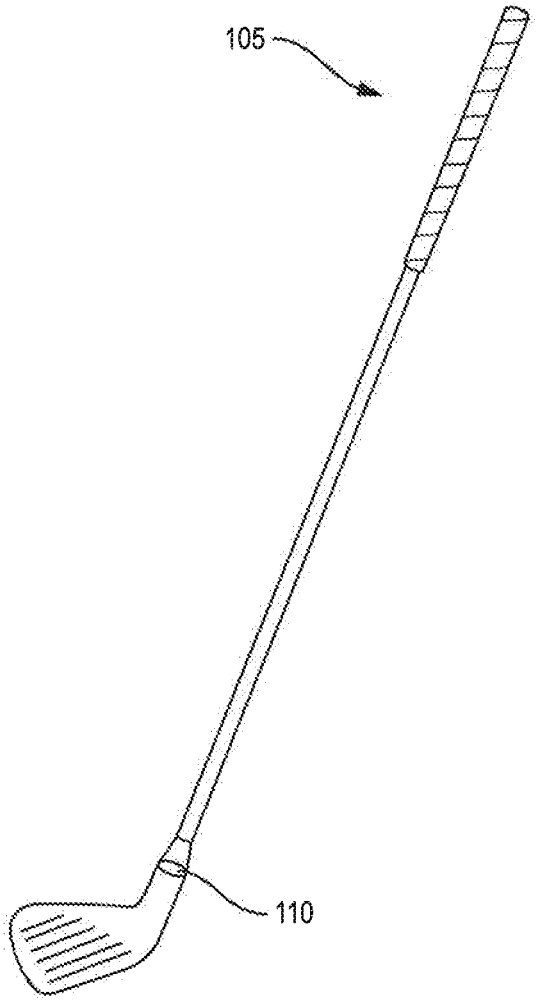


FIG. 1A

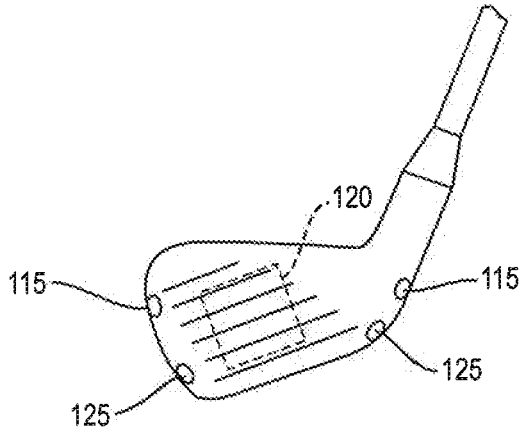


FIG. 1B

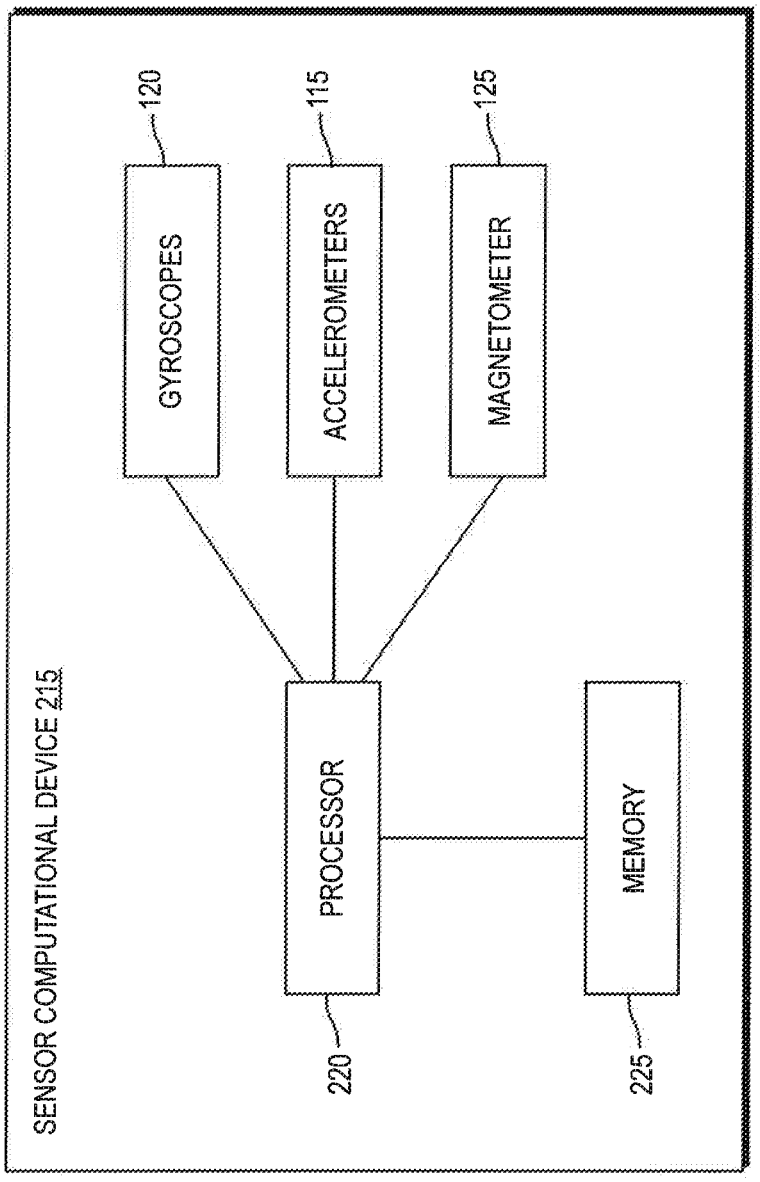

SENSOR COMPUTATIONAL DEVICE 215
120
GYROSCOPES
115
ACCELEROMETERS
125
MAGNETOMETER
PROCESSOR
220
MEMORY
225

FIG. 2

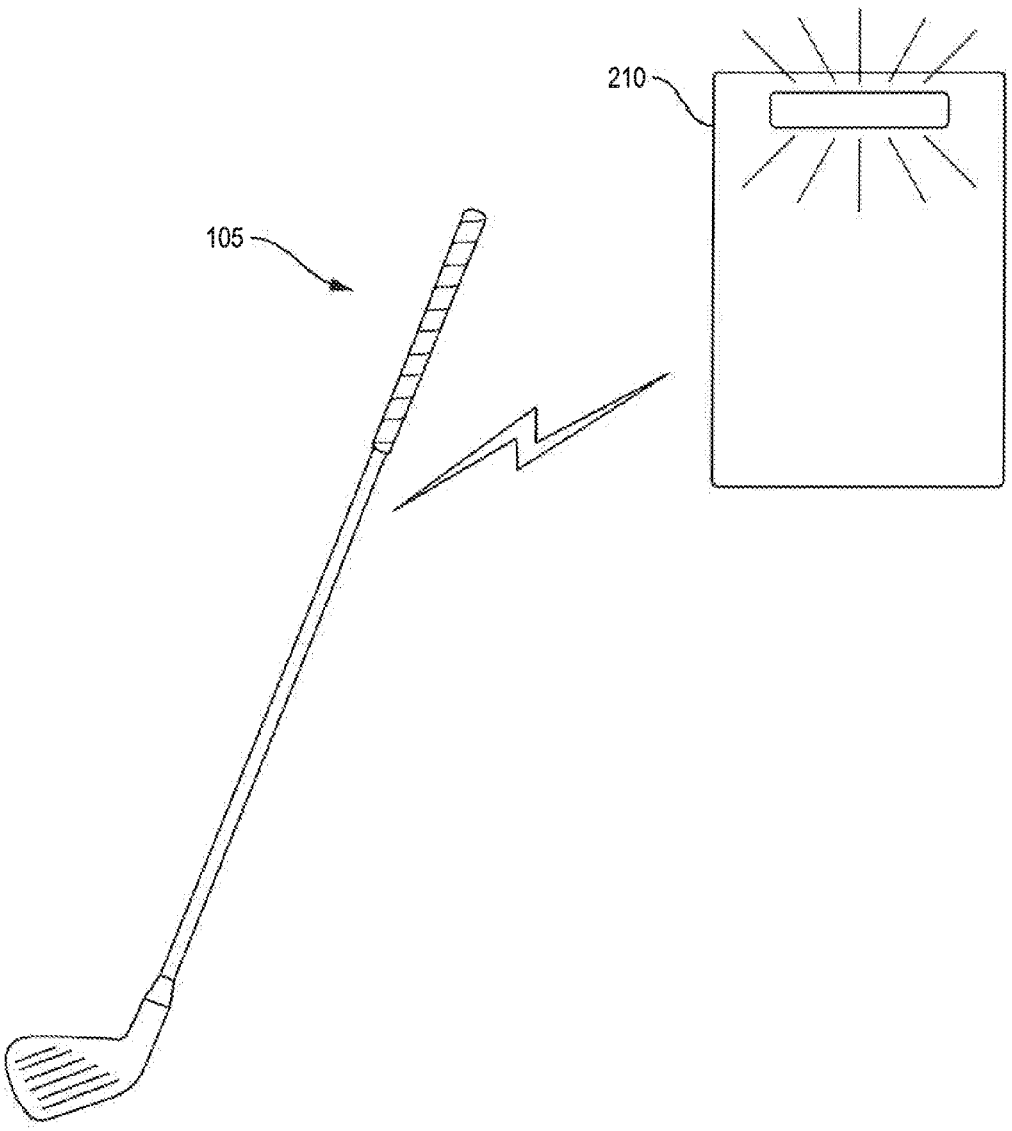


FIG. 3

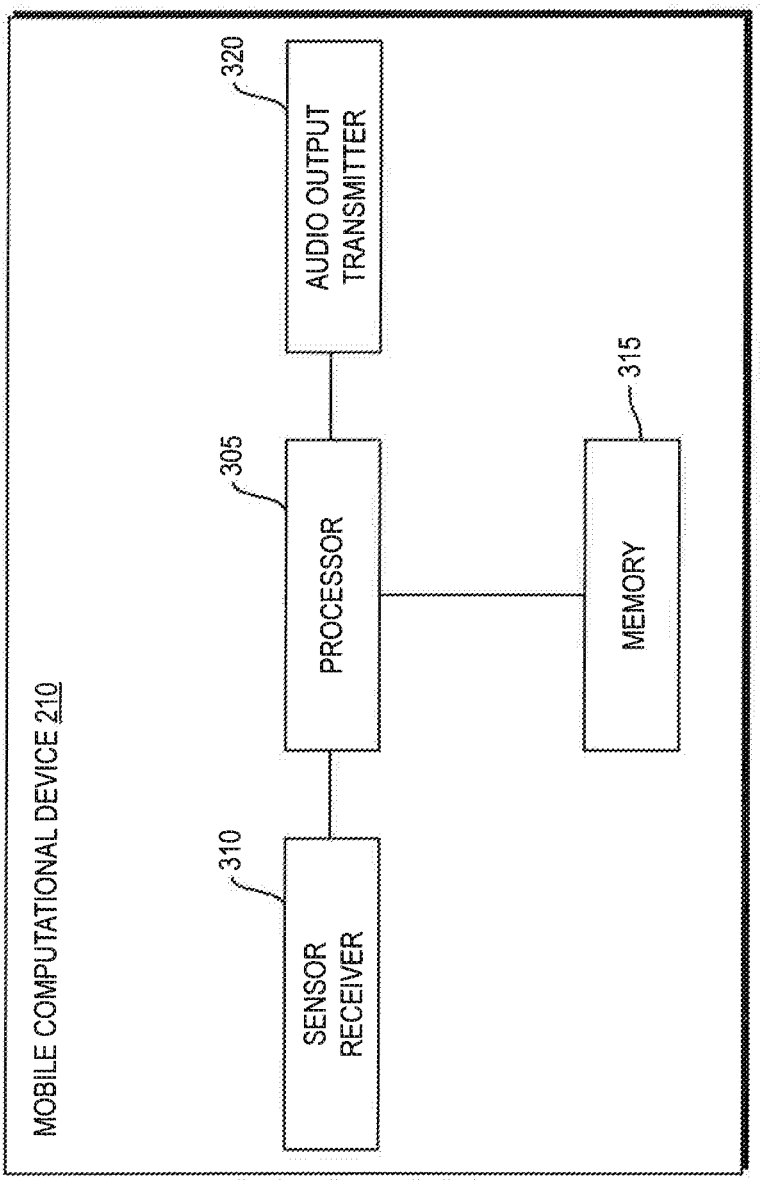

MOBILE COMPUTATIONAL DEVICE 210
320
AUDIO OUTPUT TRANSMITTER
305
PROCESSOR
315
MEMORY
310
SENSOR RECEIVER

FIG. 4

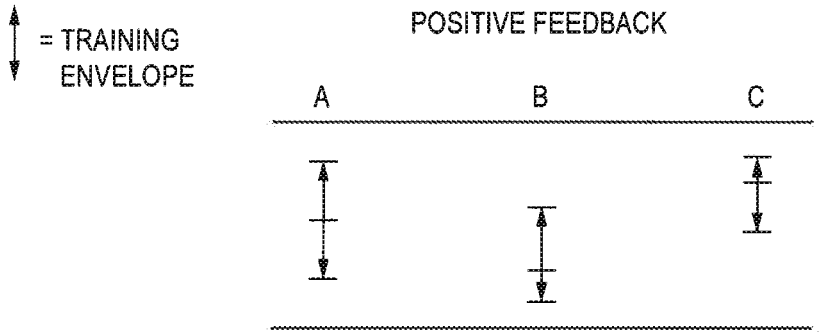

= TRAINING ENVELOPE
POSITIVE FEEDBACK
A
B
C

FIG. 5A

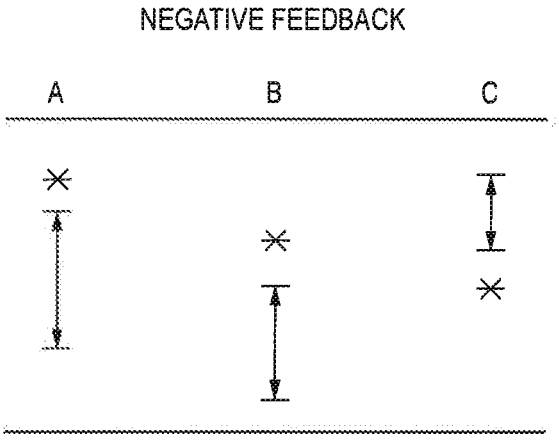

NEGATIVE FEEDBACK
A
B
C

FIG. 5B

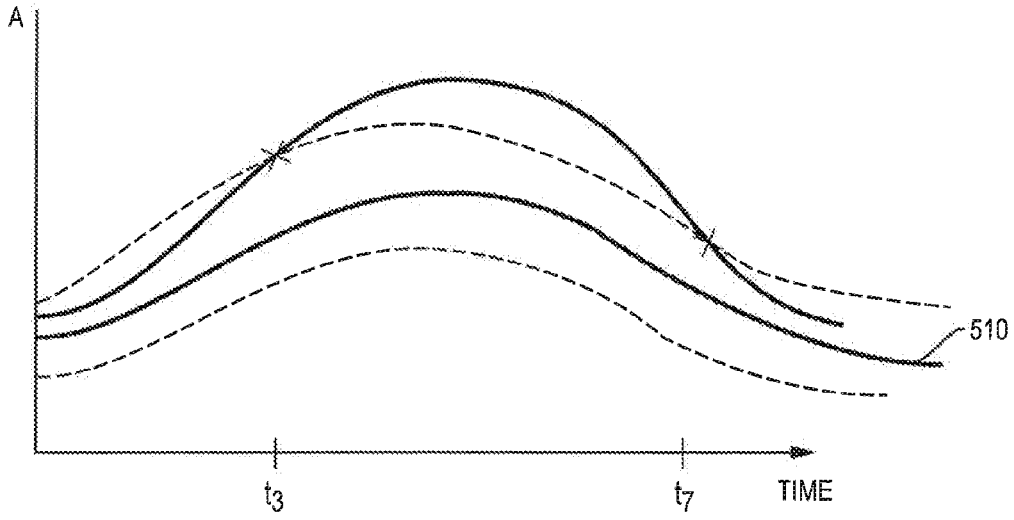


FIG. 5C

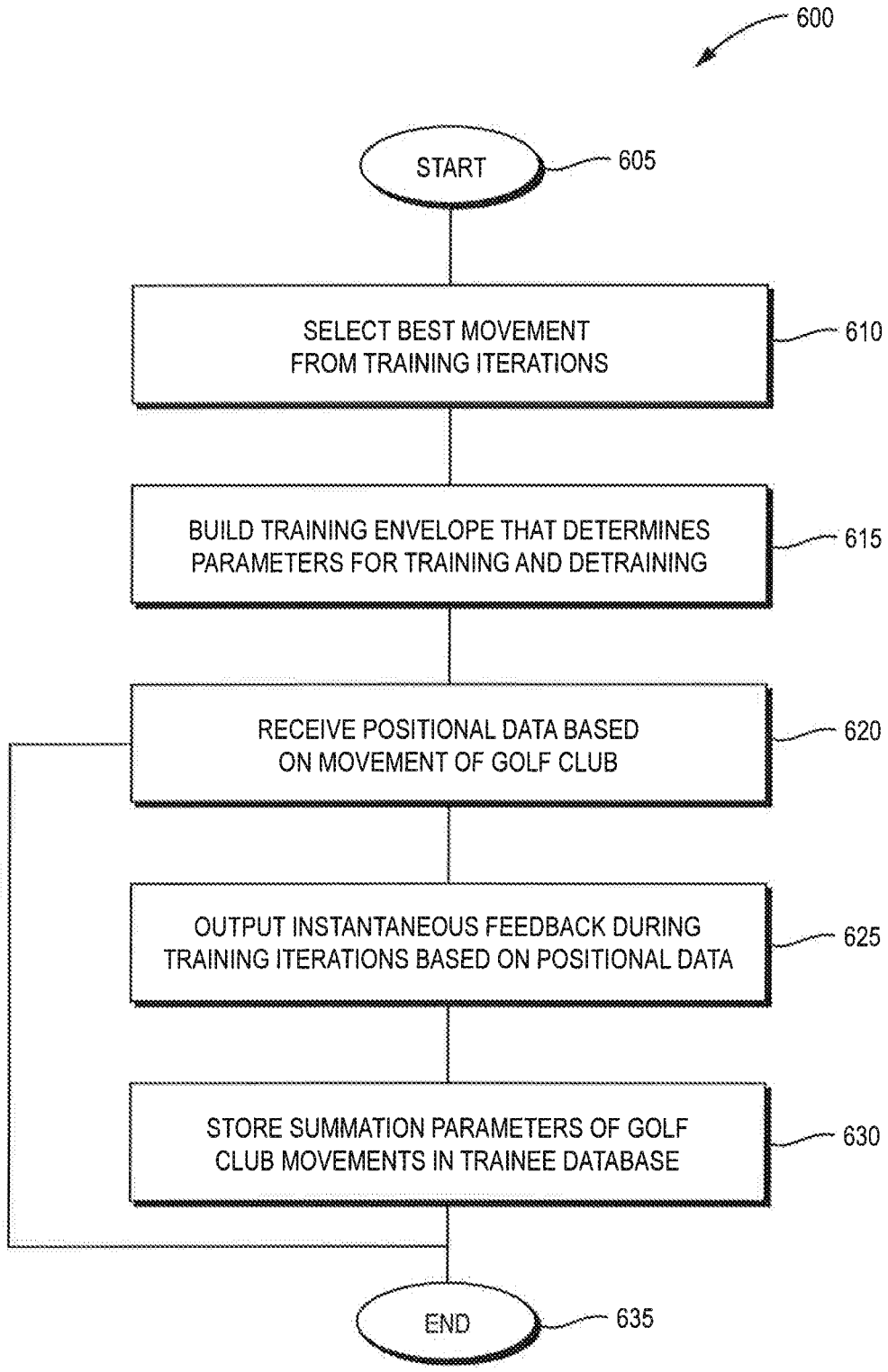

600
START
605
SELECT BEST MOVEMENT FROM TRAINING ITERATIONS
610
BUILD TRAINING ENVELOPE THAT DETERMINES PARAMETERS FOR TRAINING AND DETRAINING
615
RECEIVE POSITIONAL DATA BASED ON MOVEMENT OF GOLF CLUB
620
OUTPUT INSTANTANEOUS FEEDBACK DURING TRAINING ITERATIONS BASED ON POSITIONAL DATA
625
STORE SUMMATION PARAMETERS OF GOLF CLUB MOVEMENTS IN TRAINEE DATABASE
630
END
635

FIG. 6

SYSTEM AND METHOD FOR GOLF SWING TRAINING

RELATED APPLICATION

[0001] The present application claims priority to U.S. Provisional Patent Application Ser. No. 61/844,793, entitled "SYSTEM AND METHOD FOR TRAINING MOVEMENT OF GOLF CLUB", filed by Millers et al. on Jul. 10, 2013, the contents of which are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a golf swing training system, and, more particularly, to a golf swing training system that provides instantaneous feedback during the training movements.

BACKGROUND

[0003] Recently developed golf training systems include portable devices that are mounted on the exterior of a golf club. These systems include, for example, a detachable gyroscope that outputs a vibration alert to prevent the club face from improperly rotating on plane. Another training device includes a hinge system that breaks when the golf swing is not on plane.

[0004] Furthermore, other recently developed golf training systems include a memory that stores golf swing data during golf training iterations, These systems provide non-instantaneous feedback via a display such as a mobile device or the like. Specifically, these systems typically output a chart to a golfer that shows the scalar results of a single golf swing. However, the golfer is not provided with any instantaneous guidance as how to correct any deficiencies in the golf swing to further improve the swing.

SUMMARY

[0005] According to one or more embodiments of the disclosure, a mobile device may receive positional data based on movement of a golf club and store parameters of each golf club movement in a trainee database. In addition, the mobile device may build a training envelope that determines the parameters for training and detraining movements. A best movement may then be selected from a plurality of training iterations by the mobile device. The training envelope may be a range of deviation from the best movement parameters and may be a set of positional and rotational values that define the range of values included in a successful training movement, The mobile device may then output an instantaneous feedback during the training iterations based on the received positional data. The trainee database may include a current training level, a current improvement rate, quantitative improvement over training duration, quantitative improvement per training iteration and session, definitions of best movement, definitions of training movement, and definitions of detraining movements. The training movements may be golf club movements within the training envelope parameters and the detraining movements may be golf club movements beyond the training envelope parameters, The instantaneous feedback, which may be an audio response, may also indicate whether the golf movement conforms to or is beyond the training envelope.

[0006] In addition, the mobile device may adjust the training envelope parameters as the training movement is repeatedly performed. During periodic training, the mobile device may select a new best movement when the parameters of a golf club movement have improved beyond the previous best movement parameters. This new best movement may be a condition for outputting a positive instantaneous feedback and a detraining signal may be output by the mobile device in response to detecting a golf club rotation or position (e.g., movement) beyond the training envelope parameters. The parameters for training and detraining movements may include accuracy of golf club positioning, accuracy of a swing movement (e.g., a stroke movement), a back, swing distance control, and an even acceleration of a swing. Then, in response to reaching a training threshold, the mobile device may reset the training and detraining parameters of the training envelope and may continuously compare a current level of performance with the new best movement to output instantaneous feedback and to continue improvement of the golf club movement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The embodiments herein may be better understood by referring to the following description in conjunction with the accompanying drawings in which like reference numerals indicate identically or functionally similar elements, of which:

[0008] FIGS. **1**A-**1**B illustrate an exemplary golf club sensor system implemented on a golf club according to an exemplary embodiment of the present disclosure;

[0009] FIG, **2** illustrates an exemplary sensor computational device of the golf club sensor system according to an exemplary embodiment of the present disclosure;

[0010] FIG. **3** illustrates an exemplary communication between a golf club sensor system and a mobile device according to an exemplary embodiment of the present disclosure;

[0011] FIG. **4** illustrates an exemplary mobile computational device of the golf club training system according to an exemplary embodiment of the present disclosure;

[0012] FIGS. **5**A-**5**C illustrate exemplary training envelope graphs according to an exemplary embodiment of the present disclosure; and

[0013] FIG. **6** illustrates an exemplary simplified procedure of a method for training the movement of a golf club according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

[0014] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention, As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0015] Unless specifically stated or obvious from context, as used herein, the term "about" is understood as within a range of normal tolerance in the art, for example within 2 standard deviations of the mean. "About" can be understood

as within 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, 1%, 0.5%, 0.1%, 0.05%, or 0.01% of the stated value. Unless otherwise clear from the context, all numerical values provided herein are modified by the term "about."

[0016] Additionally, it is understood that the term controller refers to a hardware device that includes a memory and a processor. The memory is configured to store the modules and the processor is specifically configured to execute said modules to perform one or more processes which are described further below.

[0017] Furthermore, control logic of the present invention may be embodied as non-transitory computer readable media on a computer readable medium containing executable program instructions executed by a processor, controller or the like. Examples of the computer readable mediums include, but are not limited to, ROM, RAM, compact disc (CD)-ROMs, magnetic tapes, floppy disks, flash drives, smart cards and optical data storage devices. The computer readable recording medium can also be distributed in network coupled computer systems so that the computer readable media is stored and executed in a distributed fashion.

[0018] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein, It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of difference configurations, all of which are explicitly contemplated herein. Further, in the following description, numerous details are set forth to further describe and explain one or more embodiments. These details include system configurations, block module diagrams, flowcharts, and accompanying written description. While these details are helpful to explain one or more embodiments of the disclosure, those skilled in the art will understand that these specific details are not required in order to practice the embodiments.

[0019] FIGS. **1**A-**1**B are exemplary diagrams of the golf training system according to an exemplary embodiment of the present invention. As shown in FIG. **1**A, the golf training system may be embedded within a golf club **105** and may include a sensor unit **110** mounted above and/or within the club head and configured to collect data regarding the club head and orientation of the golf club from a plurality of sensors. Specifically, as shown in FIG. **1**B, the sensor unit **110** may include a plurality of sensors such as accelerometers **115**, gyroscopes **120**, and magnetometers **125** that may indicate a precise repeatable club head starting position. In addition, as seen in FIG. **2**, the sensor unit **110** may be a sensor computational device **215** that has a processor **220** and a memory **225**. The processor **220** may be configured to receive the collected data from the gyroscopes **120**, the accelerometers **115**, and magnetometers **125** and store the data in the memory **225**. In addition, the sensor computational device **215** may be configured to compute positional data from the sensor data.

[0020] Further, the sensor computational device **215** of the golf training system may be configured to communicate the positional data wirelessly (e.g., via Bluetooth, WiFi, cellular service, etc.) with a mobile computational device **210** (e.g., a mobile phone, a smart phone, a personal digital assistant, etc) as shown in FIG. **3**, In other words, the sensor computational device **215** and the mobile computational device **210** may be configured to communicate wirelessly. Additionally, the mobile computational device **210** may be configured to output audio commands related to the golf training movements and output voice recognition responses.

[0021] Referring to FIG. **4**, the mobile computational device **210** may include a microprocessor or a processor **305** which may be configured to receive the sensor positional data instantaneously from the sensor unit **110** via a sensor receiver **310**. In addition, based on the golf club training movements (e.g., training iterations), the processor **305** may be configured to establish and store a most desirable club head movement (e.g., best movement) in a memory **315** (e.g., a trainee database) to continuously compare instantaneous club head location and rotation with the best movement (e.g., the expected and desired club head movement). When the processor **305** has compared the instantaneous data with the best movement data using a plurality of algorithm calculations, the processor **305** may output feedback (e.g., audio response) via an audio output transmitter **320**, thus providing both positive and negative feedback to a golfer during the training of the golf club movement. The processor **305** may be configured to store in the memory **315** (e.g., trainee database) a plurality of parameters such as a current training level, a current improvement rate, quantitative improvement over training duration, quantitative improvement per training iteration and session, definitions of best movement, definitions of training movement, definitions of detraining movements, and the like.

[0022] Furthermore, the processor **305** of the mobile device **210** may be configured to build a training envelope that determines parameters for training and detraining movements and may be modified to control and drive trainee learning. The training envelope may be a set of positional and rotational values based on multiple swings performed during training movements. In other words, when a golf swing is within the range training parameters of the envelope, the swing may be considered a training movement. The parameters for training and detraining may include accuracy of golf club positioning, accuracy of a swing (e.g., stroke) movement, back swing distance control, even acceleration of the swing, and the like. Specifically, the precise swing parameter may be how a golf club orientation is adjusted to move through the golf ball substantially orthogonal to where the face of the golf club is pointing. The back swing distance control involves the starting position of the swing at a designated point and the golf club backswing point to achieve a designated distance. The combination of the accuracy of golf club positioning and accuracy of swing movement parameters may minimize angular deviation of the golf ball movement, In addition, the combination of the back swing distance control and even acceleration of the swing parameters may increase the precision of distance control.

[0023] As a golfer improves a golf swing (e.g., reaches a training threshold), the training envelope may decrease toward the parameters of the selected best movement. Alternatively, when a golf swing is beyond the range of the training envelope parameters, the golf swing may be considered to be a detraining movement. Thus, the mobile device may output instantaneous feedback on the deviation of the swing to training envelope parameters, thereby providing instantaneous

feedback based on the movement of the golf club and not on the results of striking a golf ball. FIGS. **5**A-**5**C show exemplary graphs of deviations for a training envelope for various parameters taken into account to form the training envelope. For example, as seen in

[0024] FIG. **5**A, when a golf swing is within the training envelope (indicated by the arrows) of the various parameters (e.g., A, B, and C, such as rotational angle, club head speed, etc.), a positive feedback may be output. Alternatively, as seen in FIG. **5**B, when a golf swing is determined to be beyond the training envelope for the various parameters of the training envelope, a negative feedback may be output. In other words, the mobile computational device **210** may be configured to output an instantaneous feedback based on whether the particular golf swing is within a training envelope parameters.

[0025] Additionally, the mobile computational device **210** may be configured to determine whether a particular golf swing is beyond the training envelope at various points in time, as illustrated in FIG. **5**C. In other words, the mobile computational device **210** may be configured to determine whether a golfer is within training envelope parameters throughout each movement of the golf club until the swing is complete. For example, in FIG. **5**C the dashed lines indicate a training envelope for a complete golf swing and shows a best movement **510** that is within the training envelope. When a golfer performs a successive swing, a negative feedback may be output at time t3 since at that particular time, the movement is beyond the training envelope parameters.

[0026] Moreover, when a negative feedback is output to a golfer, the golfer may interpret the feedback as an instruction to abort that particular swing. Thus, negative learning may be minimized and the analysis of the swing may be improved. Additionally, a positive feedback may be an indication of continuous tracking of the best movement. In one exemplary embodiment, when the positive feedback is no longer output (e.g., the positive feedback is lost), the output is not repeated. In other words, the goal of a golfer may be to maintain the positive feedback output for as long as possible. Accordingly, the golf club movements of an entire golf club swing may be monitored.

[0027] A golfer may therefore, adjust the movement of the golf club, based on the feedback to improve consistency of a golf swing. For example, the output feedback may provide the physical state of a golf club movement as an audio tone. Additionally, different audio tones may be output for different states of the golf club movement and a golfer may interpret the various tones as either positive feedback or as a correction tone. The mobile computational device **210** may be configured to only output a negative feedback when the golf club movement is beyond the training envelope parameters. Thus, the golfer may immediately be provided with a measure of deficiencies in the golf swing. When a golfer swings a new best movement, the mobile device may select the new best movement (e.g., a better movement than the best movement) to further improve a golf swing. Notably, the feedback output is not limited to an audio tone and may be any other audio response known to those skilled in the art capable of providing feedback on deviation correction. In addition, each new best movement operates as a condition for outputting positive feedback and the training envelope provides boundary conditions for outputting negative feedback.

[0028] Moreover, the phenomenon of repeating the golf club training movement while learning a selected best movement is known to those skilled in the art as cerebellar learning. Specifically, as the training movement is learned or modified, a portion of the movement control is also learned and thus, under the control of the cerebellum, may be come unconscious learning. Since the cerebellum stores both training and detraining movements, the golf training system of the present disclosure focuses on improving the training movements by outputting feedback when a golf swing is within the training envelope parameters and when the golf swing is beyond the training envelope parameters. In addition, the feedback helps ensure that the majority of training iterations are training movements and helps ensure consistency of a golf swing. The efficiency of skeletal training (e.g., the rate at which a trainee learns) is dependent on reaching an optimum ratio of training movement to detraining movements. As the trainee improves the training movements and reaches a predetermined training threshold, the parameters of a training envelope (e.g., boundary conditions) may be modified to maintain the optimum ratio.

[0029] FIG. **6** illustrates an exemplary simplified procedure **600** for training the movement of a golf club according to an exemplary embodiment of the present disclosure described herein. The procedure **600** may start at step **605**, and continues to step **610**, where a mobile device selects a best movement based on received positional data from a plurality of training iterations. In step **615**, the mobile device builds a training envelope that determines the parameters for training and detraining movements. The training envelope may be a set of positional and rotational values. In step **620**, a mobile device receives positional data based on movements of a golf club and then in step **625**, instantaneous feedback may be output during the training iterations based on the received positional data. The instantaneous feedback may indicate the deviation of golf club movements determined to conform to or be beyond the training envelope parameters. In step **630**, the mobile device stores summation parameters of golf club movements in a trainee database. Then, the process may illustratively repeat to step **620** or end in step **635**.

[0030] Note that the functional blocks, processes, devices and systems described in the present disclosure may be integrated or divided into different combinations of systems, devices, and functional blocks as would be known to those skilled in the art. The foregoing description has been directed to specific embodiments. It will be apparent; however, that other variations and modifications may be made to the described embodiments, with the attainment of some or all of their advantages. Accordingly, this description is to be taken only by way of example and not to otherwise limit the scope of the embodiments herein. Therefore, it is the object of the accompanying claims to cover all such variations and modifications as come within the true spirit and scope of the embodiments herein.

What is claimed is:

1. A golf training method, comprising:

receiving, by a mobile device, positional data based on movement of a golf club;

storing, by the mobile device, summation parameters of golf club movements in a trainee database;

building, by the mobile device, a training envelope that determines the parameters for training and detraining movements;

selecting, by the mobile device, a best movement from a plurality of training iterations; and

outputting, by the mobile device, an instantaneous feedback during the training iterations, wherein the instantaneous feedback is based on the received positional data,

wherein the instantaneous feedback indicates one or both of conforming to the training envelope or being beyond the training envelope.

2. The method of claim **1**, wherein the instantaneous feedback is an audio response.

3. The method of claim **1**, further comprising:

adjusting, by the mobile device, the training envelope parameters as the movement is repeatedly performed.

4. The method of claim **1**, further comprising:

selecting, by the mobile device, a new best movement when the parameters of a golf club movement have improved beyond the previous best movement parameters.

5. The method of claim **4**, wherein the new best movement is a condition for outputting, by the controller, positive instantaneous feedback.

6. The method of claim **1**, wherein the parameters for training and detraining movements include accuracy of golf club positioning, accuracy of a swing movement, a back swing distance control, and an even acceleration of a swing.

7. The method of claim **1**, further comprising:

outputting, by the mobile device, a detraining signal in response to detecting a golf club movement beyond the training envelope parameters.

8. The method of claim **1**, further comprising:

in response to reaching a training threshold, resetting, by the mobile device, the training and detraining parameters of the training envelope.

9. The method of claim **1**, wherein the trainee database includes one or more of a current training level, a current improvement rate, quantitative improvement over training duration, quantitative improvement per training iteration and session, definitions of best movement, definitions of training movement, and definitions of detraining movements.

10. The method of claim **1**, further comprising:

continuously comparing, by the mobile device, a current level of performance with the new best movement and training envelope to output instantaneous feedback.

11. The method of claim **1**, wherein the training movements are golf club movements within the training envelope parameters and the detraining movements are golf club movements beyond the training envelope parameters.

12. The method of claim **1**, wherein the training envelope is a set of positional and rotational values that define the range of values included in a successful training movement.

13. A golf training system, comprising:

a mobile device configured to:

receive positional data based on movement of a golf club;

store summation parameters of golf club movements in a trainee database;

build a training envelope that determines the parameters for training and detraining movements; and

select a best movement from the training iterations; and

output an instantaneous feedback during the training iterations, wherein the instantaneous feedback is based on the received positional data,

wherein the instantaneous feedback indicates one or both of conforming to the training envelope or being beyond the training envelope.

14. The system of claim **13**, wherein the instantaneous feedback is an audio response.

15. The system of claim **13**, wherein the parameters for training and detraining movements include accuracy of golf club positioning, accuracy of a swing movement, a back swing distance control, and an even acceleration of a swing.

16. The system of claim **13**, wherein the training movements are golf club movements within the training envelope parameters and the detraining movements are golf club movements beyond the training envelope parameters.

17. The system of claim **13**, wherein the training envelope is a set of positional and rotational values that define the range of values included in a successful training movement.

18. A non-transitory computer readable medium containing program instructions executed by a processor, the computer readable medium comprising:

program instructions that receive positional data based on movement of a golf club;

program instructions that store summation parameters of golf club movements in a trainee database;

program instructions that build a training envelope that determines the parameters for training and detraining movements;

program instructions that select a best movement from the training iterations; and

program instructions that output an instantaneous feedback during the training iterations, wherein the instantaneous feedback is based on the received positional data,

wherein the instantaneous feedback indicates one or both of conforming to the training envelope or being beyond the training envelope.

19. The non-transitory computer readable medium of claim **18**, wherein the instantaneous feedback is an audio response.

20. The non-transitory computer readable medium of claim **18**, wherein the training envelope is a set of positional and rotational values that define the range of values included in a successful training movement.

* * * * *