RACQUET WITH ENTERTAINMENT AND PERFORMANCE FEEDBACK

Inventors: Stefan Scheinert, San Jose, CA (US); Bob Glasberg, La Jolla, CA (US)

Correspondence Address:
HOGAN & HARTSON L.L.P.
1999 AVENUE OF THE STARS
SUITE 1400
LOS ANGELES, CA 90067 (US)

Assignee: FUN RACQUETS, INC., San Jose, CA (US)

Appl. No.: 11/556,144
Filed: Nov. 2, 2006

Related U.S. Application Data

Provisional application No. 60/733,877, filed on Nov. 7, 2005. Provisional application No. 60/739,527, filed on Nov. 28, 2005.

Publication Classification

Int. Cl.
A63B 59/00 (2006.01)
A63B 69/38 (2006.01)

U.S. Cl. 473/461; 473/516

ABSTRACT

A tennis racquet that provides audio or visual feedback to a player. Sensors sense the impact of a ball on the racquet. A feedback indicator provides visual or audio feedback. A controller controls the indicator based on data provided by the sensors. In an entertainment mode, feedback is provided based on any ball impact. In a training mode, feedback is based on a ball impact within a sweet spot of the racquet. The sensors may collect performance data such as number of impacts, location of impacts, ball speed and racquet angle. A communication link may be provided to download the performance data to an external device.
Fig. 4
RACQUET WITH ENTERTAINMENT AND PERFORMANCE FEEDBACK

RELATED APPLICATIONS

This application claims the benefit of U.S. provisional application 60/733,877, filed on Nov. 7, 2005, and U.S. provisional application 60/739,527, filed on Nov. 28, 2005.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to sporting equipment such as racquets, paddles and boards, and more particularly relates to a racquet providing entertainment and performance feedback.

2. Description of Related Art

Conventional sporting equipment, such as tennis racquets, paddles, boards and the like, are designed for players of a variety of skill levels from beginners to very advanced. They vary in size, design, weight, color, composition, etc., but are designed and manufactured primarily with player size and player performance objectives in mind. Racquet and other sporting equipment design typically does not include consideration of entertainment value or audio/visual feedback.

Moreover, conventional racquets do not provide performance feedback, such as an indication of where the ball hit the strings during a stroke. In tennis, for example, hitting the ball on the strings “sweet spot” is a critical component of success. The sweet spot is an inner area of the racquet strings. If the ball is hit outside of this area, the ball may still be returned, but with less control and with a higher chance of being off target. However, it is difficult for a player to know with certainty whether the ball was hit with the sweet spot contour or with the outer part of the strings. Since results are best when the ball is hit with the sweet spot contour, immediate feedback indicating whether the ball and sweet spot made contact would significantly enhance player performance and development. Moreover, feedback and display of other performance-related data and statistics would be of great assistance and value to a player’s training and skill development.

SUMMARY OF THE INVENTION

The electronic racquet of the present invention addresses both the entertainment and training issues that are not adequately addressed by the prior art.

Accordingly, one embodiment of the invention is a racquet that provides feedback to a player. The racquet includes feedback means for providing feedback based on an impact of a ball on the racquet. In one implementation, the feedback means comprises sensor means for sensing the impact of the ball on the racquet, indicator means for providing visual or audio feedback, and a controller for controlling the indicator means based on data provided by the sensor means. In another implementation, the feedback means comprises strings of the racquet that change properties based on the ball impact.

Another embodiment of the invention is a dual-mode racquet having an entertainment mode where audio or visual feedback is provided based on any ball impact, and a training mode where audio or visual feedback based on a ball impact within a predetermined zone (sweet spot) of the racquet.

Another embodiment of the invention is a racquet having a frame and strings mounted on and stretched across the frame. Sensors are mounted on the frame to detect an impact of a ball on the strings, and a feedback indicator provides feedback based on data collected by the sensors. In one implementation, the data collected by the sensors includes performance data such as number of impacts, location of impacts, ball speed and racquet angle, and the racquet includes a communication link for downloading the performance data to an external device. In another implementation, the feedback indicator provides audio or visual feedback based on whether the ball impact was within the sweet spot of the racquet.

OTHER FEATURES AND Advantages of the invention will be apparent from the following detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, various features of embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a tennis racquet according to the present invention.

FIG. 2 is a diagram of a tennis racquet according to the present invention.

FIG. 3 is a diagram of a tennis racquet using a strain gauge array according to the present invention.

FIG. 4 is a block diagram of a control system embodied in the tennis racquet of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The invention is described below primarily with reference to a tennis racquet. However, the scope of the invention is not so limited. The present invention has applicability in other racquets such as squash and badminton racquets, paddles such as beach paddle, and boards such as beach boards, skate boards and snow boards. Moreover, the present invention extends to the string used in the racquet.

FIGS. 1 and 2 illustrate a tennis racquet that provides entertainment and/or performance feedback. Racquet 10 includes sensors that provide visual and/or audio feedback when a ball hits the strings of the racquet. Racquets intended solely for entertainment may provide visual or audio feedback when the ball hits anywhere on the strings, while racquets intended for training purposes may provide feedback only when the ball hits a specific portion of the racquet, such as a sweet spot. Moreover, as described below, a controller in the racquet may receive, store and display data from the sensors to assist a user of the racquet in performance analysis, training and development.

Racquet 10 comprises a frame 12 across which horizontal strings 14 and vertical strings 16 are stretched, and a grip or handle 50. Horizontal sensors 22 and vertical sensors 24 are provided to determine ball impact on the strings, preferably at positions around the frame that correspond to string locations. Sensors may be provided at
locations corresponding to some or all of the strings, and the number of sensors is dependent on the size of the racquet and the precision of feedback that is desired. The sensors may be implemented, for example, as optical links with LEDs, or with lasers and photo sensors on a receiving side. Thus, for example, in the two horizontal sensors 22 at opposite end locations of a string extending across racquet 10, one sensor 22 may actually be a laser and the other sensor 22 a photo sensor receiving the laser on an opposite side.

[0019] Typically, the racquet is exposed to sunlight during use, so the links are preferably modulated to eliminate interference. Alternatively, the sensors or links may be implemented as acoustic links using ultrasound to measure the distance to the point of impact on the racquet, which can be used to determine whether the ball was hit with the sweet spot.

[0020] Other sensors that may be used include microphones, vibration sensors and piezo-transducers. A vibration sensor, for example, may be used to detect ball impact and to determine whether the impact occurred inside or outside of the sweet spot. The magnitude of the signal generated by the vibration sensor will correspond to the force of ball impact. Thus, ball impacts of greater force will create sensor signals of higher magnitude. In one embodiment, the racquet user can select thresholds for detection of ball impact. Thus, a user may select a “soft” setting, where every ball impact is detected, or a “hard” setting, where only “fast” hits or ball impacts of significant force are detected.

[0021] The waveform of the sensor signal may also be analyzed to determine whether ball impact occurred inside or outside of the sweet spot. In a waveform generated by a vibration sensor, there are at least three components: a high impact pulse; a decaying sine wave at approximately 1 kHz from the net; and a lower level wave at approximately 100-150 Hz from the frame. The net frequency varies depending on impact location, with the lowest frequency being generated when the ball impacts in the sweet spot. Thus, the waveform sensor signal can be sampled and converted into a digital signal, processed by the microcontroller or DSP, and analyzed to determine whether impact occurred in the sweet spot.

[0022] In one implementation, an LD70 solid state switch/vibration sensor from Measurement Specialties was used and placed within grip 50. The LD70 sensor employs PVDF film which is relatively inexpensive and can be attached directly to the face of the racquet or even wrapped around some of the netting.

[0023] A controller, DSP or other intelligent component 70 (FIG. 4) modulates the sensors or links and monitors for link interruption. The controller may be configured in area 40 between grip 50 and frame 12, or may be configured in grip 50 itself. A power supply 72, such as a battery or solar panel, is also provided in area 40 or grip 50 and provides power to the electrical components of racquet 10.

[0024] Racquet 10 further comprises one or more feedback indicators to provide visual and/or audio feedback to a user when a ball impact is sensed by sensors 22, 24. The feedback indicators may comprise one of, or a combination of, lights, loudspeakers and displays. Lights (such as light emitting diodes or LEDs) 74 may be configured around frame 12 in a pattern appropriate for entertainment or training purposes. Electroluminescence wire or polycarbonate light pipes, for example, may be wrapped around the frame. Lights 74 may also be provided in area 40 and/or grip 50. For all light implementations, it is preferable that the adjacent background be dark so as to provide better contrast for the light.

[0025] A loudspeaker or buzzer 76 may be provided at area 40, grip 50 or another appropriate location in racquet 10. Racquet 10 may also incorporate a visual display 78, such as an LCD screen, typically in area 40. Display 80 may display performance statistics such as, for example, total number of hits and percentage of hits in the sweet spot, for use in monitoring development and performance during a game or practice session.

[0026] Selective feedback may be provided where, as described below, sensors 22, 24 collect data beyond simple ball impact. For example, a particular sound or light may be activated for a good hit (i.e. ball hits inside of sweet spot 20), while another sound or light is activated for a bad hit (i.e. ball hits outside of sweet spot 20). Feedback may change depending on the velocity of the ball or the racquet or, as will be described below, depending on the type of stroke that is used. Feedback could also be provided to assist in specific training purposes, such as an audio count of the number of ball impacts where a player is engaged in a repetitive drill, i.e., such as hitting a ball a certain number of times for training purposes.

[0027] These examples of feedback indicators are illustrative, and not restrictive. Other components for providing audio or visual feedback of ball impact may be provided and are within the scope of this invention.

[0028] Racquet 10 may also comprise a user interface 80, such as a button or buttons (see FIG. 2), particularly where racquet 10 includes a display 78. User interface 80 may take forms other than buttons as the size of racquet 10 permits, and could also be incorporated in display 78 as a touch screen, for example.

[0029] As described below, controller 10 may also collect data from sensors 22, 24 that is indicative of various aspects of a player’s performance, such as number of impacts, location of impacts, ball speed, racquet speed, racquet angle, etc. A memory 82 may be provided, typically in area 40 or grip 50 and in communication with controller 70, for local storage of such data.

[0030] Racquet 10 may also comprise a communication link 84 for download of the collected data to a user PC, external display or other device for analysis and display. The communication link may be a wireless link or, alternatively, could be a port for a wired link to an appropriate port of a computer (such as a USB port, for example). Link 84 may also upload instructions from external devices to controller 70. For example, a user could program or select the light, audio or other feedback pattern of racquet 10, or the information to be displayed on display 78, from a PC or other computing device. Tones similar to “ringtones” for telephones may be downloaded for audio feedback. Racquet 10 could be provided or sold with appropriate software, downloadable to a user’s computer, with which to configure racquet 10 via communication link 84. Thus, racquet 10 may be configured to provide audio and visual feedback, and to
collect, store and display appropriate data, per any entertainment or training instructions of the user.

Communication link 84 may be implemented in grip 50 or area 40, and may use various wireless communication protocols. Zigbee, which is a low cost, short range technology, is one preferred protocol. The processed data from the racquet does not require a high data rate connection, and power consumption is very low making it ideal for battery operation. Alternatively, Bluetooth could be used. Bluetooth is relatively low cost and short range, but both the racquet and communicating PC station or device require an existing profile. WiFi offers high speed and the advantage that most laptops are already equipped with integrated WiFi. However, WiFi is relatively expensive and has high power consumption.

In a racquet intended solely for recreational use, the controller may activate a feedback indicator (i.e. lights, sound) anytime a ball hits the racquet, i.e., upon interruption of just one link. For such entertainment uses, the feedback indication will typically be a pleasurable or amusing display of lights or sound via lights 74 and speaker 76, rather than collection and display of data and statistics on display 78.

Alternatively, in a racquet intended for training and skill development, a great many other forms of data and feedback may be provided. As discussed above, consistently hitting the ball in a “sweet spot” 20 in the central portion of frame 12 is critical to success in tennis. FIG. 2 depicts another method of determining whether ball impact occurred within the sweet spot. As shown in FIG. 2, only particular links 30 pass through sweet spot 20. Whenever a ball hits racquet 10 in sweet spot 20, at least one horizontal and one vertical link 30 passing through sweet spot 20 will be interrupted. Thus, the feedback indicator may be activated only when a horizontal and a vertical link 30 passing through sweet spot 20 is interrupted, thereby signaling that the ball was hit with sweet spot 20. On the other hand, for example, if a ball hits in the upper portion of racquet 10 above sweet spot 20, and thereby interrupts one of the vertical links 30 but not one of the horizontal links 30, the feedback sensor is not activated since only a vertical but not a horizontal link 30 was activated. Alternatively, one type of feedback (typically positive) may be provided when the ball hits inside sweet spot 20 and another type of feedback provided (typically negative) when the ball hits outside of sweet spot 20.

Racquet 10 may be configurable for both entertainment and training purposes, either by user interface 80 on racquet 10 itself, or by remote programming via link 84. User interface 80 may allow selection of an “entertainment” mode where audio and/or visual feedback is provided anytime a ball hits the strings, and a “training” mode where the audio and/or visual feedback is dependent on the location of ball impact or other factors (type of stroke, ball speed, etc.). Various sub-modes with configurable or selectable feedback patterns and types may be provided. Alternatively, racquet 10 may be programmed remotely via link 84 with a particular entertainment or training mode of operation.

In addition to identifying whether the ball hit the sweet spot, the controller can also identify and store locations of ball impact on the racquet strings. In addition, the controller may measure and display the speed of the ball or racquet by sensing and comparing its positions at different times. This information may be stored in memory 82 in racquet 10 and/or downloaded to a PC or other device via communication link 84. A statistical or graphical display may be generated in real time on display 78 or a courtside or televised display (via link 84) to show where the ball hit the racquet strings over the course of a game or practice session. This information may also be downloaded from racquet 10 for analysis and display on a PC or other device at the convenience of the user.

In another embodiment of the invention, the controller determines the location of ball impact by measuring the electrical resistance of the strings, with a change in resistance indicating a ball impact. For example, a ball impact may be indicated if a string that normally measures 25 kΩ (without ball impact) suddenly changes to 30 kΩ. The strings are to some degree dependent, that is, a ball impact causes resistance changes in a group of strings. The string experiencing the most central and direct force of the ball impact will have the greatest resistance change, while strings on the periphery of the ball impact will have less resistance change. Thus, by looking at resistance changes across a group of strings, the controller can precisely determine the ball impact location. As described above, this information may be displayed, stored and/or downloaded by racquet 10.

In addition, the change in resistance of a string is indicative of the force with which the ball is hit by the racquet. Accordingly, the feedback indicator may provide feedback indicative of the force of hitting the ball. For example, a bright light or loud sound may be emitted for a forcefully hit ball, whereas a dimmer light or a quieter sound may be emitted for a more gently hit ball.

There are various other options for determining the location of ball impact that are within the scope of this invention. The controller may monitor a microphone and detect changes in acoustic pattern to determine the timing and location of ball impacts. An accelerometer may be used to detect changes in speed at ball impact.

FIG. 3 shows a racquet 55 outfitted with a strain gauge array 60 for determining the location of ball impact. Array 60 comprises a number of strain gauge sensors, which are thin like a film, mounted on the outer part of the frame of racquet 50. Array 60 will typically be mounted between the frame and the strings. When the racquet hits the ball, some of the strain gauges will change their resistance value allowing the ball to be located relative to the racquet, since the strain gauges measure horizontal and vertical strings of the racquet. An alternative simpler version, suitable for a racquet intended for entertainment use only, uses only one strain gauge to determine solely whether the ball hit the racquet at all, and does not determine the precise location of impact.

In another embodiment, a sensor determines the orientation and angle of the racquet at the time of ball impact. This is beneficial because the orientation of the racquet at the time of impact is indicative of the type of stroke that was used. For example, a 90 degree orientation may indicate normal play, a 180 degree orientation may indicate a volley, and a 270 degree orientation may indicate a backhand stroke. As described above, the sensor data may be stored in memory 82 and displayed on display 78, and may also be transmitted via link 84 to a PC, courtside display, television audience or elsewhere. This is a powerful performance analysis tool allowing a player and/or observers to
analyze the type and frequency of strokes used, in addition to the location of ball impact.

[0041] Accelerometer sensors are useful in determining the angle and speed of the racquet during ball impact. Accelerometer sensors may be configured, for example, to determine whether the impact was “open” (racquet facing sky) or “close” (racquet facing ground); “up” (grip facing up as in a volley) or “down” (grip facing down as in a backhand stroke); as well as the speed of the ball (speed of racquet plus impact).

[0042] In another embodiment of the invention, optical feedback is provided by the strings themselves. The strings may incorporate light emitting diodes (LEDs), for example. The LEDs may be impact sensitive and illuminate on ball impact. Or, the LEDs may be in always on mode to better illuminate the position of the racquet relative to the ball. Alternatively, the strings change color on ball impact. For example, if the strings are normally white but turn red for a period of time on ball impact, a visual indication of ball impact location is provided on the racquet itself. This embodiment has an advantage in that no other components such as electronics are required. Similarly, a spray may be applied to the strings that changes color on ball impact.

[0043] The present invention has applicability beyond tennis racquets and may be applied for example, to squash and badminton racquets, or to paddles such as beach paddles. A light on a beach paddle can be very effective for entertainment purposes in the evening, and can be either always on or activated only on ball impact.

[0044] The teachings of the present invention, that is, the provision of audio and visual feedback and data collection in sporting equipment, may also apply to sports boards, such as beach boards, snow boards and skate boards. In a snow board, for example, a sensor may determine whether there is contact with the snow. A light may be activated, for example, when there is no contact with the snow. This is very effective, since the light will go on only when the board is airborne. The light may be mounted close to the edge of the board to avoid damage if the board impacts a rock or other object. The light can be installed at the top or bottom of the board. Data, such as the amount of air time, may also be collected.

[0045] The particular embodiments of the invention described in this document should be considered illustrative, rather than restrictive. Modification to the described embodiments may be made without departing from the spirit of the invention as defined by the following claims.

1. A racquet that provides feedback to a player comprising:
   feedback means for providing feedback based on an impact of a ball on the racquet.
2. A racquet as claimed in claim 1, wherein the feedback means comprises:
   sensor means for sensing the impact of the ball on the racquet; and
   indicator means for providing visual or audio feedback; and
   a controller for controlling the indicator means based on data provided by the sensor means.
3. A racquet as claimed in claim 2, wherein the controller controls the indicator means to provide visual or audio feedback when the sensor means detects any ball impact.
4. A racquet as claimed in claim 2, wherein the controller controls the indicator means to provide visual or audio feedback when the sensor means detects a ball impact with a predetermined zone of the racquet.
5. A racquet as claimed in claim 4, wherein the predetermined zone is a sweet spot of the racquet.
6. A racquet as claimed in claim 2, wherein the sensor means comprises an optical link extending across a ball impact zone of the racquet, and wherein the controller detects interruptions in the optical link to indicate a ball impact.
7. A racquet as claimed in claim 6, wherein the optical links are aligned with strings of the racquet.
8. A racquet as claimed in claim 2, wherein the indicator means are selected from a group consisting of lights mounted on the racquet, an audio speaker mounted on the racquet, and a visual display mounted on the racquet.
9. A racquet as claimed in claim 2, wherein the sensor means collect performance data, and wherein the racquet further comprises a memory for storing the performance data.
10. A racquet as claimed in claim 9, and further comprising a display for displaying the performance data.
11. A racquet as claimed in claim 9, and further comprising a communication link for downloading the performance data to an external device.
12. A racquet as claimed in claim 11, wherein the communication link uploads instructions for operation of the indicator means from an external device.
13. A racquet as claimed in claim 1, wherein the feedback means comprises:
   strings of the racquet that emit light based on the ball impact.
14. A racquet as claimed in claim 1, wherein the feedback means comprises:
   strings of the racquet that change color based on the ball impact.
15. A racquet as claimed in claim 1, wherein the feedback means comprises:
   a spray applied to the racquet that changes color based on a ball impact itself can be used to carry light so it is visible to the player.
16. A dual-mode racquet comprising:
   an entertainment mode means for providing audio or visual feedback based on any ball impact; and
   a training mode means for providing audio or visual feedback based on a ball impact within a predetermined zone of the racquet.
17. A racquet comprising:
   a frame;
   strings mounted on a stretched across the frame;
   sensors mounted on the frame to detect an impact of a ball on the strings; and
   a feedback indicator for providing feedback based on data collected by the sensors.
18. A racquet as claimed in claim 17, wherein the data collected by the sensors includes performance data selected
from a group consisting of number of impacts, location of impacts, ball speed and racquet angle.

19. A racquet as claimed in claim 18, and further comprising a communication link for downloading the performance data to an external device.

20. A racquet as claimed in claim 17, wherein the feedback indicator provides audio or visual feedback based on a determination by the sensor of whether the ball impact was within the sweet spot of the racquet.

* * * * *