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(54) Title: GOLF IMPACT ANALYSIS SYSTEMS AND RELATED METHODS

(57) Abstract: Embodiments of golf impact analysis systems are describe herein. Other examples and related methods are also disclosed herein.

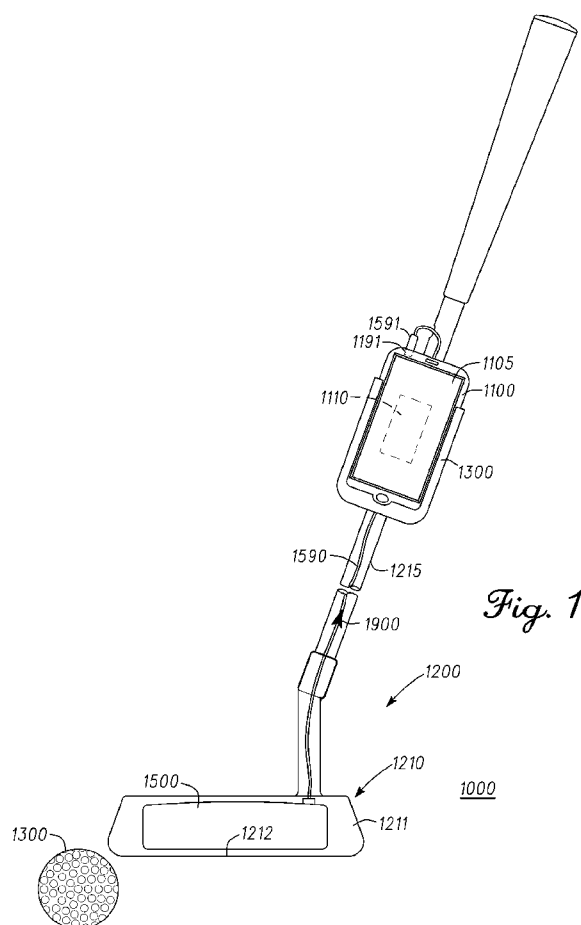


Fig. 1





CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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GOLF IMPACT ANALYSIS SYSTEMS AND RELATED METHODS

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CROSS-REFERENCE TO RELATED APPLICATION(S)

This is an International Patent Application claiming the benefit of U.S. Patent Application No. 13/218,225, filed on August 25, 2011, which claims the benefit of U.S. Provisional Application No. 61/497,891, filed on June 16, 2011.

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TECHNICAL FIELD

The present disclosure relates generally to sports equipment, and relates, more particularly, to golf impact analysis systems and related methods.

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BACKGROUND

The center of gravity of a golf club can be strategically positioned according to the desired performance of the golf club. Because the position of the center of gravity of the golf club is dependent on the distribution of mass of the golf club and because it is often desirable, for performance purposes, to move the center of gravity down toward the sole and/or away from the face of the golf club head, the face of the golf club head may be made thin in order to move mass to the sole and/or away from the face. Thinning the face permits the center of gravity to be more strategically positioned, but may have side effects, such as, for example, reducing the strength and/or durability of the face and/or the golf club as a whole.

Meanwhile, the vibrational frequency of the face and/or golf club is another factor that may affect the performance of a golf club. The vibrational frequency of the face and/or golf club can be related to the elasticity of the face, golf club head, and/or golf club.

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BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will be better understood from a reading of the following detailed description of examples of embodiments, taken in conjunction with the accompanying figures in the drawings.

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FIG. 1 illustrates a system for analyzing golf impact information.

FIG. 2 illustrates a sample schematic of a portable electronic device that can be used with the system of FIG. 1.

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FIG. 3 illustrates a magnified view of an impact sensor that can be used with the system of FIG. 1.

FIG. 4 illustrates an exemplary report generated by an impact analysis module of the system of FIG. 1, as presented by a graphical user interface at a portable electronic device.

FIG. 5 illustrates another exemplary report generated by the impact analysis module of the system of FIG. 1, as presented by the graphical user interface at the portable electronic device.

FIG. 6 illustrates a flowchart for a method for providing a golf ball impact analysis system.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the present disclosure. Additionally, elements in the drawing figures are not necessarily drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help improve understanding of embodiments of the present disclosure. The same reference numerals in different figures denote the same elements.

The terms “first,” “second,” “third,” “fourth,” and the like in the description and in the claims, if any, are used for distinguishing between similar elements and not necessarily for describing a particular sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances such that the embodiments described herein are, for example, capable of operation in sequences other than those illustrated or otherwise described herein. Furthermore, the terms “include,” and “have,” and any variations thereof, are intended to cover a non-exclusive inclusion, such that a process, method, system, article, device, or apparatus that comprises a list of elements is not necessarily limited to those elements, but may include other elements not expressly listed or inherent to such process, method, system, article, device, or apparatus.

The terms “left,” “right,” “front,” “back,” “top,” “bottom,” “over,” “under,” and the like in the description and in the claims, if any, are used for descriptive purposes and not necessarily for describing permanent relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances such that the embodiments described herein are, for example, capable of operation in other orientations than those illustrated or otherwise described herein.

The terms “couple,” “coupled,” “couples,” “coupling,” and the like should be broadly understood and refer to connecting two or more elements or signals, electrically, mechanically or otherwise. Two or more electrical elements may be electrically coupled, but not mechanically or otherwise coupled; two or more mechanical elements may be mechanically coupled, but not electrically or otherwise coupled; two or more electrical elements may be mechanically coupled, but

not electrically or otherwise coupled. Coupling (whether mechanical, electrical, or otherwise) may be for any length of time, e.g., permanent or semi-permanent or only for an instant.

“Electrical coupling” and the like should be broadly understood and include coupling involving any electrical signal, whether a power signal, a data signal, and/or other types or combinations of electrical signals. “Mechanical coupling” and the like should be broadly understood and include mechanical coupling of all types. The absence of the word “removably,” “removable,” and the like near the word “coupled,” and the like does not mean that the coupling, etc. in question is or is not removable.

DESCRIPTION

In one embodiment, a system to analyze impact data from one or more golf ball impacts at an impact sensor over a strike face of a golf club head can comprise an impact analysis module configured to run on one or more processors. The impact analysis module can be configured to (a) receive the impact data from the impact sensor, the impact data comprising impact pressure data for the one or more golf ball impacts, and at least one of impact location data for the one or more golf ball impacts, or impact duration data for the one or more golf ball impacts, (b) transform the impact pressure data into at least one of impact force data or impact speed data (3) generate impact information derived from the impact data, and (4) generate a report configured to present the impact information.

In one embodiment, a system can comprise a portable electronic device and an impact sensor configured to be coupled to the portable electronic device. The impact sensor can be configured to be positioned over a strike face of a golf club head to sense impact data for one or more golf ball impacts over the strike face. The impact data can comprise impact pressure data for the one or more golf ball impacts, and at least one of impact location data for the one or more golf ball impacts, or impact duration data for the one or more golf ball impacts. The portable electronic device can comprise an impact analysis module configured to (a) calculate from the impact pressure data at least one of impact force data or impact speed data, (b) generate impact information derived from the impact data, and (3) generate a report configured to present the impact information.

In one embodiment, a method for providing a golf ball impact analysis system can comprise providing an impact analysis module configured to run on one or more processors of a portable electronic device. The impact analysis module can be further configured to (a) receive impact data from an impact sensor coupled to a strike face of a golf club head, the impact data comprising impact pressure data for one or more golf ball impacts, and at least one of impact location data for the one or more golf ball impacts, or impact duration data for the one or more golf ball impacts, (b) transform the impact pressure data into at least one of impact force data or impact speed data, (c)

generate impact information derived from the impact data, and (d) generate a report configured to present the impact information.

Other examples and embodiments are further disclosed herein. Such examples and embodiments may be found in the figures, in the claims, and/or in the present description.

5 Turning to the drawings, FIG. 1 illustrates a system 1000 for analyzing golf impact information. In the present example, system 1000 comprises impact analysis module 1110 configured to analyze impact data 1900 from one or more golf ball impacts of golf club head 1210 against golf ball 1300. FIG. 1 also shows portable electronic device 1100, which comprises impact analysis module 1110 in the present example. Impact analysis module 1110 is configured to generate a report configured to
10 present impact information related to and/or derived from impact data 1900. In some examples such report may comprise a plurality of reports.

As seen in FIG. 1, the portable electronic device 1100 is coupled in the present embodiment to golf club 1200, which comprises golf club head 1210. Portable electronic device 1100 couples removably to shaft 1215 of golf club 1200 via cradle 1300, and is thus configured to operate while
15 located away from golf club head 1210 during the one or more golf ball impacts. There can be other examples where portable electronic device 1100 can be located elsewhere during the one or more golf ball impacts instead of being coupled to golf club 1200. As an example, a user could carry portable electronic device 1100 on his belt or pockets instead.

Golf club head 1210 comprises strike face 1211 coupled to impact sensor 1500 in the present
20 embodiment, where impact sensor 1500 is configured to sense the one or more golf ball impacts and to send information thereof as impact data 1900 to impact analysis module 1110. Impact sensor 1500 is coupled to portable electronic device 1100 via cord 1590, through which impact data 1900 is sent for receipt and analysis by impact analysis module 1110. Cord 1590 is external to golf club 1200 in FIG. 1, but in a different embodiment, can be internal to golf club 1200. In other
25 embodiments, portable electronic device 1100 and impact sensor 1500 may communicate wirelessly with each other so that cord 1590 is not needed. As defined herein, impact data 1900 is “received” by impact analysis module 1110 when it arrives thereat, regardless of any “push” or “pull” communications arrangement, regardless of whether impact analysis module 1110 passively receives it from impact sensor 1500, and/or regardless of whether impact analysis module 1110 actively
30 queries for it or actively retrieves it from impact sensor 1500.

In the present example, impact sensor 1500 is configured to be external to golf club head 1210. For example, the impact sensor 1500 may be coupled to an exterior surface of strike face 1211, so that the impact sensor 1500 may be in direct contact with ball 1300 during the one or more golf ball impacts for better data acquisition. In the same or other examples, impact sensor 1500 can

comprise an attachment mechanism configured to detachably couple to strike face 1211, where such attachment mechanism can comprise, in some embodiments, fasteners such as an adhesive, one or more screws, and/or one or more clips. There can be other examples, however, where impact sensor 1500 can be integral with strike face 1211, such as where strike face 1211 is removable or non-integral with body 1212 of golf club head 1210.

FIG. 2 illustrates a sample schematic of portable electronic device 1100. Portable electronic device 1100 can be, for example, a mobile device or a personal computer. In some examples, portable electronic device 1100 can include electrical devices of many types and designs such as cellular phones, personal digital assistants (PDA)s, “smartphones” and/or other devices incorporating one or more of the above (e.g., media players, telephones, audio-visual media players, devices incorporating media players, telephones, and/or audio-visual devices, and/or handheld game consoles). For example, portable electronic device 1100 can be an electrical device manufactured by Research in Motion Limited (e.g., a Blackberry® device), Palm, Inc. (e.g., a Palm® device), or Apple Computer, Inc. (e.g., an iPod® MP3 player, an iPod Touch® device, an iPad® device, and/or an iPhone® device). In other examples, portable electronic device 1100 can be a portable computer.

In the present example, portable electronic device 1100 comprises processor module 2111 coupled to display module 2114 and to memory module 2112, where impact analysis module 1110 is storable in memory module 2112 and configured to be run on processor module 2111. In some examples, memory module 2112 can comprise one or more types of memory, such as a hard disk and/or a solid state storage device, like flash memory. Memory module 2112 can also comprise an operating system module configured to run on processor module 2111 to operate and/or manage different functions of portable electronic device 1100. Display module 2114 can be configured to process and/or generate display signals for a graphical user interface to present a report generated by impact analysis module 1110. In the same or other examples, display module 2114 may generate or format the display signals for display at one or more electronic displays, such as at display 1105 (FIG. 1) of portable electronic device 1100, and/or at an external display in communication with portable electronic device 1100.

Impact analysis module 1110 may comprise one or more modules configured to implement one or more functionalities related to the analysis of the one or more golf ball impacts of golf club head 1210 against golf ball 1300. Impact analysis module 1110 comprises several modules in the present example, such as impact data access module 2151, impact data calculation module 2152, information generation module 2153, and information reporting module 2154. Information reporting module 2154 is configured to format and/or configure information received from information generation module 2153 for presentation via display module 2114. In some examples, impact analysis module

1110 and/or one or more of its modules may comprise software configured to be executed by processor module 2111 (FIG. 2). In the same or other embodiments, impact analysis module 1110 and/or one or more of its modules may comprise hardware configured to execute one or more functionalities of impact analysis module 1110.

5 Portable electronic device 1100 also comprises communications module 2113. In some examples, communications module 2113 may comprise software storable at memory module 2112 and/or configured to be executed by processor module 2111. Information received at processor module 2111 can be routed via impact data access module 2151 to impact analysis module 1110 for further analysis. Communications module 2113 is coupled between processor module 2111 and
10 digital data port 1192 to control or relay information sent or received therebetween. In the present example, communications module 2113 is also coupled between audio port 1191 and processor module 2111, where communications module 2113 is also configured to control or relay information sent or received therebetween. In some examples, communications module 2113 may transform or convert analog data received at audio port 1191 into digital data for processor module 2111, or
15 vice/versa. There may be other embodiments, however, where communications module 2113 may not be coupled between or relay information between processor module 2111 and audio port 1191.

In the present example, cord 1590 comprises plug 1591, which couples to portable electronic device 1100 via audio port 1191 in the present example. Audio port 1191 can comprise an audio jack normally configured for outputting and/or receiving stereo or mono audio signals, such as
20 signals for speakers and/or from microphones. In the present example, impact sensor 1500 is configured to communicate with impact analysis module 1110 through coded audio signals, where such coded audio signals can represent impact data 1900. There can be examples where the coded audio signals may be coded by impact sensor 1500, and/or where the coded audio signals may be coded by communications module 2113 (FIG. 2) of portable electronic device 1100. For instance,
25 plug 1591 and audio port 1191 can be configured as a TRRS (Tip, Ring, Ring, Sleeve) plug and jack, respectively. As an example, a microphone channel of plug 1591 can be configured to transmit coded audio signals to a microphone channel of audio port 1191, where one or more of such coded audio signals may represent impact data 1900. In the same or other examples, portable electronic device 1100 can be configured to provide power through a first audio channel of audio port 1191 to
30 impact sensor 1500 via a first audio channel of plug 1591. In the same or other examples, a second audio channel of audio port 1191 can be configured to receive coded audio signals from a second audio channel of plug 1591 of impact sensor 1500. There can also be examples, where the plug/port nomenclature can be changed, such that plug 1591 could comprise a port, and where audio port 1191 could comprise a plug.

Although the example of FIG. 1 presents cord 1590 coupling impact sensor 1500 to portable electronic device 1100 via audio port 1191, impact sensor 1500 may also be configured to communicate with communications module 2113 (FIG. 1) via digital data port 1192 of portable electronic device 1100. In some examples, digital data port 1192 can comprise a USB (Universal Serial Bus) port, and/or a thirty-pin connector. There can also be examples where impact sensor 1500 may communicate with communications module 2113 (FIG. 2) wirelessly, such as via a Bluetooth® connection. Regardless of whether impact sensor 1500 communicates with portable electronic device 1100 via audio port 1191, digital data port 1192, and/or wirelessly, impact data 1900 can be routed to impact analysis module 1110 via impact data access module 2151 for further processing.

FIG. 3 illustrates a magnified view of impact sensor 1500 as coupled to strike face 1211 of golf club head 1210. Impact sensor 1500 comprises sensor array 3510 coupled to substrate layer 3520, where substrate layer is configured to at least partially cover strike face 1211. In the present and other examples, substrate layer 3520 can conform to a shape of strike face 1211. For instance, the perimeter of substrate layer 3520 substantially matches the perimeter of strike face 1210. There can also be examples, where substrate layer 3520 may conform to other shapes of strike face 1211, such as to accommodate curvature, bulging, and/or grooves thereof. To facilitate such conforming, substrate layer 3520 may comprise a flexible material, such as a conductive cloth material, and/or a stretchable fabric.

Sensor array 3510 can be integrally coupled to substrate layer 3520. For example, sensor array 3510 may be coupled to an exterior side of substrate layer 3520, to an interior side of substrate layer 3520, and/or could be engulfed or intermeshed between the interior and exterior sides of substrate layer 3520. In the present example sensor array 3510 comprises an array defined by sensor rows 3511 and sensor columns 3512, which define electrodes that overlap each other to form capacitors mappable by row and column. In the same or other examples, substrate layer 3520 may comprise a non-conductive compressible film between sensor rows 3511 and sensor columns 3512. There can be embodiments where capacitance sensed at such capacitors may correspond to pressure readings at respective electrode overlaps. In other embodiments, sensor array 3510 can comprise a non-capacitive array, such as a resistive array and/or a piezoelectric array of sensors.

In the present example, impact data 1900 (FIG. 1) from the one or more golf ball impacts comprises impact pressure data corresponding to the capacitance sensed at the capacitors of sensor array 3510. In addition, impact data 1900 (FIG. 1) can comprise impact location data and/or impact duration data. For instance, the impact location data may comprise information regarding where over strike face 1211 the one or more golf ball impacts occurred, such as by referencing row and

column coordinates of the electrodes of sensor array 2510 that were activated or that sensed a pressure change during the one or more golf ball impacts. In the same or other examples, the impact duration data may comprise information regarding the duration of time when the electrodes of sensor array 3510 were activated during the one or more golf ball impacts.

Impact sensor 1500 may also gather or derive other types of impact data 1900 (FIG. 1). As an example, the impact pressure data may be transformed into impact force data regarding the force with which the one or more golf ball impacts occurred. In the same or other examples, one or more of the impact pressure data and/or the impact duration data may be transformed into impact speed data regarding the speed with which the one or more golf ball impacts occurred. In some examples, one or more elements of the impact data 1900, such as the impact force data and/or the impact speed data, may be derived or transformed by impact data calculation module 2152 of impact analysis module 1110 when impact data 1900 is received thereat. In other embodiments, such one or more elements of impact data 1900 (FIG. 1) may be transformed or derived by impact sensor 1500 prior to delivery to impact analysis module 1110.

FIG. 4 illustrates an exemplary report 410 as generated by information reporting module 2154 of impact analysis module 1110 and as presented by graphical user interface 4150 at digital display 1105 of portable electronic device 1100. Report 410 is configured to present impact information 4100 as received by impact data access module 2151 from impact data 1900 (FIG. 1), as calculated or transformed by impact data calculation module 2152 of impact analysis module 1110 from impact data 1900, and/or as generated by information generation module 2153 of impact analysis module 1100. In the present example, impact information 4100 comprises impact data grid 4110, presenting information related to or derived from impact data 1900 (FIG. 1), such as impact pressure information, impact force information, impact speed information, impact duration information, and/or impact location information for three golf ball impacts, as denoted by the “shot 1,” “shot 2,” and “shot 3” columns, and for average values thereof, as denoted by the “avg” column.

As seen in the present example, impact information 4100 can also comprise other types of information which may or not be derived from impact data 1900 received from impact sensor 1500 (FIG. 1). In some embodiments, such other information may be derived or generated by information generation module 2153 from one or more sensors of portable electronic device 1100, like accelerometers 2121 and/or gyroscopes 2122 in communication with information generation module 2153 via processor module 2111, as shown in FIG. 2. Impact information 4100 can thus comprise stroke type information, impact angle information, and/or swing tempo information for the one or more golf ball impacts, such as presented at report 410 in FIG. 4. In some examples, the stroke type information can relate to the amount of rotation of golf club head 1211 during the

forward stroke of a swing, which may be categorized as of a straight type, a slight arc type, or a strong arc type as measured in degrees of face rotation. In the same or other examples, the impact angle information can relate to the angle of strike face 1211 (FIG. 1) at impact, relative to an address position. In the same or other examples, the swing tempo can be related to a measure of the duration of the backswing relative to the forward swing. There can be other examples, however, where information generation module 2153 generates information for information reporting module 2154 based only on data received from impact data calculation module 2152 and/or from impact data access module 2151 with respect to impact data 1900.

In the present example of FIG. 4, information generation module 2153 of impact analysis module 1110 is configured to generate swing advice 4130 as part of impact information 4100, where swing advice 4130 can be presented as part of report 410 as seen in FIG. 4. In some examples, impact analysis module 1110 may generate swing advice 4130 based on an analysis of impact data 1900 (FIG. 1) and/or impact information 4100. As an example, swing advice 4130 may comprise a suggestion to decrease or increase swing speed, and/or to change a user's stance or alignment at address for more consistent results.

Information generation module 2153 of impact analysis module 1110 is also configured in the present embodiment to access comparative swing information from database module 2115 (FIG. 2). In some examples, database module 2115 database may comprise a module stored in memory module 2112 (FIG. 2), and/or may be configured to access an external database in communication with portable electronic device 1100. As can be seen in FIG. 4, at least a portion of comparative swing information can be presented at report 410, such as at column "Comp" of impact information 4100.

In some examples, database module 2115 can comprise comparative swing information of different types, such as individual swing information for one or more individuals, historical information for the user based on previous golf ball impact data, and/or recommended target swing information. The individual swing information can comprise swing and/or golf ball impact data from one or more persons, such as professional players or friends, for comparison against the user's impact information 4100 and/or impact data 1900. The historical swing information can comprise data from previous rounds of golf ball impacts by the user as stored in memory module 2112 (FIG. 2), such as to measure a progress or improvement of the user's skill. The target swing information can comprise recommended target goals for the user, based on the type of player the user is, the type of golf club being used, and/or the type of swing that the user tends to produce.

There can be examples where the target swing information can be generated for the user by information generation module 2153 of impact analysis module 1110. In the same or other

example, impact analysis module 1110 may provide a suggestion as part of swing advice 4130. For instance, the suggestion may make a recommendation about a type of golf club and/or a type of golf ball suitable for the user based on an analysis of the target swing information, impact data 1900 (FIG. 1) and/or impact information 4100. In some examples, the type of golf club and/or golf ball suggested by the impact analysis module may be of a specific model or brand.

In the same or other examples, the suggestion may make a recommendation about a type of training aid for the user. For instance, the suggested type of training aid may comprise a putting track to help the user gain consistency in the arc and/or face angle of the user's putting strokes, such as an "Inside Down the Line" Putting Track by Momentus Golf, of Mt. Pleasant, Iowa, U.S.A., and/or a "Perfect Putting Machine" by Z Factor Sports, LLC, of Boise, Idaho, U.S.A. In the same or other example, the suggested type of training aid may comprise a metronome to help the user gain consistency in the tempo of the user's strokes. The metronome may be incorporated as a function of the impact analysis module 1110 or of portable electronic device 1100 in some examples.

There can also be examples where the suggestion may make a recommendation about a type of training plan for the user. For instance, if the user has distance control problems, impact analysis module 1110 may suggest a specific set of putts to take during practice. If the user has direction control problems, impact analysis module 1110 may suggest instructions or tips on how to properly align with respect to the hole. Impact analysis module 1110 may also keep track of, or suggest a way to keep track of, progress made while carrying out the training plan.

In the present example, information generation module 2153 of impact analysis module 1110 is configured to generate strike face image 4120 representative of strike face 1211 of golf club head 1210, where strike face image 4120 can comprise part of impact information 4100 in report 410 in the example of FIG. 4. Information generation module 2153 is also configured to generate impact location markers 4121-4123 for the one or more golf ball impacts based on the impact location data of impact data 1900 (FIG. 1), and to generate pressure descriptors for the one or more golf ball impacts based on the impact pressure data of impact data 1900 (FIG. 1). In the present example of FIG. 4, the pressure descriptors are presented as circles of different sizes located around impact location markers 4121-4123, with larger circles representing larger pressure. There can be embodiments where other kinds of pressure descriptors may be used, such as color-based pressure descriptors.

Information generation module 2153 of impact analysis module 1110 is also configured to generate a location consistency rating in the present embodiment, derived from the impact location data of impact data 1900 (FIG. 1), for the one or more golf ball impacts. As an example, such location consistency rating can be presented as part of swing advice 4130 in FIG. 4, and may

comprise a calculation based on the distances of impact location markers 4121-4123 relative from target strike zone 4125 in strike face image 4120. In the same or other examples, information generation module 2153 impact analysis module 1110 can be configured to generate a force consistency rating derived from the impact pressure data of impact data 1900 (FIG. 1) for the one or more golf ball impacts.

FIG. 5 illustrates an exemplary report 510 generated by information generation module 2153 of impact analysis module 1110 as presented by graphical user interface 4150 on digital display 1105 of portable electronic device 1100. In the present example, impact analysis module 1110 is configured to analyze impact data 1900 (FIG. 1) to generate at least one of a shot distance prediction 5110 or a shot deviation prediction 5120 as part of report 510. As an example, impact analysis module 1110 can be configured to derive shot distance prediction at least partially from an analysis of the impact pressure data of impact data 1900 (FIG. 1). In the same or other examples, impact analysis module 1110 can be configured to derive shot deviation prediction 5120 from an analysis of the impact location data of impact data 1900, where shot deviation prediction 5120 can represent a deviation from target path 5121 as shown in FIG. 5. In some examples, as shown in FIG. 5, information generation module 2153 can be configured to generate a shot simulation graphic depicting predicted path 5122 for a golf ball based on impact data 1900 (FIG. 1) for the one or more golf ball impacts. In the same or other examples, information generation module 2153 can be configured to generate the shot simulation graphic as a motion image.

Moving on, FIG. 6 illustrates a flowchart for a method 6000 for providing a golf ball impact analysis system. In some embodiments, the golf ball impact analysis system of method 6000 can be similar to system 1000 as described above with respect to FIGs. 1-5.

Method 6000 comprises block 6100 for executing an impact analysis module with instructions for generating a report presenting impact information derived from golf ball impact data. In some examples, the impact analysis module can be similar to impact analysis module 1110 (FIGs. 1-2, 4-5), and/or may comprise one or more modules similar to . In the same or other examples, the report can be similar to, and/or comprise one or more elements of, reports 410 (FIG. 4) and/or 510 (FIG. 5).

Block 6200 of method 6000 comprises providing an impact sensor configured to sense the golf ball impact data. In some examples, the impact sensor can be similar to impact sensor 1500 (FIGs. 1 and 3), and the golf ball impact data can be similar to impact data 1900 (FIG. 1). Block 6200 may be optional in one or more implementations.

Block 6300 of method 6000 comprises providing a portable electronic device to be coupled with the impact sensor and configured to run the impact analysis module. In some examples, the

portable electronic device can be similar to portable electronic device 1100 (FIGs. 1-2 and 4-5). In the same or other examples, the portable electronic device can run the impact analysis module of block 6100 via one or more processors, such as processor module 2111 (FIG. 2). Block 6300 can be optional in some implementations, such as when a user of block 6300 already has a suitable portable electronic device.

In some examples, one or more of the different blocks of method 6000 can be combined into a single block or performed simultaneously, and/or the sequence of such blocks can be changed. For example, blocks 6100 and 6300 may be combined into a single block in some examples. In the same or other examples, some of the blocks of method 6000 can be subdivided into several sub-blocks. For example, block 6100 can comprise a sub-block for downloading the impact analysis module, and another block for installing the impact analysis module. There can also be examples where method 6000 can comprise further or different blocks. As an example, method 6000 can further comprise a block for providing a golf club to which the impact sensor of block 6200 can be attached. In addition, there may be examples where method 6000 can comprise only part of the steps described above. For instance, blocks 6200 and/or 6300 can be optional in some examples. Other variations can be implemented for method 6000 without departing from the scope of the present disclosure.

The example process 600 of FIG. 6 may be implemented as machine-accessible instructions utilizing any of many different programming codes stored on any combination of machine-accessible media embodied in a mobile application (e.g., an app) and/or an online application for various wired and/or wireless communication devices such as handheld computers, smartphones, portable media players, tablet computers, etc. In addition or alternatively, the machine-accessible instructions may be embodied in a volatile or non-volatile memory or other mass storage device (e.g., a floppy disk, a CD, and a DVD). For example, the machine-accessible instructions may be embodied in a machine-accessible medium such as a programmable gate array, an application specific integrated circuit (ASIC), an erasable programmable read only memory (EPROM), a read only memory (ROM), a random access memory (RAM), a flash memory, a magnetic media, an optical media, and/or any other suitable type of medium. The systems, apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Although the golf impact analysis systems and related methods herein have been described with reference to specific embodiments, various changes may be made without departing from the spirit or scope of the present disclosure. For example, report 410 (FIG. 4), report 510 (FIG. 5), and/or elements thereof may be displayed at an external digital display separate from portable electronic device 1100 (FIGs. 1-2 and 4-5). In the same or other examples, portable electronic device 1100 (FIGs. 1-2 and 4-5) may communicate wirelessly with such external digital display. Additional

examples of such changes have been given in the foregoing description. Other permutations of the different embodiments having one or more of the features of the various figures are likewise contemplated. Accordingly, the specification and drawings herein are intended to be illustrative of the scope of the disclosure and are not intended to be limiting. It is intended that the scope of this application shall be limited only to the extent required by the appended claims.

The golf impact analysis systems and related methods discussed herein may be implemented in a variety of embodiments, and the foregoing discussion of certain of these embodiments does not necessarily represent a complete description of all possible embodiments. Rather, the detailed description of the drawings, and the drawings themselves, disclose at least one preferred embodiment, and may disclose alternative embodiments.

All elements claimed in any particular claim are essential to the embodiment claimed in that particular claim. Consequently, replacement of one or more claimed elements constitutes reconstruction and not repair. Additionally, benefits, other advantages, and solutions to problems have been described with regard to specific embodiments. The benefits, advantages, solutions to problems, and any element or elements that may cause any benefit, advantage, or solution to occur or become more pronounced, however, are not to be construed as critical, required, or essential features or elements of any or all of the claims, unless such benefits, advantages, solutions, or elements are expressly stated in such claims.

As the rules to golf may change from time to time (e.g., new regulations may be adopted or old rules may be eliminated or modified by golf standard organizations and/or governing bodies such as the United States Golf Association (USGA), the Royal and Ancient Golf Club of St. Andrews (R&A), etc.), golf equipment related to the apparatus, methods, and articles of manufacture described herein may be conforming or non-conforming to the rules of golf at any particular time. Accordingly, golf equipment related to the apparatus, methods, and articles of manufacture described herein may be advertised, offered for sale, and/or sold as conforming or non-conforming golf equipment. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

While the above examples may be described in connection with a putter-type golf club, the apparatus, methods, and articles of manufacture described herein may be applicable to other types of golf club such as a fairway wood-type golf club, a hybrid-type golf club, an iron-type golf club, a wedge-type golf club, or a driver-type golf club. Alternatively, the apparatus, methods, and articles of manufacture described herein may be applicable other type of sports equipment such as a hockey stick, a tennis racket, a fishing pole, a ski pole, etc.

Moreover, embodiments and limitations disclosed herein are not dedicated to the public under the doctrine of dedication if the embodiments and/or limitations: (1) are not expressly claimed in the claims; and (2) are or are potentially equivalents of express elements and/or limitations in the claims under the doctrine of equivalents.

CLAIMS

What is claimed is:

1. A system to analyze impact data at a portable electronic device, the impact data corresponding to one or more golf ball impacts at an impact sensor over a strike face of a golf club head, the system
5 comprising:

an impact analysis module configured to run on one or more processors, and further configured to:

receive the impact data from the impact sensor, the impact data comprising:

impact pressure data for the one or more golf ball impacts; and

10 at least one of:

impact location data for the one or more golf ball impacts; or

impact duration data for the one or more golf ball impacts;

transform the impact pressure data into at least one of:

impact force data; or

15 impact speed data;

generate impact information derived at least in part from the impact data; and

generate a report configured to present the impact information.

2. The system of claim 1, further comprising:

20 at least one of the portable electronic device or the impact sensor;

wherein the report is configured to be displayed via a graphical user interface at the portable electronic device.

3. The system of claim 1 or 2, further comprising:

25 the impact sensor;

wherein the impact sensor is external to the golf club head when coupled to the strike face.

4. The system of claim 3, wherein:

the impact sensor comprises:

30 a sensor array; and

a substrate layer coupled to the sensor array and configured to conform to a shape of the strike face of the golf club head when coupled thereto.

35

5. The system of claim 4, wherein:

the sensor array comprises at least one of:

a plurality of capacitive sensors;

a plurality of resistive sensors; or

5 a plurality of piezoelectric sensors;

and

the substrate layer comprises at least one of:

a conductive cloth material; or

a stretchable fabric.

10

6. The system of claim 3, wherein:

the impact sensor is attachable to and removable from the strike face of the golf club head.

7. The system of any one of claims 1-6, wherein:

15

the impact analysis module is configured to communicate with a communications module; and

the communications module is configured to receive the impact data from the impact sensor for
the impact analysis module via an audio jack of the portable electronic device.

8. The system of any one of claims 1-7, further comprising:

20

the portable electronic device;

wherein:

the portable electronic device comprises at least one of:

a cellular phone, a portable media player, a handheld game console, or a
portable digital assistant;

25

and

the portable electronic device is configured to operate while located away from the
golf club head during the one or more golf ball impacts and comprises:

the impact analysis module; and

at least a portion of the one or more processors.

30

9. The system of any one of claims 1-8, wherein:

the impact analysis module is configured to:

generate a swing advice based on the impact data; and

present the swing advice in the report.

35

10. The system of any one of claims 1-9, wherein:

the impact analysis module is configured to:

access comparative swing information from a database module, the comparative swing information comprising at least one of:

individual swing information from one or more individuals;

historical swing information for a user of the system based on previous impact data; or

target swing information for at least one of:

a type of player;

a type of golf club; or

a type of swing;

and

present at least a portion of the comparative swing information in the report.

11. The system of any one of claims 1-9, wherein:

the impact analysis module is configured to:

analyze the impact data to provide an advice regarding a suggested type of golf club for a user of the system.

12. The system of claim 11, wherein:

the impact analysis module is configured to:

analyze the impact data to provide an advice regarding at least one of:

a suggested type of golf ball for the user;

a suggested type of training aid for the user; or

a suggested type of training plan for the user.

13. The system of any one of claims 1-12, wherein:

the impact analysis module is configured to generate at least one of:

a location consistency rating derived from the impact location data for multiple ones of the one or more golf ball impacts; or

a force consistency rating derived from the impact pressure data for multiple ones of the one or more golf ball impacts.

14. The system of any one of claims 1-13, wherein:

the impact analysis module is configured to:

generate a strike face image representative of the strike face of the golf club head;

generate one or more impact location markers for the one or more golf ball impacts

5 based on the impact location data;

generate one or more impact pressure descriptors for the one or more golf ball impacts based on the impact pressure data; and

present the strike face image, the one or more impact location markers, and the one or more impact pressure descriptors in the report.

10

15. The system of any one of claims 1-14, wherein:

the impact analysis module is configured to analyze the impact pressure data and the impact location data to generate at least one of:

a shot distance prediction; or

15 a shot deviation prediction.

16. The system of any one of claims 1-15, wherein:

the impact analysis module is configured to:

generate shot simulation data from the impact data; and

20 transmit the shot simulation data to a digital display module for rendering as a motion image.

17. The system of claim 16, further comprising:

the digital display module;

25 wherein the digital display module is external to the portable electronic device.

18. A system comprising:

a portable electronic device; and

an impact sensor configured to be coupled to the portable electronic device;

wherein:

5 the impact sensor is configured to be positioned over a strike face of a golf club head to sense impact data for one or more golf ball impacts over the strike face, the impact data comprising:

 impact pressure data for the one or more golf ball impacts; and

 at least one of:

10 impact location data for the one or more golf ball impacts; or

 impact duration data for the one or more golf ball impacts;

and

the portable electronic device comprises an impact analysis module configured to:

 calculate from the impact pressure data at least one of:

15 impact force data; or

 impact speed data;

 generate impact information derived from the impact data; and

 generate a report configured to present the impact information.

20 19. The system of claim 18, wherein:

 the portable electronic device comprises at least one of:

 a cellular phone, a portable media player, a handheld game console, or a portable digital assistant;

 the portable electronic device comprises:

25 a digital display configured to display the report;

and

 the impact sensor comprises:

 a sensor array;

 a substrate layer comprising the sensor array and configured to conform to a shape

30 of the strike face of the golf club head when coupled thereto; and

 an attachment mechanism configured to detachably couple the substrate layer to the strike face.

35

20. The system of claims 18 or 19, wherein:

the impact analysis module is configured to:

access comparative swing information from a database module, the comparative swing information comprising at least one of:

5 individual swing information from one or more individuals;
historical swing information for a user of the system based on previous impact data; or
target swing information for at least one of:

10 a type of player;
a type of golf club; or
a type of swing;

generate a swing advice based on the impact data;

present the swing advice in the report; and

present at least a portion of the comparative swing information in the report.

15

21. The system of any one of claims 18-20, wherein:

the impact analysis module is configured to:

generate a strike face image representative of the strike face of the golf club head;

generate one or more impact location markers for the one or more golf ball impacts

20 based on the impact location data;

generate one or more impact pressure descriptors for the one or more golf ball impacts based on the impact pressure data; and

present the strike face image, the one or more impact location markers, and the one or more impact pressure descriptors in the report.

25

22. The system of claim 18, wherein:

the impact sensor is configured to wiredly couple to the portable electronic device;

the portable electronic device comprises at least one of:

a cellular phone or a portable digital assistant;

the portable electronic device comprises:

a digital display configured to display the report;

the impact sensor comprises:

a sensor array;

a substrate layer comprising the sensor array and configured to conform to a shape

of the strike face of the golf club head when coupled thereto; and

an attachment mechanism configured to detachably couple the substrate layer to the strike face;

and

the impact analysis module is configured to:

receive the impact data from the impact sensor via an audio jack of the portable electronic device;

access comparative swing information from a database module, the comparative swing information comprising at least one of:

individual swing information from one or more individuals;

historical swing information for a user of the system based on previous impact data; or

target swing information for at least one of:

a type of player;

a type of golf club; or

a type of swing;

generate a swing advice based on the impact data;

present the swing advice in the report;

present at least a portion of the comparative swing information in the report.

generate a strike face image representative of the strike face of the golf club head;

generate one or more impact location markers at the strike face image for the one or more golf ball impacts based on the impact location data;

generate one or more impact pressure descriptors at the strike face image for the one or more golf ball impacts based on the impact pressure data; and

present the strike face image, the one or more impact location markers, and the one or more impact pressure descriptors in the report.

23. A method for providing a golf ball impact analysis system, the method comprising:
executing, at one or more processors of a portable electronic device, an impact analysis
module with instructions for:
receiving impact data from an impact sensor coupled to a strike face of a golf club
head, the impact data comprising:
impact pressure data for one or more golf ball impacts; and
at least one of:
impact location data for the one or more golf ball impacts; or
impact duration data for the one or more golf ball impacts;
transforming the impact pressure data into at least one of:
impact force data; or
impact speed data;
generating impact information derived from the impact data; and
generating a report configured to present the impact information.
24. The method of claim 23, wherein:
the report is configured to be displayed by a graphical user interface at a digital display of the
portable electronic device; and
wherein the impact sensor is external to the golf club head when coupled to the golf club
strike face.
25. The method of claim 23 or 24, further comprising:
providing the impact sensor to be attachable to and removable from the strike face;
wherein providing the impact sensor comprises:
providing a sensor array; and
providing a substrate layer coupled to the sensor array and configured to conform to
a shape of the strike face of the golf club head when coupled thereto.

26. The method of any one of claims 23-25, further comprising:

providing the portable electronic device;

wherein:

providing the portable electronic device comprises:

5 providing at least one of a cellular phone or a PDA;

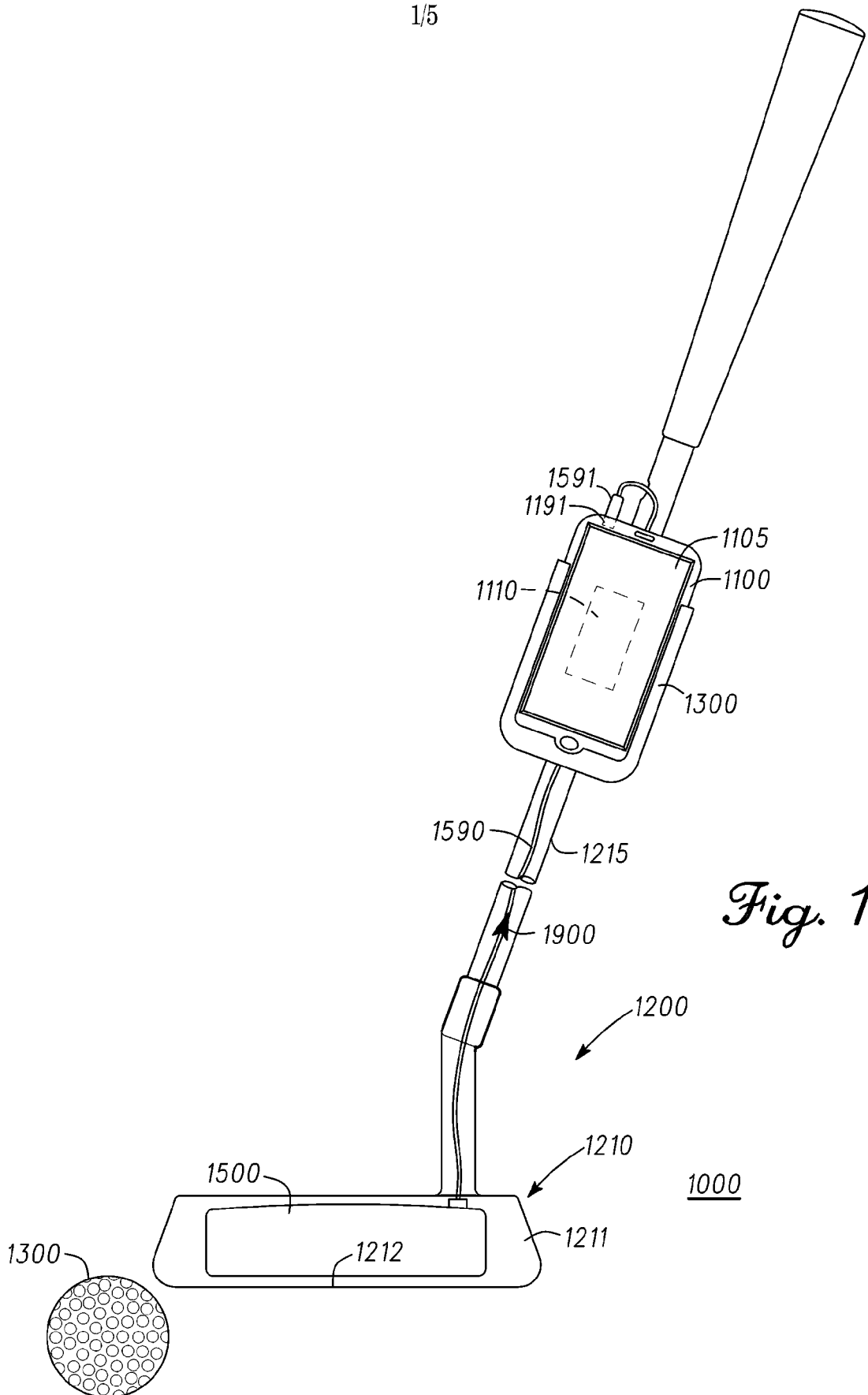
and

the portable electronic device is configured to operate while located away from the
golf club head during the one or more golf ball impacts and comprises:

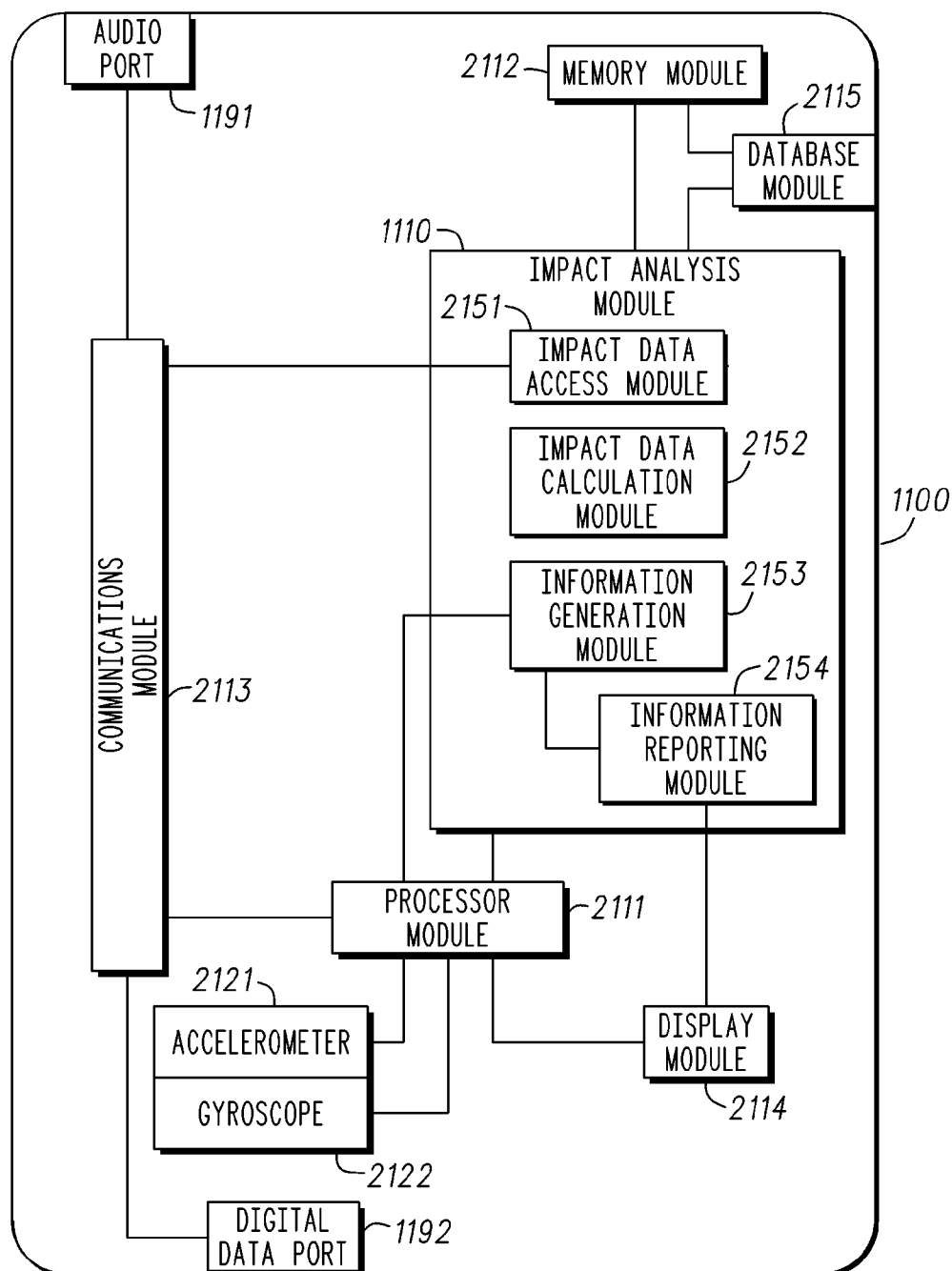
the impact analysis module; and

10 at least a portion of the one or more processors.

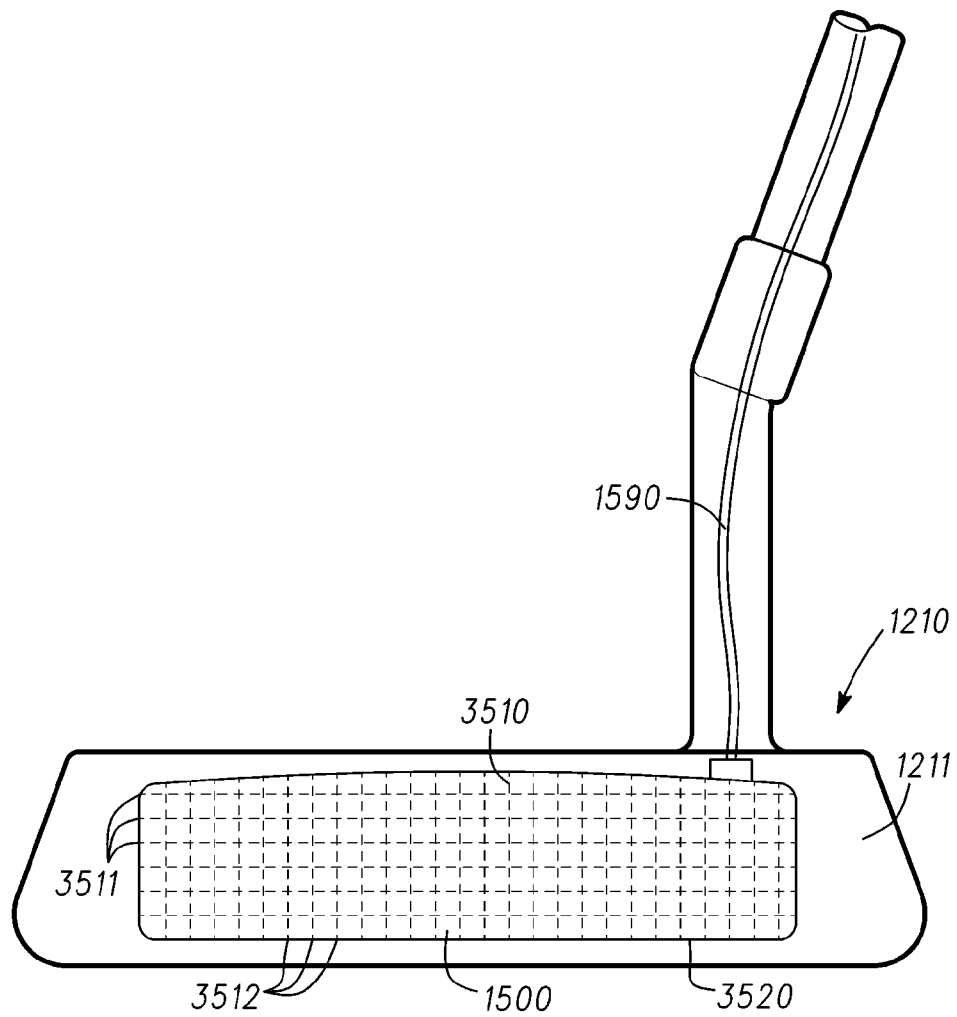
1/5



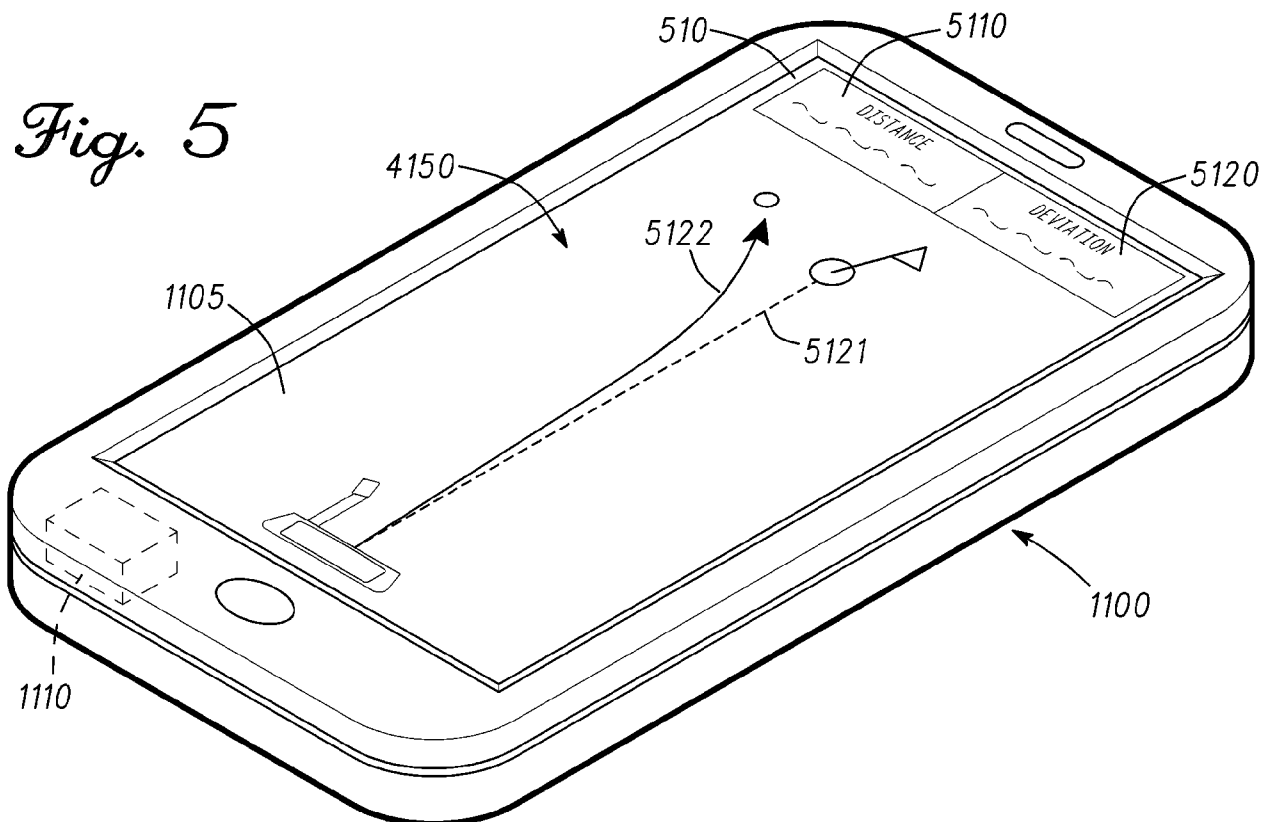
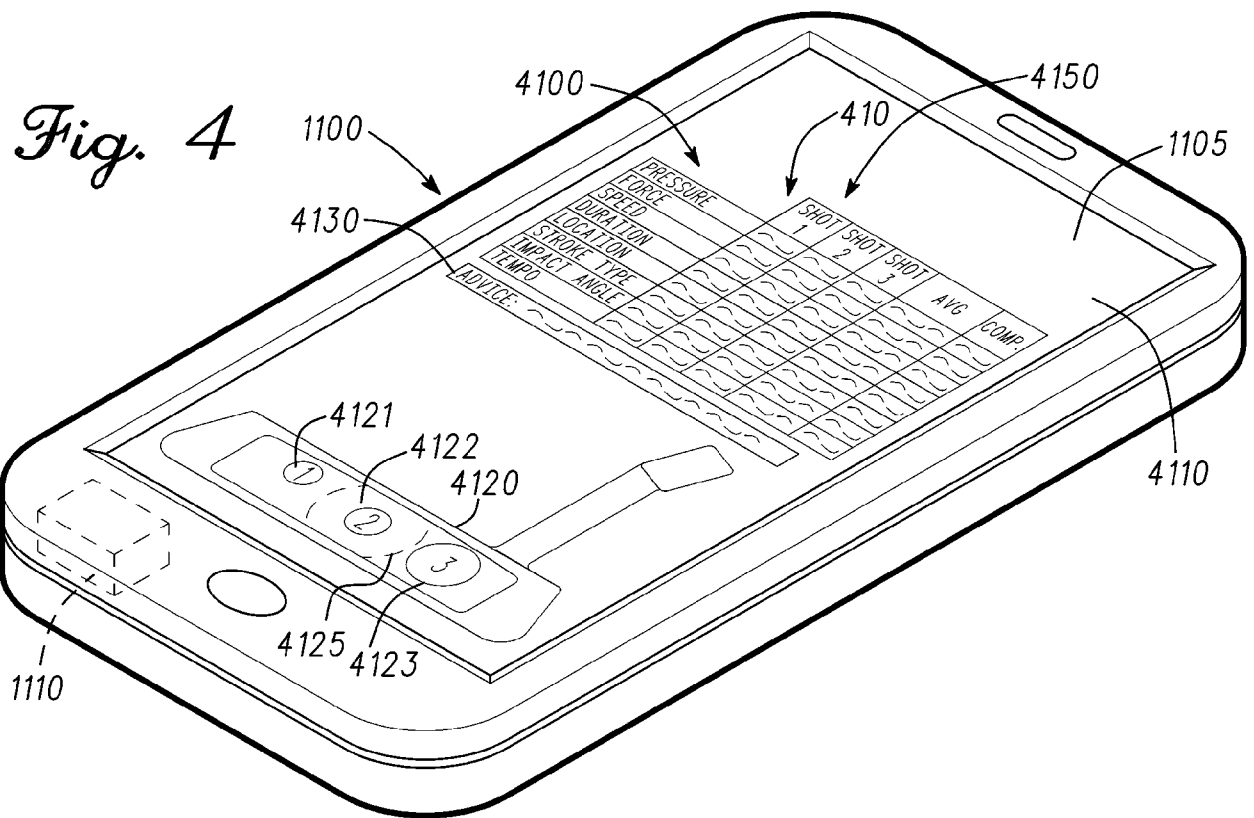
2/5

*Fig. 2*

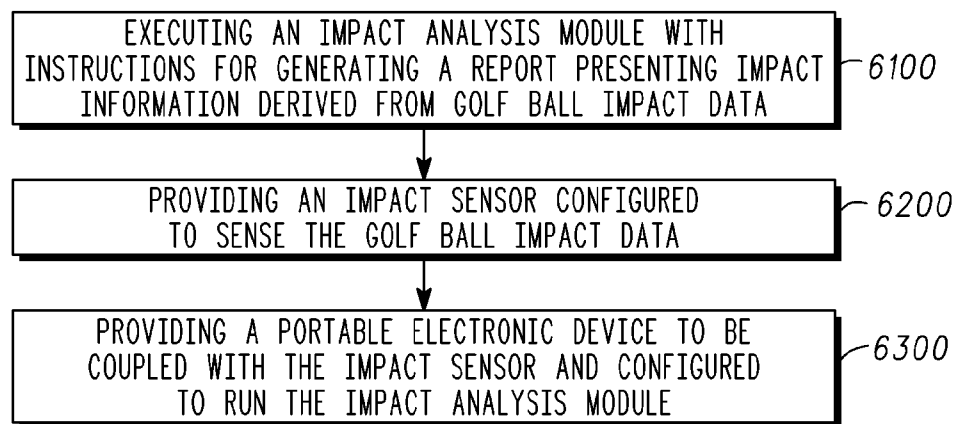
3/5

*Fig. 3*

4/5



5/5

6000*Fig. 6*

A. CLASSIFICATION OF SUBJECT MATTER***A63B 69/36(2006.01)i, A63B 53/04(2006.01)i***

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 69/36; A63B 57/00; G01P 1/07; A63B 53/04

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: golf club, impact sensor, impact analysis, portable electronic device, information

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006-010934 A2 (O`CARROL, JARLATH JUDE FRANCIS) 02 February 2006 See the abstract, claims 1-7, and figures 2, 3.	1-6, 18-20, 22-25
X A	US 2010-0093463 A1 (DAVENPOR, ROGER et al.) 15 April 2010 See the abstract, claims 1, 5, 8, 12, and figures 1-17.	1, 18, 23 2-6, 19, 20, 22, 24, 25
X A	US 2006-0029916 A1 (BOSCHA, BOOGIE) 09 February 2006 See the abstract, claims 1, 6, 13, and figures 1-5.	1, 18, 23 2-6, 19, 20, 22, 24, 25
X A	US 5779555 A (NOMURA, KAZUO et al.) 14 July 1998 See the abstract, claim 1, and figures 1-4.	1, 18, 23 2-6, 19, 20, 22, 24, 25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

15 NOVEMBER 2012 (15.11.2012)

Date of mailing of the international search report

23 NOVEMBER 2012 (23.11.2012)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
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City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Kim, Kyoung Hou

Telephone No. 82-42-481-3360



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/038691

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 12 and 17
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claims 12 and 17 are not clear and unsearchable because it refers to a claim which is not drafted in accordance with the third sentence of Rule 6.4(a).
3. ☒ Claims Nos.: 7-11, 13-16, 21, and 26
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/038691

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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