METHOD AND APPARATUS FOR PREDICTING THE DROP POINT OF A GOLF BALL

BACKGROUND

1. Field

[0001] The present disclosure relates to a method and landing point prediction apparatus of a golf ball. More particularly, the present disclosure relates to a method and landing point prediction apparatus of a golf ball by generating an estimated trajectory based on golf club information, golf course information, and a set of images captured at the moment of impact.

2. Description of the Related Art

[0002] Golf is a sport in which players use golf clubs to hit balls into holes on a courses. Recently, due to the improvement of national income, the spread of well-being culture, the globalization of sports exchange, and the prominence in the PGA and LPGA, Korean people's interest in golf has rapidly increased.

[0003] A golf course is also referred to as a field, and when performing golf in a field, if a flying ball does not enter a hole, it is essential to find a landing point of the golf ball for a next hit.

[0004] However, it may be difficult to find a location of the golf ball that has flown in the field with the human eyes, and even if an approximate location is recognized, it may be inconvenient to find the location of the golf ball specifically.

[0005] Therefore, there is a need to resolve the inconvenience of finding a golf ball by predicting a landing point by analyzing a trajectory of a golf ball blown away by the hit.

SUMMARY

[0006] The present disclosure provides a method and landing point prediction apparatus of a golf ball. The problems to be solved by the present disclosure are not limited to the aforementioned problems, and other problems and advantages of the present disclosure that are not mentioned above may be understood by the following description and more clearly understood by the embodiments of the present disclosure. It will also be

appreciated that the problems and advantages to be solved by the present disclosure may be realized by means and combinations thereof as set out in the claims.

[0007] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments of the disclosure.

[0008] According to an aspect of the inventive concept, there is provided a method for predicting a landing point of a golf ball, including acquiring input information including golf club information and golf course information, acquiring an image set in which a swing scene is imaged for a preset time before and after a moment of impact, generating an estimated trajectory of a golf ball based on the input information and the image set, and generating estimated landing point information of the golf ball based on the estimated trajectory.

[0009] According to another aspect of the inventive concept, there is provided an apparatus for predicting a landing point of a golf ball, including a memory storing at least one program and a processor operating by executing the at least one program, wherein the processor is configured to acquire input information including golf club information and golf course information, acquire an image set in which a swing scene is imaged for a preset time before and after a moment of impact, generate an estimated trajectory of a golf ball based on the input information and the image set, and generate estimated landing point information of the golf ball based on the estimated trajectory.

[0010] According to another aspect of the inventive concept, there is provided a computer-readable recording medium in which a program for executing the method of claim 1 on a computer is recorded.

[0011] Other aspects, features, and advantages than those described above may become apparent from the following drawings, claims, and detailed description of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

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

[0013] FIG. 1 is a system diagram including a landing point prediction apparatus according to an embodiment;

[0014] FIG. 2 is a block diagram of a landing point prediction apparatus according to an embodiment;

[0015] FIG. 3 is a diagram illustrating an operation of acquiring an image set according to an embodiment;

[0016] FIG. 4 is a diagram illustrating an image set of golf clubs according to an embodiment;

[0017] FIG. 5 is a diagram illustrating a captured image set a golf ball according to an embodiment;

[0018] FIG. 6 is a diagram illustrating a captured image set of a swing posture of a player according to an embodiment;

[0019] FIG. 7 is a diagram illustrating an operation of acquiring golf club information according to an embodiment;

[0020] FIG. 8 is a diagram illustrating an operation of acquiring player information according to an embodiment;

[0021] FIG. 9 is a diagram illustrating 3D terrain information according to an embodiment;

[0022] FIG. 10 is a diagram illustrating an operation of generating tee shot location information according to an embodiment;

[0023] FIGS. 11A is a diagram illustrating an operation of generating final predicted location information using a reproduced virtual space according to an embodiment;

FIG. 11B is a diagram illustrating an interface displayed on a user terminal according to an embodiment;

[0024] FIG. 12 is a diagram illustrating an operation of generating a recommended movement path of a golf cart according to an embodiment; and

[0025] FIG .13 is a flowchart of a method of predicting a landing point of a golf ball according to an embodiment.

DETAILED DESCRIPTION

[0026] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions, such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0027] The present disclosure may be implemented by various conversions and may have various embodiments, and specific embodiments are illustrated in the drawings and described in the detailed description. Effects and features of the present disclosure and methods for achieving them will become apparent with reference to embodiments described below in detail in conjunction with the drawings.

[0028] However, the present disclosure is not limited to the embodiments disclosed below and may be implemented in various forms. In the following embodiments, terms, such as first and second, are used for the purpose of distinguishing one element from another element, not in a limiting sense. Also, a singular expression includes a plural expression unless the context clearly dictates otherwise. In addition, terms such as “including” or “having” mean that the features or elements described in the specification exist, and do not preclude the possibility that one or more other features or elements may be added.

[0029] In addition, in the drawings, the size of components may be exaggerated or reduced for convenience of description. For example, the size and thickness of each component shown in the drawings are arbitrarily indicated for convenience of description, so the present disclosure is not limited thereto.

[0030] Hereinafter, embodiments of the present disclosure are described in detail with reference to the accompanying drawings, and when described with reference to the drawings, the same or corresponding components are given the same reference numerals, and repeated descriptions thereof will be omitted.

[0031] Hereinafter, the present disclosure is described in detail with reference to the accompanying drawings.

[0032] FIG. 1 is a diagram illustrating a system 100 including an apparatus110 for predicting a landing point (or a landing point prediction apparatus 110) according to an embodiment.

[0033] Referring to FIG. 1, the system 100 according to an embodiment may include the landing point prediction apparatus 110 and a user terminal 120.

[0034] The landing point prediction apparatus 110 may refer to all types of servers that manage web and/or applications capable of providing a service for predicting a landing point of a golf ball, and a server that manages homepages of various management platforms. However, the present disclosure is not limited thereto. A camera (not shown) may be included as part of the landing point prediction apparatus 110 or may communicate with the landing point prediction apparatus 110 outside the landing point prediction apparatus 110 using a network.

[0035] The user terminal 120 may include smartphones, tablet PCs, PCs, smart TVs, mobile phones, personal digital assistants (PDAs), laptops, media players, micro servers, global positioning system (GPS) devices, e-book readers, digital broadcasting terminals, navigation devices, kiosks, MP3 players, digital cameras, home appliances, devices with cameras, and other mobile or non-mobile computing devices, but are not limited thereto. In addition, the user terminal 120 may be a wearable device having a communication function and a data processing function, such as watches, glasses, hair bands, and rings. However, the present disclosure is not limited thereto.

[0036] Meanwhile, users include all persons involved in golf, such as golf players, caddies, and golf course managers. A plurality of users may exist, and thus, a plurality of terminals used by the users may also exist. The landing point prediction apparatus 110 may generate an interface displaying landing point prediction information to be provided to a user, and the generated interface may be provided to the user through the user terminal 120.

[0037] Meanwhile, the landing point prediction apparatus 110 may communicate with the user terminal 120 through a network. According to an embodiment, the landing point prediction apparatus 110 may acquire input information including golf club information, golf course information, and player information by communicating with the user terminal 120 through a network. In addition, the landing point prediction apparatus 110 may

provide an interface displaying at least one of an estimated trajectory, predicted landing point information, tee shot location information for each player, player posture analysis information, reproduced virtual space, and recommended movement path, and a strategy to the user by performing communication with the user terminal 120 through a network.

[0038] The landing point prediction apparatus 110 may perform communication with the user terminal 120 using a network. For example, the network may include a local region network (LAN), a wide region network (WAN), a value added network (VAN), a mobile radio communication network, a satellite communication network, and combinations thereof, may be a comprehensive data communication network enabling the network components 110 and 120 shown in FIG. 1 to smoothly communicate with each other, and may include wired Internet, wireless Internet, and mobile wireless communication network. In addition, wireless communication may include, for example, wireless LAN (Wi-Fi), Bluetooth, Bluetooth low energy (BLE), Zigbee, Wi-Fi direct (WFD), ultra-wideband (UWB), infrared data association (IrDA), near field communication (NFC), etc., but are not limited thereto.

[0039] FIG. 2 is a block diagram of a landing point prediction apparatus 200 according to an embodiment.

[0040] Referring to FIG. 2, the landing point prediction apparatus 200 may include a processor 210, a memory 220, and a communication module 230. The landing point prediction apparatus 200 of FIG. 2 includes only components related to the embodiment. Accordingly, those skilled in the art may understand that other general-purpose components may be further included in addition to the components shown in FIG. 2. In addition, the landing point prediction apparatus 200 of FIG. 2 may correspond to the landing point prediction apparatus 110 of FIG. 1.

[0041] The processor 210 controls the overall operation of the landing point prediction apparatus 200. For example, the processor 210 may generally control an input unit (not shown), a display (not shown), a camera (not shown), the memory 220, the communication module 230, and the like and may control an operation of the landing point prediction apparatus 200 by executing programs stored in the memory 220. The processor 210 may control at least some of the operations of the landing point prediction apparatus 200 described with reference to FIGS. 1 to 13.

[0042] The processor 210 may be implemented using at least one of application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), controllers, microcontrollers, microprocessors, and electrical units for performing other functions.

[0043] The memory 220 is hardware for storing various data processed in the landing point prediction apparatus 200, and may store programs for processing and controlling the processor 210.

[0044] The memory 220 may include random access memory (RAM), such as dynamic random access memory (DRAM) and static random access memory (SRAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), and CD-ROM, Blu-ray or other optical disk storage, hard disk drive (HDD), solid state drive (SSD), or flash memory.

[0045] The communication module 230 may include one or more components that enable wired/wireless communication with an external server or external device. For example, the communication module 230 may include at least one of a short-range communication unit (not shown), a mobile communication unit (not shown), and a broadcast reception unit (not shown).

[0046] FIG. 3 is a diagram illustrating an operation of acquiring an image set according to an embodiment.

[0047] Referring to FIG. 3, the camera 310 may be part of a landing point prediction apparatus, or may be a device that generates an image set outside of the landing point prediction apparatus and provides the generated image set to the landing point prediction apparatus. The camera 310 may be installed on the front and/or side of a player by the user before the player hits a golf ball 331 with a golf club 321.

[0048] The camera 310 may generate image sets by imaging the golf club 321, the golf ball 331, and a swing posture 341 of the player. The camera 310 may include any device that generates an image using visible light reflected on a subject, but may include a camera that generates an image using invisible ray electromagnetic waves including infrared rays, ultraviolet rays, and X-rays.

[0049] According to an embodiment, the camera 310 may include an ultra-high-speed camera capable of continuously taking pictures at minute frame intervals, and may include a high-resolution camera capable of identifying the degree of movement and rotation of a subject when taking pictures at minute frame intervals.

[0050] According to an embodiment, the camera 310 may include at least one image capturing unit to generate image sets, and may include an image capturing unit for imaging 322 a golf club, a capturing unit for imaging 332 a golf ball 332, and an image capturing unit for imaging 342 a swing posture of the player. Alternatively, a plurality of cameras 310 may be located at the front and side of the player to perform imaging to generate image sets.

[0051] According to an embodiment, only an image set obtained by imaging the golf club 321, the golf ball 331, and the swing posture 341 of the player together may be generated, and in this case, an operation of processing images of each subject from the image set captured together and generating each image set may be further performed.

[0052] According to an embodiment, the landing point prediction apparatus may use an artificial intelligence (AI) neural network model trained by using golf club and golf ball images as learning data. The landing point prediction apparatus may input an image set in which the golf club 321 and the golf ball 331 are imaged together to the pre-trained AI neural network model as input data, and acquire an image set for the golf club 321 and an image set for the golf ball 331 as output data.

[0053] According to an embodiment, the camera 310 may generate image sets by imaging the golf club 321, the golf ball 331, and the swing posture 341 of the player for a preset time before and after the moment of impact. The preset time may be an interval from first specific point in time to second specific point in time. The image sets may include several images to hundreds of thousands of images, but are not limited thereto.

[0054] According to an embodiment, the moment of impact may be the moment when the golf club touches the golf ball. According to an embodiment, the swing scene may be imaged for a time including first specific point in time before a moment of impact, the moment of impact, and second specific point in time after the moment of impact. According to an embodiment, the swing scene may be imaged for a time from first specific point in time before a moment of impact second specific point in time after the moment of

impact, and the preset time may be time sufficient to analyze the physical quantity of the subjects. The time may correspond to several milliseconds (ms) to several seconds (s), but is not limited thereto.

[0055] FIG. 4 is a diagram illustrating an image set 400 in which a golf club is imaged according to an embodiment.

[0056] Referring to FIG. 4, according to an embodiment, the landing point prediction apparatus may use the image set 400 in which a golf club is imaged. The illustrated image set 400 represents shapes of a continuously imaged golf club in an overlapping manner, in which the shapes of the golf club approaching the shape of the golf club represented by the solid line as a final location are represented by the dotted line.

[0057] According to an embodiment, the landing point prediction apparatus may calculate a speed of a head of the golf club at the time of impact, an angle of a surface of the head that touches the golf ball with respect to the ground, and an angle of the surface of the head contacting the gold ball with respect to a target direction from the image set 400 obtained by imaging the golf club.

[0058] According to an embodiment, the landing point prediction apparatus may calculate the speed of the head of the golf club using an imaging time and a location of the head of the golf club before and after an impact point according to classical mechanics.

[0059] According to an embodiment, the landing point prediction apparatus may receive a reference for the ground and target direction by the user to use, or calculate and use the reference by using three-dimensional (3D) terrain information input from the user and location information of a place to prepare for a current hit, but the present disclosure is not limited thereto.

[0060] According to an embodiment, the landing point prediction apparatus may calculate the angle of the surface of the head with respect to the ground using a normal vector of the ground calculated from ground height information at a location to prepare for a current hit on the 3D terrain information, and may calculate an angle of the surface of the head with respect to the target direction using the location of the hole and the location at which a current hit is prepared.

[0061] FIG. 5 is a diagram illustrating an image set 500 in which a golf ball is imaged according to an embodiment.

[0062] Referring to FIG. 5, according to an embodiment, the landing point prediction apparatus may use the image set 500 in which a golf ball is imaged. The illustrated image set 500 represents shapes of a continuously imaged golf ball in an overlapping manner, in which the shapes of the golf ball approaching the shape of the golf ball represented by the solid line as a final location are represented by the dotted line.

[0063] According to an embodiment, the landing point prediction apparatus may calculate a speed of the golf ball at the time of impact, an angle of an initial path of the golf ball with respect to the ground, and a rotation rate of the golf ball from the image set 500 obtained by imaging the golf ball.

[0064] According to an embodiment, the landing point prediction apparatus may calculate the speed of the golf ball using an imaging time and a location of the golf ball before and after an impact point according to classical mechanics.

[0065] According to an embodiment, the landing point prediction apparatus may calculate a rotation rate of the golf ball using an imaging time and a rotation degree of the golf ball before and after the point of impact according to classical mechanics.

[0066] According to an embodiment, the landing point prediction apparatus may receive a reference for the ground and target direction by the user to use, or calculate and use the reference by using 3D terrain information input from the user and location information of a place to prepare for a current hit, but the present disclosure is not limited thereto.

[0067] According to an embodiment, the landing point prediction apparatus may calculate the angle of the initial path of the golf ball with respect to the ground using the normal vector of the ground calculated from the ground height information at the location to prepare for a current hit on the 3D terrain information, and may calculate an angle of the initial path of the golf ball with respect to the target direction using the location of the hole and the location at which a current hit is prepared.

[0068] FIG. 6 is a diagram illustrating an image set 600 in which a swing posture of a player is imaged according to an embodiment.

[0069] Referring to FIG. 6, according to an embodiment, the landing point prediction apparatus may use the image set 600 in which a swing posture of a player is imaged. The illustrated image set 600 represents shapes of a continuously imaged player in an

overlapping manner, in which the shapes of the player approaching the shape of the player represented by the solid line as a final location are represented by the dotted line.

[0070] According to an embodiment, the landing point prediction apparatus may obtain a physical quantity for each body part of the player from the image set 600 in which the swing posture of the player is imaged. For example, a velocity or angular velocity of a body part, such as a player's arm, may be acquired.

[0071] According to an embodiment, the landing point prediction apparatus may compare the acquired physical quantity for each body part of the player with a physical quantity calculated from a preset swing standard image set, and generate posture analysis information using a difference therebetween.

[0072] According to an embodiment, the landing point prediction apparatus may compare the player's swing posture with the preset swing standard image and generate an analyzed difference or a method for posture correction selected from a preset database based on the difference, as posture analysis information.

[0073] According to an embodiment, the landing point prediction apparatus may use a pre-trained AI neural network model when identifying a body part, acquiring a speed or angular velocity of the body part, analyzing the difference from othe prset swing standard image set, and selecting a method for posture correction from a preset database. The AI neural network model in use may be a model trained using images and videos of golf swing postures as learning data, and the AI neural network model may extract and use the characteristics of body part movement with resepct to a physical quantity regarding a translational movement and a rotation movement. The landing point prediction apparatus may input an image set obtained by imaging a body part of the player as input data to the pre-trained AI neural network model and acquire identification information of the body part, the speed and angular velocity of the body part, and the difference from the preset swing standard image set, and a method for correcting a posture selected from a preset database, as output data.

[0074] FIG. 7 is a diagram illustrating an operation of acquiring golf club information according to an embodiment.

[0075] Referring to FIG. 7, the landing point prediction apparatus according to an embodiment may acquire golf club information received from the user, and the golf club information may be input through a display of a user terminal.

[0076] According to an embodiment, the landing point prediction apparatus may receive information on the type of a golf club, manufacturer and seller of the golf club for each golf player, and a display for receiving the golf club information may include a region 710 for selecting a player, a region 720 for selecting a type of a golf club, a region 730 for selecting a manufacturer or seller of golf clubs, and a region 740 for displaying a list of total golf clubs. Also, according to an embodiment, the landing point prediction apparatus may acquire a driver, wood, iron, wedge, and the like as a type of golf club.

[0077] According to an embodiment, the landing point prediction apparatus may acquire golf club information including whether the head of the golf club being used is covered with a cover.

[0078] According to an embodiment, the landing point prediction apparatus may calculate the physical quantity described above with reference to FIG. 4 by calculating a weight of the golf club and a weight of the head of the golf club using the received type, manufacturer, and seller information of the golf club.

[0079] According to an embodiment, the landing point prediction apparatus may select a bolf club by the user used by a player currently playing golf, to acquire golf club information to be used for calculating a physical quantity regarding the golf club.

[0080] According to an embodiment, the landing point prediction apparatus may determine a weight of the golf club, a weight of the head of the golf club, and a shape of the golf club from the acquired golf club information. This may be information previously input to correspond to one golf club specified from the golf club information.

[0081] Alternatively, according to an embodiment, when there is no corresponding previously input information, the landing point prediction apparatus may estimate the weight of the golf club, the weight of the head of the golf club, and the shape of the golf club using an AI neural network model trained using types and brands of golf clubs as learning data. The landing point prediction apparatus may input at least one of a type, a manufacturer, and a seller of the golf club as input data, and acquire the weight of the

golf club, the weight of the head of the golf club, and the shape of the golf club as output data.

[0082] FIG. 8 is a diagram illustrating an operation of acquiring player information 800 according to an embodiment.

[0083] Referring to FIG. 8, the landing point prediction apparatus according to an embodiment may acquire the player information 800 received from the user, and the player information 800 may be input through a display of a user terminal.

[0084] According to an embodiment, the landing point prediction apparatus may receive information on a name, age, and sex for each player playing golf, and the display for receiving the golf club information according to an embodiment may include a region 810 for inputting a name of a player, a region 820 for selecting a sex of the player, and a region 840 for selecting age of the player, but the present disclosure is not limited thereto and the display may further receive additional information, such as a height and a weight of the player, a skill of the player, etc.

[0085] FIG. 9 is a diagram illustrating 3D terrain information 900 according to an embodiment.

[0086] According to an embodiment, the landing point prediction apparatus may receive 3D terrain information, temperature of a golf course, a humidity of the golf course, a wind speed of the golf course, and a wind direction of the golf course from the user. Meanwhile, temperature, humidity, wind speed, and wind direction may be input to the landing point prediction apparatus in real time from a separate measurement device.

[0087] Referring to FIG. 9, according to an embodiment, the 3D terrain information 900 input from the user may include a planar distance of the golf course, a height of the golf course, a passage 910 used by a card, a location 920 of tee boxes, a region of fairway, a region of rough, a region of bunker, a region of green, a region of fringe, a region of an OB zone, a region of hazard, and location information of a hole, and may include friction coefficient information of each region.

[0088] According to an embodiment, in estimating a final predicted location from an estimated landing point to be described below, the landing point prediction apparatus may use the planar distance of the golf course, the height of the golf course, a type of a region in which a golf ball is to be located, and friction coefficient information in the corresponding

region, to be described below with reference to FIG. 11A. For example, the landing point prediction apparatus may predict a direction in which the golf ball will head after first landing using a normal vector of the ground at the estimated landing point, and may predict a location at which the golf ball to roll will stop using the friction coefficient in the corresponding region.

[0089] FIG. 10 is a diagram illustrating an operation of generating tee shot location information 1000 according to an embodiment.

[0090] A golf tee shot refers to a shot hit first in each hole, and a tee box is a region in which a tee shot is performed. Generally, there are 4 types of tee boxes, and the assignment of the tee boxes depends on the players' physical ability and skill level, and a tee box farther from a hole is assigned as the physical ability and skill level is higher. FIG. 10 is an enlarged representation of the location 920 of the tee boxes in FIG. 9. FIG. 10 shows red tee 1010, yellow tee 1020, white tee 1030, and blue tee 1040 in a direction close to the hole.

[0091] According to an embodiment, the landing point prediction apparatus may automatically allocate the location of the tee shot for each player according to the player information described in detail above with reference to FIG. 8. For example, the landing point prediction apparatus may assign the red tee 1010 when a player who is currently to perform a tee shot is an amateur woman in her twenties. Alternatively, when the player to perform the tee shot is an amateur male in his 50s, the yellow tee 1020 may be assigned. Alternatively, when the player to perform the tee shot is a professional male in his 30s, the blue tee 1040 may be assigned. According to an embodiment, the landing point prediction apparatus may generate tee shot location information based on previously assigned information, and may display the tee shot location information on the display of the user terminal.

[0092] FIG. 11A is a diagram illustrating an operation of generating final estimated location information using a reproduced virtual space 1100 according to an embodiment.

[0093] According to an embodiment, the landing point prediction apparatus may generate an estimated trajectory 1110 based on input information and image sets. The landing point prediction apparatus may generate the estimated trajectory 1110 by calculating a speed of the golf ball and a speed of the head of the gold club at the time of impact, an

angle of the surface of the head that touches the golf ball with respect to the ground at the time of impact, an angle of an initial path of the golf ball with respect to the ground at the time of impact, an angle of the surface of the head contacting the golf hole with respect to a target direction at the time of impact, an angle of the initial path of the golf ball with respect to the target direction at the time of impact, and a rotation rate of the golf ball.

[0094] According to an embodiment, the speed of the golf ball and the speed of the head of the golf club may be used to calculate a distance by which the golf ball moves in a direction parallel to the ground or in a direction perpendicular to the ground.

[0095] According to an embodiment, the angle of the initial path of the golf ball with respect to the ground at the time of impact and the angle of the surface of the head that touches the golf ball with respect to the target direction at the time of impact may be used to calculate a carry distance in relation to a rotation amount of the golf ball and a vertical movement distance of the golf ball with respect to the ground.

[0096] According to an embodiment, the angle of the surface of the head that touches the golf ball with respect to the target direction at the time of impact and the angle of the initial path of the golf ball with respect to the target direction at the time of impact may be used to calculate a side spin given to the golf ball and calculate an angle at which the estimated trajectory deviates from the target direction.

[0097] According to an embodiment, a total spin rate of the golf ball may be used to calculate a fade and a slice.

[0098] According to an embodiment, when generating the estimated trajectory 1110 with the calculated value, the landing point prediction apparatus may generate the estimated trajectory in consideration of the influence of a temperature, humidity, wind direction, and wind speed of the golf course on the calculated value together. For example, when the wind direction is opposite to the direction in which the golf ball flies, the estimated trajectory may be generated to be different by calculating a force exerted by air resistance on the golf ball.

[0099] According to an embodiment, the landing point prediction apparatus may generate an estimated trajectory by inputting an image set to a pre-trained trajectory estimation model and obtaining 3D coordinate information of the golf ball over time. For example, the landing point prediction apparatus may input an image set in which the whole swing

scene is imaged to the pre-trained trajectory estimation model or may input an image set of a golf club and/or a golf ball extracted from the image set of the whole swing scene to the pre-trained trajectory estimation model.

[00100] The pre-trained trajectory estimation model according to an embodiment may include a learning model learned using image sets obtained before and after the time of impact and trajectories of golf balls corresponding to the image sets as learning data. At this time, the estimated trajectory may be a trajectory generated according to the 3D coordinate information of the golf ball. For example, in a 3D coordinate space having a location of the golf ball at the time of impact as an origin, the estimated trajectory may be a trajectory in which the location of the golf ball over time is mapped to the 3D coordinate space.

[00101] According to another embodiment, the landing point prediction apparatus may generate the estimated trajectory by calculating at least one of a speed of the golf ball at the time of impact, an angle of the initial path of the golf ball with respect to the ground at the time of impact, an angle of the initial path of the golf ball with respect to a target direction at the time of impact, a rotation rate of the golf ball, and a rotation axis of the golf ball using the image set, inputting the calculated value into the pre-trained trajectory estimation model, and acquiring the 3D coordinate information of the golf ball over time.

[00102] The landing point prediction apparatus according to an embodiment may calculate at least one of various physical quantities related to the trajectory of the golf ball, such as the speed of the golf ball at the time of impact, the angle of the initial path of the golf ball with respect to the ground at the time of impact, the angle of the initial path of the golf ball with respect to the target direction at the time of impact, the rotation rate of the golf ball, and the rotation axis of the golf ball using the image set, and input the calculated value into the pre-trained trajectory estimation model. In this case, the trajectory estimation model according to an embodiment may include a learning model trained by using the physical quantities and the corresponding trajectory of the golf ball as learning data.

[00103] The pre-trained trajectory estimation model may include a learning model inferring an estimated trajectory subject of the golf ball using the image set and the trajectory of the golf ball corresponding thereto as learning data, using at least one physical quantity calculated from the image set and the trajectory of the golf ball corresponding thereto as

learning data, or the both as learning data. For example, the trajectory estimation model may include a learning model inferring the estimated trajectory based on at least one or two or more of various artificial neural network models, such as pre-net, CBHG module, deep neural network (DNN), convolutional neural network (CNN), recurrent neural network (RNN), autoencoder, generative adversarial network (GAN), long short-term memory network (LSTM), bidirectional recurrent deep neural network (BRDNN), etc., but is not limited thereto.

[00104] Meanwhile, the landing point prediction apparatus inputs the image set into the trajectory estimation model and acquires the 3D coordinate information of the golf ball over time. A first operating unit of the trajectory estimation model according to an embodiment may calculate at least one of the speed of the golf ball, the angle of the initial path of the golf ball with respect to the ground at the time of impact, the angle of the initial path of the golf ball with respect to the target direction at the time of impact, the rotation rate of the golf ball, and the rotation axis of the golf ball, and a second operating unit of the trajectory estimation model may generate the 3D coordinate information of the golf ball over time using the calculated value.

[00105] The trajectory estimation model according to an embodiment may include a nonlinear regression analysis model, and in this case, a model function may include the estimated trajectory itself. For example, the nonlinear function that is a model function may include each polynomial function representing each of an x value, a y value, and a z value of the golf ball in the 3D coordinate space having x, y, and z axes. For example, the model function may include "x(t) = ax^4 + bx^3 + cx^2 + dx + e" as a quartic function representing the x value. The trajectory estimation model according to an embodiment may include a nonlinear regression analysis model that takes an image set itself and/or at least one physical quantity calculated based on the image set as an input and outputs information on coefficients of the model function.

[00106] Meanwhile, when inputting the image set and/or at least one calculated physical quantity into the pre-trained trajectory estimation model, the landing point prediction apparatus may further include at least one of various environmental indicators, such as a wind speed, a wind direction, air pressure, humidity or temperature. In this case, the trajectory estimation model may include a learning model trained by using the

environmental indicators and the trajectory of the golf ball, as well as the image set and the physical quantity generated based thereon, as learning data. The landing point prediction apparatus may further input at least one of various environmental indicators into the pre-trained trajectory estimation model and acquire the 3D coordinate information of the golf ball reflecting the environmental indicators as an estimated trajectory.

[00107] According to an embodiment, the landing point prediction apparatus may reproduce the received 3D terrain information in the virtual space 1100 using a 3D modeling technique, and may generate estimated landing point 1120 information using the current location and the generated estimated trajectory 1110.

[00108] According to an embodiment, the reproduced virtual space 1100 may be reproduced by reflecting the physical laws of the real space. After the golf club hits the golf ball, the estimated trajectory 1110 may be generated and the estimated landing point 1120 information may be generated by reflecting physical quantities calculated based on image sets and physical quantities related to the golf club and golf ball calculated from input information in the virtual space. For example, when the values of the other physical quantities are the same, the landing point prediction apparatus may reproduce the estimated trajectory 1110 to display a longer plane movement distance in the virtual space 1100 when the weight of the head of the golf club is large.

[00109] According to an embodiment, the landing point prediction apparatus may generate final estimated location 1130 information at which the golf ball moving from the estimated landing point 1120 is to be finally stopped by reflecting the height of the terrain, the friction coefficient, the temperature, the humidity, the wind speed, and the wind direction of the golf course in the reproduced virtual space 1100. For example, the landing point prediction apparatus may predict a direction in which the golf ball will head after first landing using the normal vector of the ground at the estimated landing point, and may predict a location at which the golf ball to roll will stop using the friction coefficient in the corresponding region.

[00110] The landing point prediction apparatus may reproduce a golf course in a 3D virtual space based on the 3D terrain information. In this case, the landing point prediction apparatus according to an embodiment may generate estimated landing point information by mapping the 3D coordinate information of the golf ball estimated by the trajectory

estimation model to the virtual space. In this case, the 3D coordinate information may include 3D coordinate values of the golf ball constituting the estimated trajectory of the golf ball over time.

[00111] According to an embodiment, the landing point prediction apparatus may map 3D coordinate information of the golf ball to the virtual space based on the input information. For example, the landing point prediction apparatus may acquire a location at which an impact is performed as input information and acquire the 3D coordinate information of the golf ball in the 3D coordinate space based on the location as an origin. In this case, the landing point prediction apparatus may map the 3D coordinate information of the golf ball to the virtual space by overlapping the 3D coordinate space in the reproduced virtual space.

[00112] According to another embodiment, the landing point prediction apparatus may map the 3D coordinate information of the golf ball to the virtual space by using a location sensor provided in an image capture device or a user terminal possessed by a player and a posture sensor provided in the image capture device. For example, the landing point prediction apparatus may determine a location at which the impact is performed as a specific location of the golf course using the location sensor, and determine coordinate axes of the 3D coordinate information constituting the estimated trajectory using the posture sensor. The landing point prediction apparatus may map the 3D coordinate information of the golf ball to the virtual space by applying the determined impact location and the coordinate axes of the 3D coordinate information to the reproduced virtual space.

[00113] The landing point prediction apparatus may generate estimated landing point information by mapping the 3D coordinate information to the virtual space and determining the 3D coordinates of the golf ball corresponding to a time when the golf ball falls and touches the ground as an estimated landing point in the virtual space.

[00114] According to an embodiment, the landing point prediction apparatus may determine a strategy for each terrain from a preset database according to which region of the golf course the final estimated location 1130 is. For example, when the final estimated location 1130 is a bunker, a method of holding a grip when hitting a bunker shot, a method of positioning a leg when hitting a bunker shot, and the like may be determined as a strategy.

[00115] According to an embodiment, the landing point prediction apparatus may generate an interface displaying the reproduced virtual space 1100. Any one of the estimated trajectory 1110, the estimated landing point 1120, the final estimated location 1130, and the strategy may be displayed along with the virtual space 1100 on the interface.

[00116] According to an embodiment, the landing point prediction apparatus provides an interface displayed on the user terminal so that users may check a movement target point using the user terminal, while moving for a next shot.

[00117] According to an embodiment, the landing point prediction apparatus may determine first interest information for generating a first interface displaying at least one of input information, the estimated trajectory 1110, and the estimated landing point 1120 information. In this case, the first interface may include an interface for providing the information related to the trajectory of the golf ball to the user, and the first interest information may be understood as a set of pieces of information necessary to generate the first interface.

[00118] As an example, the landing point prediction apparatus reproduces the virtual space 1100 using the 3D terrain information included in the input information, and determine the first interest information for generating the first interface for displaying the estimated trajectory 1110 and the estimated landing point 1120 in the reproduced virtual space 1100. Here, the first information of interest may include the 3D terrain information, 3D modeling information necessary to display the reproduced virtual space 1100, information on the estimated trajectory 1110 in the reproduced virtual space 1100, and location information of the estimated landing point 1120 in the reproduced virtual space.

[00119] As another example, the landing point prediction apparatus may reproduce the virtual space 1100 using the 3D terrain information included in the input information, and determine the first interest information for generating the first interface displaying a real-time estimated location of the golf ball on the estimated trajectory 1110 in the reproduced virtual space 1100. Here, the first information of interest may include the 3D terrain information, the 3D modeling information necessary to display the reproduced virtual space 1100, the information on the estimated trajectory 1110 in the reproduced virtual space 1100, and information on an estimated location of the golf ball over time. Meanwhile,

the landing point prediction apparatus may determine estimated location information of the golf ball over time using the image set.

[00120] Also, the landing point prediction apparatus may determine second interest information for generating a second interface displaying comparison information generated based on past swing information and current swing information. The past swing information may be related to a swing performed by a player who hit the golf ball in the past, and may include information to be compared with a current swing performed by the player, and the current swing information may be generated based on the input information and the image set.

[00121] The past swing information according to an embodiment may include swing information collected through virtual golf, such as screen golf, performed by a player in the past or actual golf play performed in a field. In this case, the swing information may include a kind of the golf club, a kind of region in which hitting is performed, a speed of the golf ball, a speed of the golf club, an angle of the golf ball, a hitting angle of the golf club, and/or a rotation amount of the golf ball. For example, the past swing information may include ball flight information, carry distance information, and/or region information of a landing point in a first past swing using a specific golf club. For another example, the past swing information may include an average carry distance of a specific player in the case of using a specific golf club. As another example, the past swing information may include swing information collected from a virtual golf play reproduced identically to the terrain of an actual golf course where golf is currently played.

[00122] The current swing information according to an embodiment may be generated based on at least one of input information and an image set in which a swing scene is imaged. For example, the current swing information may include a region (e.g., rough, bunker, etc.) in which a current hit generated based on at least one of the input information and the image set is performed, a ball flight, or an estimated carry distance.

[00123] As an alternative embodiment, the past swing information may include swing information collected from a virtual golf play reproduced identically to the terrain of the actual golf course in which golf is currently played. For example, when a player currently performs a tee shot on a first hole, the past swing information may include swing information on the tee shot performed by the player on the first hole in a virtual golf play

in which the first hole is reproduced. Alternatively, when the player performs a virtual golf play in which the first hole is reproduced several times, average swing information for a plurality of tee shots performed by the player at the first hole may be included. In this case, the average swing information may include an average of all carry distances among a plurality of carry distances collected through virtual golf play.

[00124] The comparison information refers to every information provided so that the user may compare information related to a currently performed swing and a past performed swing. For example, comparison information may be provided by providing current swing information and past swing information together. Alternatively, the comparison information may include characteristics of the current swing information compared with the past swing information. According to an embodiment, the comparison information may be provided by providing a past average carry distance and a current estimated carry distance together. According to another embodiment, the comparison information may include characteristics of ball flights based on the current swing compared with ball flights based on past swings corresponding thereto. In this case, when a ball flight based on the current swing is a straight, ball flights based on past swings corresponding thereto may be slices.

[00125] According to an embodiment, at least one of the first interface and the second interface may be displayed on the user terminal. In this case, the user terminal may include at least one of a personal device used by a player and a common device used by a player group. For example, the first interface and/or the second interface may be displayed on a common device, on a personal device, or on both types of devices. The personal device may include a device individually used by each user, such as a golf player. A personal device according to an embodiment may include a wearable device worn on the body. In addition, the common device may include a device commonly used by a player group who play golf together and/or an employee providing a service for playing golf. A common device according to an embodiment may include a device provided in a golf cart. Meanwhile, a player group who play golf together may include a player who hits a golf ball.

[00126] A wearable device that may be worn on the body according to an embodiment may include a watch, a hat, clothing, or glasses. For example, glasses, which is a

wearable device, may include a display unit capable of displaying an interface on a lens portion. According to an embodiment, glasses, which is a wearable device, may further include a communication unit that receives information for displaying an interface and a controller that controls the display unit to display the interface. When the first interface and/or the second interface are displayed on the glasses including the display unit, the user who is a golf player may check and analyze his/her estimated trajectory 1110 immediately after hitting the golf ball, and may compare his/her current swing information with past swing information.

[00127] Meanwhile, according to an embodiment, when the first interface and/or the second interface are displayed on a device provided in a golf cart, the user who is a golf player may check and analyze his/her estimated trajectory 1110 and compare his/her current swing information and past swing information, while moving for a next hit.

[00128] The first interface according to an embodiment may further display a location of the golf ball relative to the location of the user terminal. In this case, the location of the user terminal may be determined based on a user's input or a global navigation satellite system (GNSS), and the location of the golf ball may be determined based on a location at which hitting was performed and the estimated trajectory 1110.

[00129] According to an embodiment, the first interface may display the location of the user terminal and an estimated current location of the golf ball. For example, the first interface may display the location of the user terminal by a first icon and display the estimated current location of the golf ball by a second icon. According to an alternative embodiment, when the first interface is displayed on glasses, which is a wearable device, the user, who is a player, may check the first icon representing his/her location and the second icon representing the estimated current location of the golf ball until the golf ball falls to stop immediately after hitting. Through this, the user who is a player may objectively check and analyze the movement of the golf ball based on the user's swing immediately after hitting, and thus, user experience may be improved.

[00130] According to another embodiment, the first interface may display the estimated current coordinates of the golf ball with respect to the location of the user terminal. As an example, the first interface may display an estimated current plane distance of the golf ball as a first indicator and an estimated current height of the golf ball as a second

indicator based on the user terminal. For example, when the plane distance of the golf ball from the user terminal is 150 m and the height is +10 m, 150 m may be displayed as a first indicator and +10 m may be displayed as a second indicator. As another example, when the coordinates of the user terminal are set to (0,0,0) and the current coordinates of the golf ball are predicted to be (90m, 120m, 10m), the first interface may display (90m, 120m, 10m) as estimated current coordinates of the golf ball relative to the location of the user terminal.

[00131] Meanwhile, the first interface and the second interface according to an embodiment may be displayed together. For example, the second interface may overlap the first interface to be displayed. As an example, the first interface may display the 3D virtual space 1100 in which a current golf course is reproduced, and the estimated trajectory 1110 on the 3D virtual space 1100. In this case, the second interface may overlap the first interface to be displayed. The second interface may display a current estimated carry distance and an average carry distance based on swings performed in the past using the same golf club in the same region (e.g., a rough, a bunker, etc.). As another example, the second interface may display the current ball flight and estimated carry distance and display ball flights and carry distances of swings performed in the past virtual golf plays as past swings corresponding to the current swing.

[00132] FIG. 11B is a diagram illustrating an interface displayed on a user terminal according to an embodiment.

[00133] Referring to FIG. 11B, the landing point prediction apparatus 1101 may transmit information for displaying an interface on an external device in order to display the first interface and/or the second interface on the external device, such as a user terminal. Meanwhile, a landing point prediction apparatus 1101 shown in FIG. 11B may correspond to the landing point prediction apparatus 120 shown in FIG. 1, and first to fourth player personal devices 1111, 1112, 1113, and 1114 shown in FIG. 11B and a common device 1121 may be included in the user terminal 110 shown in FIG. 1.

[00134] The player personal devices refers to personal devices individually respectively used by players playing golf. For example, when the number of players is four, a personal device used by a first player, one of the players, refers to the first player personal device 1111.

[00135] According to an embodiment, the landing point prediction apparatus 1101 may generate a first interface and/or a second interface and transmit the first interface and/or the second interface to an external device. The external device may include a user terminal and may include the first to fourth player personal devices 1111, 1112, 1113, and 1114 and the common device 1121. According to another embodiment, the landing point prediction apparatus may determine first interest information and/or second interest information and transmit the determined first interest information and/or second interest information to an external device.

[00136] The external device may receive the first interface and/or the second interface and display the received first and second interfaces through a display unit provided in the external device. Alternatively, the external device may receive first interest information and/or second interest information, generate the first interface and/or the second interface based on the first interest information and/or the second interest information, and display the generated first interface and/or the second interface through a display unit provided in the external device.

[00137] At least one of the first interface and the second interface, when displayed on a personal device, may display information related to a player, and, when displayed on the common device 1101, may display every information related to each member included in a player group. For example, when the first interface or the second interface is displayed on the first player personal device 1111, the displayed first interface or the second interface may display only information related to a first player. Alternatively, when the first interface or the second interface is displayed on a second player personal device 1112, the displayed first interface or the second interface may display only information related to a second player. For another example, when the first interface or the second interface are displayed on the common device 1121, the displayed first interface or the second interface may display every information related to each of the first to fourth players.

[00138] As an alternative embodiment, the first interface may display the virtual space 1100, the player's location and the estimated trajectory 1110 in the virtual space 1100. Here, the first interface displayed on the first player personal device 1111 may display the virtual space 1100, a location of the first player in the virtual space 1100, and an estimated trajectory of the golf ball hit by the first player. In addition, the first interface displayed on

the second player personal device 1112 may display the virtual space 1100, a location of the second player in the virtual space 1100, and an estimated trajectory of the golf ball hit by the second player. Meanwhile, the first interface displayed on the common device 1121 may display the virtual space 1100 and respective locations of the first to fourth players in the virtual space 1100, and display all estimated trajectories of golf balls hit respectively hit by the first to fourth players.

[00139] As an alternative embodiment, the second interface may display comparison information on an estimated carry distance based on a player's current swing and an average carry distance based on past swing information collected for the player. Here, the second interface displayed on the first player personal device 1111 may display comparison information on an estimated carry distance based on a current swing of the first player and an average carry distance based on past swing information collected for the first player. In addition, the second interface displayed on the second player personal device 1112 may display comparison information on an estimated carry distance based on a current swing of the second player and an average carry distance based on past swing information collected for the second player. Meanwhile, the second interface displayed on the common device 1121 may display comparison information comparing an estimated carry distance based on a current swing of each of the first to fourth players with an average carry distance based on past swing information collected for each player.

[00140] According to an embodiment, the landing point prediction apparatus 1101 may transmit first interest information related to a player corresponding to the personal device and/or second interest information related to a corresponding player to each personal device, such as the first player personal device 1111. Also, according to an embodiment, the landing point prediction apparatus 1101 may transmit first interest information related to all players and second interest information related to all players to the common device 1121.

[00141] As an example, the first player personal device 1111 may include glasses which is a wearable device. The landing point prediction apparatus 1101 may transmit first interest information related to the first player to the glasses worn by the first player, and accordingly, the glasses worn by the first player may display the first interface generated using the first interest information. In this case, the first interface may display the virtual

space 1100, a location of the first player in the virtual space 1100, and an estimated trajectory of the golf ball hit by the first player in the virtual space 1100. Meanwhile, the landing point prediction apparatus 1101 may transmit second interest information related to the first player to the glasses worn by the first player, and accordingly, the glasses worn by the first player may display the second interface generated by using the second interest information. In this case, the second interface may display comparison information generated by using information on an estimated carry distance based on a current swing of the first player and past swings. Through this, the first player may check and analyze the information related to his or her play during play.

[00142] As another example, the common device 1121 may include a device (e.g., a tablet PC, etc.) installed in a golf cart. The landing point prediction apparatus 1101 may transmit first interest information related to each of the first to fourth players to the device installed in the golf cart, and accordingly, the device installed in the golf cart may display a first interface generated by using the first interest information. Here, the first interface may display the virtual space 1100, respective locations of the first to fourth players in the virtual space 1100, and estimated trajectories respectively corresponding to the first to fourth players in the virtual space 1100. Meanwhile, the landing point prediction apparatus 1101 may transmit second interest information related to each of the first to fourth players to the device provided in the golf cart, and accordingly, the device provided in the golf cart may display the second interface generated by using the second interest information. Here, the second interface may display comparison information generated using the information on the estimated carry distances based on current swings of the first to fourth players and past swings for each player. In this case, the comparison information may include information comparing the estimated carry distance of the first player with a past average carry distance of the first player and information comparing the estimated carry distance of the second player with a past average carry distance of the second player. Through this, the first to fourth players may check and analyze information on other players playing golf together on the golf cart and information related to their own play. In addition, the common device 1121 according to an embodiment may display the final estimated locations for the first to fourth players, and thus, the path of the golf cart may be efficiently displayed together with the final estimated locations.

[00143] Meanwhile, the first interface may display the location of the golf ball relative to the location of the user terminal. According to an embodiment, after hitting the golf ball, the first player may check a location of the golf ball relative to his/her location through the first interface displayed on the first player personal device 1111. Through this, each player may immediately check and analyze the motion of the golf ball that he/she hits after hitting the golf ball. According to another embodiment, users, such as the first to fourth players, may check the location of the golf ball relative to the location of the golf cart through the first interface displayed on the common device 1121 provided in the golf cart. Through this, the path of the golf cart may be effectively displayed.

[00144] FIG. 12 is a diagram illustrating an operation of generating a recommended movement path of a golf cart according to an embodiment.

[00145] Referring to FIG. 12, according to an embodiment, the landing point prediction apparatus may select a cart passage location closest from a final predicted location 1211 of a golf ball hit by a first player, a final estimated location 1212 of a golf ball hit by a second player, a final estimated location 1213 of a golf ball hit by a third player, and a final estimated location 1214 of a golf ball hit by a fourth player.

[00146] According to an embodiment, the landing point prediction apparatus may select a cart passage location closest from the final estimated location 1211 of a golf ball hit by the first player as a first location 1221 and select a cart passage location closest from the final estimated location 1212 of a golf ball hit by the second player as a second location 1222.

[00147] According to an embodiment, the landing point prediction apparatus may generate a path by way of the first location 1221 closest to the current location at which a shot was performed and the second location 1222 second closest to the current location, as a recommended movement path of the golf cart, generate an interface displaying the recommended movement path, and provide the generated interface to the user.

[00148] According to an embodiment, when the sum of a distance from the final estimated location 1211 of a golf ball hit by the first player to the first location 1221 after the cart reaches the first location 1221 and a distance from the second location 1222 to the final estimated location 1212 of a golf ball hit by the second player is greater than a distance from the final estimated location 1211 of a golf ball hit by the first player to the final

estimated location 1212 of a golf ball hit by the second player, the landing point prediction apparatus may generate a path in which the golf cart passes through only the first location 1221 and does not pass through the second location 1222, as a recommended movement path, generate a message recommending to move from the final estimate location 1211 of a golf ball hit by the first player to the final estimated location 1212 of a golf ball hit by the second player on foot, and display the recommended movement path and the message on the user terminal.

[00149] FIG. 13 is a flowchart of a method 1300 of predicting a landing point of a golf ball according to an embodiment.

[00150] Referring to FIG. 13, in operation 1310, the landing point prediction apparatus may acquire input information including golf club information and golf course information.

[00151] The golf club information may include at least one of a type of a golf club, a manufacturer of the golf club, and a seller of the golf club.

[00152] The golf course information may include at least one of 3D terrain information of the golf course, temperature, humidity, wind speed, and wind direction of the golf course.

[00153] The input information may include player information including at least one of a player's name, age, and sex.

[00154] The landing point prediction apparatus may generate tee shot location information for each player based on the player information.

[00155] In operation 1320, the landing point prediction apparatus may acquire an image set in which swing scenes are imaged for a preset time before and after the moment of impact.

[00156] The image set may include a first image set of a golf club and a second image set of a golf ball.

[00157] The image set may include a third image set in which the player's swing posture is imaged for a preset time before and after the moment of impact.

[00158] The landing point prediction apparatus may generate posture analysis information of the player based on the third image set and a preset swing standard image set.

[00159] In operation 1330, the landing point prediction apparatus may generate an estimated trajectory of the golf ball based on the input information and the image set.

[00160] The landing point prediction apparatus may calculate at least one of i) a speed of the golf ball and a speed of the head of the golf club at the time of impact, ii) an angle of the surface of the head that touches the golf ball with respect to the ground at the time of impact and an angle of an initial path of the golf ball with respect to the ground at the time of impact, iii) an angle of the surface of the head contacting the golf ball with respect to a target direction at the time of impact and an angle of the initial path of the golf ball with respect to the target direction at the time of impact, and iv) a rotation rate of the golf ball, using the image set.

[00161] The landing point prediction apparatus may generate an estimated trajectory based on the calculation.

[00162] According to an embodiment, the landing point prediction apparatus may generate the estimated trajectory by inputting the image set into the pre-trained trajectory estimation model and acquiring the 3D coordinate information of the golf ball over time.

[00163] According to another embodiment, the landing point prediction apparatus may generate the estimated trajectory by calculating at least one of a speed of the golf ball at the time of impact, an angle of the initial path of the golf ball with respect to the ground at the time of impact, an angle of the initial path of the golf ball with respect to a target direction at the time of impact, a rotation rate of the golf ball, and a rotation axis of the golf ball using the image set, inputting the calculated value into the pre-trained trajectory estimation model, and acquiring the 3D coordinate information of the golf ball over time.

[00164] In operation 1340, the landing point prediction apparatus may generate estimated landing point information of the golf ball based on the estimated trajectory.

[00165] The landing point prediction apparatus may reproduce a golf course in a 3D virtual space based on the 3D terrain information.

[00166] The landing point prediction apparatus may generate final estimated location information at which the golf ball will stop after landing, based on the reproduced virtual space, golf course information, and estimated landing point information.

[00167] Meanwhile, the landing point prediction apparatus may generate the estimated landing point information by mapping the 3D coordinate information of the golf ball to the virtual space.

[00168] The landing point prediction apparatus may generate a recommended movement path of the golf cart based on the final estimated location information and the 3D terrain information.

[00169] The landing point prediction apparatus may determine a strategy included in a preset strategy database for each terrain based on the final estimated location information and 3D terrain information.

[00170] The landing point prediction apparatus may determine first interest information for generating a first interface displaying at least one of the input information, the estimated trajectory, and the estimated landing point information.

[00171] The landing point prediction apparatus may determine second interest information for generating a second interface displaying comparison information generated based on the past swing information and the current swing information. Here, the past swing information may be related to a swing performed by a player who hit the golf ball in the past, may include information to be compared to a swing currently performed by the player, and the current swing information may be generated based on the input information and the image set.

[00172] According to an embodiment, at least one of the first interface and the second interface may be displayed on the user terminal. The user terminal may include at least one of a personal device used by a player and a common device used by a player group. In this case, the player group may include players. Meanwhile, the first interface may further display a location of the golf ball relative to a location of the user terminal.

[00173] A personal device according to an embodiment may include a wearable device worn on the body, and a common device according to an embodiment may include a device provided in a golf cart. At least one of the first interface and the second interface may display information related to the player when displayed on the personal device, and display every information related to each member included in the player group when displayed on the common device.

[00174] An embodiment according to the present disclosure may be implemented in the form of a computer program that may be executed on a computer through various components, and such a computer program may be recorded on a computer-readable medium. Here, the medium may include magnetic mediums, such as hard disks, floppy

disks, and magnetic tapes, optical mediums, such as CD-ROMs and DVDs, magneto-optical mediums, such as floptical disks, and hardware devices specifically configured to store and execute program commands, such as ROMs, RAMs, and flash memories, etc.

[00175] Meanwhile, the computer program may be specially designed and configured for the present disclosure, or may be known and usable to those skilled in the art of computer software. Examples of the computer program may include not only machine language code generated by a compiler but also high-level language code that may be executed by a computer using an interpreter or the like.

[00176] According to an embodiment, the methods according to various embodiments of the present disclosure may be included and provided in computer program products. The computer program products may be traded between sellers and buyers, as commodities. The computer program products may be distributed in the form of a device-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or may be distributed (e.g., downloaded or uploaded) directly online through an application store (e.g., Play Store™) or between two user devices. In the case of online distribution, at least part of the computer program products may be temporarily stored or temporarily generated in a device-readable storage medium, such as a manufacturer's server, an application store's server, or a relay server's memory.

[00177] Unless an order is explicitly stated or stated to the contrary for steps forming a method according to the present disclosure, the steps may be performed in a proper order. The present disclosure is not necessarily limited to the order of description of the steps. The use of all examples or illustrative terms (e.g., etc.) in this disclosure is simply to describe the present disclosure in detail, and the scope of the present disclosure is not limited due to the examples or illustrative terms unless limited by the claims. In addition, those skilled in the art may appreciate that various modifications, combinations, and changes may be made according to design conditions and factors within the scope of the appended claims or equivalents thereof.

[00178] Therefore, the spirit of the present disclosure should not be limited to the aforementioned embodiments, and all ranges equivalent to or equivalently changed from the claims, as well as the claims described below, are within the scope of the spirit of the present disclosure.

WHAT IS CLAIMED IS:

1. A method for predicting a landing point of a golf ball, the method comprising:

acquiring input information including golf club information and golf course information;

acquiring an image set in which a swing scene is imaged for a preset time before and after a moment of impact;

generating an estimated trajectory of a golf ball based on the input information and the image set; and

generating estimated landing point information of the golf ball based on the estimated trajectory.

2. The method of claim 1, wherein the image set includes a first image set of a golf club and a second image set of a golf ball.

3. The method of claim 1, wherein

the generating of the estimated trajectory includes:

calculating at least one of i) a speed of the golf ball and a speed of the head of the golf club at the time of impact, ii) an angle of the surface of the head that touches the golf ball with respect to the ground at the time of impact and an angle of an initial path of the golf ball with respect to the ground at the time of impact, iii) an angle of the surface of the head contacting the golf ball with respect to a target direction at the time of impact and an angle of the initial path of the golf ball with respect to the target direction at the time of impact, and iv) a rotation rate of the golf ball using the image set; and

generating the estimated trajectory based on the calculation.

4. The method of claim 1, wherein the golf club information includes at least one of a type of a golf club, a manufacturer of the golf club, and a seller of the golf club.

5. The method of claim 1, wherein

the input information further includes player information including at least one of a player's name, age, and sex,

wherein the method further comprises generating tee shot location information for each player based on the player information.

6. The method of claim 1, wherein

the input information further includes player information including at least one of the player's name, age, and sex, and

the image set includes a third image set in which a swing posture of the player is imaged for a preset time before and after the movement of impact,

wherein the method further comprises:

generating posture analysis information of the player based on the third image set and a preset swing standard image set.

7. The method of claim 1, wherein the golf course information includes at least one of 3D terrain information of the golf course, temperature, humidity, wind speed, and wind direction of the golf course.

8. The method of claim 7, further comprising:

reproducing the golf course in a three-dimensional (3D) virtual space based on the 3D terrain information; and

generating final estimated location information at which the golf ball will stop after the landing, based on the reproduced virtual space, the golf course information, and the estimated landing point information.

9. The method of claim 8, wherein the generating the estimated trajectory includes generating the estimated trajectory by inputting the image set to a pre-trained trajectory estimation model and acquiring 3D coordinate information of the golf ball over time.

10. The method of claim 8, wherein the generating of the estimated trajectory includes:

calculating at least one of a speed of the golf ball at the time of impact, an angle of the initial path of the golf ball with respect to the ground at the time of impact, an angle of the initial path of the golf ball with respect to a target direction at the time of impact, a rotation rate of the golf ball, and a rotation axis of the golf ball by using the image set; and

generating the estimated trajectory by inputting the calculated value into the pre-trained trajectory estimation model and acquiring the 3D coordinate information of the golf ball over time.

11. The method of claim 9 or 10, wherein the generating of the estimated landing point information includes generating the estimated landing point information by mapping the 3D coordinate information to the virtual space.

12. The method of claim 8, further comprising generating a recommended movement path of a golf cart based on the final estimated location information and the 3D terrain information.

13. The method of claim 8, further comprising determining a strategy included in a preset strategy database for each terrain based on the final estimated location information and the 3D terrain information.

14. The method of claim 1, further comprising determining first interest information for generating a first interface displaying at least one of the input information, the estimated trajectory, and the estimated landing point information.

15. The method of claim 14, further comprising:

determining second interest information for generating a second interface displaying comparison information generated based on past swing information and current swing information,

wherein the past swing information is related to a swing performed by a player who hit the golf ball in the past and includes information to be compared with a swing currently performed by the player,

wherein the current swing information is generated based on the input information and the image set.

16. The method of claim 15, wherein

at least one of the first interface and the second interface is displayed on a user terminal, and

the user terminal includes at least one of a personal device used by the player and a common device used by a player group,

wherein the player group includes the player.

17. The method of claim 16, wherein the personal device includes a wearable device that can be worn on a body, and the common device includes a device mounted on a golf cart.

18. The method of claim 16, wherein the first interface further displays a location of the golf ball with respect to a location of the user terminal.

19. The method of claim 16, wherein

at least one of the first interface and the second interface, when displayed on the personal device, displays display information related to the player, and

when displayed on the common device, displays all information related to each member included in the player group.

20. An apparatus for predicting a landing point of a golf ball, the apparatus comprising:

a memory storing at least one program; and

a processor operating by executing the at least one program,

wherein

the processor is configured to acquire input information including golf club information and golf course information, acquire an image set in which a swing scene is imaged for a preset time before and after a moment of impact, generate an estimated trajectory of a golf ball based on the input information and the image set, and generate estimated landing point information of the golf ball based on the estimated trajectory.

21. A computer-readable recording medium in which a program for executing the method of claim 1 on a computer is recorded.