GOLF SWING CLASSIFICATION METHOD, CLASSIFICATION SYSTEM, CLASSIFICATION APPARATUS, AND NON-TRANSITORY COMPUTER-READABLE STORAGE MEDIUM WITH PROGRAM RECORDED THEREON

Applicants: Takashi SAITO, Kodaira-shi (JP); Koji TAKAO, Kodaira-shi (JP); Hideo MATSUNAGA, Chichibu-shi (JP); Hirotada IWANAYE, Chichibu-shi (JP)

Inventors: Takashi SAITO, Kodaira-shi (JP); Koji TAKAO, Kodaira-shi (JP); Hideo MATSUNAGA, Chichibu-shi (JP); Hirotada IWANAYE, Chichibu-shi (JP)

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ABSTRACT

The method according to the present invention includes a step of dividing a golfer's golf swing into three golf swing trajectories, namely a backswing, downswing, and follow through, and allocating each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as the origin; a step of establishing, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and calculating an angle enclosed between each established line and the horizontal axis; and a step of calculating an angular difference between any two angles among the calculated angles, plotting the angular difference on a 2D map, and classifying the golf swing.
FIG. 1
FIG. 5
FIG. 6

Tendency to slice vs. Tendency to hook

- Advanced tier
- Highly advanced tier
- Average tier

Legend:
- □ Male pro
- ○ Female pro
- △ Male amateur
- × Female amateur

θ_{back} - θ_{down} [deg.]

Less lag → More lag
Acquire golf swing trajectories, allocate to coordinate system

Calculate features

Plot features on a 2D map

Display classification results

End
GOLF SWING CLASSIFICATION METHOD, CLASSIFICATION SYSTEM, CLASSIFICATION APPARATUS, AND NON-TRANSITORY COMPUTER-READABLE STORAGE MEDIUM WITH PROGRAM RECORDED THEREON

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on an application No. 2012-093721 filed in Japan on Apr. 17, 2012, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

[0002] The present invention relates to a golf swing classification method, a classification system, a classification apparatus, and a non-transitory computer-readable storage medium with a program recorded thereon.

BACKGROUND ART

[0003] In general, when a golfer swings a golf club and hits a golf ball (takes a shot) while intending for the ball to fly straight, the direction in which the ball flies is ideally relatively straight, without curving (or only curving slightly). By using an appropriate golf club, golfers can make such an ideal shot relatively easily. It is not easy, however, for a golfer to actually visit a store and select a golf club that is a good match.

[0004] Research has therefore been made into a golf club design method that yields the characteristics and shape of a club optimal for a golfer's swing (for example, see Patent Literature 1). According to Patent Literature 1, not only static properties such as length of the golf shaft (hereinafter simply referred to as the “shaft”), balance, club weight, shaft hardness, and the like, but also torsional stiffness, the moment of inertia of the head, center of gravity, shape (for example, loft angle and lie angle) and the like are golf club design factors that affect the head speed, the angle at which the golf ball (hereinafter referred to as the “ball”) begins to fly, the spin amount, and hitability. These factors are considered to be important for carry and directionality.

[0005] Furthermore, a golf club selection method has been proposed to select a golf club by, for example, acquiring information on the vertical movement direction of the golf club head with respect to the horizontal plane immediately before hitting (impacting) a golf ball during a golf swing, as well as information on the horizontal movement direction of the golf club head in a plane parallel to the horizontal plane immediately before golf ball impact. These pieces of information are then used to classify the golf swing into a predetermined type and to select a golf club in accordance with the classification (for example, see Patent Literature 2).

CITATION LIST

Patent Literature

[0006] PTL 1: JP6210027A
[0007] PTL 2: JP201046539A

SUMMARY OF INVENTION

[0008] However, even if a golf club design method is established to yield the characteristics and shape of a club optimal for each golfer's swing using a variety of parameters as indicated in Patent Literature 1, it would require a long time to design a custom golf club. Therefore, a golfer cannot visit a store to select and evaluate a golf club that is a good match.

[0009] Even when using the classification method indicated in Patent Literature 2 as a method for a relatively simple classification of a golf swing type, classification is made based on information such as the direction of the golf club head immediately before impact, without taking into account whatsoever information on the swing up to a point near the impact. Therefore, the accuracy of classification has room for improvement.

[0010] In particular, it is an object of the present invention to provide a golf swing classification method, a classification system, a classification apparatus, and a program that can accurately classify a golf swing.

[0011] In order to achieve the above object, a classification method according to an aspect of the present invention is a method for classifying a golf swing of a golfer hitting a golf ball with a golf club, comprising the steps of: (a) dividing the golfer's golf swing into three golf swing trajectories and allocating each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through; (b) establishing, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and calculating an angle enclosed between each established line and the horizontal axis; and (c) calculating an angular difference between any two angles among the calculated angles, plotting the calculated angular difference on a 2D map, and classifying the golf swing based on the 2D map.

[0012] In the classification method according to an aspect of the present invention, in step (c), the angular difference between the angle for the backswing and the angle for the downswing and the angular difference between the angle for the follow through and the angle for the downswing are preferably plotted on the 2D map, and the golf swing is classified based on the 2D map.

[0013] In order to achieve the above object, a classification system according to an aspect of the present invention is a system for classifying a golf swing of a golfer hitting a golf ball with a golf club, comprising: a camera configured to capture an image of the golfer's golf swing; and a classification apparatus configured to analyze and classify the captured golf swing, wherein the classification apparatus comprises: a measurement unit configured to divide the golfer's golf swing into three golf swing trajectories and to allocate each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through; a feature extraction unit configured to establish, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and to calculate an angle enclosed between each established line and the horizontal axis; and a classification unit configured to calculate an angular difference between any two angles among the calculated angles, to plot the calculated angular difference on a 2D map, and to classify the golf swing based on the 2D map.

[0014] In order to achieve the above object, a classification apparatus according to an aspect of the present invention is an apparatus for analyzing and classifying a golf swing of a
golfer hitting a golf ball with a golf club, comprising: a measurement unit configured to divide the golfer’s golf swing into three golf swing trajectories and to allocate each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through; a feature extraction unit configured to establish, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and to calculate an angle enclosed between each established line and the horizontal axis; and a classification unit configured to calculate an angular difference between any two angles among the calculated angles, to plot the calculated angular difference on a 2D map, and to classify the golf swing based on the 2D map.

In order to achieve the above object, a program according to an aspect of the present invention is a program for causing a computer, constituting a classification apparatus for analyzing and classifying a golf swing of a golfer hitting a golf ball with a golf club, to perform the steps of: (a) dividing the golfer’s golf swing into three golf swing trajectories and allocating each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through; (b) establishing, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and calculating an angle enclosed between each established line and the horizontal axis; and (c) calculating an angular difference between any two angles among the calculated angles, plotting the calculated angular difference on a 2D map, and classifying the golf swing based on the 2D map.

According to the present invention, it is possible to accurately classify a golfer’s golf swing.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be further described below with reference to the accompanying drawings, wherein:

FIG. 1 illustrates a golf swing classification system according to an embodiment of the present invention;

FIG. 2 is a functional block diagram schematically illustrating the structure of an analysis apparatus in the system shown in FIG. 1;

FIG. 3 illustrates an example of a golf club used in the system shown in FIG. 1;

FIG. 4 illustrates a golf swing;

FIG. 5 illustrates an example of measurement results with the system shown in FIG. 1;

FIG. 6 illustrates an example of classification results with the system shown in FIG. 1; and

FIG. 7 is a flowchart illustrating the golf swing classification method according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

The golf swing classification system according to an embodiment of the present invention will be described with reference to the drawings. The classification method, classification system, classification apparatus, and program according to the present invention will become clear from the explanation of the golf swing classification system according to the embodiment of the present invention.

FIG. 1 illustrates the golf swing classification system according to the embodiment of the present invention. A golf swing classification system 1 illustrated in FIG. 1 is provided with a first camera 2A and a second camera 2B, which are image pickup apparatuses for capturing images (video) of a golf swing of a golfer hitting a golf ball with a golf club, and an analysis apparatus 3 for analyzing and classifying golf swing trajectories based on the acquired images. The analysis apparatus 3 constitutes a classification apparatus.

The first camera 2A and the second camera 2B film a golf swing by a subject (golfer) 4. The first camera 2A and the second camera 2B are separated by a predetermined interval to allow for capturing of video for 3D measurement of a golf swing trajectory. The interval between the first camera 2A and the second camera 2B is preferably fixed so that after capturing of a golf swing video by the first camera 2A and the second camera 2B, the relative positions between the first camera 2A and the second camera 2B can be easily calculated in order to facilitate 3D measurement of the golf swing trajectory.

In order to film a golf swing by the subject 4, the first camera 2A and the second camera 2B are placed at an appropriate distance from the subject 4 to allow for filming while the golf club used by the subject 4 is in each stage of the swing (backswing, downswing, and follow through (details are provided below with reference to FIG. 4)). As described above, the interval between the first camera 2A and the second camera 2B is preferably fixed. Therefore, swing trajectories measured in the same plane can be compared even if the interval between the subject 4 and the first and second cameras 2A and 2B is appropriately adjusted for factors such as the height and body build of the subject. This is because the disparity is constant due to the fixed interval between the first camera 2A and the second camera 2B, making conversion from a camera coordinate system to a world coordinate system easy.

The center position of the golf ball (not illustrated) hit by the subject 4 is treated as the origin. For clarity, FIG. 1 shows the X, Y, and Z axes, described below, shifted forward from their original position with respect to the subject 4. The axis passing vertically through the origin (vertical axis) is the Z axis. The axis that passes through the origin, is perpendicular to, for example, a line connecting the shoulders of the subject 4, and that extends horizontally (horizontal axis) is the X axis. Finally, the axis that passes through the origin and is perpendicular to both the X and Z axes is the Y axis. Note that the direction of the Y axis roughly corresponds to the direction in which the ball is hit by the golf swing. The position of the origin is not limited to the center position of the golf ball, but rather may be any given point on the below-described golf swing trajectories. Here, “(any) given point on the golf swing trajectories” in the present description refers to (any) given point in a 2D coordinate space on which the golf swing trajectories are projected.

FIG. 2 is a functional block diagram schematically illustrating the analysis apparatus 3. The analysis apparatus 3 is provided with a calculation unit 6 that acquires a golf swing video from the first camera 2A and the second camera 2B via interfaces (1/F) 5A and 5B and performs calculations, a control unit 7 that controls the entire analysis apparatus 3, a display unit 8 that displays results of calculations by the calculation unit 6 and video captured by the first camera 2A and the second camera 2B, and a database 9 that stores the
results of calculations by the calculation unit 6. Furthermore, the calculation unit 6 is provided with a measurement unit 10, a feature extraction unit 11, and a classification unit 12.

[0031] The measurement unit 10 divides a golfer's golf swing into three golf swing trajectories, namely a backswinging, downswinging, and follow through, and allocates each golf swing trajectory to a 2D coordinate system formed by a horizontal and a vertical axis with a given point among the golf swing trajectories as the origin.

[0032] For each of the three golf swing trajectories, the feature extraction unit 11 establishes a line connecting the origin and a point selected in the golf swing trajectory and calculates an angle enclosed between each established line and the horizontal axis.

[0033] The classification unit 12 calculates an angular difference between any two angles among the angles calculated by the feature extraction unit 11, plots the calculated angular difference on a 2D map, and classifies the golf swing based on the 2D map. The classification unit 12 preferably creates the 2D map based on the angular difference between the angle for the backswing and the angle for the downswing and on the angular difference between the angle for the follow through and the angle for the downswing calculated by the feature extraction unit 11 and classifies the golf swing based on the 2D map.

[0034] FIG. 3 illustrates an example of a golf club used in the golf swing classification system according to the embodiment of the present invention. The subject 4 shown in FIG. 1 swings a golf club 13 (hereinafter referred to as a “measurement club”). The first camera 2A and the second camera 2B capture video of the swing. The measurement club 13 includes a tracking marker 14 on a shaft 15 near a golf club head 16, which is the portion that hits the golf ball. The affixed marker is, for example, white reflective tape, a spherical marker, a reflective marker, or the like. By filming a golf swing against a black background, the trajectory of the marker 14 can easily be tracked by image processing. Even if the first camera 2A and the second camera 2B are, for example, positioned behind the subject 4, affixing the marker 14 near the golf club head reduces the period of time in which the marker 14 is blocked by the subject 4 and cannot be filmed.

[0035] FIG. 4 illustrates a golf swing. In this explanation, a golf swing is divided into three stages: a backswinging, a downswinging, and a follow through. FIG. 4(a) shows the backswing, the stage in which the subject 4 raises the measurement club backwards. Next, FIG. 4(b) shows the downswing, the stage in which the measurement club is raised by the backswing (FIG. 4(a)) is swung down to hit (impact) the golf ball. Finally, FIG. 4(c) shows the follow through stage of the measurement club after hitting the golf ball. After the follow through, the swing ends in a finish position.

[0036] FIG. 5 illustrates an example of measurement results with the system shown in FIG. 1. The dashed line indicates the trajectory of the backswing, the alternate long and short dash line indicates that of the downswing, and the solid line indicates that of the follow through. The center position of the golf ball (hereinafter referred to as the “impact position”) corresponding to the origin in FIG. 1) included in these golf swing trajectories is the given point taken as the origin of the 2D coordinate system. The vertical axis corresponds to the Z axis shown in FIG. 1 and indicates the distance from the impact position, with the impact position being 0 m. The forward direction from the perspective of the golfer (subject) is a positive value, and the backward direction is a negative value. The position of the marker when the golfer swings the measurement club shown in FIG. 2 is plotted on this plane to generate a trajectory distribution. Note that as shown in FIG. 3, in the present embodiment, the marker is affixed to the shaft near the head of the measurement club, making it difficult for the marker to be ahead of the impact position. Accordingly, the probability of the value along the horizontal axis being positive is low.

[0037] Below, a method of extracting features, which serve as indices for classifying the golf swing trajectory, in the feature extraction unit 11 of the analysis apparatus 3 will be described. The inventors discovered that (i) the difference between the angles enclosed by the horizontal axis and lines connecting the impact position with a point on each of the follow through and the downswing trajectories and (ii) the difference between the angles enclosed by the horizontal axis and lines connecting the impact position with a point on each of the backswing and the downswing trajectories are useful indices for classifying a golf swing. Instead of using a spatial position on the golf swing trajectory, this approach of calculating the angles enclosed by the horizontal axis (X axis) and lines between the origin and a point on each of the three golf swing trajectories and using the angular differences between these angles as classification indices allows for classification of a golf swing while excluding the effects of differences in subject height and the like.

[0038] To calculate these indices, first the impact point is taken as the reference for the origin, any point on the follow through trajectory (for example, the marker position on the trajectory at approximately +1 m along the horizontal axis from the impact position) and the origin are connected by a line, and the angle enclosed by the line and the horizontal axis is calculated. The resulting value is $\theta_{\text{follow}}$. The same calculation is made for the downswing and the backswing trajectories, and the calculated angles are respectively $\theta_{\text{down}}$ and $\theta_{\text{back}}$. If $\theta_{\text{down}}$ is larger than $\theta_{\text{follow}}$, the ball tends to have hook spin. Due to hook spin, the ball curves to the left in the direction of travel. A golf swing that imparts hook spin to the golf ball is a golf swing executed with the golf club raised. By contrast, if $\theta_{\text{down}}$ is larger than $\theta_{\text{follow}}$, the ball tends to have slice spin. Due to slice spin (outwards), the ball curves to the right in the direction of travel. A golf swing that imparts slice spin to the golf ball is a golf swing executed with the golf club only slightly raised.

[0039] As $\theta_{\text{back}}$ is increasingly larger than $\theta_{\text{down}}$, the amount of so-called “lag” increases. Here, “lag” refers to addition of a “cock angle” during the downswing. A “cock angle” is the angle between the golfer's arm and the golf club and changes depending on factors such as the wrists returning during the golf swing. When “lag” occurs, the downswing trajectory becomes lower than the backswing trajectory, causing the value yielded by subtracting $\theta_{\text{down}}$ from $\theta_{\text{back}}$ to be positive.

[0040] In this way, valuable information for classifying the type of golf swing can be obtained based on the mutual relationships between $\theta_{\text{down}}$, $\theta_{\text{follow}}$, and $\theta_{\text{back}}$. Note that the given point does not have to be the impact position, but rather any established point other than the impact point (the center position of the golf ball) may be the origin, and the above calculations may be made using that point as a reference.
FIG. 6 illustrates an example of classification results with the system shown in FIG. 1. FIG. 6 is a 2D map with the values of the features described with reference to FIG. 5, i.e., the difference between $\theta_{\text{follow}}$ and $\theta_{\text{down}}$ ($\theta_{\text{follow}} - \theta_{\text{down}}$) and the difference between $\theta_{\text{back}}$ and $\theta_{\text{down}}$ ($\theta_{\text{back}} - \theta_{\text{down}}$), respectively on the vertical and horizontal axes. In this 2D map, the region labeled "highly advanced tier" is a region with considerable lag and corresponds to a golf swing with a relatively strong tendency to hook. The region labeled "advanced tier" is a region with little lag and corresponds to a golf swing with a relatively weak tendency to hook. The region labeled "average tier" is a region with little lag and corresponds to a golf swing with a relatively strong tendency to slice.

The "$\theta_{\text{follow}} - \theta_{\text{down}}$" value and the "$\theta_{\text{back}} - \theta_{\text{down}}$" value calculated for multiple male professional golfers (male pros), female professional golfers (female pros), male amateur golfers (male amateurs), and female amateur golfers (female amateurs) are plotted on this sort of chart. By such plotting, the classification unit 12 of the analysis apparatus 3 clearly shows the tier, within the 2D map, into which a golf swing is classified.

FIG. 7 is a flowchart illustrating the golf swing classification method according to the embodiment of the present invention. The measurement unit 10 acquires information on the golf swing trajectories from data acquired by the first camera 2A and the second camera 2B and allocates the golf swing trajectories to a coordinate system (S1). Based on the method described with reference to FIG. 5, the feature extraction unit 11 calculates features (S2). Specifically, the feature extraction unit 11 calculates the "$\theta_{\text{follow}} - \theta_{\text{down}}$" value and the "$\theta_{\text{back}} - \theta_{\text{down}}$" value. The classification unit 12 plots the features calculated in step S2 on a 2D map like the one in FIG. 6 (S3). The control unit 7 can preferably display the golf swing type classified by the plot in step S3 on the display unit 8 (S4). Furthermore, the database 9 may store a plurality of pieces of measured data (for multiple male and female pros and male and female amateurs) each in association with predetermined information on the optimal golf club for each individual. In this case, the information on the golf club appropriate for the classified golf swing can be displayed along with the classification results in step S4.

The control unit 7 preferably stores the classification class extracted by clustering by the classification unit 12 in the database 9. In this way, each function block included in the calculation unit 6 performs calculations on at least a predetermined number of pieces of data and stores the results of calculation in the database 9 to gradually build up the database.

According to the present embodiment, it is thus possible to classify a golf swing trajectory accurately. Based on the classification results, a candidate golf club appropriate for the subject is preferably presented in order to provide an index for the subject to select an optimal golf club.

Furthermore, as an aspect of the present invention, the analysis apparatus 3 may be constituted by a computer. A program for causing the computer to function as this apparatus is stored on a storage unit internal or external to the computer. The storage unit may be achieved by an external storage device, such as an external hard disk, or an internal storage device, such as read only memory (ROM) or random access memory (RAM). The computer functioning as the above-described apparatus may be achieved by control of a central processing unit (CPU) or the like. Specifically, the CPU reads the program, which describes processes for achieving the functions of the constituent elements, from the storage unit as necessary and causes the functions of the constituent elements to be achieved on the computer. Here, the functions of the constituent elements may be achieved by a portion of hardware.

Furthermore, the program describing these processes may be distributed by sale, transfer, loan, or the like of a non-transitory computer-readable storage medium, for example a Digital Versatile Disc (DVD), CD-ROM, or the like, or the program may be distributed by being stored on a storage unit in a server on a network, for example, and transferred from the server to another computer over the network.

A computer executing such a program may temporarily store, in its own storage unit, a program recorded on a non-transitory computer-readable storage medium or a program transferred from a server, for example. Moreover, as another embodiment of this program, the computer may read the program directly from a non-transitory computer-readable storage medium and perform processing in accordance with the program, or each time the program is transferred to the computer from a server, the computer may perform processing in accordance with the successively received program.

While an embodiment of the present invention has been described, a variety of modifications may be made within the scope of the present invention. For example, in the above embodiment, filming is performed in stereo using the first camera 2A and the second camera 2B in order to increase measurement accuracy, but alternatively, cameras placed in front of the subject 4 may perform regular, non-stereo filming, and the golf swing trajectories may be acquired by 2D measurement.

REFERENCE SIGNS LIST

1: Classification system
2: Camera
3: Analysis apparatus
4: Subject
5: Interface
6: Calculation unit
7: Control unit
8: Display unit
9: Database
10: Measurement unit
11: Feature extraction unit
12: Classification unit
13: Measurement club
14: Marker
15: Shaft
16: Golf club head

1. A method for classifying a golf swing of a golfer hitting a golf ball with a golf club, comprising the steps of:
   (a) dividing the golfer’s golf swing into three golf swing trajectories and allocating each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through;
   (b) establishing, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and calculating an angle enclosed between each established line and the horizontal axis; and
(c) calculating an angular difference between any two angles among the calculated angles, plotting the calculated angular difference on a 2D map, and classifying the golf swing based on the 2D map.

2. The method according to claim 1, wherein in step (c), the angular difference between the angle for the backswing and the angle for the downswing and the angular difference between the angle for the follow through and the angle for the downswing are plotted on the 2D map, and the golf swing is classified based on the 2D map:

3. A system for classifying a golf swing of a golfer hitting a golf ball with a golf club, comprising:
   a classification apparatus configured to analyze and classify the captured golf swing, wherein
   the classification apparatus comprises:
   a measurement unit configured to divide the golfer’s golf swing into three golf swing trajectories and to allocate each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through;
   a feature extraction unit configured to establish, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and to calculate an angle enclosed between each established line and the horizontal axis; and
   a classification unit configured to calculate an angular difference between any two angles among the calculated angles, to plot the calculated angular difference on a 2D map, and to classify the golf swing based on the 2D map.

4. An apparatus for analyzing and classifying a golf swing of a golfer hitting a golf ball with a golf club, comprising:
   a measurement unit configured to divide the golfer’s golf swing into three golf swing trajectories and to allocate each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through;
   a feature extraction unit configured to establish, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and to calculate an angle enclosed between each established line and the horizontal axis; and
   a classification unit configured to calculate an angular difference between any two angles among the calculated angles, to plot the calculated angular difference on a 2D map, and to classify the golf swing based on the 2D map.

5. A non-transitory computer-readable storage medium having recorded thereon a program for causing a computer, constituting a classification apparatus for analyzing and classifying a golf swing of a golfer hitting a golf ball with a golf club, to perform the steps of:
   (a) dividing the golfer’s golf swing into three golf swing trajectories and allocating each golf swing trajectory to a 2D coordinate system formed by a horizontal axis and a vertical axis with a given point among the golf swing trajectories as an origin, the golf swing trajectories being a backswing, a downswing, and a follow through;
   (b) establishing, for each of the three golf swing trajectories, a line connecting the origin and a point selected in the golf swing trajectory and calculating an angle enclosed between each established line and the horizontal axis; and
   (c) calculating an angular difference between any two angles among the calculated angles, plotting the calculated angular difference on a 2D map, and classifying the golf swing based on the 2D map.