



US 20050153785A1

(19) **United States**

(12) **Patent Application Publication**
Sun

(10) **Pub. No.: US 2005/0153785 A1**

(43) **Pub. Date: Jul. 14, 2005**

(54) **AUTOMATIC INSTANT VIDEO REPLAY APPARATUS SYSTEM FOR SPORTING**

Publication Classification

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(51) **Int. Cl.⁷ A63B 67/02**

(52) **U.S. Cl. 473/151**

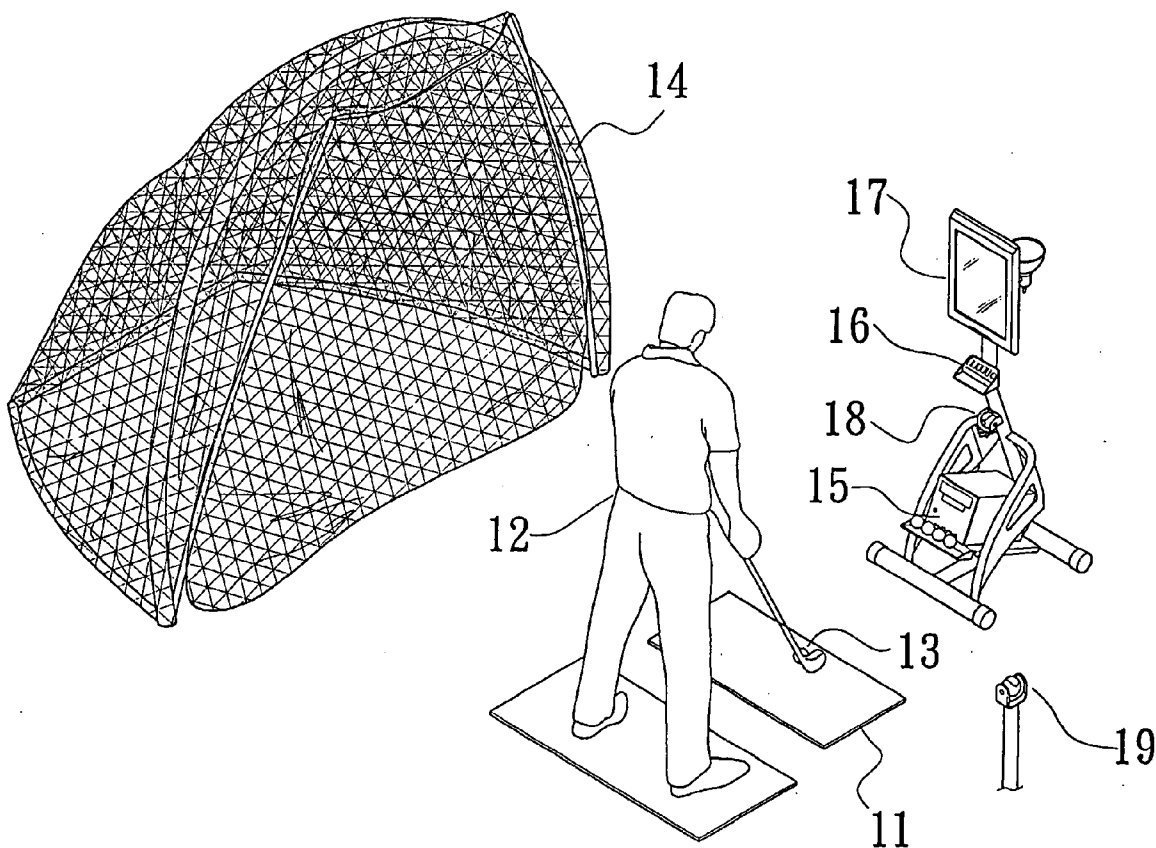
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(57) **ABSTRACT**

An automatic instant video replay apparatus system for sporting, which relates to a computerized video recording and automatic instant replay apparatus system, can be used for providing instant video visualization of a golfer's swing at home, at golf driving ranges, and at outdoor natural grass, and for other sport activities.

(21) **Appl. No.: 10/756,264**

(22) **Filed: Jan. 14, 2004**



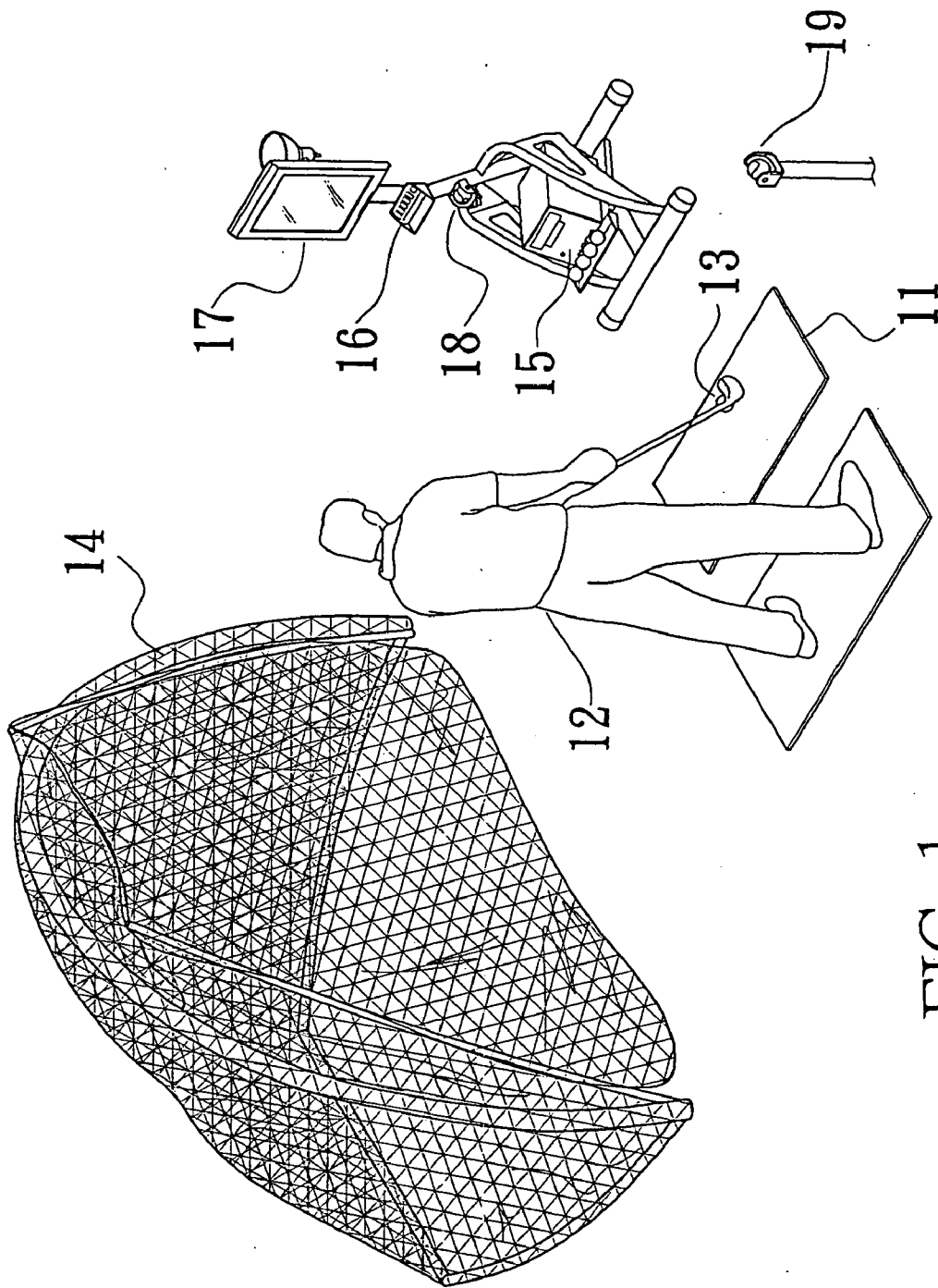


FIG. 1

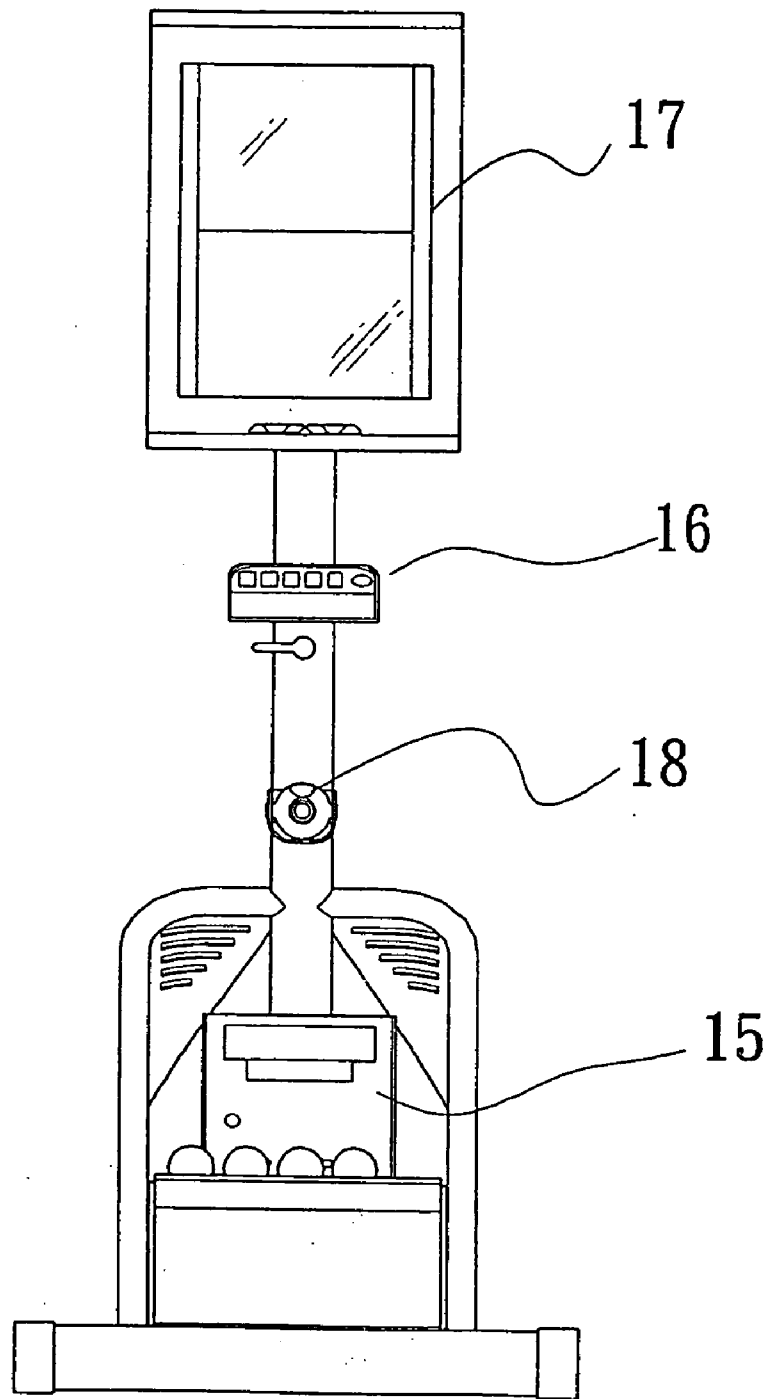


FIG. 2

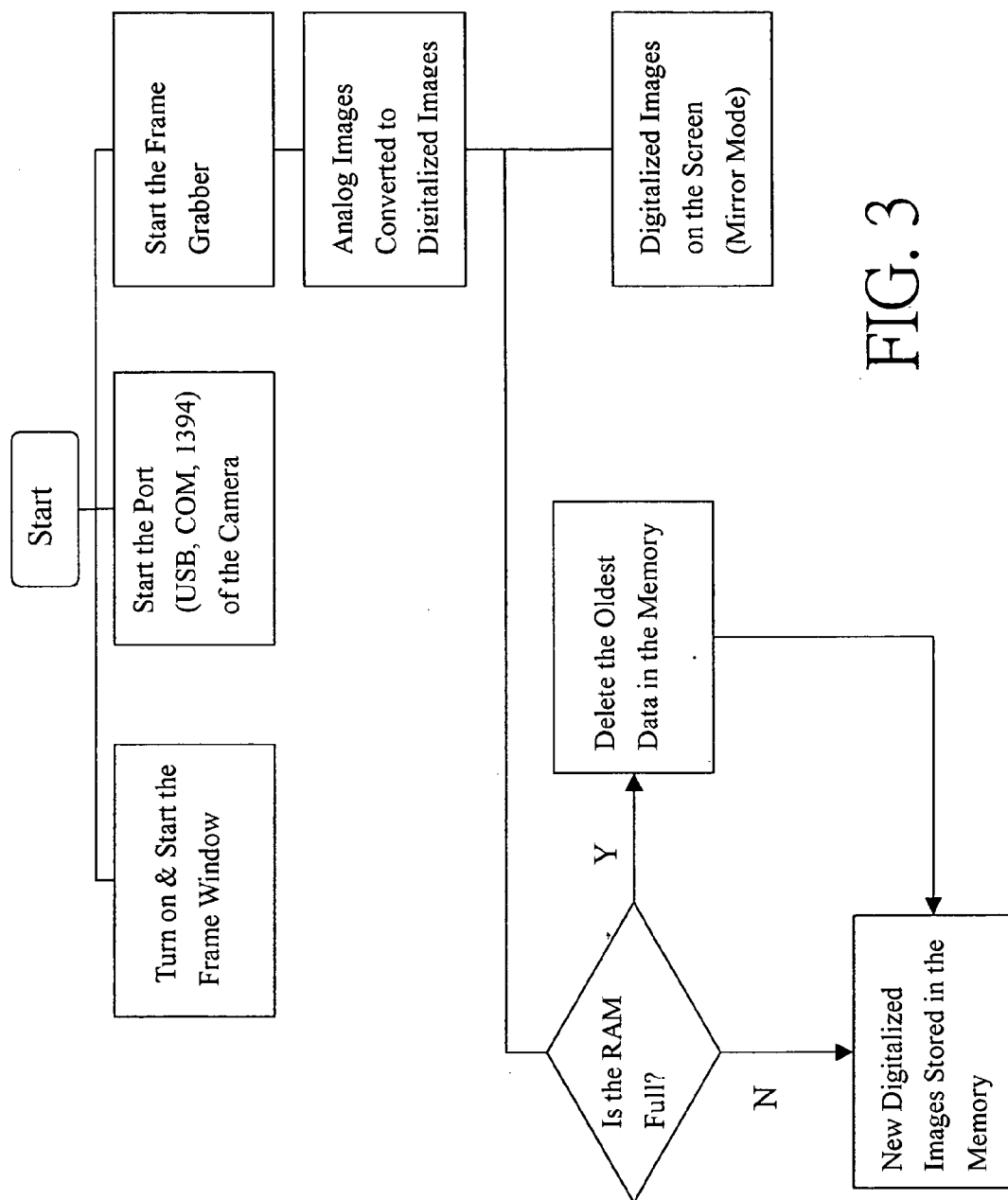


FIG. 3

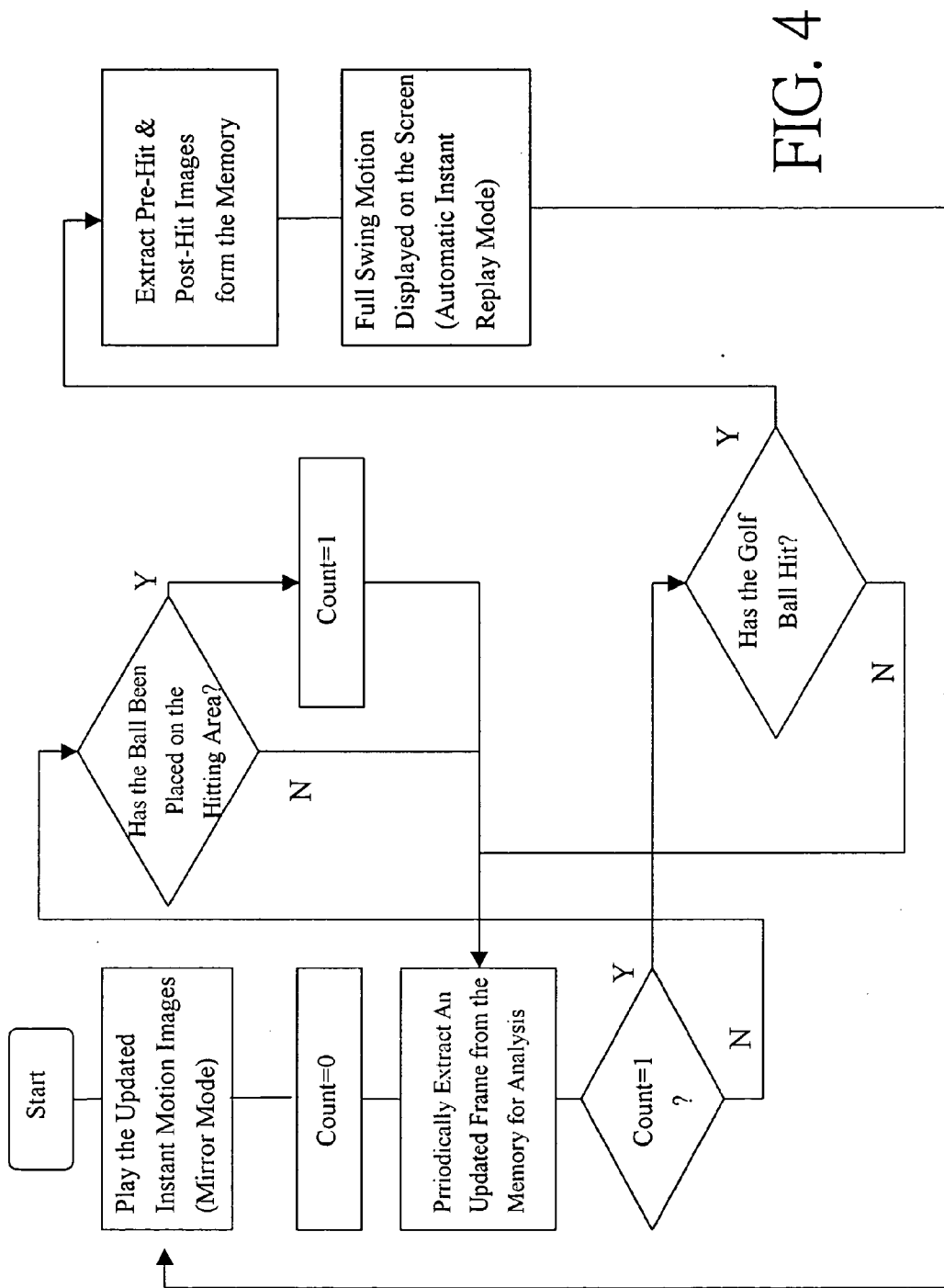


FIG. 4

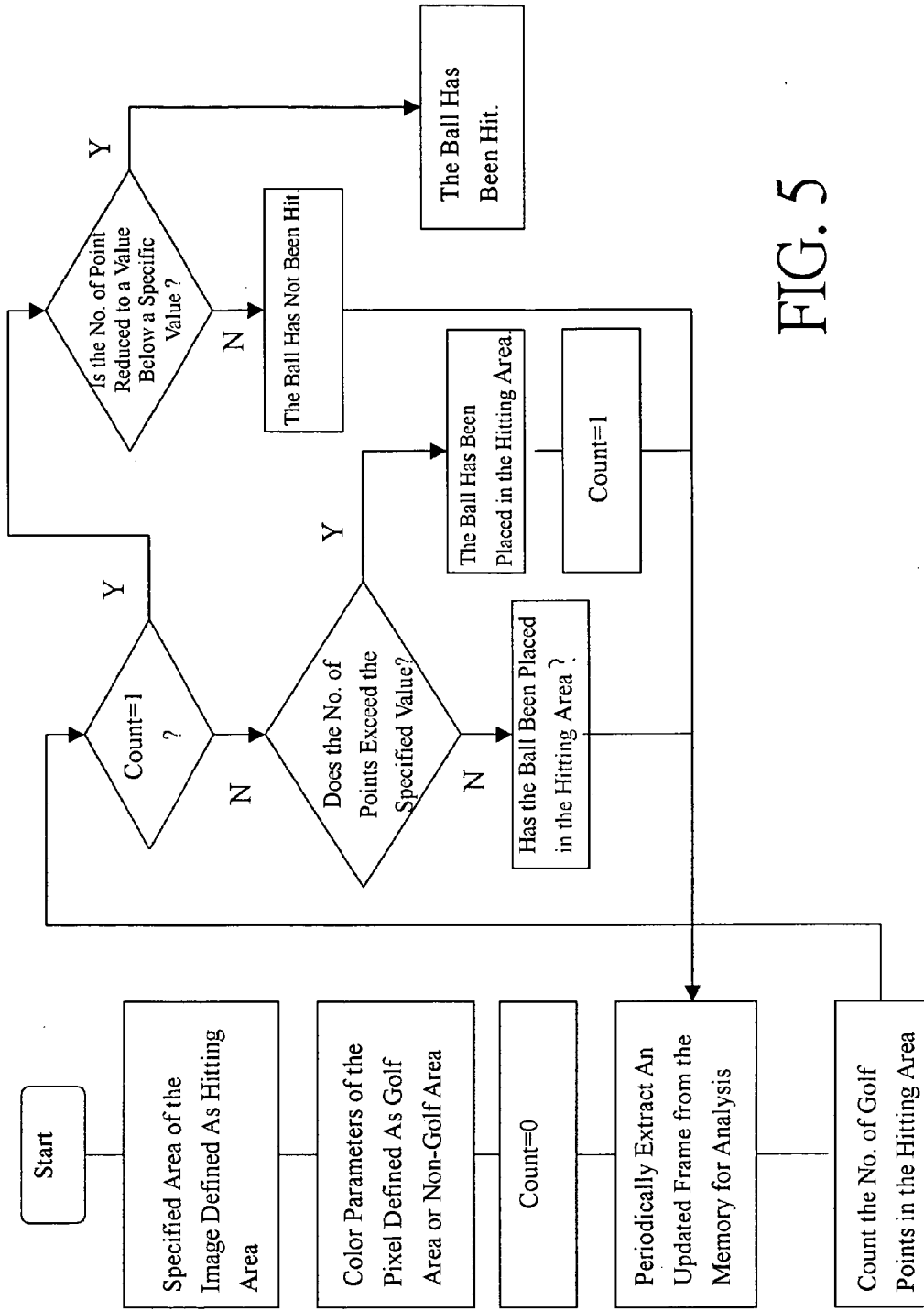


FIG. 5

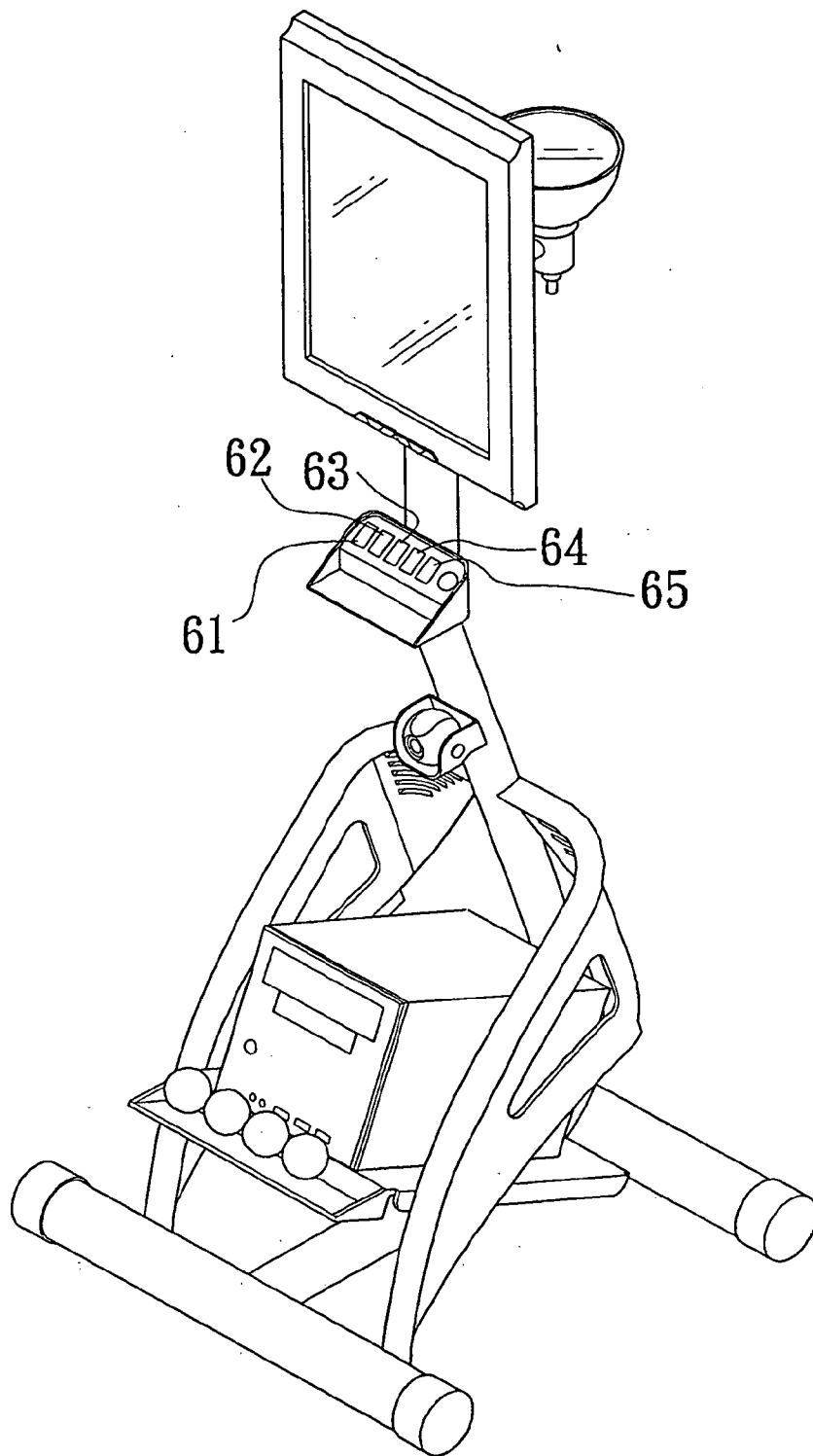


FIG. 6

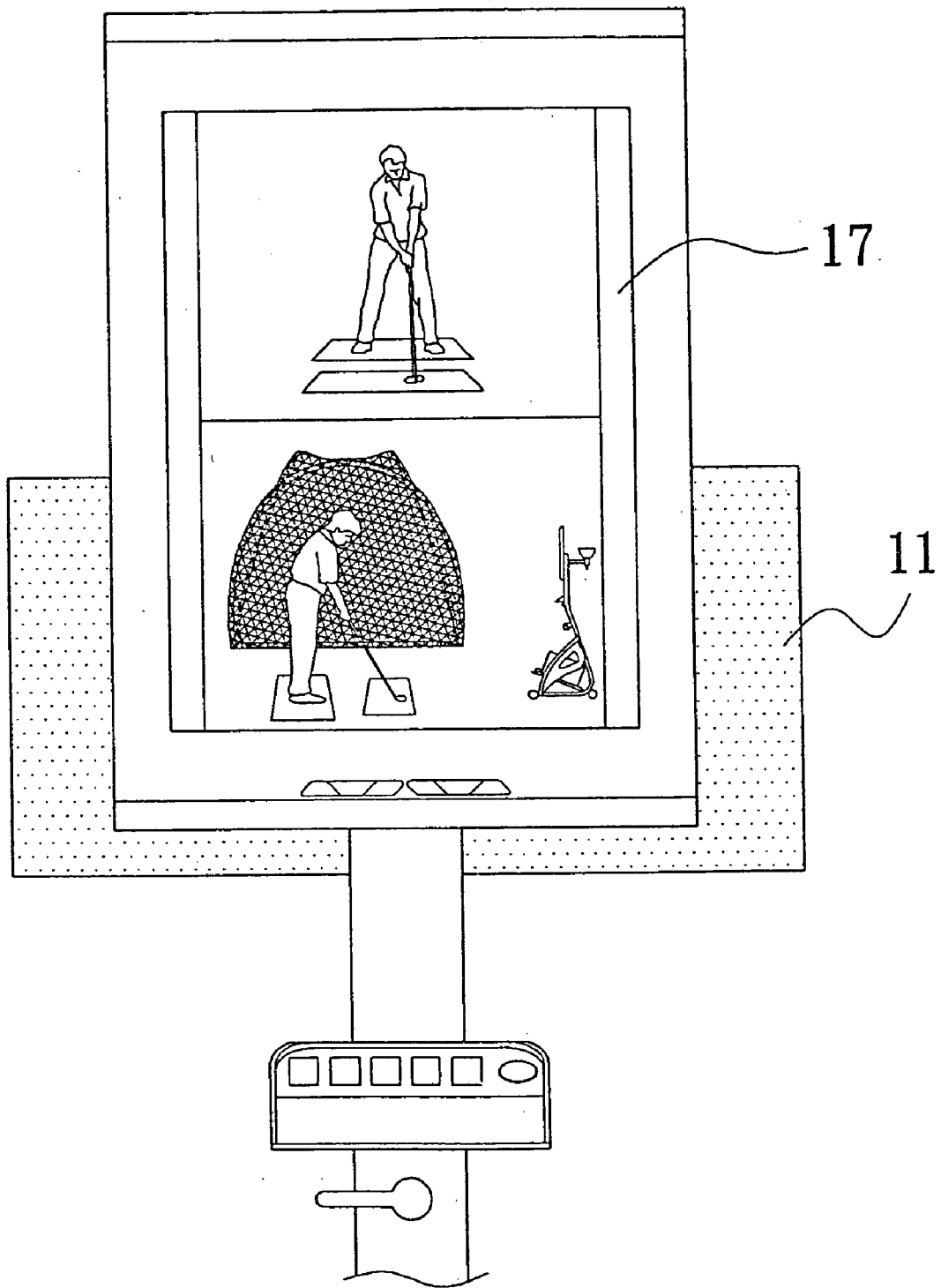


FIG. 7

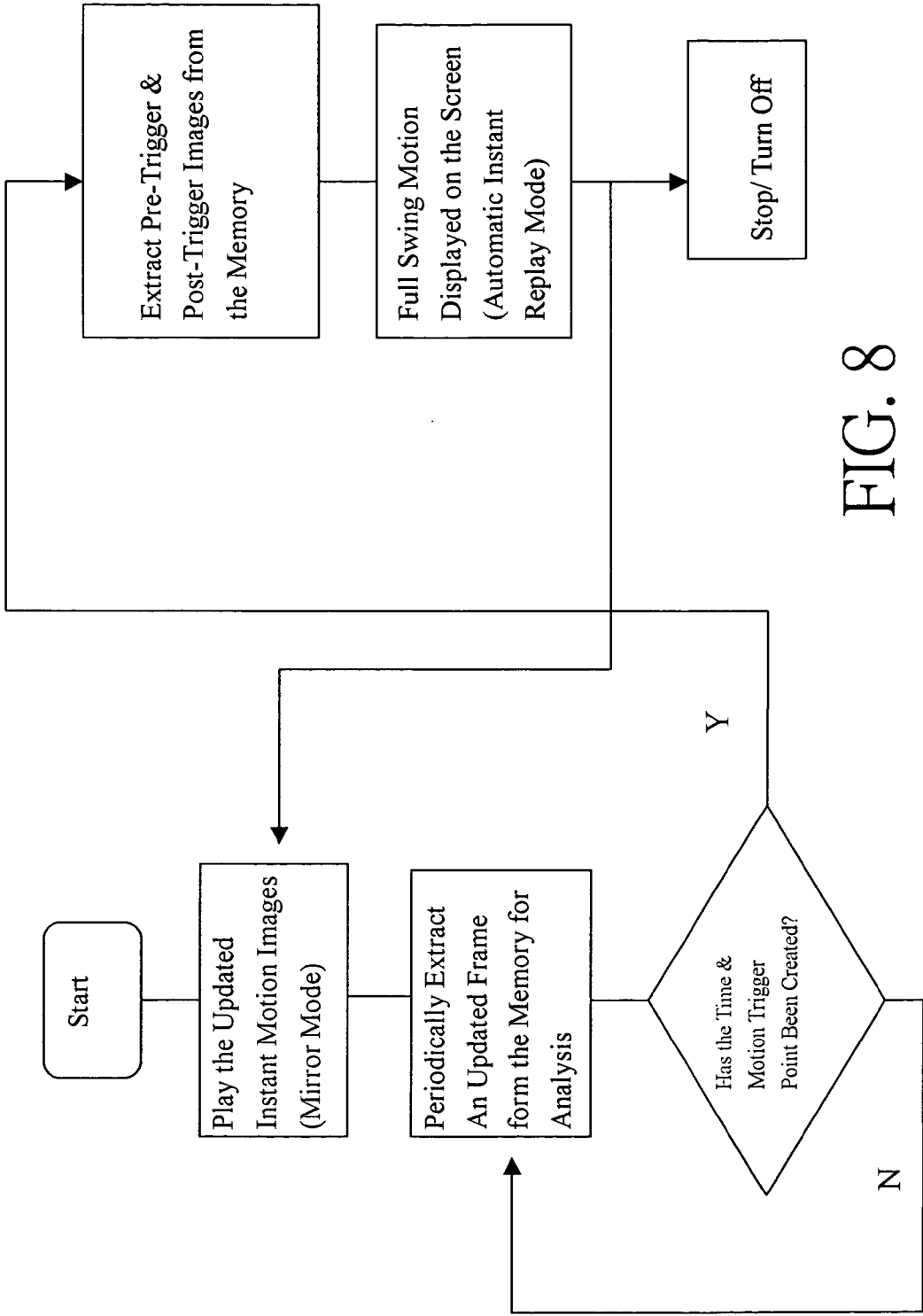


FIG. 8

AUTOMATIC INSTANT VIDEO REPLAY APPARATUS SYSTEM FOR SPORTING

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to the application of a computer, cameras, and image analyzing technology for a video recording and automatic instant video replay apparatus system of a golfer's swing or other sporting activities, and the application of the apparatus for the golfer's swing practice at home, at golf driving ranges, and at outdoor natural grass, or for other spoilt activities.

[0003] 2. Description of the Prior Art

[0004] The golf is one of the most popular sports in the world. According to recent statistics released by the Department of Commerce of the USA, there are 23 million occasional or frequent golfers in the USA. Moreover, there is a trend of gradual decreasing age with these golfers. The golf is also one of the most difficult sports recognized by the people of the world to learn. In terms of the quantity and the types of learning materials, apparatuses, or equipment, the golf is second to none among the world's sports. The golf swing motion requires the accurate coordination of different body parts (such as hands, elbows, alms, shoulders, waists, hips, thighs, legs, feet, heads, and necks) in time, force, and movement so as to produce good impact at golf balls. However, as the golfer cannot see his own bodily golf swing motion (without the assistance of any equipment, the golfer can only see a partial vision of his golf swing motion of the hands, feet, and abdomen.) Consequently, there are a lot of difficulties in learning it. To overcome these difficulties, some golfers place one or several upright mirrors on the floor or walls indoors so as to assist themselves in observing their own swing movements. Moreover, some other golfers record their own swing movements by means of a portable camera supported on a tripod (or a camera operated by the others.) To facilitate subsequent evaluation, generally speaking, a full-set of computerized swing-analyzing apparatus is always installed in some well-established golf-learning schools. This type of apparatus generally includes computers, one or several cameras, image analyzing software, and graphic software, which can record the swing images of the golfers at several angles under the operation of one or several persons. After the images have been subject to digital transformation, they are stored in the memory of the computer, then replayed from the memory, and subsequently are subject to further image analysis of each image frame by means of graphic software. Finally, the results of the analysis are interpreted and illustrated by the trainer. Some of these swing practice accessory equipment cannot provide whole-body images (such as upright mirrors), and others require the assistance of the others in the operation (such as computers and several cameras). Their greatest common disadvantage is the inability to replay the swing movement instantly. In the cases of portable cameras, after having recorded a pair of the swing motion, it is necessary to press keys such as the "Rewind" key and the "Replay" key on the cameras so as to see the pre-recorded swing movement. Similarly, the functions of the computerized swing analyzing equipment in the golf-learning schools have to be operated by golfers or the third party so as to replay the pre-recorded images. To alleviate the burden caused by the repetition of these com-

plicated operations, most of the golfers or trainers will record several swing movements (such as five to ten movements) at one time, then replay and analyze these movements.

[0005] In Europe and America, there is a swing-analyzing equipment called the MotionCoach™ (the company web-site at <http://motioncoach.com>; the company name is Mediavention Inc., which is a company registered in Guelph, Ontario, Canada), which is widely used in a lot of golf-learning schools. This equipment can be set up by the users to record, replay, and pause motions in an automatic manner. For example, the users can program to record the motions for five minutes, replay the motions for five minutes, and then pause the motions for one minute. Although this equipment can obviate the above-mentioned complicated key-pressing operations, it cannot instantly and automatically replay the images right after the ball impact of each swing. In terms of the efficiency of swing video training tools, a single complete swing motion (starting from the address, back swing, down swing, ball hitting, to follow-through, which generally lasts approximately 3~6 seconds) is the most basic step and the most suitable cycle unit for recording and replay analysis. For the golfers or the trainers, they can all analyze the merits and shortcomings of the swing motion right after each swing with the objective that the merits can be enhanced and the shortcomings can be got rid of in their next swing. In general it is not necessary to record and replay the scenes of body movements in between two swing motions, the mis-hit, or those unrelated to golf swings. Consequently, there is a need for an apparatus capable of instantly and automatically recording and replaying the images whenever the swing motion has been made so as to assist the golfers in self-practice or practice under the guidance of trainers to increase learning effects. The U.S. Pat. No. 5,342,054 has already disclosed the application of computers, a plurality of color image cameras, an infra-red (IR) camera, and an infrared flash lamp (which is a group of optical sensors). This invention applies infrared cameras and image analysis to detect whether the golfer has already placed the golf ball on the golf hitting mat, and then turn on the photodetector sensor array to determine the time spot at which the golf club strikes at the hitting area, and within this period, a series of club head images are photographed by the infrared cameras and the infrared flash lamp so as to calculate the speed of the club heads. Although in this cited invention, the golfer can replay the images after the swing has been made, it needs at least two cameras (one of them is an expensive infrared camera), an infrared flash lamp, and a photodetector sensor array. The users of the cited invention should at least press a key for instant video replay. Also, the core technology of the cited invention relies on detecting whether the golf ball has been placed in the hitting area. Obviously, the technology disclosed in the cited invention differs from the present application in many ways. First, the present invention requires a minimum of one camera without key pressing for video replay. The cited patent needs at least two cameras and the users must press at least one button for video replay. Secondly, on the image analyzing technology (please refer to the following illustration), the present application determines whether the golf ball has been hit, while the cited patent detects whether the ball is placed on the hitting mat. Another U.S. Pat. No. 6,042,483 has already disclosed the application of two optic sensors, two high-speed CCD cameras, and one control unit to record the characteristics

(speed of the ball, impact angle, and amount of backspin) of the golf ball when the golf ball is hit and then calculate the carry and the trajectory. The cited invention detects the impact time by means of optic sensors and then starts the CCD cameras based on this impact time, but no related technology in connection with instant replay of the swing motion has been mentioned in the cited invention. The present invention is intended to provide an apparatus capable of recording, storing, and instantly automatically replaying and the method thereof, and then apply the technology in the golfer's swing practice at home, at golf driving ranges, and at outdoor natural grass, and for other sport activities.

[0006] In order to rectify the above-mentioned disadvantages inherent to the conventional techniques, the inventor has endeavored for years by continuous research and experimentation attempting to find out the remedies for such disadvantages, and at last has succeeded in realizing the present invention.

SUMMARY OF THE INVENTION

[0007] As the above-mentioned disadvantages are inherent in the conventional golf swing accessory equipment, the present invention is intended to provide an apparatus capable of recording, storing, and instant and automatic replaying of the golfer's motions by means of image technology to be used in the golfer's swing practice at home, at golf driving ranges, and at outdoor natural grass, and for other spoilt activities.

[0008] Unlike the common computerized swing analyzing equipment, the instant automatic image video replay apparatus of the present invention is composed of computers, one or a plurality of cameras, image analyzing software, and graphic software so that it can first record the swing images of the golfer at different angles under the operation of one person or several persons and then the images are subject to digital transformation, stored in the memory of the computer and subsequently replayed from the memory. These images are later subject to further individual image frame analysis by means of graphic software. In this way, this can assist the golfer in self-practice or practice under the instruction of trainers so as to increase the learning effectiveness, which is an object of the present invention.

[0009] The instant automatic image video replay apparatus of the present invention also does not need to be constructed from a lot of expensive equipment, unlike the above-mentioned computerized swing-analyzing equipment. Hence, this can allow people to have an apparatus of better functions and effects at a lower price, which is another object of the present invention.

[0010] The instant automatic image video replay apparatus of the present invention does not need a plurality of cameras (and even extremely expensive infrared cameras), and only one camera is required to achieve the function. Moreover, the users do not need to press any key to achieve the function of replaying after the recording has been made. Moreover, its operations become even simpler, which is another object of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] For fuller understanding of the nature and objects of the invention, reference should be made to the following detailed description taken in conjunction with the accompanying drawings in which:

[0012] FIG. 1 is a full view of a better embodiment of the apparatus system of the present invention.

[0013] FIG. 2 is a front and side image view of the frame of the present invention.

[0014] FIG. 3 is a flow chart of the mirror mode of the present invention.

[0015] FIG. 4 is a flow chart of the automatic replay of the swing image when the present application has been applied in golf.

[0016] FIG. 5 is a flow chart of the image frame analyzing technology of the present invention.

[0017] FIG. 6 is a flow chart showing the five functional keys of the apparatus system according to the present invention.

[0018] FIG. 7 is an illustrative view of the hitting area at which the golf ball is placed (and golf mat) when the present application is applied in golf.

[0019] FIG. 8 is a flow chart of the automatic image replay system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIEMNTS

[0020] The object of the present invention is to provide the sport circles with a multiple-angle video recording and automatic instant video replay system that meet the imminent needs of the spoilt circles. For a clearer explanation, the golf is taken as an example here, and the application of the apparatus in the other sports will be explained later. In its broadest sense, the apparatus of the present invention includes one or a plurality of cameras so as to catch one-angle or multiple-angle images of the swing motion of the golfer; analogical image data is digitalized and then stored and the results are subsequently used to determine whether the ball has been hit by means of an image processing, analyzing and storing system; a frame display instantly displays or replays the swing motion of the golfer on the frame; and a control keyboard to monitor the entire apparatus system. Likewise, taking the indoor golf swing practice as an example, as shown in FIG. 1, an artificial green golf mat (11) has been installed on a hitting area at the front of which a golfer (12) stands and gets ready for the swing motion, and then places a golf ball (13) on top of the golf mat (13) (with a tee or directly on the golf mat); later, when the golfer raises the golf club to hit the golf ball, which falls inside a net (14) after the ball has been hit.

[0021] A host (15), a control panel (16), and a frame display (17) provided by the present invention can be placed at the back of the artificial golf mat to facilitate front viewing and operation of the golfer.

[0022] A front camera (18) provided by the present invention can also be placed together with the computer on the same frame and then connected to the computer by means of a socket (generally speaking, USB 1394 in series parallel or parallel) provided by the computer.

[0023] After a side camera (19) provided by the present invention is connected to the computer by means of a socket, it can be moved by the golfer to the required position, but the commonly used position is the backside of the golfer (as shown in FIG. 1) so as to record the side body motion of the

golfer. After a variety of apparatus system has been connected to the power source, the computer has been turned on to execute the main programme, and the front view and side image view (as shown in FIG. 2) of the golfer can instantly be displayed on the frame and then be arranged on the top and the bottom (or leftward and rightward). At that time, the function of the present invention is to provide a real-time front side image view just like the image shown by a two-face mirror. At that time, the golfer can warm up for trial swing motion, and the computer system can only provide the function of a "mirror" (which will be explained later). After the golfer has placed the golf ball on the golf mat, and it is only until the ball has been hit, the system of the present invention only provides the function of a "mirror". It is only when the ball has been hit beyond the golf mat (or beyond the hitting area), and the system has confirmed that the ball has been hit through image analysis (which will be explained later), the swing image (generally speaking, approximately 1.5 to 3 seconds composing of club gripping, back swinging and down swinging) recorded before the ball has been hit and the swing images (generally speaking, approximately 1.5 to 3 seconds, composing of ball hitting, post-hit launch, and follow-through) remaining after the ball has been hit have been retrieved from the memory and then displayed on the front frame. After the previous swing motion has been replayed, the system returns to the "mirror" mode of the original swing motion until the next ball will be hit and replayed once again. The above-mentioned is the description of the basic functions of the automatic video replay system of the present invention.

[0024] The above-mentioned "mirror" mode and the operation of the computerized image system are shown in FIG. 3. Basically, turn on the apparatus and start the frame window and then start the port of the camera. Later the computer software and hardware will transform the images at the front and side camera into analog and instantly display them on the frame and store the digitalized images into the memory (generally speaking RAM or harddisk, but the speed for retrieval and storing of the RAM is better). The RAM can be partitioned into a region (with a capacity of storing one or several complete swing motions) for storing images. When the RAM of this region is full, the information first stored will be replaced by new image information. The information storing and processing procedure follows this cycle. The above-mentioned image analysis determines whether the ball has been hit and the automatic video replay function proceeds as shown in FIG. 4. Basically, computer software system periodically (every 0.2 second) extracts one frame from the updated digitalized images and then analyzes it (which will be explained later) to determine whether the golf ball has been placed in the hitting area. If the ball has not yet been placed into the hitting area, then monitoring continues until the ball has been found to be placed in the hitting area. At that time, the computer system is set periodically (at every 0.2 second per section) again to extract the frame and analyze it to determine whether the ball has disappeared from the hitting area (or the golf mat). If the ball still remains in the hitting area, then monitoring continues until the ball has been found to hit. Once the ball has been found to hit, then the computer system instantly retrieves the image information (approximately 1.5 second to 3.0 seconds, set by the users on their own according to the speed of the swing motion, which will be explained later) before the ball is hit and the image information (approximately 1.5

second to 3.0 seconds, to be explained later) after the ball has been hit from the RAM, automatically replays them on the frame and then restores them to original "mirror" mode.

[0025] The software flow chart of the above-mentioned image frame analyzing technology is shown in FIG. 5, which illustrates how to determine whether the ball has hit at the hitting area. Basically the computer software defines the specific area in the lower part of the image frame as "the hitting area" (its size can be larger or smaller than the size of the golf mat). Inside the area, the color parameters of every pixel have a fixed value respectively. The color parameters can be divided into the RGB (Red, Green and Blue) mode, the grayscale mode, and the HSB mode (equivalent to the Hue, the Saturation, and the Brightness respectively) in accordance with international standards. The inventor finds that regardless of the color used, the color of the golf ball can be differentiated from the color of the golf mat (and its nearby floor). For example, in terms of the RGB mode, for the white golf ball, the R value ranges from 180 to 220; the G value ranges from 180 to 220; the B value ranges from 180 to 220; for the green golf mat, the R value ranges from 15 to 20; the G value ranges from 25 to 50; the B value ranges from 5 to 20. Consequently, image-analyzing software can determine whether these values exceed a fixed value of the white pixel based on these values so as to confirm if the ball has already been placed. This fixed value is related to the size of the golf ball, the type and the position of cameras used, and the size of image frame, but in general, it lies between 5 and 30. Likewise, if the grayscale is used, then the white golf ball approaches to a brightness value of 0~10% (0% means white), whereas a brightness value of 0 to 10% (0% means the white color), and the brightness of the green golf mat is 70%~90% (100% means the black color). Consequently, the image analyzing software can determine whether the ball has been placed based on the difference in brightness. If the HSB mode is used, then the H value of the white golf ball is 280~320°; the S value is 2~10%; the B value is 75~90%; the H value of the green golf mat is 280~320°; S value is 50~80%; the B value is 10~20%. The same analogy can also be applied for the above-mentioned judgment. In general, the range of the RGB value of the cement floor is 160~180, 150~170, and 130~160 respectively. The brightness value of the graylevel is 25~35%; the HSB value is 10~30°, 5~20%, and 60~70% respectively. Consequently, the green golf mat can be differentiated from the white golf ball.

[0026] FIG. 5 can also be used to determine whether the ball has already been hit beyond the hitting area (or the golf mat.) After the above-mentioned image analyzing software has already confirmed that the ball has already been placed in the hitting area, the computerized analyzing software continues to monitor the total white pixel periodically, and when the majority of the white pixels (for example more than 60% of the original) suddenly disappear from the hitting area (or the golf mat), the analyzing software can determine if the ball has already been hit beyond the hitting area and then proceed to automatic instant replay.

[0027] Until the above-mentioned, the main difference between the system disclosed in the present invention and the above-mentioned U.S. Pat. No. 5,342,034 lies in the fact that the present invention applies a visible ray image analysis of a low-priced CCD camera to determine whether the golfer has already swung the golf club, whereas the cited US

patent applies the infrared ray image data of an expensive infrared camera for analysis. Moreover, the main difference between the present invention and the cited invention is that the present invention uses ball hitting as the trigger point for starting the automatic replay. However, the disadvantage of the cited US patent is that a lot of golfers are used to place the ball in the hitting area but they do not hurry to swing the golf club, thereby causing an early start of the camera, overflow of images in the storage area, and the recording of the non-swing frame. Furthermore, the users of the cited US patent need to press at least one key for instant replay. However, no key pressing is required for instant replay in the present invention.

[0028] The above-mentioned swing speed and time settings are primarily adjusted based on the swing properties of different golfers. For example, some people are slow in back swinging but fast in down swinging, whereas some other people are slow or fast both in back swinging and in down swinging. The technology disclosed in the present invention takes ball hitting as the reference point and allows the golfers to set the pre-hit swing time (generally ranging from approximately 1.5 to 3 seconds) and the post-hit swing time (generally ranging from approximately 1.5 to 3 seconds). If the golfers do not change the settings in the setting window of the software, then the default settings (for example, 2 seconds for the pre-hit swing time; 2 seconds for the post-hit swing time) are taken as the standard. To make the technology disclosed in the present application more applicable, no-manual operation, automatic "mirror" mode and replay function are installed. Moreover, additional five function keys (except the Start/Power key) are provided as shown in **FIG. 7**. Among them, the first key is the "Instant Replay" key **61** which allows the users to replay the swing motion remaining in the previous repetitive viewing; the second "Slow Replay" key **62** allows the users to repeat viewing the previously recorded swing motion in slow motion (which will be explained later); the third "Save Swing" key **63** allows the users to press the key and then start the computer to store the subsequent swing image data into the hard disk (or other RAMs) for viewing them in the future; that storing function will continue until the key is pressed again; the fourth "Play Fast" key **64** allows the users to retrieve the swing motion that has already been stored in the hard disk (or other RAMs) for repetitive viewing; the fifth "Create CD" key **65** allows the users to burn the swing image data previously stored in the hard disk into CD for repetitive viewing by the golfer or the other (such as the trainer), or being plugged into the other computer (or VCD or DVD) so that the users transmit the swing image to the third party (such as the coach in the golf school) for analysis via computer or the Internet. The speed of the replay function of the above-mentioned two keys, namely, the "Instant Replay" and the "slow replay", can be set and adjusted by the users. For example, the default settings of the "Instant Replay" key for replay speed can be the original swing speed (approximately ranging from 3 to 6 seconds for the replay of one complete swing motion), but the users can set the settings (such as 50% of the original swing speed). Likewise, the default settings of the "Slow Replay" can be one third of the original swing speed (ranging from approximately 9 to 18 seconds), but the users can set the settings (such as one fifth of the original swing speed.) Moreover, if the two keys are pressed during the replay, then image freezes. If the keys are pressed again, then replay continues. The above-mentioned

settings and the above-mentioned swing time settings can be set by pressing a key (except the Start/Power key) to enter the settings window of the software.

[0029] The system disclosed by the present invention can be applied both in the indoor golf (golf mat) practice and outdoor grasslands. The difference between them is that for indoor practice, the hitting area of the white golf ball is the golf mat (or an area covering a larger or smaller golf mat) whereas for outdoor practice, there is no specific ball-placing area or ball-hitting area. However, because the color of natural grass (green or pale green), the color of mud (yellowish), the color of shrubs (gray or brown), and the color of pebbles (gray or brown) all differ from the white color of the white golf ball, the technology disclosed in the present invention can determine whether the ball has been placed and the ball has been hit by means of the above-mentioned image analyzing software so as to activate the instant replay function. To further prevent the interference of foreign colors (such as the color of the white golfer's shoes or socks) on the color analysis procedure of the image, the present invention can separately provide a rectangular (or other shaped) border on the lower region of the frame as shown in **FIG. 7** and then request the golfer to place the golf ball (and the golf mat) inside the frame, so that the rectangular border will only be displayed in the "mirror" mode. Moreover, its image will not be stored in the memory of the computer. Because there is a certain distance and geometric relationship between the golfer and the computer screen, the golfer's body or clothes will not be displayed in the border, thereby reducing the interference from foreign colors.

[0030] The inventor also finds that the system disclosed in the present invention can be applied to the other sports that requires instant image replay such as the tennis service practice. As the tennis ball is greenish yellow in color and the tennis racket (mostly black or silver; the tennis player should avoid using a yellowish green racket) and the player's skin and clothes (the player should avoid wearing yellowish green clothes) for being differentiated from the tennis ball. Consequently, one of the cameras of the system disclosed in the subject application is adjusted to the ball throwing location of the player up in the sky so that the image color can be analyzed to determine whether the player has already thrown the ball and the ball has already been hit beyond the hitting area so as to activate the automatic instant video replay function, whereas another or several cameras can provide multiple-angle images. Likewise, the player can set the pre-hit and the post-hit time (or use the default settings); for example, for the ball pitching practice of the baseball, as the color (grayish white) of the baseball and the color (yellowish brown) of the baseball glove, or the batter's palm (yellowish white) or clothes (the batter should avoid wearing grayish white clothes) can be differentiated from each other. Consequently only one camera of the system disclosed in the present application is adjusted to the area at which the batter raises his arm to pitch the ball so as to determine whether the baseball has already been thrown based on the image color analysis so as to activate the instant automatic replay function. For example, the service of table tennis ball follows the similar practice. For example, for the specific postures (such as triple loop jump) of figure skating, as it is difficult for the ice skaters to recognize the fault in their posture, if the technology disclosed in the present application is used, then one camera is adjusted to the indoor rink at which the skater jumps, and when the skater glides

into the frame, then the image color analysis software can determine whether the skater has already glided inside the video recording area based on the data (all white before the skater glides into the area; additional colors shown for the ice-skates and clothes after the skater has glided into the area) so as to start the automatic video replay to fully record the motion of the skater. To facilitate viewing, the computer, keys, and screen display of the present invention can be placed near the location at which the skater has already finished a specific motion. Likewise, the ice skater can set (or use default settings) the recording time after gliding into the jumping area. To take the different application fields and the users' habits into account, the present application separately allows the users to adjust the settings in the settings window of the software for the lag time for automatic replay. Taking the indoor golf swing practice as an example, once the image color analysis software detects that the ball has already been hit, it continues to record the subsequent motion (ranging from 1.5 to 3 seconds; can be adjusted by the player) after the ball has been hit. Then if there is no lag, then instantly retrieve the complete swing motion before and after the ball has been hit from the memory for video replay. However sometimes the golfer is used to stand for a while after the follow-through and then view the replay frame again. Consequently, under these two conditions, its replay lag time differs and should be set by the user on his own. The other sports can also have the requirement of a replay lag time. Like the other settings, this setting can be adjusted in the settings window of the software once the computer is started.

[0031] Concluding the different sports applications of the above-mentioned system disclosed in the present application, the following points can be summarized (Please refer to Table 1 and FIG. 8 for details) and then the widely applicable hard disk and technology can be explained in terms of the description in Table 1.

[0032] (1) Time & Motion Trigger Point: This is a point selected from the repetitive motions starting from the time at which recording and automatic replay are intended to be taken and the instantaneous time is taken as the trigger point for recording and replay. For example, in Table 1, the trigger point of the golf swing motion is the "point at which the ball has been hit" in the golf; the trigger point for serving the tennis ball is "the point at which the tennis ball has been hit" in the tennis; the trigger point of the baseball batter is "the point at which the baseball has been pitched" in the baseball; the trigger point of the table tennis service practice is "the point at which the table tennis ball has been hit"; the trigger point of the triple loop jump of the figure skating is "the point at which the skater glides into the jump area." The repetition motion of the other similar spoils can also take the trigger point as the specific motion of image color differentiation.

[0033] (2) The pre-launch motion, subsequent motion and time at the trigger point: Once the trigger point has been selected, the system disclosed in the present application sets the video recording time for the pre-launch practice and the subsequent motion of the golf swing practice. For example as shown in Table 1, the pre-launch motion of the golf swing

practice is the grip, address, back swinging, and down swinging (until the hitting area), which generally take 1.5 to 3 seconds overall whereas the subsequent motion is the post-hit launch, follow through, and the viewing of carry and trajectory for outdoor practice, which generally takes 1.5 to 5 seconds; the pre-launch motion of the tennis is the grip, ball throwing, and patting (until the teeing ground is reached), which generally takes 1 to 2 seconds, and the other subsequent motion is the post-hit pat, follow-through, and viewing that the ball has hit the ground, which generally takes 2 to 4 seconds; the pre-launch motion of the baseball pitching practice is the grip, ball raising, and throwing (till the ball leaves the batter's glove), which generally takes 2~3 seconds; the post-launch motion of the baseball pitching practice is the subsequent motion after the baseball has left the glove and the viewing that the baseball has fallen into the glove of the catcher, which generally takes 2 to 3 seconds; the pre-launch motion of table tennis is the upward throwing and patting the ball (until the ball has been hit), which generally takes approximately 1~2 seconds whereas the subsequent motion is the subsequent motion after the ball has been hit and the view of the location at which the ball has fallen and its effects, which generally takes 1 to 2 seconds; the pre-launch motion of the triple loop jump of the figure ice skating is flexing and speeding, which generally takes 0.5 to 1 second, whereas the subsequent motion is the jump, teeing to the ground, and the subsequent gliding motion, which generally takes 1 to 2 seconds. The other similar sports follow the same principle to determine the pre-launch and subsequent motion.

[0034] (3) Install one commonly visible ray camera (such as CCD or CMOS camera) near the players to catch the continuous frames at the time and motion trigger point and then periodically draw out the frames to check if a specific area (or a complete frame) is analyzed based on the color parameters (international standard colors such as RGB, HSB, and Grayscale) and then to determine whether the trigger point has already been activated.

[0035] (4) Separately install one or a plurality of visible ray cameras near the players (selectively) and the camera is used to catch the multiple-angle frames of the above-mentioned pre-launch and the subsequent motion.

[0036] (5) Store the digitalized images from different cameras into the memory and then display them on the screen; if there is a plurality of cameras, then it is possible to partition the screen into several regions to display multiple continuous frames. This function is known as "mirror mode." If the size of the memory of the computer is not sufficient or already full, then new images can be used to replace the memory taken by the old images. In this way, one or a plurality of complete motions can be repetitively stored.

[0037] (6) When the image color analysis software checks that the motion at the trigger point has already been activated, then the computer system will retrieve the pre-launch, the trigger point, and the subsequent motion from the memory and replay them on the screen. Afterwards, the computer returns to the original mirror mode once the replay is completed. In this way, this series of motions repeats.

Sport Application	Time & Motion Trigger Point	Pre-launch Motion & Time at the Trigger Point	Subsequent Motion & Time at the Trigger Point	Area at which the Camera has been Installed
Golf swing	The ball has been hit	Grip, the address, the back swing, the down swing (until the ball has been hit), which generally takes approximately 1.5 to 3 seconds	The post-hit launch, follow-through, and the viewing the carry and the trajectory in indoor practice, which generally takes 1.5 to 5 seconds	At least one camera adjusted to the hitting area (golf mat); the other cameras adjusted to the side or other angles of the golfer
Tennis Service	The ball has been hit	Grip, throwing, and Patting (until the ball has been hit), which generally takes 1 to 2 seconds	Post-hit pat, follow-through, and viewing the ball has hit the ground, which generally takes 2 to 4 seconds	At least one camera adjusted to the hitting area and the players; the other cameras adjusted to the side or other angles of the player
Baseball Pitching	The ball has been hit	Grip, raising the arm to throw the ball, and throwing the ball (until the ball leaves the glove), which generally takes 2~3 seconds	The subsequent motion at which the ball leaves the glove, and viewing that the ball has hit the ground, which generally takes 2~3 seconds	At least one camera adjusted to the hitting area and the players; the other cameras adjusted to the side or other angles of the player
Table Tennis Throwing	The ball has been hit	Upward throwing, patting, and hitting (until the ball has been hit), which generally takes 1~2 seconds	The post-hit subsequent motion and viewing that the ball has hit the table and its effect, which generally takes 1~2 seconds	At least one camera adjusted to the hitting area and the players; the other cameras adjusted to the side or other angles of the player
Triple Loop Jump of Figure Ice Skating	Gliding into the Jump Area	Flex and acceleration; which generally takes 0.5 to 1 second	Jump, teeing the floor, and subsequent gliding, which generally takes 1~2 seconds	At least one camera adjusted to the rink; the other cameras adjusted to the different angles of the skater and the subsequent gliding area of the triple loop jump

[0038] The system of the present invention is composed of a computer, which can be but is not limited to common desktops or portable lap computers, which consist of software and hardware, which are used to digitalize, store, analyze, and display the images transmitted from the cameras, which can be but not limited to common visible ray CCD or CMOS cameras or portable V 8 cameras, which are used to record the motions of the players and then transmit these images to the computer wherein the display can be but not be limited to common LCD, digitalized television (HDTV), and CRT (cathode ray tube), wherein the control keyboard can be but not be limited to common computer keyboard, soft press, and start/power, which is used to transmit the control signals to the computer and cameras so as to monitor the apparatus system of the present invention; the memory can be but not be limited to common RAM, compact flash, fixed hard disk, and portable hard disk.

[0039] Although the present invention has been described with a certain degree of particularity, the present disclosure has been made by way of example and changes in details of structure may be made without departing from the spirit thereof.

What is claimed is:

1. An instant automatic video replay system for recording and instantly replaying motion images, comprising:
 - (a) a time and motion trigger point, capable of placing a golf ball on it and to be used as a point for receiving an impact force onto the golf ball;
 - (b) a camera, installed near said time and motion trigger point, and adjusted to said point so as to acquire motion images of balls such as golf ball and players;
 - (c) a computerized image analysis and storing system, connected to said camera and then process, analyze and store the images caught by said camera;
 - (d) a display, connected to said computer system to display the images of said camera or the images analyzed by or stored in said computer;
 - (e) a control panel, connected to said computer system so as to monitor said computer system and said camera;
 wherein said computerized image analysis and storing apparatus periodically analyzes the image frames of

said computerized image analysis and storing apparatus and then determines whether said time and motion trigger point has already been activated;

if the time and motion trigger point has not yet been activated, then said display displays current images of said time and motion trigger point and the player; if the time and motion trigger point has already been activated, then said computer system retrieves the complete motions of the players (consisting of the pre-hit, hit, and post-hit motion in the golfing) from the memory of said computer and then displays them on the display; if said images have been completely displayed, then the display returns to said time and motion trigger point and the current images of the player.

2. The instant automatic video replay system as claimed in claim 1, wherein the number of cameras can be increased from one to multiple so as to simultaneously catch, analyze, store, and display the images of the player's motions at different positions and directions.

3. The instant automatic video replay system as claimed in claim 1, wherein a control panel can separately provide an "Instant Replay" key to replay the motions already stored in the memory and a "Slow Replay" key to replay the motions already stored in the memory at a reduced speed, a "Save Swing" key to store images into the harddisk and a "Create CD" key to store images into CD.

4. The instant automatic video replay system as claimed in claim 2, wherein said camera can be installed near the player to catch the continuous frames of said time and motion trigger point and periodically extract the frames from them to check the analysis of a specific area (or the whole frame), and, in accordance with the analysis of international standard color parameters such as RGB, HSB, and Gray-scale, to determine whether the motion at said time and motion trigger point has already been activated.

5. The instant automatic video replay system as claimed in claim 2, wherein one or a plurality of cameras can selectively be installed near the player to catch the multiple-angle frames of pre-launch and subsequent motions at said time and motion trigger point.

6. The instant automatic video replay system as claimed in claim 1, wherein the digitalized images of a plurality of cameras are stored into the memory of said computer and then displayed on said display; if there are a plurality of cameras, then the screen can be divided into multiple regions to display multiple continuous frames, and if the size of the memory of said computer is not sufficient or is full, then the new images will replace the memory taken by the old images so that one or multiple complete motions are repetitively stored.

7. The instant automatic video replay system as claimed in claim 1, wherein when the image color analyzing software finds that the motion at said time and motion trigger point

has already been activated, then the images of the pre-launch, trigger point, and subsequent motion will be retrieved from the memory of said computer and replayed on said display until the replay is completed, then afterwards, the computer returns to the original state, and then the cycle continues.

8. An instant automatic video replay system for recording and instant and automatic replay of motion images is composed of:

- (a) a hitting area, on which a golf ball can be placed;
- (b) a camera, installed near said hitting area and adjusted to said hitting area to catch the swing images of the golf ball and the golfers.
- (c) a computerized image analysis and storing apparatus, connected to said camera to process, analyze and store the images caught by said camera;
- (d) a display, connected to said computer system to display the images from said cameras or the images analyzed by or stored in said computer;
- (e) a control panel, connected to said computer system to monitor said computer system and camera(s);

wherein said computerized image analysis and storing apparatus periodically analyzes the image frames stored in the computerized image analysis and storing apparatus based on colors and then determines whether the golf ball placed in said hitting area has already been hit;

if the golf ball has not yet been hit, then said display displays current images of said hitting area and the golfer; if the golf ball has already been hit, then said computer system retrieves the complete swing motion (including the pre-hit, hit, and post-hit motion) of the golfer from the memory and then displays them on the display until the display of these images is completed such that afterwards, the computer returns to the current images of said hitting and the golfer's swing motion.

9. The instant automatic video replay system as claimed in claim 8, wherein the number of cameras can be increased from one to multiple to simultaneously catch, analyze, store, and display the swing motions of the golfers at different locations and directions.

10. The instant automatic video replay system as claimed in claim 8, wherein a control panel can separately provide an "Instant Replay" key to replay the motions already stored in the memory, a "Slow Replay" key to replay the motions already stored in the memory at a reduced speed, and a "Save Swing" key to store images into the harddisk, and a "Create CD" key to store images into CD.

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