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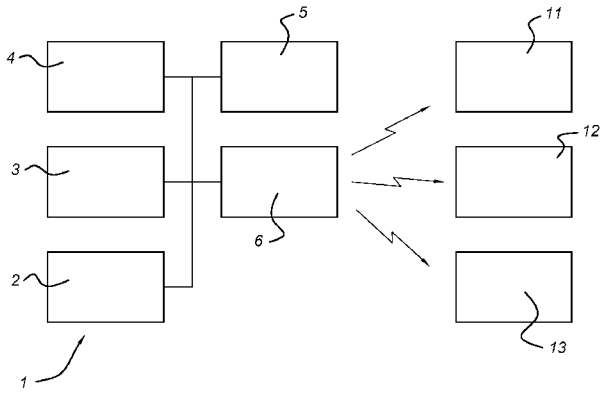
(54) Title: MOTION TRACKING METHOD AND DEVICE

Fig. 1




(57) Abstract: The invention relates to a method and apparatus for analyzing a swing of a sporting tool by a player. The method comprises recording of a reference swing by determining trajectories of a body part of the player, during the learning swing by using sensors positioned on the body part forming a part of a kinetic chain between a fixed point and the sporting tool; storing the determined trajectories of the body part of the learning swings; displaying the determined trajectories of the learning swings; selecting one of the displayed trajectories as the reference trajectory; recording of a playing swing by determining playing trajectories of a body part during the playing swing by using the sensors;storing the determined playing trajectories of the body part during the playing swings; selecting one of the stored playing trajectories; and displaying at least one of the selected playing trajectory and the reference trajectory on a display device.. The apparatus is arranged to perform the steps of the method.

# Motion tracking method and device

## Field of the invention

The invention relates to a method and device for analyzing a swing of a sporting tool

## Background of the invention

The sporting tool can be, for example, a golf club, a tennis racket or baseball bat. A player of golf can exercise his or her swing of the golf club in 3D space and can have another person look at the golf swing when the player is playing the ball to analyze his swing.

In view of the speed of the swing, in the past only the arm movement and planes created by arm and club, racket or bat, could be identified.
Development of technology allows this analysis to be performed with the aid of analyzing devices.

One of such known devices is disclosed in WO 2004/056425. That document discloses an orientation and position tracking system in three-dimensional space and over a period of time utilizing multiple inertial and other sensors for determining motion parameters to measure orientation and position of the sporting tool or swing tool. The sensors, for example vibrational and angular velocity sensors, generate signals characterizing the motion of the swing tool. The sensors can be placed, for example, on the handle, grip or head of a golf club. The information is received by a data acquisition system and processed by a microcontroller. The data is then transmitted via wireless communication to an external data reception system (locally based or a global network). The information can then be displayed and presented to the user through a variety of means including audio, visual, and tactile.

A drawback of the known device is that it is difficult for a user to analyze the swings of a player during a match on the golf course, because the sensors may affect the characteristics, for example balance and/or weight of the golf club. A further drawback can be that the data can only be collected on certain positions on the golf course, for example a driving range. A further drawback can be that the sensors are provided in a special golf club which is not representative for a standard golf club.

A further drawback is that it is difficult to analyze the swings without having feedback from a pro or coach based on the displayed swings.

US5111410 discloses a motion diagnosis system which picks up images of a subject and analyzes them, and is characterized by measuring address data at points of the images thus picked up according to a trigger condition set in advance, displaying the result of the measurement in graphic images or stored images or in comparison with reference images, outputting the evaluation of such comparison to thereby enable measurement under flexible trigger conditions and analyzing the motions of the subject based on quantitative data in a manner easily understandable by the viewers and simple operation.

US20070135225 discloses a sport movement analyzer and training device and method, in real time, detect, analyze, correct and re-create sport movements of a user. An analyzer is secured to a user's wrist engaged in sport movements. A sensing unit in the analyzer provides signals representative of the movement of the wrist at various swing positions along a swing path during a sport movement. A processor in the analyzer processes the signals to measure various parameters descriptive of a sport performance of the user at the swing positions along the swing path. Stored programs in the analyzer service the processor in processing the signals representative of the sport performance for display to the user. A history of past sport performances by the user is stored for comparison purposes with current sport performances.

Summary of the invention

It is an object of the invention to provide a method and device for analyzing a swing of a sporting tool by a player which method and device can provide an improved feedback to the player.

According to a first aspect of the invention this object is achieved in a method for analyzing a swing of a sporting tool by a player comprising:

1) recording of a reference swing by

1a) determining trajectories of a body part of the player, during learning swings by using sensors positioned on the body part forming a part of a kinetic chain between a fixed point and the sporting tool;

1b) storing of the determined trajectories of the body part of the learning swings;

1c) displaying the determined trajectories of the learning swings;

1d) selecting one of the displayed trajectories as the reference trajectory;

2) recording of a playing swing by

2a) determining playing trajectory of the body part during the playing swing by using the sensors;

2b) storing of the determined playing trajectories of the body part during the playing swings;

3) selecting one of the stored playing trajectories

4) displaying at least one of the selected playing trajectory and the reference trajectory on a display device.

In this way a number of trajectories of the body part during respective learning swings can be determined from the sensor data and recorded. The recorded trajectories of one or more body parts can be displayed on a display device. A player together with a professional player or a coach can review selected trajectories and select one of the displayed and recorded trajectories of the learning swings as the reference trajectory of the body part. This reference trajectory of the one or more body parts may correspond to a near perfect or perfect swing of the sporting tool. The sporting tool can be for example a golf club, tennis racket, baseball bat or hockey stick.

The invention is based on the insight that speed and power in a swing, for example with golf, tennis or baseball, is the resultant of biomechanics of the body. A swing is mainly generated from the arms. Swing faults are often the result of an incorrect coordination of movements of the involved body parts. The kinetic chain of motion instigated by the legs and the resulting ground reaction force is transferred through the legs into pelvis, followed by the body core, shoulders, arms and finally the swing tool. A perfect coordination of the kinetic chain prevents swing faults. A better coordination of motion will result in an improved kinetic chain and thus higher and more efficient swing speed.

To improve the coordination one first and foremost needs to train the body to be able to produce the most efficient swing within ones capability. Each individual has a unique physical range of motion, strength and balance. In order to achieve optimal performance these should be trained within the individual's capabilities with or without supervision by swing coach or pro.

This analyzing method enables a player to reproduce a motion required to realize optimal feasible performance of the swing by providing information of the kinetic chain of the motion by attaching movement sensors on body parts forming the kinetic chain.

The further steps of the method record the playing trajectories of the body parts played during playing swings in the game. After the game is finished one or more recorded playing trajectories of the played swings and the reference trajectory can be displayed on a display. The displayed playing trajectories and the reference trajectory can be analyzed by the player and/or his coach. An advantage of this method is that all the swings of the player during the game can be recorded and the player can select the playing trajectories of the body parts corresponding to swings, of which the player knows, that were well hit or were badly hit. In this way the player can get feedback from the displayed playing trajectories and can compare them with the reference trajectory.

In an embodiment the method further comprises determining a difference between the selected playing trajectories and the reference trajectory; displaying the difference on the display device. For example, the difference between one of the recorded playing trajectories and the reference trajectory can be determined by a projection of respectively the reference trajectory and the selected playing trajectory on a reference plane and determine a quantitative measure from the difference of these projections.

In a further embodiment of the method the body part comprises a left and right shoulder, the method further comprising positioning of a first and second one of the sensors at the respective shoulders of the player. By positioning the first and second sensor on the shoulders parameters of a line between the left and right shoulder can be determined and a reference plane can be determined.

In a further embodiment of the method the body part further comprises a left and right hips, the method further comprises positioning a third and fourth one of the sensors at the respective hips of the player or a fifth or sixth one of the sensors on the knees of a the player. The movement information of the hips and/ or knees can provide additional trajectories for displaying coordinated movements of the kinetic chain.

In an further embodiment, the method comprises positioning a seventh sensor at a proximal end of the sporting tool.

In a still further embodiment, the method further comprises positioning an eight sensor at a distal end of the sporting tool. Positioning of the seventh and/or eighth sensor on the proximal and distal ends of the playing tool enables determining of the positioning and the movement of the playing tool.

In a further embodiment the method comprises determining a reference backswing or reference downswing plane from the determined positions of the sensors, and

displaying the reference backswing plane or downswing plane. For example, this reference backswing or downswing can be determined in a golf game using a plane defined by the shoulder line and the club head, when the club head is in a downward position near the ball to be hit.

According to a second aspect of the invention this object is achieved by a device for analyzing a swing of a sporting tool by a player comprising

a sensor for determining a position and an orientation of the body part and to be attached to the body part forming a part of a kinetic chain between a fixed point and the sporting tool;

a memory for storage of data;

a processor connected with the sensor, the processor being arranged to

1) to record a reference swing by

1a) determining trajectories of the body part during a learning swing by using the sensors;

1b) storing the trajectory of the body part of the learning swing in the memory;

1c) displaying the determined trajectories of the learning swings

1d) receiving an input from the input device for selecting one of the displayed trajectories as a reference trajectory;

2) to record a playing swing by

2a) determining playing trajectories of the body part during the playing swing by using the sensors;

2b) storing of the determined playing trajectories of the body part during the playing swings in the memory;

3) to receive an input from the input device to select one of the stored playing trajectories;

4) to display at least one of the selected playing trajectory and the reference trajectory on the display device.

In an embodiment of the device the sensors comprise 3D accelerometers. An example of such device is the WISP sensor as marketed by INTEL such a sensor comprises near field RF communication a microcontroller and wireless power supply.

In a further embodiment the device comprises an RF communication device arranged to communicate between the controller and the sensor. RF communication between the sensors and the device enables freedom of movement to the player. Further advantageous embodiment are defined in the dependent claims.

Brief description of drawing

The above and other, more detailed aspects of the invention will be elucidated and described hereinafter, by way of example, with reference to the accompanying drawing.

Therein:

Fig. 1 shows schematically an embodiment of the device according to the invention;

Fig. 2 shows diagrammatically a golf player and the sensors attached to the golf player and the golf club;

Fig. 3 shows a back swing plane and a downswing plane with respect to a golf player; and

Fig. 4 shows an example of a display screen showing lines representing trajectories of two sensors.

Detailed description of embodiments

The invention relates to a method for analyzing a swing or motion of a sporting tool or swing tool by a player. The sporting tool can be, for example, a golf club, a tennis racket, a hockey stick or a baseball bat. The method can be used to improve the swings or strokes by a player with one of the mentioned sporting tools of a ball game.

In the described embodiments below the golf club is used as an example of a sporting tool.

A known method to analyze motion comprising recording a video of a golf player hitting several trial swings on a stationary position on the golf course, for example the driving range. In order to take the video or pictures a video camera is positioned on a fixed reference position and several trial swings are recorded and can be played backed on a display for further analysis with a pro or coach.

According to the invention the trajectories of the moving body parts of the player during the swing of the golf club can be recorded by a device for analyzing a swing of the player. The body part of the player form a kinetic chain of movement between a fixed point, for example, the ground or green and the sporting tool. The device collects and provides information on the movement of selected body part of the kinetic chain. The device can be compactly built and carried in a small box by the player and/or can be connected to a portable terminal or smart phone. After the collecting the information can be displayed.

Fig.1 shows schematically an embodiment of the analyzing device according to the invention. The device 1 comprises one or more sensors 11, 12, 13 arranged to determine a motion, position and an orientation along the trajectory of body parts of the player 7 playing the golf club 8. This sensor can be, for example, an RFID comprising a 3D-accelerometer, a microprocessor and RF-communication device, such as WISP-device, as can be obtained from Intel. Furthermore, the WISP device does not need an external power source, but collects the required power via an RF-antenna harvesting power from ambient RF fields.

The device further comprises a memory 3 for storage of data , an input device 4 for receiving input from the user, for example, a touch screen, mouse, keyboard or tracker ball. Furthermore, the device comprises a display device 5, for example, an LCD or OLED device for displaying information, such as the determined trajectories of the golf club 8.

an RF communication device 6 for communication with the WISP sensors and a processor 2 arranged to control the memory 3, the input device 4, the display device 5, the RF communication device 6 and the WISP sensors 11, 12, 13

Furthermore, the processor 2 can be in wireless connection with the WISP sensors 11, 12, 13 via the RF communication device 6.

Fig. 2 shows schematically a player 7 with a golf club 8 and the positions of the WISP sensors 11-18 attached to the player 7 and the golf club 8.

The sensors 11-16 can be attached to body parts of the player forming a kinetic chain between the ground and the golf club 8. For example, the first and second sensors 11, 12 can be attached to respectively to each of the shoulders of the player 7 holding the golf club 8 of which the swings should be analyzed. An additional third and fourth sensors 13, 14 can be attached to respectively the left and right hips of the player. A fifth and a sixth sensor 15, 16 can be attached to the knees of the player 7. A seventh sensor 17 can be attached to the grip of the golf club 8 and a eighth sensor 18 can be attached to the club head of the golf club 8.

The processor 2 can be arranged to communicate with the sensors 11-18 and to receive data corresponding to accelerations in x, y, z-directions of the respective sensors. The sampling rate of the sensors can be selectable in the range between 12,5 Hz and 400 Hz. Furthermore, the range for measuring accelerations can be selectable between -2g, 2g;-4g, 4g; -8g, 8g.

Furthermore, the processor 2 is arranged to determine trajectories of the movements of the body parts and/or the golf club during swing of the player and the golf club from the received accelerations in x, y and z-directions from the sensors 11-18 in a way well known to a person skilled in the art.

For example, such position detection is known from "Position Detection and Digital level Sensor using Accelerometer" by Neeraj Purohit, Ravikumar K and Mahima Satsangi, as retreived on 05-02-2014 from the Internet, http://shukra.cedt.iisc.ernet.in/edwiki/Position_Detection_and_Digital_level_Sensor_using_Accelerometer.

Furthermore, in order to increase accuracy of the position and tranjectories, the device 1 can be provided with one or more gyroscopic devices, for example, a gyroscopic device LPY4150AL, as can be obtained from ST Microelectronics. The device 1 can be furter arranged to determine the trajectories by using also the angular velocities provide bt the gyroscopic sensors.

A trajectory can be defined as a curved line along which a certain point of the body parts of the player 7 or the golf club 8, at which one of the sensors 11-18 is attached, is moving during the backswing or the downswing. Such a point represents,

for example, the grip or the club head, a point between the grip and the club head or a point on a shoulder, hip or knee of the player.

According to the method of the invention, the device is firstly set in a learning mode for recording of the trajectories of the body parts and/or golf club during a number of respective learning swings or strokes in order to select a reference trajectory. The number of learning swings can be, for example 5 or 10.

The recording of the trajectories in the learning mode comprises

1a) determining a position and an orientation of the shoulders, knees, hips and the golf club 8 from the received x, y, z acceleration data of the sensors 11-18.;

1b) storing of the determined position and orientation of the shoulders, knees, hips and the golf club of a plurality of learning swings in the memory 3;;

1c) determining trajectories of the shoulders, knees, hips and the golf club 8 from the determined positions and orientations;

1d) storage of the determined trajectories of the shoulders, knees, hips and the golf club in the memory 3.

When the trajectories have been recorded, the player can use the device to display the trajectories on the display device 5 and analyze the displayed trajectories. The displayed trajectories provide information on the kinetic chain formed by respectively the legs, the hips and the shoulders of the player 7 and the golf club.

In a next step in the learning mode the player 7, a coach or golf pro selects one of the displayed trajectories as the “ideal” trajectory or the reference trajectory, which corresponds to a nearly perfect or perfect swing of the golf club 8. The processor 2 receives the input from via the input device 4 and stores a sequence number corresponding to this selected reference trajectory in the memory 3.

Secondly, the player sets the device 1 into a playing mode and the player can play a game or a number of holes on the golf course. During the game the device 1 records the playing trajectories of the sensors 11-18 of respectively the shoulders, knees, hips and of the player and the golf club. The recording of the trajectories in the playing mode comprises

2a) determining positions and orientations of the shoulders, knees, hips and the golf club during the playing swing determined from x, y, z - acceleration received from the sensors 11-18;

2b) storing of the determined positions and orientations of the shoulders, knees, hips of the player 7 and the golf club 8 during the playing swings in the memory 3;

2c) determining playing trajectories from the shoulders, knees, hips of the player and the golf club from the determined positions and orientations of the respective sensors;

2d) storage of the determined playing trajectories in the memory 3.

When the player has finished his game, the player or his coach or pro can analyze the trajectories of the performed swings. Thereto the processor 2 receives an input via the input device 4 from the player corresponding to a selected one of the stored playing trajectories corresponding to one of the playing swings and retrieves the selected playing trajectory and/or the reference trajectory from the memory 3, and displays the selected playing trajectory and/or the reference trajectory on the display device 5.

In an embodiment the player can select the trajectory of one or two of the sensor 11-18 of one or more of the body parts to be stored.

The player can now analyze the performed playing swing and the reference swing on the display device 5 using the information of the trajectories of the respective body parts of the player 7 that form the kinetic chain of movement between the ground and the golf club 8.

Fig. 4 shows an example of a display screen of a display device 5 on which two lines 42, 41 are shown representing two possible trajectories of the respective sensors 13, 14 which are positioned on the hips of the player.

For further evaluation of the swings the processor 2 can determine a difference between the selected playing trajectories and the reference trajectory and can display the difference on the display device. The difference between the playing trajectory corresponding with a playing swing and the reference trajectory corresponding to a reference swing can be determined, for example, by using projections of the respective trajectories of the body parts forming the kinetic chain on a reference plane.

The reference plane can be a reference backswing plane or reference downswing plane.

Fig. 3 shows schematically a backswing plane 20 and a downswing plane 21 with respect to a golf player 7. These reference planes 20, 21 can be determined from the determined positions of the first and second sensors 11, 12 at the shoulders of the player 7 and the seventh sensor 17 of the grip of the golf club 8. The reference

backswing plane 20 is determined by the position of the sensors 11, 12, 17 at the top of the backswing. The downswing plane is determined from the positions of these sensors 11, 12, 17 when the player 7 has turned his hips to the left to initiate the downswing. The determined downswing plane or backswing plane 20, 21 can then be displayed on the display device 5 as the reference backswing plane or downswing plane.

The backswing plane 20 or downswing plane 21 are known *per se* from " Five lessons The modern fundamentals of golf", by Ben Hogan, 1985.

When the processer 2 has determined the backswing plane or the downswing plane the processor can determine the projections of the respective playing trajectories of the body parts a played swing and a reference swing.

These projections of the trajectories of the respective playing swings and the reference swing on the backswing plane or the downswing plane can be displayed on the display device 5. The player can now analyze on the display device 5 the differences between the respective projections on the backswing plane or the downswingplane of the playing trajectories and the reference trajectories..

In an embodiment the display device 5 comprises a 3D display device. Such a device can display the trajectories in 3D to a viewer. In this embodiment the processor 2 is arranged to convert the stored data of the trajectories in a 3D data stream that can be displayed via the 3D display device.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims.

CLAIMS

1. Method for analyzing a swing of a sporting tool by a player comprising:

1) recording of a reference swing by

1a) determining trajectories of a body part of the player during learning swings by using sensors positioned on respective body parts forming a part of a kinetic chain between a fixed point and the sporting tool;

1b) storing the determined trajectories of the body part of the learning swings;

1c) displaying the determined trajectories of the learning swings;

1d) selecting one of the displayed trajectories as the reference trajectory;

2) recording of a playing swing by

2a) determining playing trajectories of the respective body part during the playing swing by using the sensors;

2b) storing the determined playing trajectories of the respective body part during the playing swing;

3) selecting one of the stored playing trajectories;

4) displaying at least one of the selected playing trajectory and the reference trajectory on a display device.

2. Method according to claim 1 further comprising determining a difference between the selected playing trajectories and the reference trajectory;
displaying the difference on the display device.

3. Method according to claim 1 or 2, wherein the body part comprises a left and right shoulder, the method further comprising positioning of a first and second one of the sensors at the respective shoulders of the player.

4. Method according any of the claims 1-3, wherein the body part further comprises a left and right hips, the method further comprising positioning a third and fourth one of the sensors at the respective hips of the player.

5. Method according to any of the claims 1-4, wherein the body part comprises a left and right knee, the method further comprising positioning of a fifth or sixth one of the sensors on the respective knees of a the player.

6. Method according to any of the claims 1-5 further comprising positioning a seventh sensor at a proximal end of the sporting tool.

7. Method according to claim 6, further comprising positioning an eight sensor at a distal end of the sporting tool.

8. Method according to any of the claims 1-7, comprising determining a reference backswing plane or reference downswing plane from the determined positions of the sensors, and
displaying the reference backswing plane or downswing plane on the display device.

9. Method according to claim 8, wherein comprising
determining a projection of the trajectories on the backswing plane or the downswing plane,
and displaying the projection on the display device.

10. Method according to any of the claims 1-8 comprising displaying the determined trajectories on a 3D-display device.

11. Device for analyzing a swing of a sporting tool by a player comprising
a sensor (11-18) for determining a position and an orientation of the body part and to be attached to the body part forming a part of a kinetic chain between a fixed point and the sporting tool;
a memory for storage of data;
an input device;
a display device;
a processor for controlling the memory, the input device, the display device, and the sensor, the processor being arranged

to perform the method according to any of the claims 1-10.

12. Device according to claim 11, wherein the sensor comprises 3D-accellerometers.

13. Device according to claim 10 or 11, wherein the device comprises an RF communication device arranged to communicate between the controller and the sensor.

Fig. 1

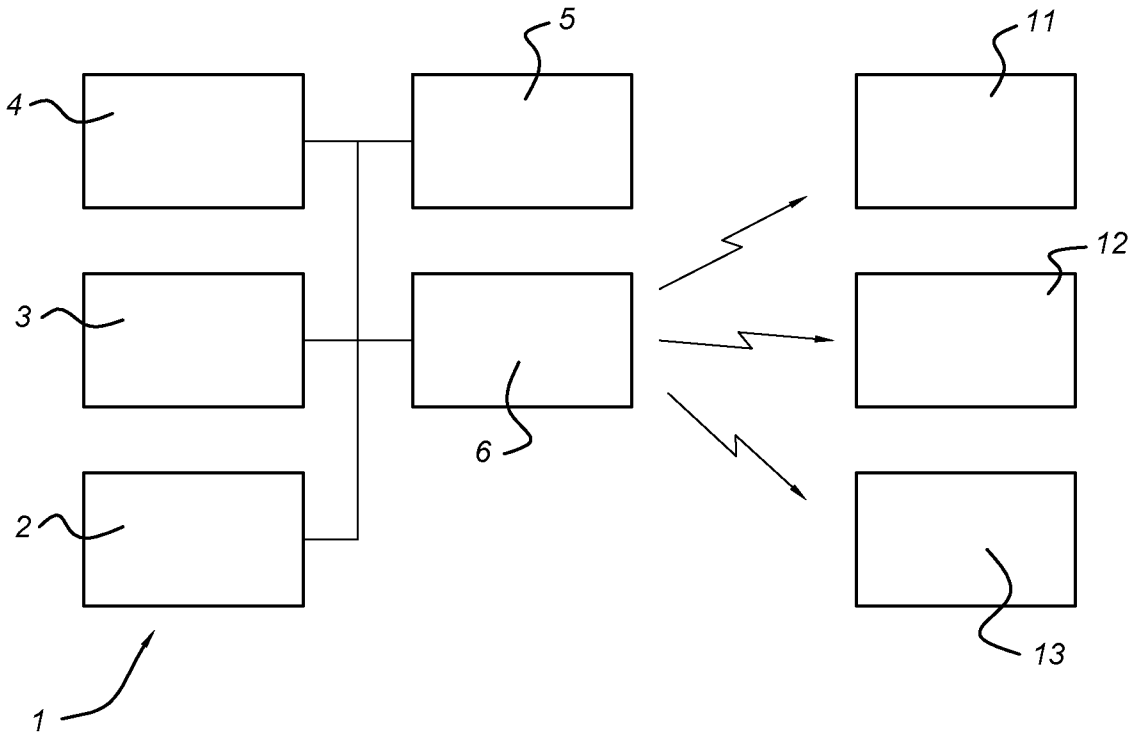



Fig. 2

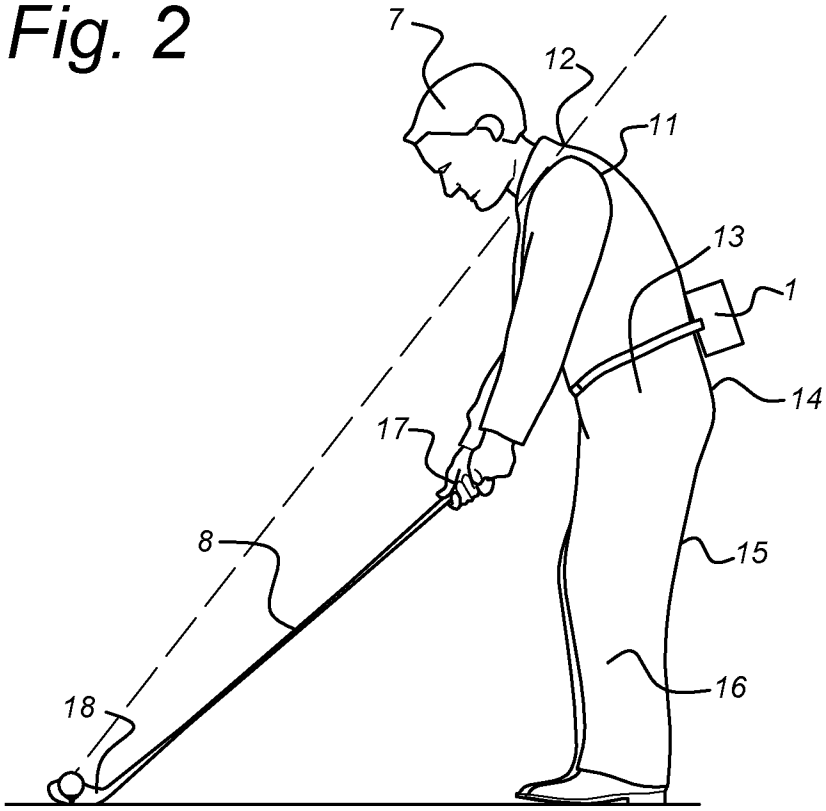


Fig. 3

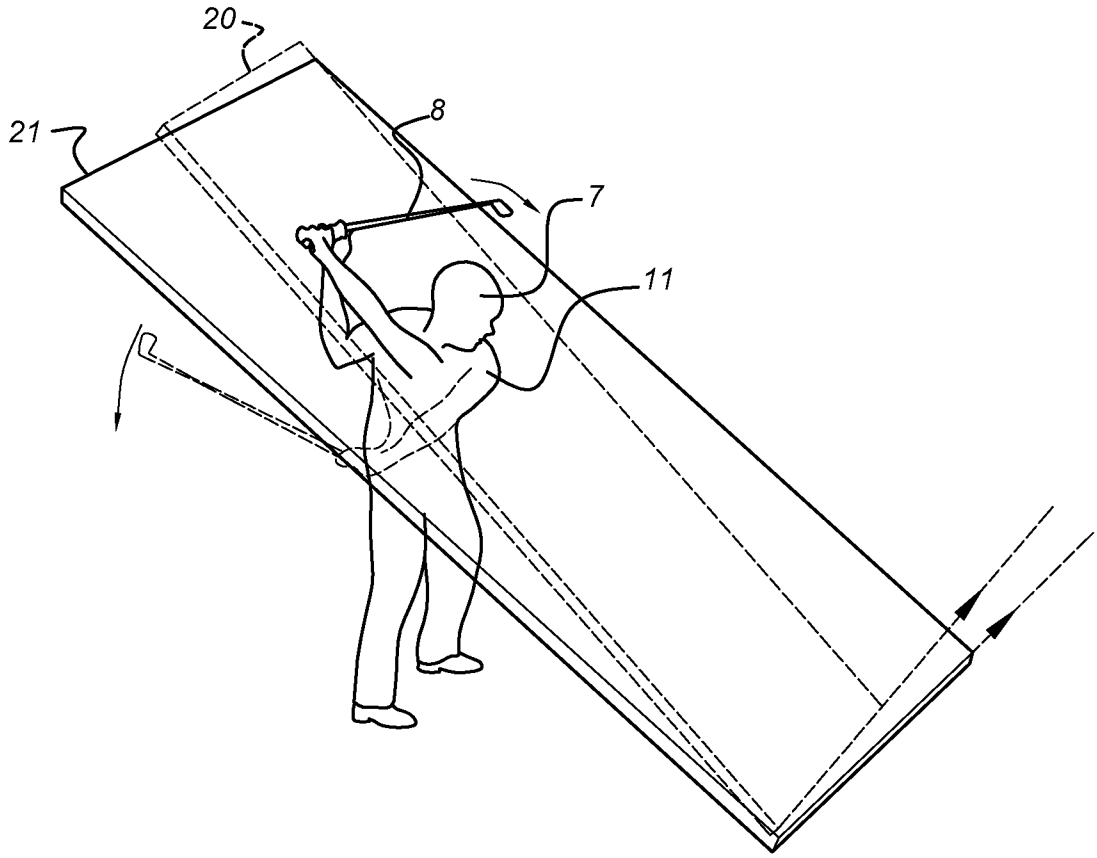
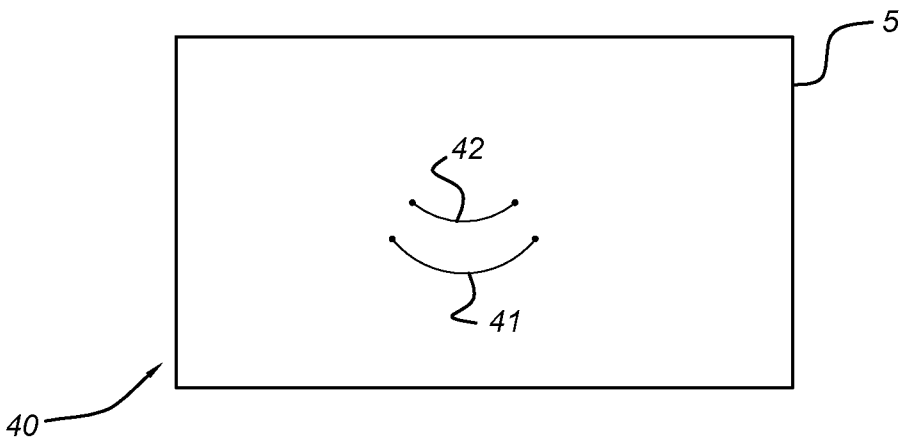



Fig. 4



# INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2014/050076

A. CLASSIFICATION OF SUBJECT MATTER
INV. G09B19/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G09B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 5 111 410 A (NAKAYAMA MIZUO [JP] ET AL) 5 May 1992 (1992-05-05) figures 1,11-13 column 5, lines 48-66 column 9, line 17 - column 11, line 42 ----- | 1-13 |
| A | US 2007/135225 A1 (NIEMINEN HEIKKI V [FI] ET AL) 14 June 2007 (2007-06-14) abstract figures 1, 7a, 7b, 7c paragraphs [0046], [0185] ----- | 1-13 |

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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# INTERNATIONAL SEARCH REPORT

International application No
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| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| T | NEERAJ PUROHIT; RAVIKUMAR K; MAHIMA SATSANGI: "POSITION DETECTION AND DIGITAL LEVEL SENSOR USING ACCELEROMETER", , 13 May 2013 (2013-05-13), pages 1-7, XP002722639, Retrieved from the Internet: URL:ukra.cedt.iisc.ernet.in/edwiki/Position_Detection_and_Digital_level_Sensor_using_Accelerometer [retrieved on 2014-04-01] the whole document ----- | |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2014/050076

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5111410 A | 05-05-1992 | NONE | |
| US 2007135225 A1 | 14-06-2007 | US 2007135225 A1 | 14-06-2007 |
| | | WO 2007069014 A1 | 21-06-2007 |