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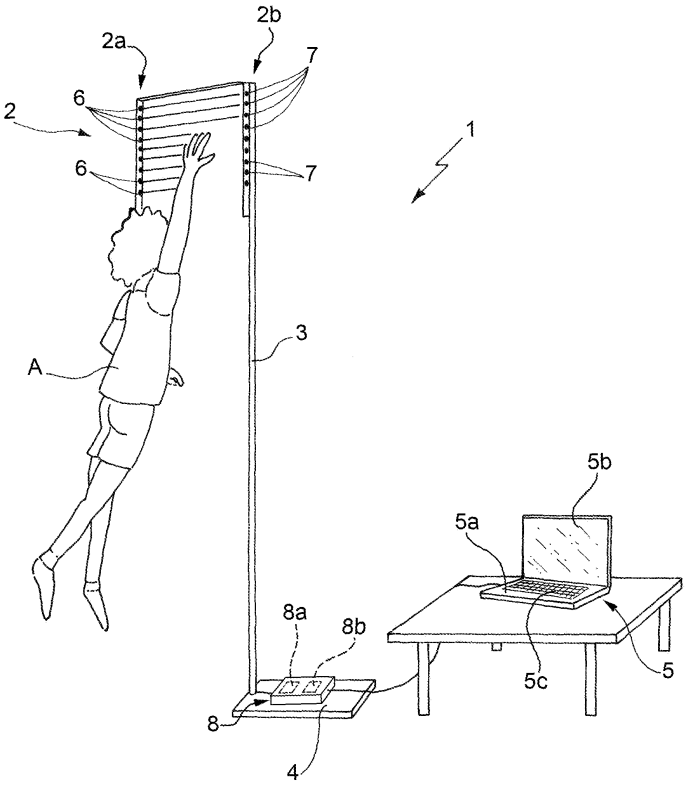
(54) **Method and device for measuring the vertical jumping ability of an athlete**

(57) A device (1) for measuring the vertical jumping ability of an athlete (A), said device (1) having a plurality of optical emitters (6) to emit a plurality of optical signals, a plurality of optical receivers (7) to receive the optical signals, the optical receivers (7) being arranged at a distance from the optical emitters (6) such that the athlete (A), during a vertical jumping movement, interposes oneself between the optical emitters (6) and the optical receivers (7) to intercept at least one of the optical signals, and supplying an analog or digital signal which depends on the received optical signals so as to be correlated to the vertical height reached by the athlete; and a processing unit (5) to process a plurality of heights reached by the athlete (A) during a corresponding plurality of vertical jumping movements in order to obtain a measurement of said vertical jumping ability.



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Description

[0001] The present invention relates to a device and a method for measuring the vertical jumping ability of an athlete.

[0002] In various sports disciplines, such as volleyball and basketball, it is necessary to know the athletes' vertical jumping ability, especially in relation to their state of fatigue. This is also necessary in order to understand whether a particular training program is effective and, if so, how long it takes to achieve the desired results.

[0003] At present there are no tests capable of measuring an athlete's vertical jumping ability by accurately reproducing the jumping conditions that the athlete encounters when actually practising the sport. For example, the height reached by the athlete with the jump is measured roughly by measuring the height of a handprint made by the athlete on a vertical wall, or using other methods that do not envisage the storage of results. It may seem obvious that this type of method necessarily misrepresents the athlete's vertical jumping ability. When jumping in front of a vertical wall the athlete is in a different condition from that when jumping during the normal course of the game.

[0004] The object of the present invention is to provide a device having the technical characteristics to be able to measure the vertical jumping ability of individual athletes, guaranteeing the same jumping conditions that the athlete would encounter during the normal course of the game.

[0005] According to the present invention there are provided a method and a device for measuring the vertical jumping ability of an athlete according to that set forth in the appended claims.

[0006] The following non-limiting example is provided in order to better understand the invention with the help of the figure in the accompanying drawing, which illustrates a preferred embodiment of the device according to the present invention during its use.

[0007] In the figure designated as a whole by number 1 is the device according to the present invention.

[0008] The device 1 comprises an optical unit 2, a supporting rod 3 for the optical unit 2, said supporting rod 3 being adjustable in height and fitted to a stand 4 resting on the floor, an acquisition unit 8 connected to the optical unit 2 to acquire a first analog signal sent by said optical unit 2 and convert said first signal into a second digital signal, and a processing and display unit 5, which is connected to the acquisition unit 8 to receive, record and process the second signal sent by the acquisition unit 8.

[0009] According to an alternative embodiment of the present invention, the height of the support 3 can be adjusted using a motor installed in the stand 4.

[0010] The processing and display unit 5 comprises, in particular, a programmable calculation unit 5a to process the data received with the second signal, a screen 5b to display the data received from the acquisition unit 8 and a keypad 5c to acquire data entered by an operator. In this case, the processing and display unit 5 consists of a laptop computer.

[0011] The optical unit 2 comprises an emitter module 2a provided with a plurality of emitter elements 6, each of which is suitable to emit a respective optical signal, and a receiver module 2b provided with a plurality of receiver elements 7, each of which is associated with a respective one of the emitters 6 and is suitable to receive the relative optical signal. The receiver module 2a is arranged at a distance from the emitter module 2a such that when the athlete jumps he interposes oneself between the receiver module 2a and the emitter module 2a to intercept at least one of the optical signals. The receiver module 2a is provided with an 0-10 volt analog output, which is suitable to provide the first signal and is connected to the input of the acquisition unit 8.

[0012] The acquisition unit 8 comprises a microcontroller card, which comprises a programmable device 8a of the PIC type of integrated circuit and a serial communication port 8b suitable to be connected to an analogue serial communication port of the processing and display unit 5 for the transmission of said second signal according to the RS-232 standard. Each optical signal useful for the present invention can be a laser light beam, an infrared light beam or any electromagnetic ray that can be obscured by the human body without being harmful thereto.

[0013] As shown in the figure, when an athlete A jumps, with his arm outstretched, in the space between the emitter elements 6 and the receiver elements 7 he intercepts a certain number of optical signals emitted by the emitter elements 7. The receiver elements 7 detect said interceptions and the receiver module 2a transmits said information to the acquisition unit 8 via said first signal. The amplitude of the first signal, which is of the analog type, depends on the number of optical signals that are intercepted. The programmable device 8a is configured to acquire the first signal, process said first signal to obtain a height value expressing the vertical height reached by the athlete, incorporate the height value into said second signal, and transmit the second signal in real-time to the processing and display unit 5. Thus the acquisition unit 8 actually processes the first signal a first time to obtain the height value expressing the vertical height reached by the athlete, or, in other words, to measure the vertical height jumped by the athlete. The processing and display unit 5 displays said height value on the screen 5b and processes the height value using the calculation unit 5c to measure the vertical jumping ability of the athlete A.

[0014] According to an alternative embodiment of the invention, the receiver module 2a is provided with a digital output. Thus, the first signal sent by the optical unit 2 is a digital signal and incorporates the information relating to the number of optical signals that are intercepted.

[0015] The calculation unit 5a comprises a memory on which a program is loaded to measure the vertical jumping ability of an athlete using the information acquired by the optical unit 2. In particular, said program is designed

to implement, when run on the calculation unit 5a, a method for measuring the vertical jumping ability of an athlete according to the present invention and described below. In particular, said method is based on a fatigue test performed on the athlete during which, starting from a starting point in time, said athlete performs a first previously defined number N1 of series of a second previously defined number N2 of jumps with a run-up equal to a previously defined distance D, and after each jump the athlete returns, running backwards, to the starting point and each series being separated by a previously defined recovery time T. Said fatigue test can be adapted for use in athletic training for any kind of sport and at any level of competitive activity. For example, athletic training for volleyball may comprise three series (N1=3) of four jumps (N2=4), with a recovery time TR of 20 s, and a run-up and jump typical of the attacking movement with a distance D equal, for example, to 4 m.

[0016] The method for measuring the vertical jumping ability of an athlete according to the present invention consists, first of all, of acquiring a reference height value corresponding to the maximum height the athlete can reach from the ground when standing still, that is the height of the athlete's hand with his arm outstretched. At the starting point in time a time counter is started, which time counter actually implements a chronometer. The time beaten by the time counter is displayed on the screen 5b. Starting from the starting point in time, for each series of jumps the reception of height values acquired and transmitted by the acquisition unit 8 for each jump performed by the athlete is awaited. Each of the height values acquired corresponds to the height reached by the athlete with the relative jump and is displayed in real-time on the screen 5b. When the last jump of each series of jumps is detected, the time counter is stopped and read to record the time taken to perform the series of jumps, hereinafter referred to as the series time TS. The time counter is re-started immediately to beat the recovery time T according to a countdown displayed on the screen 5b. At the end of the recovery time T, the time counter is reset and immediately re-started to measure the series time TS of the next series of jumps.

[0017] At this stage, the method for measuring the vertical jumping ability of an athlete consists of calculating a performance index IPG that expresses a measure of the athlete's vertical jumping ability and is defined by a sum of partial indices IPP, each of which expresses a partial measure of vertical jumping ability relating to a respective series of jumps. In particular, the partial index IPP is defined by the ratio between the square of a specific vertical jump height EJ of the series of jumps and the respective time TS:

$$IPP = (ESJ)^2/TS.$$

[0018] The specific vertical jump height ESJ is defined by the sum of the single vertical jump heights EJ reached with the respective jumps in the series of jumps, each single vertical jump height EJ being calculated as the difference between the height value acquired with the relative jump and the reference height value.

[0019] Lastly, the reference height value, the height values acquired with the various jumps, the series time TS measured for each series of jumps and the performance index IPG are stored in the memory of the calculation unit 5a along with other data identifying the athlete in order to create a database with the information relating to several athletes. The performance index IPG expressing a measure of the vertical jumping ability of the athlete may also be displayed on the screen 5b.

[0020] According to another embodiment of the invention (not illustrated), the device 1 comprises a luminous indicator, for example a bar of LEDs, mounted on the receiver module 2a to provide a qualitative indication of the vertical height reached by the athlete.

[0021] According to a further embodiment of the invention (not illustrated), the device 1 comprises a digital display to display the vertical height reached by the athlete in real-time. The digital display is advantageously mounted on the supporting rod 3, for example beneath the receiver module 2a, and is connected to the acquisition unit 8 to receive said second signal and display the height value incorporated in the second signal in real-time. The digital display is of a known type and is not illustrated. For example, the digital display is of the three-digit type. Advantageously the digital display is of the double-sided type.

[0022] According to a further embodiment of the present invention (not illustrated), the device 1 is not provided with the processing and display unit 5 and comprises a keypad of a known type connected to the acquisition unit 8 to enable an operator to enter commands to the acquisition unit 8 and a digital display of the type mentioned previously on which the vertical height reached by the athlete is displayed in real time. In this embodiment the digital display is again mounted on the support rod 3 and is connected to the acquisition unit 8 to receive said second signal.

[0023] The device 1 according to the present invention thus enables the athlete's vertical jumping ability to be measured and recorded, without having to alter the jumping conditions that the athlete would encounter during the normal course of the game. It is apparent from the above description that when he jumps the athlete does not physically interact with any part of the device except for the electromagnetic rays of the optical signal and can thus jump freely as if he were not being measured.

[0024] Moreover, the processing and display unit 5 is configured to implement the method for measuring the vertical jumping ability according to the present invention, which enables the vertical heights acquired during several series of jumps performed by the athlete to be processed in order to determine a performance index IPG expressing, in a concise manner, the vertical jumping

ability of said athlete, enables the vertical heights acquired to be displayed in real-time and enables the acquired data and performance index IPG of several athletes to be stored for subsequent processing. In other words, with the method according to the present invention it is possible to obtain a concise measure of an athlete's vertical jumping ability and monitor performance in time.

[0025] Lastly, it is worth noting that the device 1 described above can also be used, by adjusting the height of the supporting rod 3 as necessary, to measure and display the height reached by a ball thrown upwards into the air by the athlete so that it passes between the receiver module 2a and the emitter module 2a.

Claims

1. Method for measuring the vertical jumping ability of an athlete during a fatigue test during which said athlete performs a first previously defined number (N1) of series of a second previously defined number (N2) of jumps with a run-up of a previously defined length (D), each series being separated by a previously defined recovery time (T); the method being **characterized in that** it comprises the steps of:

   - acquiring a first height value of said athlete standing still;
   - starting a time counter, at the beginning of each series of jumps;
   - acquiring, for each jump and by using optical sensing means (2a, 2b), a second height value corresponding to the height reached by the athlete performing said jump;
   - reading, in correspondence with the recording of the last jump of each of said series of jumps, the time counter to obtain a series time (TS) corresponding to the time taken to perform the series of jumps;
   - beating said recovery time, starting from the moment of recording the last jump of each of said series of jumps;
   - determining, for each series of jumps, a partial measure (IPP) of said vertical jumping ability by processing the first height value with the second height values and the series time (TS) relating to said series of jumps;
   - determining an overall measure (IPG) of said vertical jumping ability by processing the partial measures (IPP) together.

2. Method for measuring the vertical jumping ability of an athlete according to claim 1, the method being **characterized in that** said step of determining an overall measure (IPG) of said jumping ability consists of adding said partial measures (IPP) together.

3. Method for measuring the vertical jumping ability of an athlete according to claim 1 or 2, the method being **characterized in that** said step of determining, for each series of jumps, a partial measure (IPP) of said jumping ability comprises:

   - determining, for each jump in the series of jumps, a respective first vertical jump height (EJ) as the difference between the relative said second height value and said first height value;
   - determining, for each series of jumps, a second vertical jump height (ESJ) as the sum of the first vertical jump heights (EJ) determined for the jumps in the series of jumps; and
   - calculating the partial measure (IPP) as a function of the second vertical jump height (ESJ) and of the relative said series time (TS).

4. Method for measuring the vertical jumping ability of an athlete according to claim 3, the method being **characterized in that** said step of calculating the partial measure (IPP) consists of calculating the ratio between the square of said second vertical jump height (ESJ) and the relative said series time (TS).

5. Device for measuring the vertical jumping ability of an athlete, said device being **characterized in that** it comprises optical emitter means (2a) to emit a plurality of optical signals; optical receiver means (2b), which are suitable to receive the optical signals, are arranged at a distance from the optical emitter means (2a) such that, during a jumping movement, said athlete interposes oneself between said optical emitter means (2a) and said optical receiver means (2b) to intercept at least one of said optical signals, and are suitable to provide a first signal which is a function of the optical signals received so as to be correlated to the vertical height reached by the athlete; and processing means (5) configured to implement the method for measuring the vertical jumping ability of an athlete according to one of the claims from 1 to 4.

6. Device for measuring the vertical jumping ability of an athlete, said device being **characterized in that** it comprises optical emitter means (2a) to emit a plurality of optical signals; optical receiver means (2b), which are suitable to receive the optical signals, are arranged at a distance from the optical emitter means (2a) such that, during a jumping movement, said athlete interposes oneself between said optical emitter means (2a) and said optical receiver means (2b) to intercept at least one of said optical signals, and are suitable to provide a first signal which is a function of the optical signals received so as to be correlated to the vertical height reached by the athlete; and processing means (5) to process a plurality of heights reached which are

obtained in correspondence with a plurality of vertical jumping movements by the athlete so as to obtain a measure of said vertical jumping ability.

7. Device for measuring the vertical jumping ability of an athlete, said device being **characterized in that** it comprises optical emitter means (2a) to emit a plurality of optical signals; optical receiver means (2b), which are suitable to receive the optical signals, are arranged at a distance from the optical emitter means (2a) such that, during a jumping movement, said athlete interposes oneself between said optical emitter means (2a) and said optical receiver means (2b) to intercept at least one of said optical signals, and are suitable to provide a first signal which is a function of the optical signals received so as to be correlated to the vertical height reached by the athlete; and acquisition means (8) connected to said optical receiver means (2b) to acquire the first signal and process the first signal in order to obtain a value of said height reached by the athlete.

8. Device for measuring the vertical jumping ability of an athlete according to claim 7, **characterized in that** it comprises processing means (5) to process a plurality of heights reached which are obtained in correspondence with a plurality of vertical jumping movements by the athlete in order to obtain a measure of said vertical jumping ability.

9. Device for measuring the vertical jumping ability of an athlete according to claim 6 or 8, **characterized in that** it comprises acquisition means (8) connected between said optical receiver means (2b) and said processing means (5) to convert said first signal into a second signal incorporating said value of the height reached by the athlete and transmit the second signal to the processing means (5).

10. Device for measuring the vertical jumping ability of an athlete according to claim 8 or 9, **characterized in that** said acquisition means (8) comprise a programmable PIC unit (8a) and a serial communication port (8b) suitable to be connected to an analogue serial communication port of said processing means (5) to transmit said second signal according to RS-232 standard.

11. Device for measuring the vertical jumping ability of an athlete according to any one of claims 6, 8, 9 or 10, **characterized in that** said processing means (5) comprise display means (5b) to display said height reached by the athlete and/or said measure of the vertical jumping ability.

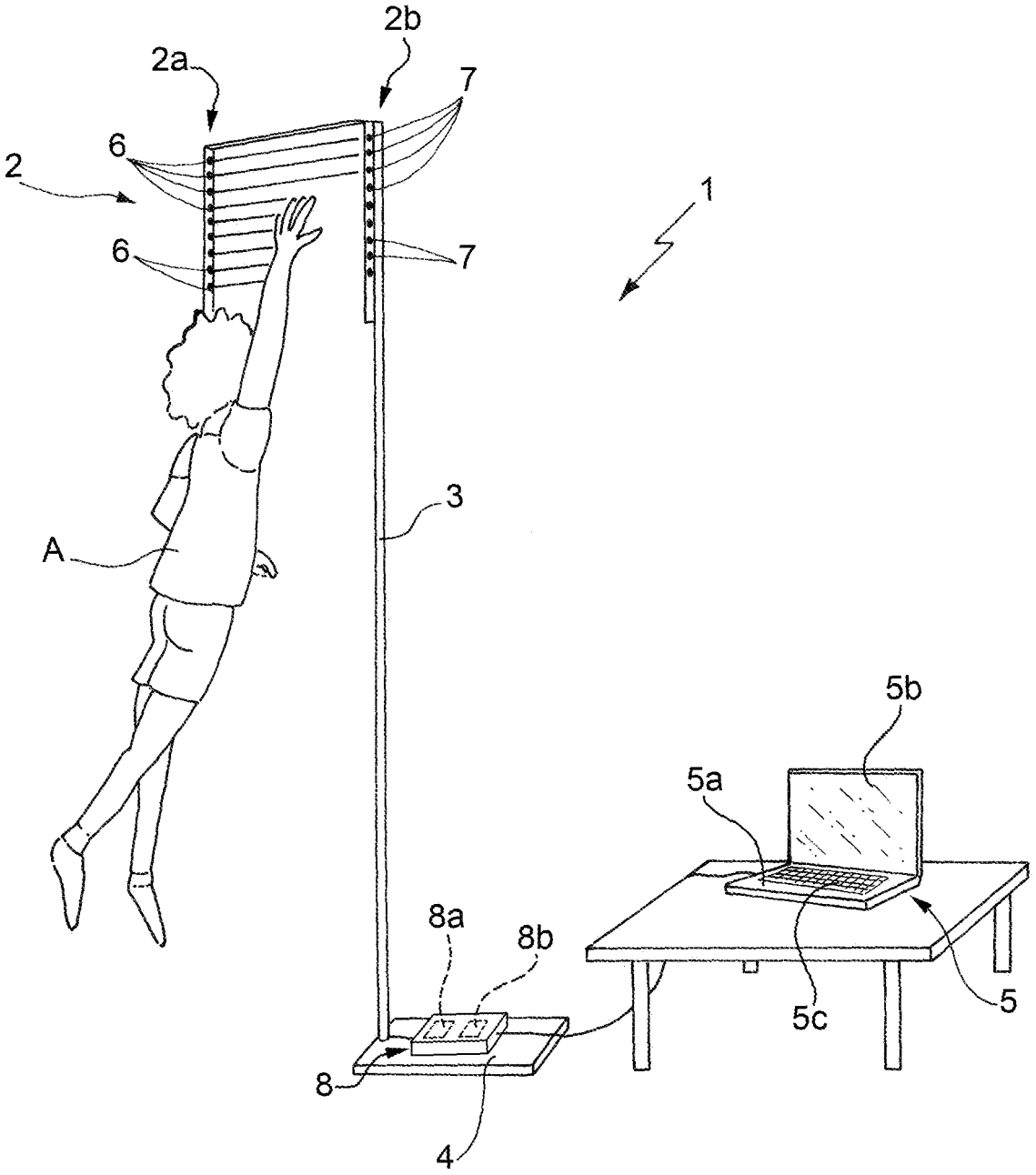
12. Device for measuring the vertical jumping ability of an athlete according to any one of the claims from 7 to 11, wherein said acquisition means (8) are suitable to convert said first signal into a second signal incorporating said value of the height reached by the athlete; the device (1) comprising digital display means connected to the acquisition means (8) to receive the second signal and display said value of the height reached by the athlete in real-time.

13. Device for measuring the vertical jumping ability of an athlete according to any one of the claims from 7 to 12, **characterized in that** said optical receiver means (2b) comprise a 0-10 volt analog output, which is suitable to provide said first signal and is connected to the input of said acquisition means (8).

14. Device for measuring the vertical jumping ability of an athlete according to any one of the claims from 6 to 13, **characterized in that** said optical emitter means (2a) comprise a plurality of emitter elements (6), each of which transmits a respective one of said optical signals, and said optical receiver means (2b) comprise a plurality of receiver elements (7), each of which is associated with a respective emitter element (6) and is suitable to receive the relative optical signal; said first signal incorporating the information relating to the number of optical signals intercepted by said athlete during said vertical jumping movement.

15. Device for measuring the vertical jumping ability of an athlete according to any one of the claims from 6 to 14, **characterized in that** it comprises a supporting rod (3) which is adjustable in height and is suitable to support said optical emitter means (2a) and said optical receiver means (2b).

16. Device for measuring the vertical jumping ability of an athlete according to any one of the claims from 6 to 15, **characterized in that** each of said optical signals is an infrared light beam.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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 4470

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* column 1, line 41 - column 3, line 32; figures 1-4 *	1,5	G01V8/20
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TECHNICAL FIELDS SEARCHED (IPC)
G01V
A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 June 2009	Oelschläger, Holger

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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