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(54) **Sport sticks with sensor enhancements**

(57) A piece of sport equipment is proposed. The piece of sports equipment can be a Nordic walking stick which comprises a sensor that is configured to produce sensor data; a processor being coupled to the sensor for receiving the sensor data; a memory being coupled to the processor for storing the sensor data; and an output device for selectively signaling the sensor data. In the piece of sports equipment provides the user of it with an immediate feedback of his training.

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Description

The field of the invention

[0001] The present invention is related to a piece of sports equipment and in particular to sports sticks like Nordic walking sticks or poles which are equipped with a movement sensor. Furthermore, the present invention is also related to a method for using a piece of sports equipment.

Background

[0002] For several sports -including Nordic walking, Nordic ski or blade skiing- proper usage of the sticks or poles is crucial for both the efficiency of the sport activity and the associated health benefits. In Nordic walking for instance, two walkers walking at the same speed can exercise at very different intensity levels depending on the way they use their sticks and the associated way they move their upper body. Also, improper usage of the sticks can lead to useless stress on the arm joints or of the back and neck.

[0003] For all those sports specialized trainers or self training methods help people get started and do the correct movements. However, experience shows that people forget this good practice over time or when they get tired. Furthermore, on the one side people want to increase the intensity of their practice as their skills improve. But on the other side people are not always accompanied by a personal trainer who monitors the change in their practice to prevent them from adopting wrong movements and the like.

[0004] US 2006/0148594A1 discloses a system for interfacing mobile communication devices with sports equipment that includes a sensor. Data from the sensor are transmitted wirelessly to a device for further analysis and display of the data. Actual sensor data is sent from the piece of equipment to another device, such as a mobile device.

[0005] Generally there remains a desire of sports equipment for improving existing training methods.

Summary of the invention

[0006] The present invention responds to that need and describes various technologies and techniques that will allow for sport practitioners using a piece of sports equipment to monitor in real time the way they exercise these. In one embodiment the piece of sports equipment is a Nordic walking stick or pole. In another embodiment, the piece of sports equipment is a Nordic skiing stick or pole or a blade skiing stick. In spite of the plurality of the embodiments of the invention the underlying concept is similar for all embodiments. The present innovation enables access to key performance indicators regarding the usage of the sticks while they are normally utilized and allows for multiple training usages with immediate feedback and adaptation of utilisation both for professional and amateur sports.

[0007] The present invention suggests a piece of sports equipment comprising

- a sensor that is configured to produce sensor data;
- a processor being coupled to the sensor for receiving the sensor data;
- a memory being coupled to the processor for storing the sensor data; and
- an output device for selectively signaling the sensor data.

[0008] The piece of sports equipment may comprise a plurality of sensors. The one or several sensor(s) may be capable to measure acceleration, speed or angles in one or several spatial dimensions, position, altitude, humidity and/or temperature.

[0009] In an improvement of the present invention the piece of sports equipment the memory contains reference data corresponding to some or all sensor data, wherein the processor is arranged to produce an output device signal as a function of the comparison result of the sensor data with the corresponding reference data. Advantageously, the output device signals a deviation of the sensor data from the reference data exceeding a predefined threshold.

[0010] In a preferred embodiment of the sports equipment according to the invention the output device is designed to generate visual, acoustic and/or vibration signals.

[0011] The piece of sports equipment may comprise a wireless link to connect the piece of sports equipment to a base station. In this case the wireless link comprises a transceiver and an antenna.

[0012] Advantageously, the piece of sports equipment comprises a power source for supplying electrical energy to the sensor, the processor the output device and/or the memory.

[0013] In an advantageous embodiment the power source comprises photovoltaic cells, Peltier elements or a mechanical apparatus to generate electrical energy.

[0014] In another embodiment of the invention, the piece of sports equipment is a Nordic walking stick, a Nordic skiing stick or a blade skiing stick.

[0015] According to a second aspect of the present invention a system for communicating with a piece of sports equipment according to the first aspect of the invention is suggested. The system comprises a base station provided with a processor, a display device, a transceiver and an antenna for establishing a wireless connection between the base station and the piece of sports equipment.

[0016] In view of the plurality of advantages of the sports equipment according to the present invention it is also briefly referred to as "smart sticks" in the following description.

[0017] For example, smart sticks allow capturing ac-

curately in real-time the orientation and acceleration of the stick in the three dimensions. Subsequent processing of these measurements enables to derive a wealth of information on the trajectory of the sticks. From these metrics advices can be provided on how the user can improve his practices while doing his normal sports activity, e.g. Nordic walk or ski. The same information, compared over a longer period of time, allows monitoring the progresses of the user.

[0018] The smart sticks according to the present invention can greatly improve existing training or self training methods. For illustrative purposes for instance a situation is considered in which people learn exercises by themselves. Currently, it is common practice to buy a video tape or DVD where a coach is showing the movements to execute. The major limitation of this method is the absence of feedback: practicing some exercise wrongly or too intensively can be ineffective or even cause a health risk. The smart sticks incorporating motion sensing devices will track user's movements in space and time and hence provide real-time, personalised advice or issue a warning in case of risk of injury. Similarly after the trainee has been performing correct movements under the supervision of a personal trainer, the correct movements are recorded for reference. If later the trainee's movement differ too much from this reference, he can be warned and advised to correct.

[0019] Taking these considerations as a starting point, the present invention proposes according to a third aspect a method for operating a piece of sports equipment comprising the following steps:

- selecting alternatively between a recording mode and a training mode of the piece of sports equipment; and when the recording mode has been selected
- acquiring sensor data from a sensor, and
- storing the sensor data as reference data in a memory;

whereas when the training mode has been selected

- acquiring sensor data from a sensor, and
- comparing the sensor data with prerecorded reference data.

[0020] According to an improvement of the inventive method it comprises additionally the step of outputting a warning signal when the piece of sports equipment is in the training mode and the sensor data deviate beyond a predetermined threshold from the prerecorded reference data.

[0021] According to a further development of the method may comprise the step of transferring stored data from the piece of sports equipment to a base station. Advantageously the method further comprises the step of transferring reference data from a base station to the piece of sports equipment.

[0022] In addition to the advantages described above the inventive as piece of sports equipment or smart stick provide further improvements. E.g. the energy consumed by sportsmen practicing those sports depends heavily on the way they exercise their poles. For instance, two walkers walking at the same speed can burn calories at a rate ranging from 1 to 1.5 depending on the way they use their sticks. Therefore, traditional measurements such as pedometers, which are only based on steps are not capable of providing accurate information. The smart sticks will enable accurate measurement of the energy consumed by the sport activity.

[0023] This Summary was provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

Brief description of the drawings

[0024] The invention will be better understood and other particular features and advantages will become apparent on reading the following description appended with drawings. In the drawings similar or identical elements are labelled with the same reference signs. It shows:

Fig. 1 is a diagrammatic view of the standard usage of one embodiment of the present invention in the form of sticks for Nordic walking;

Fig. 2a is a diagrammatic view of the main components for a stand alone system;

Fig. 2b is a diagrammatic view of the main components for a system connected to a hand held device;

Fig. 3 shows a schematic system diagram of a simple configuration of one embodiment of the present invention;

Fig. 4 shows a system diagram of an enhanced configuration of the present invention with additional sensors added in the head of the stick;

Fig. 5 shows a schematic system diagram of a complete configuration of an embodiment of the present invention with a radio communication towards a hand held computing device;

Fig. 6 illustrates a possible implementation of the of an embodiment of the present invention in a pole;

Fig. 7 shows a schematic system diagram of a computing device also referred to as the "base station".

Detailed description of preferred embodiments

[0025] For the purposes of promoting an understand-

ing of the principles of the invention, reference will now be made to preferred embodiments illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles as described herein are contemplated as would normally occur to one skilled in the art.

[0026] Though the present invention is generally related to a piece of sports equipment, the following description will be directed to sport sticks for the sake of conciseness and for illustrative purposes.

[0027] The system may be described in the general context as an embedded monitoring system fitted in sport sticks, such as Nordic walking sticks, ski sticks or blade skiing sticks. Fig. 1 shows how sportsmen 1 use their sticks 2 in the normal way in the case of Nordic walking. Nordic Walking is rapidly growing as, when practiced correctly, it is demonstrated to work upper and lower body at the same time, strengthening back, legs and arms, and reducing neck and shoulder tension - all this while improving the health of heart and lungs. Nordic walking is practiced using "walking sticks" or "Nordic poles". It is however demonstrated that the benefits of Nordic walking can be obtained only if practiced correctly and especially if the poles are exercised correctly. Similar usages happen in other sports such as Nordic ski or blade ski. Here again, Nordic walking serves as an example and it is not intended to limit the invention to Nordic walking sticks.

[0028] Walking sticks according to the present invention do not change the way sportsmen use their sticks while practicing their favourite sport but enable to gather measurements while the sticks 2 are used. The invention enables a new equipment class called "smart stick" in the following description, where one or several microelectronics based sensor(s) are used to enhance in a new way the sporting experience. Preferably the sensors are pre-calibrated. The patent application describes also a way to move this information through a wireless or a fixed link to personal devices such as PDA, mobile phone or mobile entertainment device. Through the link, the sensor information can selectively be stored into these devices and later presented to the user.

[0029] Fig. 2a shows as an exemplary embodiment of a piece of sports equipment a Nordic walking stick 200. The stick 200 comprises a handgrip 201, a shaft 202 and a tip 203. During normal use as shown in Fig. 1 the user takes the walking stick at the handgrip 201 in his hand to push himself forward by engagement of the tip 203 with the ground. In the handgrip 201 a casing 204 incorporates at least one sensor, e.g. a sensor measuring acceleration in three spatial dimensions (3D acceleration sensor), a processor for read out and processing of sensor data, as well as a memory for storing the sensor data. The sensor, the processor and the memory are operatively connected with each other as it is known in the art. The casing 204 is mechanically stable to protect the electronic components in its interior against externally applied forces or shocks as well as against other detrimental environmental influences, e.g. humidity, dust and the like. The sensor data stored in the memory and during the use of the walking sticks are subsequently transferred by the link to a base station(not shown in Fig. 2a) for further analysis and display. The link is a wired or a wireless link. Finally, the stick is also provided with a loop 207 at the handgrip 201 for a hand of the user.

[0030] The electronic equipment including the link is briefly referred to as a sensor equipment 300(Fig. 3).

[0031] Fig. 2b shows a pair of walking sticks 200, each of which are provided with a sensor equipment 300 contained in the casing 204. In the embodiment shown in Fig. 2b both sensor equipments communicate wirelessly with the base station 205 that is provided with an antenna 206 for receiving the signals of the sensor equipment. The base station 205 serves to store, analyse and display the data captured with the sensor equipments. In specific embodiments of the invention the base station 205 is a computing device or a handheld electronic device.

[0032] Other configurations than those shown in Fig. 2b are also possible, such as: Only one stick is equipped with a wireless communication device to the base station 205 while the other stick is not equipped with a wireless communication device.

[0033] FIG 3 schematically illustrates a simple version of the sensor equipment 300 embedded in a smart stick 200: It typically includes a microprocessor 301 and an associated memory 302, a set of sensors, such as a micro electromechanical systems (MEMS) sensors 303, a feedback device 304 for communicating feedback to the user and some power supply 305. In a specific embodiment of the invention of a set of sensors includes only a single sensor. The microprocessor 301 and the memory 302 are shown in Fig. 3 as separate components. However, in other embodiments of the invention the microprocessor 301 and the memory 302 are integrated into a single integrated circuit. The sensors 303 capture raw data regarding the usage of the stick. This data can include all or part of: acceleration in three spatial dimensions, orientation of the device in the three dimensions, "vertical stress" and torque of the pole. Vertical stress and torque are generated by the user of the sticks by applying force via the handgrip 201 to the ground. The sensor data is processed by the processing unit 301 and resulting measurements are stored in memory 302. These measurements are compared with reference statistics and some feedback is communicated to the user through the feedback device 304. The feedback can be communicated with colour coded visual feedback, for instance provided by LEDs, some distinctive sounds or by a vibrating handgrip. For instance, if the measurements appear to be outside of the acceptable range, a red light could be displayed or a warning sound can be emitted. In some versions of the smart sticks, the feedback unit could also include a small display screen, for instance in

the form of a small water-resistant LCD screen, on which information such as estimate of energy consumed by the user, number of step per minute or amount of time elapsed since the beginning of the exercise.

[0034] Typically, the sensor equipment 300 is powered by a power supply 305 such as a small cylindrical 3V lithium battery, resulting into six months to a year of operation before battery depletion. Some implementation using advanced energy management techniques can result in much longer battery life. To conserve power, the device may be put to sleep and only wake up when the smart sticks are used. Alternatively, the sensor is powered from secondary batteries, which are backed up by external sources of energy such as light, temperature difference or movement using appropriate energy conversion devices. Photovoltaic cells are used to convert ambient light into electrical energy while Peltier elements are appropriate to convert temperature differences into electrical energy. In another embodiment of the invention the repetitive movement of the stick while in normal operation is used to induce a current within a specially designed piezoelectric or induction element. Such energy scavenging technique allows the device to operate for a long time without requirement for battery replacement or recharge with a conventional power supply.

[0035] According to one embodiment of the present invention, each sensor equipment 300 includes an operating system ("FreeRTOS" or "TinyOS") which are open-source operating systems designed for wireless embedded sensor networks. The operating system includes a scheduler, a database, a wireless radio stack, mesh networking software, power management, and encryption technology. The operating system component library includes network protocols, distributed services, sensor drivers, and data acquisition tools. The operating system is an event-driven execution model which enables fine-grained power management. It also allows the scheduling flexibility made necessary by the unpredictable nature of wireless communication and of physical world interfaces.

[0036] Fig. 4 depicts a further embodiment where additional sensors 401 are added in the tip 203 of the stick to perform additional measurements. The additional sensors 401 are e.g. movement sensors. The additional sensors 401 allow a more precise tracking of the actual movement of the walking stick during use. This may contribute to even more advantageous training results. The other components of the embodiment shown in Fig. 4 correspond to the components of the embodiment illustrated in Fig. 3. Double headed arrows 402, 403, and 404 indicate the allocation of the components shown in Fig. 4 in the walking stick. Arrow 402 indicates the area of the handgrip 201; arrow 403 indicates the area of the shaft 202; and arrow 404 indicates the area of the tip or head 203.

[0037] Fig. 5 adds to this configuration some radio technology 405 and antenna 406. This radio communication can serve in two ways. In one implementation it can be used to synchronise the measurements acquired by two sticks. This exchange of information between two sticks enables additional feedback for the user such as checking that the two sticks are used in correctly synchronised movements or that the energy is correctly balanced between the two arms. In another implementation, the measurements gathered by the sensor equipment 300 can also be transmitted through the wireless interface 405 to some nearby computing device 205 as shown in Fig. 2b. The two implementations can be combined and the same radio communication systems can be used to synchronise two poles and to transmit their data to a computing device.

[0038] A typical implementation of the walking stick 200 is displayed in greater detail in Fig. 6. The sensor equipment 300 is fitted in the handgrip 201 of the pole 200. The power supply 305 is located in the shaft 202 of the pole itself or again in the handgrip 201. If additional sensors 401 are present, they are fitted in the head 203 or in the bottom part of the pole 200. The feedback device 304 for information of the user 1 is typically located on the top of the handgrip 201 for easy visualisation by the user.

[0039] Fig. 7 shows a schematic block diagram of a computing device 205 (Fig. 2b). The computing device 205 itself could be any type of standard computing device, including mobile phone or smart phone, PDA (Personal Digital Assistant), entertainment mobile device such as an MP3 player, an electronic watch, etc. The computing device 205 typically receives the measurements transmitted by the smart sticks through antenna 206. Specifically, an associated wireless processor 701 stores the measurement data in a memory 702, manipulates and the data in a specific application 703 and offers various ways to display them on a display 704. Data processing ensured by the computing device 205 can range from simple synchronisation of some music stored a on the device with the rhythms of the user to sophisticated statistics regarding the exercises performed, the progress over time, etc.

[0040] The invention also suggests a method for operating a piece of sports equipment. The piece of sports equipment or the walking stick can be selectively switched between a recording mode and a training mode. In the recording mode the sensor equipment 300 captures sensor data and stores these data in the memory 302 as reference data. Normally, the recording mode is exercised by a trainer or an experienced practitioner of Nordic walking. When the recording mode is terminated the Nordic walking sticks are a switched into the training mode and are then ready for the use by a less experienced user. In the training mode again the sensor data are captured by the sensor equipment 300. However, in the training mode the sensor data are compared with the previously recorded reference data. In case the currently captured sensor data deviate beyond a predefined threshold from the reference data a warning signal for the user is emitted. The warning signal he is e.g. a visual

signal, an acoustic signal or a vibration signal. In one embodiment of the present invention of the visual signal is provided by one or several light emitting diodes turning on or off or changing colors. In another embodiment an LCD display is provided for this purpose. In other embodiments appropriate devices known in the art are provided to generate the acoustic signal or the vibration signal. This method provides the user with an immediate feedback whether his practice is in conformity with good practice. Advantageously the training is more effective and even more important the user is warned when his practice presents a risk to his health. The recording mode can be repeated by trainer as the level of practice of the user develops.

[0041] The sensor data captured during the training mode may also be transferred to the computing device 205 for further analysis and display eventually together with the trainer. In principle it is also possible to transfer basic reference data to the piece of sports equipment when no trainer is available to execute the recording mode.

[0042] The invention provides better in situ information for using sticks or poles in sport activities. In addition of the having sensor technology the invention also exhibits the following features:

(i) using a local wireless communications capability to transfer data from the sensors so that need for invasive cabling is suppressed;
(ii) Using wireless communications capability directly from the sensors, or through a control unit that is integrated into the pole, towards smart devices such as a PDA or smart phones but not limited to them. This wireless technology provides the possibility to flexibly move information to more powerful computing devices with a higher memory capacity.

[0043] As a straightforward but non-trivial addition, it is pointed out that specific embodiments of a smart stick include USB-port and Flash Memory with uPnP (universal Plug and Play) description of its capabilities. This provides a very efficient and standardized way to connect and exchange information between the smart stick and standard computer platforms or computer equipments.

[0044] The above the specification, examples and drawings provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims herein after appended.

Claims

1. A piece of sports equipment (200) comprising

- a sensor (303) that is configured to produce sensor data;
- a processor (301) being coupled to the sensor (303) for receiving the sensor data;
- a memory (302) being coupled to the processor (301) for storing the sensor data; and
- an output device (304) for selectively signaling the sensor data.

2. The piece of sports equipment according to claim 1 comprising a plurality of sensors (303, 401).

3. The piece of sports equipment according to claim 1 or 2, wherein the sensor (303) is capable to measure acceleration, speed or angles in one or several spatial dimensions, position, altitude, humidity and/or temperature.

4. The piece of sports equipment according to claim 1 or 2, wherein the memory (302) contains reference data corresponding to some or all sensor data, and wherein the processor (301) is arranged to produce an output device signal as a function of the comparison result of the sensor data with the corresponding reference data.

5. The piece of sports equipment according to claim 4 wherein the output device signals a deviation of the sensor data from the reference data exceeding a predefined threshold.

6. The piece of sports equipment according to claim 1 wherein the output device (304, 704) is designed to generate visual, acoustic and/or vibrational signals.

7. The piece of sports equipment according to one or several of the preceding claims comprising a wireless link to connect the piece of sports equipment to a base station (205).

8. The piece of sports equipment according to claim 7, wherein the wireless link comprises a transceiver (405) and an antenna (406).

9. The piece of sports equipment according to one or several of the preceding claims comprising a power source for supplying electrical energy to the sensor, the processor the output device and/or the memory.

10. The piece of sports equipment according to claim 9 wherein the power source comprises photovoltaic cells, Peltier elements or a electro-mechanical apparatus to generate electrical energy.

11. The piece of sports equipment to one or several of the preceding claims, wherein the piece of sports equipment is a Nordic walking stick, a Nordic skiing stick or a blade skiing stick.

12. System for communicating with a piece of sports

equipment according to one or several of the preceding claims comprising a base station (205) provided with a processor(301), a display device(304, 704), a transceiver (405) and an antenna (206, 406) for establishing a wireless connection between the base station and the piece of sports equipment.

13. Method for operating a piece of sports equipment comprising the following steps:

- selecting alternatively between a recording mode and a training mode of the piece of sports equipment; and when the recording mode has been selected
- acquiring sensor data from a sensor, and
- storing the sensor data as reference data in a memory;

whereas when the training mode has been selected

- acquiring sensor data from a sensor, and
- comparing the sensor data with prerecorded reference data.

14. Method according to claim 13 further comprising the step of outputting a warning signal when the piece of sports equipment is in the training mode and the sensor data deviate beyond a predetermined threshold from the prerecorded reference data.

15. Method according to claim 13 further comprising the step of transferring stored data from the piece of sports equipment to a base station.

16. Method according to claim 13 further comprising the step of transferring reference data from a base station to the piece of sports equipment.

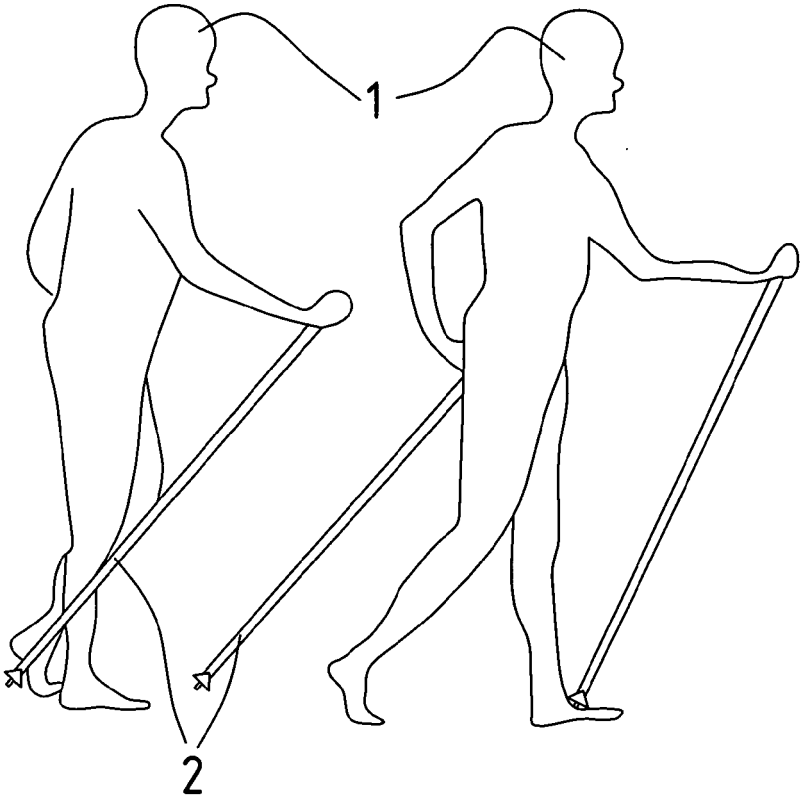

Fig.1

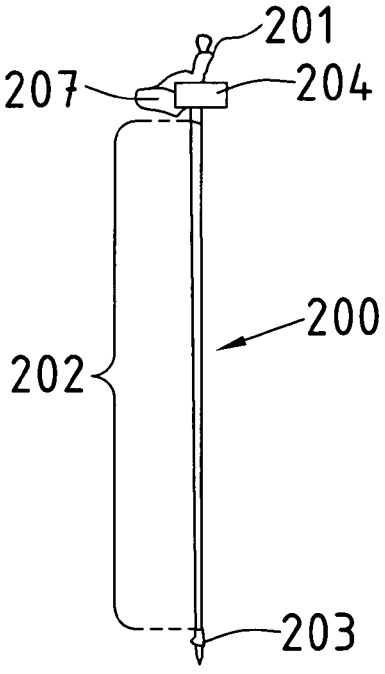

Fig.2a

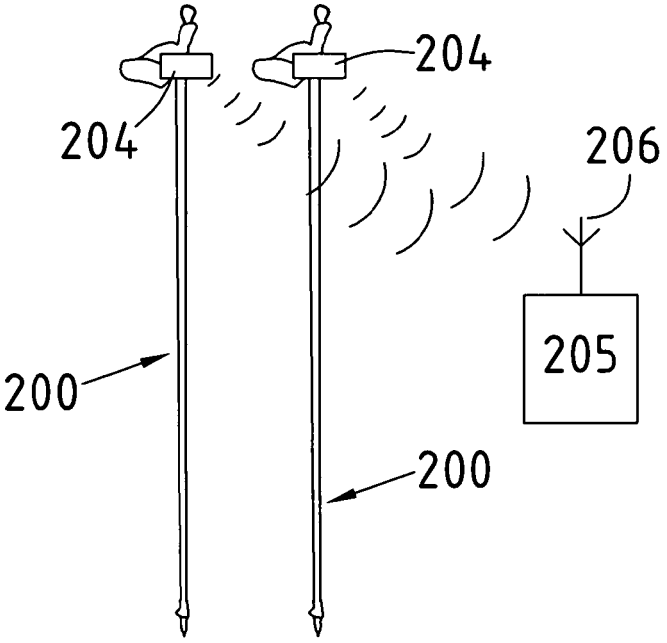

Fig.2b

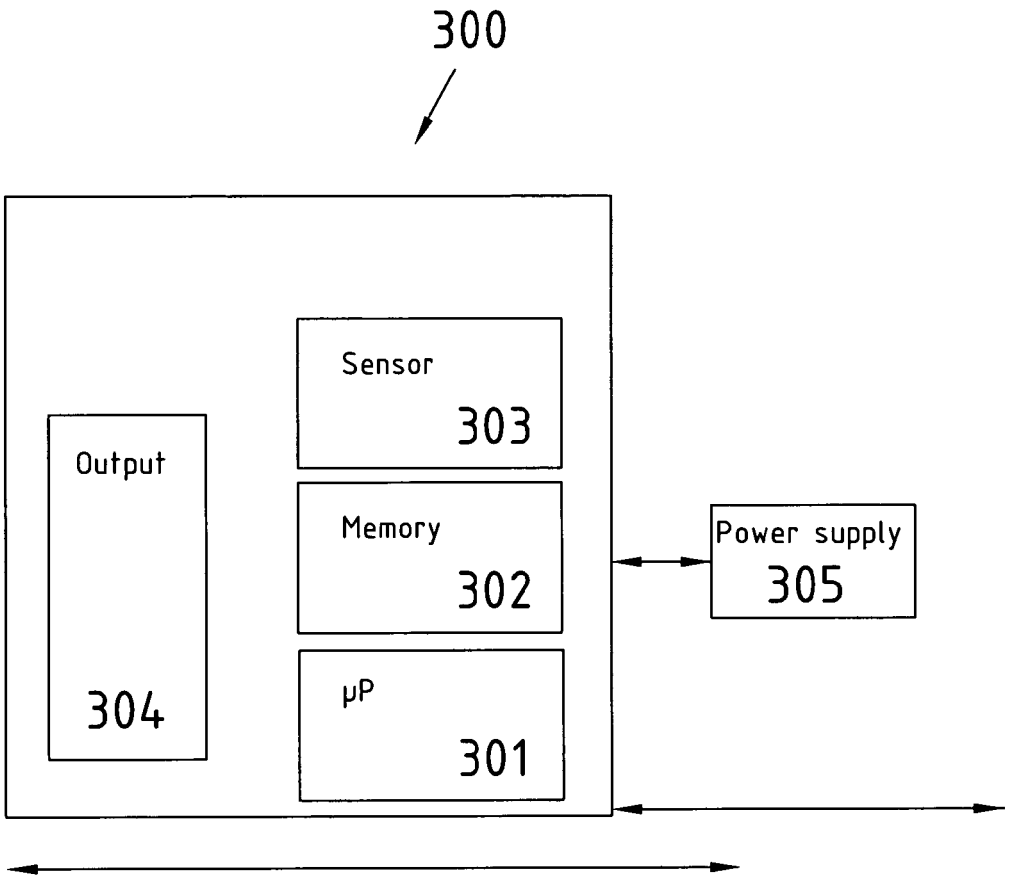

Fig.3

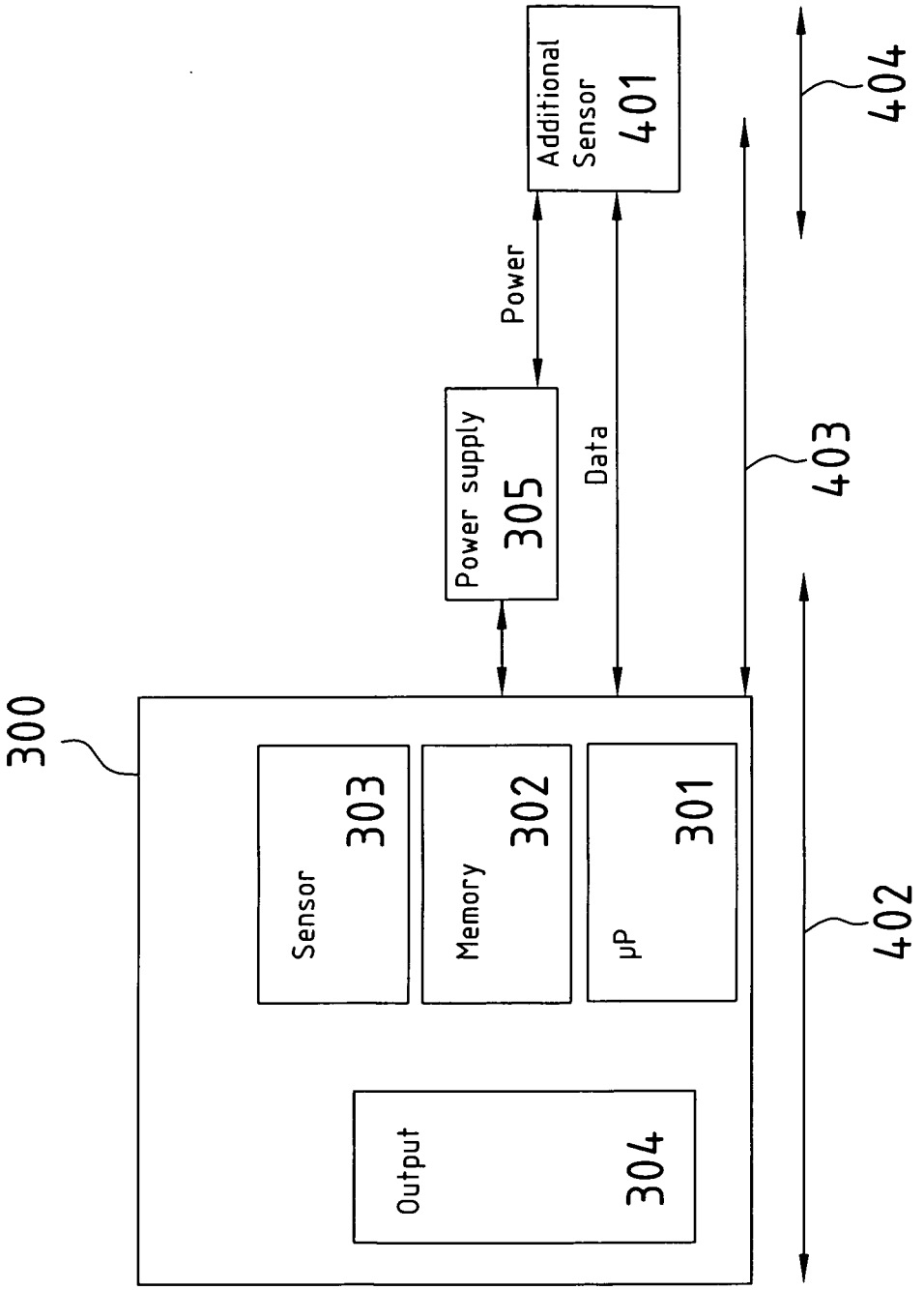
300
Sensor
303
Memory
302
µP
301
Output
304
Power supply
305
Power
Data
Additional Sensor
401
402
403
404

Fig.4

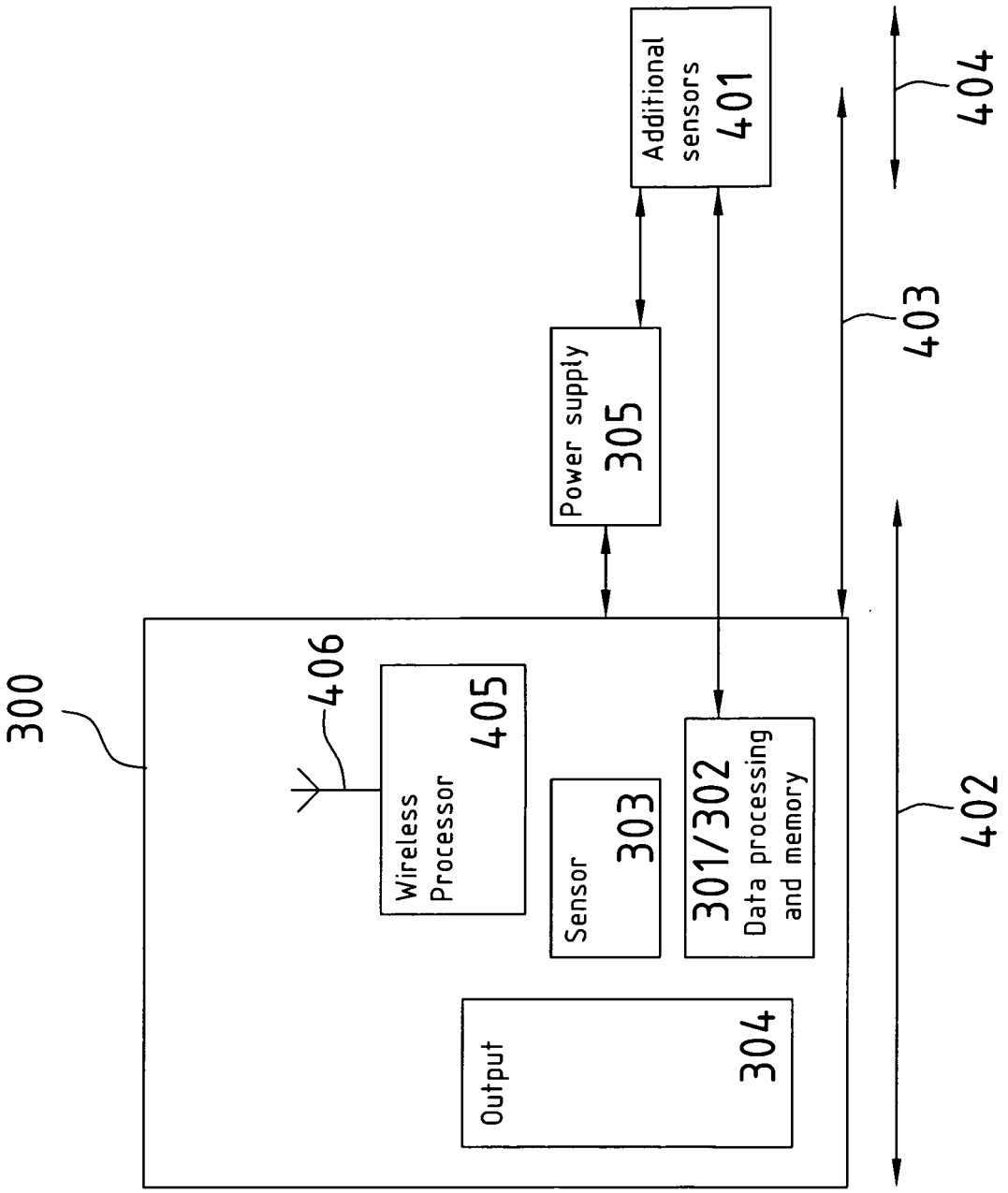
300
406
Wireless Processor
405
Sensor
303
301/302
Data processing and memory
Output
304
Power supply
305
Additional sensors
401
402
403
404

Fig.5

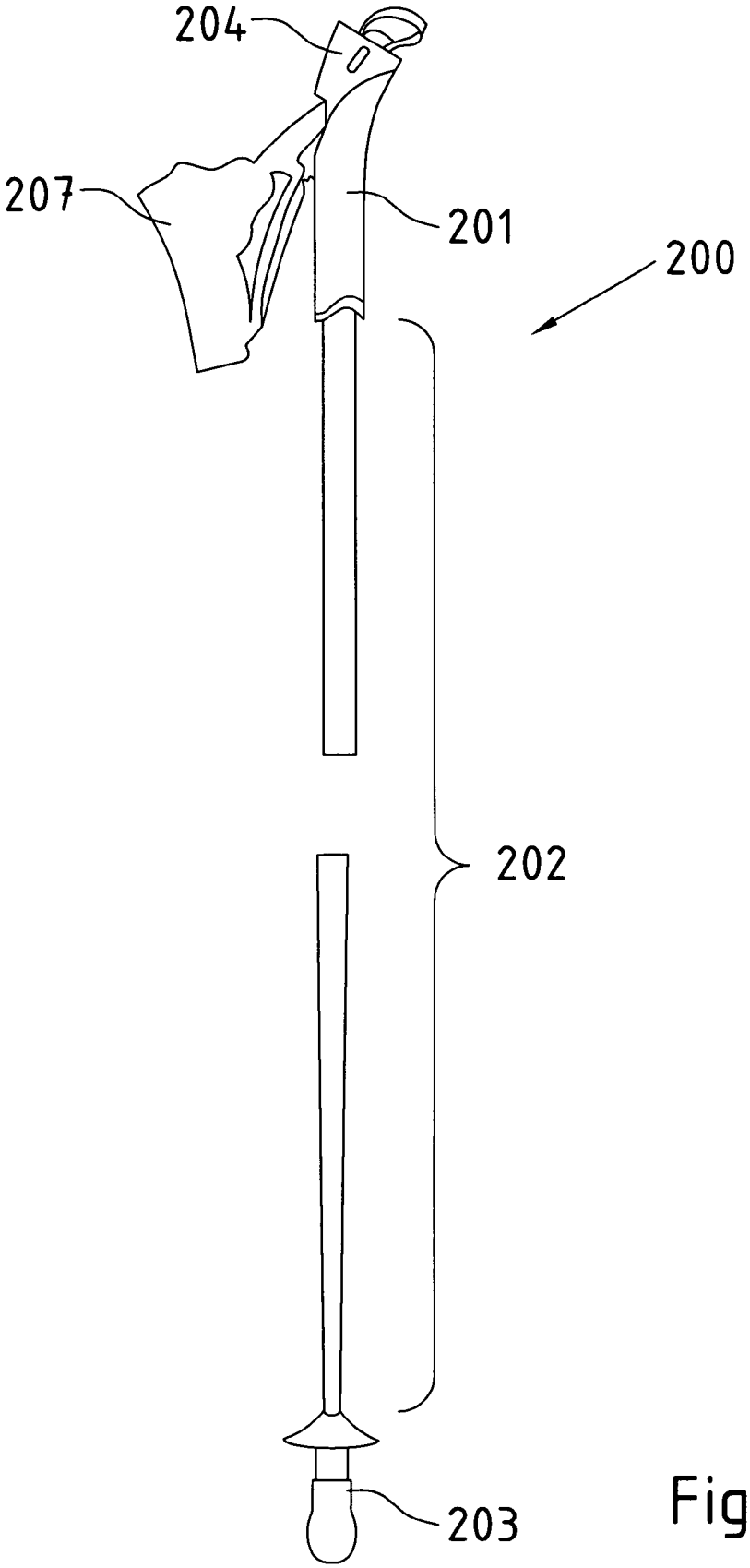

Fig.6

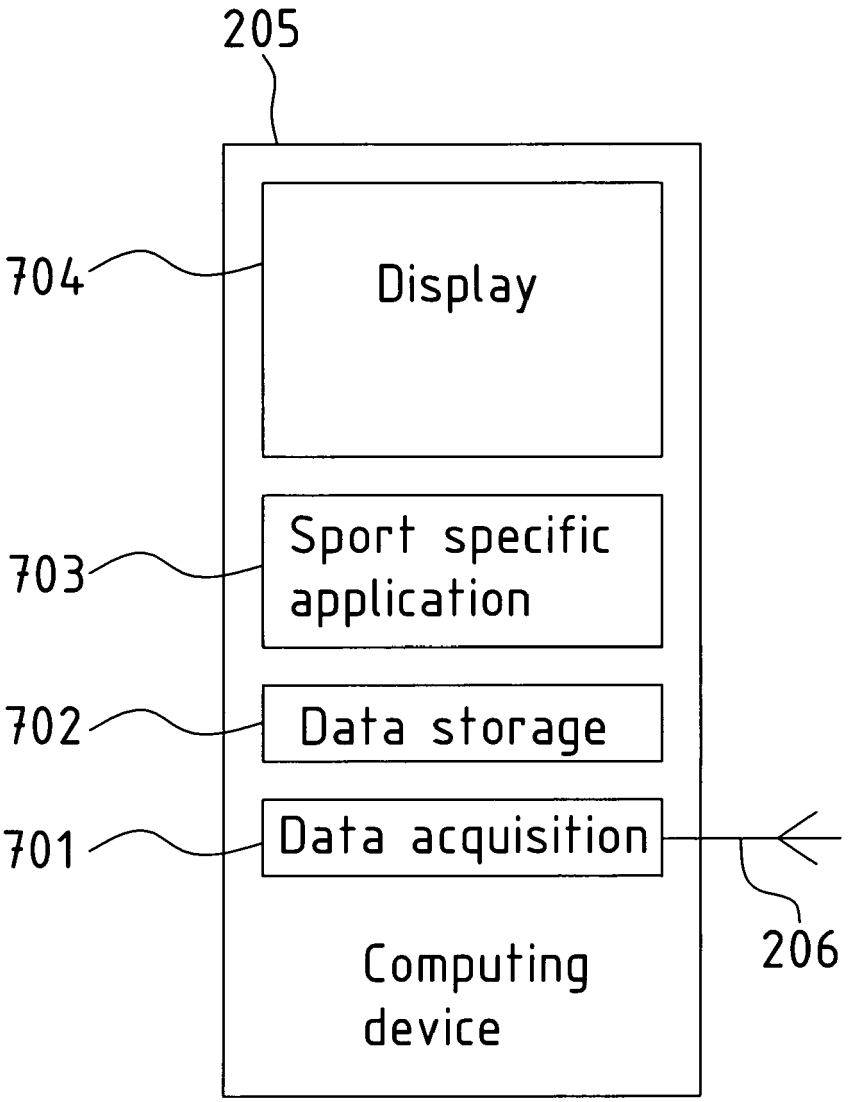
205
704
Display
703
Sport specific application
702
Data storage
701
Data acquisition
206
Computing device

Fig.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 02 0896

DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 February 2007	Tejada Biarge, Diego

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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13-02-2007

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